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The Species Recovery Programme

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The Species Recovery Programme 10th Anniversary Conference Proceedings

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Preface

These are the official proceedings of English Nature's Species Recovery Programme 10th anniversary conference, held at the Hayes Conference Centre at Swanwick in Derbyshire, between Wednesday 5 and Friday 7 December 2001.

Introduction

In December 2001 over 200 of the UK's leading conservationists gathered in Derbyshire, England for a conference to celebrate the tenth anniversary of English Nature's Species Recovery Programme. The conference delegates represented over 100 organisations, all of which had played their part in taking forward this ambitious programme to conserve some of the most endangered plants and animals in the country.

The conference was a celebration of partnership, as well as longevity. The programme reflected on the successes of the past ten years, critical lessons for species conservation, and perhaps most importantly, some of the challenges that species' recovery work will have to meet over the next decade.

The challenges that emerged over the three days focused on the issues of agricultural practice; ecosystem solutions to species management; the importance engaging communities and businesses, developing international collaboration; and the need to address exploitation of our seas. As I write this, nearly one year on from the actual conference, I am acutely aware that the conference touched on many issues raised by the England Biodiversity Strategy and even at the 2002 world summit in Johannesburg. The recovery of species is not an easy process, and it is often asked what the real value is in years of work to save an obscure invertebrate or lichen. It can be argued that the saving an organism is a laudable act in its own right, and I have a great deal of sympathy with that view. The added value lies in the important focus for learning provided by scarce species. The extremes of their predicament and the solutions there-in often bring to light approaches that have a wider utility in delivering gains for biodiversity and a sustainable environment.

The contents of this volume are selected transcripts of the papers as they were presented on the day, though some have been redrafted for publication. As these proceedings show, a lot was achieved in the first ten years of the Species Recovery Programme. This was in no small part due to the concentrated efforts of all the partners. It was also obvious that there still remains a lot to do before we can sit back safe in the knowledge that all our biodiversity has a sustainable future ahead of it.

Dave Stone, English Nature Species Recovery Programme Manager, October 2002

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Finally my thanks to all the organisations, who have contributed to the Species Recovery Programme over the years.

Dave Stone
English Nature Species Recovery Programme Manager, October 2002

Dr Tony Whitten, World Bank

Origins of the Species Recovery Programme

Twelve or thirteen years ago, when the *Recovery* report was started, no one even entertained the possibility that there would be a day like today. We were, in fact, feeling that there was a certain amount of opposition to the species-focused approach, and because there was limited money available we did not think that it would take off in a wholesale manner. If you look at Derek Langslow's foreword to the *Recovery* report, he wrote that he would be really happy if one or more of these plans were actually acted upon. It was a very conservative hope which clearly we, or rather you, have gone way beyond.

Let me first explain a little about how someone who wrote the *Recovery* report finds something to do at the World Bank. The World Bank is in fact the largest financier of biodiversity conservation worldwide. The size of the biodiversity portfolio is approaching $3 billion - that is about $1 billion in loans and credits, $500 million from the Global Environment Facility, and the remainder from governments themselves or from other donors, foundations, private sector and so on. The institution is committed to alleviating poverty with lasting results. The "lasting results" can be thought of as a sub-agenda on sustainable development, and the job of the 15 or so professional biologists within the Bank is; (a) to work with other Bank staff who are designing the bridge projects or the road projects or the structural adjustment projects and to try and 'green' those to the maximum extent possible; (b) to ensure that no significant biological damage is done by Bank projects; and (c) to work with our clients to conceive, design and manage stand-alone conservation projects. We are also the biodiversity advocates within the Bank and we devise tools by which we can demonstrate that biodiversity has value and is useful. We have also produced a 'toolkit' to improve the way in which biodiversity is dealt with in environmental assessments, something which is now becoming increasingly widely used, and is now in Chinese and Vietnamese. There is a whole range of other publications written by us or by others, which you can find on the World Bank Biodiversity website www.worldbank.org/biodiversity - and that is the end of the advertisement!

Much of the area in which in I work – stretching from Mongolia through China, Indo-China, Indonesia and Papua New Guinea - is decidedly depressing when it comes to conservation and biodiversity. There is so much being lost. I am a biologist: my early interest was in birds, especially ducks, but my doctorate was in gibbons. I worked on Indonesian freshwater fish, and I now have a great passion for land snails. During an eighteen-month period of working at the World Bank and squeezing time out of my mission agenda, now and again I was able to collect land snails and found 100 new species in Laos, Vietnam and Indonesia. It pains me that there is so much that we do not know about and it is being lost so very quickly through greed or inattention or failed policies and policies. 'Crisis' is not too strong a word to use in the global context. Only the most remote areas are unscathed. To be in a setting in which you are able to consider species recovery plans is a real privilege. Such plans might in time, in some cases, in some countries, be done with effect, but in general the situation is years behind. I believe that we should be celebrating the fact that you are

actually allowed to do species recovery work, and that you generally have the support from the different stakeholders to allow you to do it.

The 'crisis' I referred to is illustrated by the situation in Sumatra. When I was first doing fieldwork there, in the early to mid-seventies, we used to fly from Jakarta to West Sumatra and we had forest below us most of the way. Now much of it has been lost and is fragmented as a result of agricultural developments, major forest fires, and illegal logging. Most of the forest that has been lost – the lowland rainforest – is both the most valuable for logging and also the best for biodiversity. The trend line indicates that all the lowland rainforest will be lost in the next three years. So if you want to go and see any I'd go now. In a very few years from now all that will be left will be a few pockets of wetland forest and montane forest.

There is, of course, a lot of conservation activity, and donor-led conservation slides from fashionable solution to fashionable solution. Some wild assumptions have been made. An early assumption was that you just had to get your protected area system in place, but it soon became obvious that if the policies were not in place then you could have something on paper but you would not necessarily have anything on the ground. The second of these major assumptions was that 'sustainable use' was the answer; it's a lovely idea and I wish it were true. Unfortunately, in most cases 'sustainable use' actually means 'less use' and as soon as you let that secret out of the bag you get rather less support. There are places where sustainable use is going to work but it certainly is not a panacea. A third assumption is some sort of an economic incentive. Typically this will be an alternative livelihood strategy for people who are, for example, hunting the snow leopard or bombing the reefs. One soon discovers that human beings do not actually set an upper limit to their income. They may set some sort of lower limit but they certainly do not set an upper limit. Thus, an 'alternative livelihood strategy' becomes an 'additional livelihood strategy' that the grandmother can adopt. A fourth assumption is that we should devolve to the lowest level; a problem with this is that you just get local 'fat cats' rather than central 'fat cats'. Again, it can work in some areas but it does not necessarily give one the conservation sought for. A fifth assumption is that there are technical solutions such as eco-tourism, which will deliver conservation. Ecotourism is mentioned as part of the management for many reserves, but they are important for only a small number, likewise technical solutions such as butterfly farming. The last assumption is that local people are co-operative, and live in harmony with one another and with nature. For obvious reasons there is nothing that needs to be added to that!

The US Government, through its Agency for International Development, has funded the Biodiversity Support Program for the last seven years (from1994); it has another few weeks to run. The Program has identified five critical conditions for conservation success. It is quite interesting to look at these in the context of the Species Recovery Programme. The first one is 'Clarity of Conservation Objectives and goals'; it is clear that this is certainly in place. The second is that there are 'Equitable and Effective Social Processes and Partnerships for Conservation'; certainly the partnership angle has been remarkable within Species Recovery Programme, many types of people are involved, and the fact that the press is interested in this I think indicates that this has been fulfilled.

"Incentives for Biodiversity Valuation' is the next condition; people tie themselves in knots over trying to show economic value of biodiversity. There are places where it works but in British culture conservation is widely regarded as "a good thing" to do. It is a privilege to work in that situation. You do not find yourselves trying to devise some economic value for your rare species. It is just 'right' to have them conserved. There are places where we are working with major faiths on the moral right in conservation. I am working with the Chief Lama in Mongolia, with Muslim clerics and Protestant pastors in Indonesia, with Catholic priests in East Timor, and trying to get that moral value for conservation promoted more by them rather than for us. The fourth condition is that 'Policies Need to be in Place' and clearly that is the case for Species Recovery Programme. The last condition is that there has to be 'Sufficient Awareness, Knowledge and Capacity. That is, awareness from the general public, knowledge about the species or the ecosystem that you are trying to conserve, and there has to be enough capacity among the individuals who are going to do the conservation itself. All those conditions have to be in place if you are going to have success. It seems to apply well to the Species Recovery Programme.

Much more could be done in the area of awareness building. This is more than just producing a poster or a slideshow and should instead demonstrate in some more practical and inspiring way what biodiversity is about; that it is a pleasurable thing. Surprisingly, awareness building gets precious little support. It is almost always mentioned as a priority in the conservation meetings I go to, but it gets very little money. Part of the reason is that donors want to know what the 'return' is on any dollar they might give you. Unfortunately, it is very hard to show a direct relationship between awareness activities and conservation outcome. If anyone knows of good examples where they can absolutely show that an awareness programme clearly resulted in conservation I would very much like to hear from you. We have recently been able to support two programmes producing local language field guides. Most of the countries I deal with have almost no field guides at all. We can complain about people not knowing and not caring for their biodiversity, but how could they possibly know what they've got if they have nothing in their own language to turn to. English-language field guides might already exist but they would probably cost a month's salary to buy. We are trying to break into that, either by translating books or by doing books with original text. Many of the young people who are now working in conservation have identified field guides as the major reason that got them interested in biodiversity and its conservation.

1988 was when I started work on the Recovery Report. This was the year of *"Candle in the Wind"* sung by Elton John, Louis Armstrong re-released "What a Wonderful World", it saw the first Red Nose Day, Prozac was launched, Salman Rushdie and the Ayatollah Khomeini were having arguments, there was the Lockerbie disaster, fax machines were pretty cool, and Mutant Ninja Turtles were everywhere.

The story of the *Recovery* report actually begins in 1986 when the first quinquennial review of Schedules 5 and 8 of the Wildlife and Countryside Act was conducted. RSNC and some of the trusts that were part of the consultations on this review were asking what the point was of doing this review species by species, when there was no coherent strategy. That started the move towards doing a recovery programme or at least looking at what would be necessary to put a Species Recovery Programme into place.

I drafted the species recovery sheets and sent them out to some 230 people, a good number of whom are in the audience today. If I have not thanked you before, I thank you now for the work you did on those. We had an NCC Protected Species Network meeting to see how we were doing a year after starting. Then in October 1990 the *Recovery* report was published. It was launched in November 1990, but the break up of the NCC, the risk of losing jobs, etc were occupying most people's minds, and the 'launch' did not exactly translate into 'take off'. However, thanks to Derek Langslow's personal interest, the Species Recovery Programme was successfully transferred to English Nature and in the first year of English Nature £130,000 was allocated for recovery work on 13 species.

The objective that we set for the recovery plan was that "each of the scheduled species would become a secure, sustaining member of its ecosystem and thus be considered for removal from those schedules". We were dealing with the whole slew of species from whales through to dormice, and recovery was clearly more feasible for some species than it was for others. So, for each of the species we had a realistic recovery goal, a prescription, requirements for site management and various other items. We also devised an index of threat, which was based on Frank Perring and Lynne Farrell's index in the *Red Data Book of Plants,* and we assessed recovery potential, a concept, which we borrowed and adapted from work under the U.S. Endangered Species Act. I calculated a budget, which I thought was realistic - time has proved me wrong!

The strategy was thus to give direction to many of the conservation efforts at the time. The Wildlife and Countryside Act allowed for protection of the species on Schedules 5 and 8, but it did not anywhere say why you were supposed to protect it, or how long you were supposed to protect it. We were trying to move away from the defensive approach, from trying to keep it where it was to actually improving the lot of those species.

The index of recovery potential looked at biological and ecological limiting factors, the threats and the management needed. I did this to aid the inevitable prioritisation of the species that would be part of the hoped-for Species Recovery Programme. We recognised that even in a favourable budgetary environment, not all species would suddenly be allocated funds, and so one would have to pick among them on some basis. Ideally what one really wanted was something with a very high threat that it would cost almost nothing to conserve and had a very high recovery potential. We did not have any of those and so amongst the 34 annexes in the *Recovery* report there were a series of three-dimensional graphs to help people make decisions.

Since the time that we were doing the *Recovery* report, other things were happening in species recovery. In the US many regional recovery plans were being written for specific localities. Australia was starting recovery planning. In Indonesia, BirdLife International did recovery plans for three species, although those have really gone nowhere because those conditions for conservation success just have not been met. Spain did some recovery planning for the Canary Islands, and in the EU, there have been these action plans, for example, the brown bear. A major shift has occurred though, in that the Convention on Biological Diversity has shifted attention away

from species and towards ecosystems. This is reflected in what the Global Environment Facility will fund and this has affected other donors too.

There are so many conservation problems, but also there has never been so much money for conservation. Unfortunately, the more activity there is, the more chance there is for displacement behaviours to occur. Displacement behaviours are seen when a cat chases after a bird; the bird flies off, and the cat sits down and licks itself, making it look as though that cleaning itself was what it really wanted to do anyway. Or monkeys that want to challenge the alpha male will sidle up to him, but then scratch their backsides instead as though scratching their backsides is a really serious activity, and that's really what they wanted to do. In conservation there is a lot of bum scratching as well, particularly in the area of priority setting and re-setting prioritised areas or reprioritising other settings. It is really rather atrocious when you see some of the dollars that are lost in this displacement behaviour and there are things we would dearly love to do with some of that money that is just being wasted. One should ask whether the Species Recovery Programme might in fact be displacement behaviour. I think it is important to recognise the risk that the individual species plans can become displacement behaviours when you can be too focussed in one or a few small areas with one snail or one spider and thereby miss the big picture. But as long as you acknowledge the context of the action plan work and ensure that it becomes or remains a means to broader conservation, and not the end for conservation, I think that species recovery is free of being labelled as bum scratching.

Chris Baines

The Nature of the Future

We started seriously monitoring Britain's loss of wildlife in the UK in the year that I was born, and in my lifetime rarities have disappeared and familiar species of my childhood have become depressingly uncommon. Development pressure, agrochemicals, farm mechanisation and over-grazing are just a few of the factors that have worked in concert to destroy our natural heritage, but I believe that fragmentation of the landscape, and the focus on individual species and 'special' sites has compounded the problem enormously.

Preservationist policies for nature conservation, combined with our failure to make wildlife truly relevant to post-war generations, have seen the UK's wildlife suffer very badly. The good news is that we *can* bring the UK's missing wildlife back. If we work more creatively with nature we can realise all kinds of benefits for people, and rebuilding biodiversity will be a glorious bonus. A more "joined up" ecological approach to managing both land and water can help to reduce flooding, clean the air we breath, enable farmers to produce more wholesome food, reclaim our derelict land, protect our coasts and purify our drinking water. It makes good economic sense to use our natural life support systems as wisely as we can, and if we do, then there is bound to be much more wildlife for people to enjoy.

There is plenty of proof that recreated wildlife habitats really work. Indeed, this country's conservation charities and government agencies have a world-class wealth of expertise between them. Rarities such as the bittern and the otter are now enjoying brand new reed beds up and down the country. The London Wetland Centre, by the Thames at Barnes, is just the latest in a 50-year success story, which famously began with the RSPB's reserve at Minsmere, on the Suffolk coast. Avocets began to colonise this artificial wetland habitat back in the 1950s, and conservationists have been increasing their detailed knowledge of the way to manage wildlife ever since

Wetland may be relatively easy to create, but there are equally impressive success stories in a whole variety of different kinds of habitat. For example, a £10 million lottery-funded programme is bringing wildlife back to thousands of hectares of badly damaged heather moorland across the UK, whilst on low-lying coasts and around several tidal estuaries artificial sea defences are being dismantled, arable farmland is being flooded and returned to nature, and wild geese have begun to graze again on restored saltmarsh habitat.

In many places conifer crops are being cleared for wildlife habitat recovery, with spectacular examples in the Caledonian pine forests of the Scottish highlands, and the blanket bogs of the Flow Country. In addition, the Woodland Trust, the Forestry Commission and others have shown that many of the post-war plantations were superimposed on sites of ancient broadleaved woodlands. Time and again, as conifers are now removed, the rain and sunlight rekindles the suppressed woodland habitat and we are seeing the return of wildflowers, fungi, insect life and all the rich diversity of wildlife that we thought was lost forever. Bluebells and primroses, songbirds and beetles are bouncing back from decades of gloomy suffocation.

There is great success in urban landscapes, too. Urban forestry is increasing woodland cover in dozens of towns and cities, and it should be no surprise that woodland species such as sparrowhawks, song thrushes and speckled wood butterflies are thriving once again in the woodland glades that we call gardens. The current BUGS (Biodiversity in Urban Gardens in Sheffield) survey by the local Wildlife Trust and the university has revealed 25,000 garden ponds, each contributing to what must be a world-class mosaic of unpolluted wetland habitat in that one city alone. It's worth remembering that there are 15 million domestic gardens in the UK, and beyond the garden fence there are city-dwelling skylarks singing over reclaimed colliery waste tips from St. Helens to south Wales, and other farmland birds such as the bullfinch and the goldfinch are beginning to increase in numbers, thanks to conservation management of urban green space.

These are just a few examples of the way that wildlife will return if we can take a bold approach to habitat renewal. All kinds of native plants and animals are beginning to recover in response to skilful and creative conservation. Nevertheless, each restored site is little more than an exception to the general rule, and hostile landscape management still prevails, from overgrazing in the hills and sterile mower-habitat in city parks, to concrete coastal defence and agro-chemical farming in the lowlands. Simply creating bigger nature reserves will never be enough to rebuild the UK's biodiversity. It's time to change the nature of whole landscapes and make wildlife central to the way we manage all our land.

The breakthrough will come once policy-makers are convinced that wildlife can be made to work for people. We need to put the natural life support system at the heart of the economy, and there is no shortage of political and economic issues to choose from: flood management and water quality; coastal defence; carbon balance and climate change; economic recovery from foot-and-mouth disease; reliable food production and healthy urban living. Applying joined-up thinking and conservation management expertise to each of these issues in turn, we should be able to establish large-scale demonstration landscapes, which take UK nature conservation way beyond the scale of isolated wildlife sanctuaries.

Working on water

Sustainable water management is a particularly useful place to start. In fact, the water industry already relies on nature to a very large extent. A sewage treatment works is little more than a condensed river eco-system, with a range of unglamorous organisms such as green slime, snails and maggots employed to consume our waste. Kill the wildlife, and the sewage treatment system simply fails to function. Nurture nature and it works extremely well on our behalf. *The Water Framework Directive* is a new piece of European legislation, which demands a 'whole river catchment' approach to managing both the quantity and the quality of water. The UK government is now bound by international law to start adopting this sustainable approach to water resource management, and this is a perfect opportunity to demonstrate just how a strategy for bringing back the wildlife can make economic and environmental sense.

At present, a rainstorm in the rural uplands tends to pour off over-grazed moorland, gush out of agricultural land drains and gather pollutants along the way, thus threatening downstream settlements with flooding and with costly clean up of the

drinking water. A more sustainable approach to water management would hold the rainstorm run-off longer in the countryside and minimise pollution in the gathering grounds. We should reduce over-grazing in the hills, encourage more wide-spread deciduous woodland cover on the lower slopes and in the valleys, block drains, farm with far fewer added chemicals and use some of the lowland agricultural land to create more extensive wetlands. These changes in the way we manage land will help to moderate the rise and fall of streams and rivers, absorb pollution, reduce the risk of flooding, increase the reliability of the drinking water supply, and still allow us to produce high value, wholesome home-grown food. Moorland, woodland, reed bed, bog and water meadow habitats all help in managing both quantity and quality of water, and of course they all support a rich diversity of wildlife, too.

Who will pay for this far more enlightened way of managing the land? We will of course, but then we already pick up the bill for unsustainable land and water management, and the current costs are massive. The floods of the year 2000 lead to insurance claims for £3 billion - equivalent to the UK's annual Common Agricultural Policy grant from Europe. Billions more are currently being spent on concrete *end of pipe* approaches to most of our flood defence, whilst millions are also spent each year removing harmful chemicals from the drinking water, most of which we paid to introduce in agricultural landscapes in the gathering grounds. If we begin to tackle water problems at the source, instead of merely mopping up the damage, then supply will be much more dependable, floods will be reduced and many wildlife species that depend on woodland, heath and wetland will begin to thrive once more.

Turning the tide more naturally

The economic case for using nature to defend the coast is just as strong. The sea level is rising thanks to global climate change, and this is a particular problem where the land is also sinking. Past policies have relied on holding back the sea with earth embankments, concrete walls and other engineering structures, despite the fact that even King Canute knew that idea was quite wrong-headed. Now, in low-lying coastal landscapes, artificial flood defences are at last being removed. Planned coastal retreat is helping to restore extensive wildlife habitat along the Essex coast, beside the Humber estuary and elsewhere. Instead of defending intensively farmed agricultural land, the Environment Agency, conservation charities and others are successfully demonstrating that Saltmarsh and sand dune habitat can cope quite naturally with the sea, and some of our most globally significant British wildlife is reaping the benefits.

Farming for the future

Foot-and-mouth disease has finally revealed the truth. Rural jobs depend on tourism and leisure more than food production. Landscapes from Northumberland to north Devon, and from the Solway to the South Downs have temporarily lost their livestock, and there is an opportunity to rebuild farming practice in ways, which will deliver a wider, more sustainable and relevant range of rewards. Areas such as the southern Lake District, the Yorkshire Dales and the Brecon Beacons have the chance to bring back wildlife with a vengeance, and to do this as a major aid to rural economic recovery. By farming less intensively, minimising chemical pollution, marketing the food more locally, and adding value with distinctive local produce, food production can go hand-in-hand once more with care for the environment. This

will in turn increase the natural enjoyment of the countryside for local people and for those who visit. The wild fish in streams and rivers, songbirds in fields and hedgerows, and wildflowers in woodland all have real economic value in a country where most people live a relatively stressful life in towns, and tourism plays a central role in the economy.

Penetrating other policies

If this bold vision of a land revitalised seems rather fanciful we can take heart from the response of those who hold the power to make the change. We are already signed up as a nation to the Biodiversity Action Plan and this translates quite naturally into wide scale wildlife habitat restoration. What is appealing to government ministers, conservation leaders, government agencies and industrialists alike is the way that wildlife can be restored by joining up a range of economically worthwhile policy changes. It makes perfect sense to move the flood control expenditure upstream and use it to prevent the risk at source. The nation is crying out for more honest accounting of the cost of food production, and it is quite clear that many billions of pounds could be more wisely spent each year on caring for a countryside that's fit to eat and drink. The forestry industry has already recognised that whilst we can always import the timber that we need, we cannot import any of the other benefits that come from forestry. Rebuilding biodiversity is just one more justification for a national policy of multi-purpose forestry that is now widely embraced at national level, and being delivered on the ground.

Even in urban Britain there is recognition that the quality of life is closely linked to the environment. People prefer to live and work in green, leafy surrounding. The public health agenda is increasingly acknowledging the need for better preventative measures to reduce the costs of cure. Access to nature is known to relieve stress and encourage exercise, whilst urban forests are being shown to purify the air we breathe. Since heart and lung and stress related illness cost the nation billions every year, again the use of nature on the doorstep makes good economic sense. That link is well-established elsewhere in the world, and health care policymakers in the UK are at last beginning to acknowledge the beneficial connection.

This (joined-up, whole landscape) strategy for species recovery offers everyone the chance to contribute by playing to their strengths. As the success begins to build, the whole will be enormously greater than the sum of the parts, and this is such a contrast from the old *exclusive* model, which produced a dwindling resource of isolated fragments and a constant moan about the loss of wildlife. This is an optimistic alternative vision of a landscape where the wildlife will return because it is needed. Highlighting the relevance of nature to our modern way of living has to be the key to success for conservation in the UK of the new millennium, and there is every sign that this makes sense to many of the individuals who can make a major difference.

Wildlife needs proactive allies in every walk of life, from the ministry of defence to the minerals industry, from furniture makers to food retailers, from park keepers to politicians, from health professionals to holidaymakers. Wherever you care to look there are opportunities to work creatively with nature for the benefit of people, from an extra nest box in an individual's back garden to a company policy that impacts nationwide. What really matters is the shared ambitious vision. Ours is the nation

that gave the world the industrial revolution, and embraced intensive agriculture despite the hidden costs. Now we have a new opportunity to use resources much more wisely, work with nature, use the knowledge that the conservation movement has acquired in 50 post war years of habitat creation, and bring the nation's wildlife back for good. If we can put the pieces of the jigsaw back together, strengthen the ecological links and make our natural heritage relevant once more, then I believe we can reverse the damage of the post-war years and bring much of our missing wildlife back within a generation.

Dr Tony Gent, The Herpetological Conservation Trust

Conservation of amphibians and reptiles

During this talk I shall look at the conservation of amphibians and reptiles, collectively known as herpetofauna, and in particular at the role of translocations in achieving conservation objectives for these animals.

However, we need to set our amphibian and reptile fauna in a context, and perhaps the best place to start is the beginning. Turning the clock back to the peak of the last Ice Age, say 20-25,000 years ago, we would find that large areas of the country are covered in ice. Elsewhere it is too cold for amphibians or reptiles to survive. In a herpetological sense, we were starting with a clean sheet. Climate warmed and cooled, ending with a very cold spell at around 12,000 years ago. During this time there would have been various colonisations by animals and people, but it is unlikely any persisted for very long. From 11,500 years ago there began a period of warm and comparably stable climate.

As the ice retreated and the land warmed, we saw a series of changes; from an essentially barren landscape, through the development of 'early successional habitats' and gradually increasing tree cover, starting with birch and hazel. Significantly, the British Isles were connected to continental Europe and migration across the land bridge from around 11,500 years ago brought the first arrivals of the species that would become our present day herpetofauna.

During the period 8,000 to 10,000 years ago the human population would have been small and would probably have had little impact on the environment. During this time the 'wild woods' would have developed. This is likely to have been a vast mosaic of open and closed woodlands, with areas being kept open by fire, plant diseases, large mammals such as boar and wild cattle, and flooding rivers – in part caused by beaver that would have dammed water courses. We would also have seen large natural fens, accreting and eroding coastlines. In short there would have been extensive 'wall to wall' natural habitat, uninterrupted by human influences, which would have been dynamic and self-sustaining. It is interesting to surmise where in such a system our amphibians and reptiles would have lived and how abundant they would have been (and indeed to speculate about the 'truly natural' distribution and status of other taxa as well). It is also worth considering how important the natural dynamics of the system would have been to sustaining these animals.

By 8,000 years ago the land bridge between the British Isles and continental Europe would have been lost. At that point we also lost the opportunity for any more natural colonisation of herpetofauna. At that time though, it was likely that we had at least 16 native species compared to the 12 still extant in the wild today. It wasn't until around 4,000 years ago, that man started to make a significant impact on the environment and many of the activities involving 'opening up' habitats, which are likely to have benefited herpetofauna.

Moving the clock forward to a point between 500 and 150 years ago, we see a time where the human population has grown significantly but is still under 20 million.

Agriculture has now developed and industrialisation has now released the ecological constraints on human population growth, and people are having a significant impact on the land. Indeed, most of the countryside has been changed to some degree by humans. To a herpetologist these habitats may appear ideal; extensive heathlands, countryside with low intensity agriculture, farm and village ponds, hedges and dry stones walls. In addition, there would have been hand-digging of turves and minerals, and creation of cart tracks, cutting of bracken and scrub and an essentially 'peasant economy'. Which is what, in ecological terms, peasants do best – keeping habitats open. It is relatively easy to imagine where our amphibians and reptiles would thrive in such habitats. Such changes, though, would have brought mixed fortunes for other species – and certainly the fate of many of our former large mammal species would have been sealed during this time.

Moving forward to the present day, the human population in Britain is now in the region of 58 million. Agriculture has intensified and 10.6% (by 1991) of the land surface is urbanised. Large numbers of people are moving around. There is 375,000 km of tarmac roads carrying 23 million vehicles. Our countryside is both diminished and fragmented. Not only is there limited space for our wildlife to live in, but also movement between areas is difficult. The areas are small and not robust, and there is little scope for naturally dynamic systems to develop or be sustained.

So what of the near future? Will there be more than 65 million people in 25 years? How will our agriculture develop? Where are the proposed 4 million new homes going to be built in that period – and presumably a further 4 million in the 25 years after that? Will there be new, larger, container ports in the Solent; more runways at Heathrow; more leisure time? Will there be any countryside left that can be allowed to manage itself? Will we need to intensify our gardening of nature reserves, to be increasingly precious and keep people out? Certainly, we will need to look more specifically at managing for particular species interests if we are going to sustain the variety of wildlife we would wish for, and be less reliant on managing the habitats at a landscape scale while expecting the species to be able to look after themselves.

This introduction illustrates the way we need to consider setting our objectives for conserving amphibians and reptiles. What are we working towards? What is the truly natural distribution? Can we use our understanding (or presumption) of historic distributions and abundance for defining our aspirations for these animals? If so, what time do we choose, and why? Currently we have 12 species, although there were 13 in the early 1990's (the pool frog *Rana lessonae* is now considered extinct as a native species). In addition to these, moor frogs (*Rana arvalis*), agile frogs (*Rana dalmatina*) and European pond terrapins (*Emys orbicularis*) would also have been on the British list naturally since the end of the last Ice Age, though now lost probably through a combination of climatic and anthropogenic reasons.

Should we aspire to seeing a return to at least as diverse a fauna as we had at that time? And what of species like the wall lizard (*Podarcis muralis*): a native or just a long-standing interloper? They are threatened as natives elsewhere in northern Europe. It would make sense – or at least be good fun – to conserve these in the UK as well.

As for herpetological conservation, the 'modern generation' probably started in earnest during the early 1970's. During the 1960's, there was a gradual appreciation of the impact of human activities on herpetofauna, and by the late 1970's the stark realisation of what was going on was frightening. Conservation action could be described as fire fighting and in some cases quite literally so. It involved very focussed efforts mobilising limited numbers of (often fanatical) volunteers – keeping habitats open, chopping down trees, digging ponds. Ecological understanding developed pragmatically and empirically - often based on assessment of what worked and what didn't – rather than on pure science in the strictly statistical understanding of the word. However, what it also involved was a huge amount of fieldwork, and a very comprehensive assessment of the rare species. Effort was almost exclusively aimed towards sand lizards and natterjacks: keeping habitats open, maintaining mature vegetation structures, creating breeding ponds and focussing our efforts on key areas within colonies (often termed *foci*).

This very much set the tenor for what has followed on ever since. Even today we tend to focus our resources on those areas and activities where the impact is greatest. We now have more chainsaws and use fewer bow saws; sand is often created using machinery and not spades; bracken is sprayed professionally and not by amateurs. But, the principles of species conservation have remained the same; that is, to provide all of the features that a species needs within the ecological units used by the animals. Greater funding and 'habitat orientated' schemes have allowed significant improvements in overall habitat quality. They have allowed linkage between amphibians and reptile populations, but within these schemes we still need greater 'species specific' management to ensure the integration of important features that allow the survival and reproduction of populations of threatened species.

One of the tools that we have always had at our disposal is translocation. In particular, this originated from moving things out of the way of development, and putting them in areas that appear to be good for the animals. Fortunately, this requirement (at least for the more threatened species) is reducing as more sites are being given statutory protection. Assessment of sites for release relies on a form of multivariate analysis – the type that goes on in your brain when you look at a site and it says 'yeah, that looks good'. Perhaps, given that this is based on significant field experience and a sound understanding of the animals' ecological needs, it is not surprising that this has been remarkably successful for many species.

But translocation wasn't new to us even in the 1970's. People had been moving animals around for years. This had been for aesthetic reasons (for example – people like frogs), practical and commercial reasons (people like eating frogs!), and rescuing protected species from threatened sites. Once, this latter approach was simply a case of 'moving a problem out of the way', but increasingly we are seeing the use of words like 'sustainability' to justify moving the problem out of the way for a development. It is 'sustainable' if you move them, 'unsustainable' if you don't! However, as conservationists our main involvement in moving animals is motivated by different objectives – so why are we deliberately moving things about?

In its simplest terms we have seen a reduction in range between some historic 'maximum' that would have occurred since the end of the Ice Age, and the present day. Conservation re-introductions are aimed at working towards reversing that

process. However, strategically we have perhaps never really explained what we are trying to restore and I believe that we really need to think about putting more effort into explaining what *we* are trying to achieve (and why) when setting our objectives.

Translocating to sustain the current range is controversial, but the principles are simple to explain. Basically, where a population is not able to hold its own bringing in new blood (restocking) can help. Some populations might be too small to survive and need more animals to build up numbers – perhaps after a fire – or releases maybe made to different parts of the same site to speed up colonisation and make a more robust population. There's some evidence with natterjack toads (in which most of the 'real' science has been undertaken on UK herpetofauna) that there are problems genetically in small populations. For example, some of the Lincolnshire populations aren't doing as well as they should be, and the recent 'failure' of releases in Surrey using stock from the only surviving Hampshire population may be because of genetic problems. There have been comparative studies using caged tadpoles from different populations that have shown that animals from genetically more diverse populations mature more successfully than those that are comparatively genetically depauperate.

So genetic diversity is important and may affect fitness. However, for our translocation work, we have deliberately kept different stock separate to maintain regional diversity. Perhaps this policy needs to be reviewed, but we are conscious that 'out-breeding' from genetic mixing can also be a problem.

There are also good public relations benefits from translocations. It's easy to promote interest in projects such as 'Bringing the Dragon back to Wales', which was one of the messages we used to raise awareness of the re-introduction of the sand lizard back to North Wales.

But, what have we done, and has it worked?

For the sand lizard, during the early 1970s and the start of the Recovery Programme (1994), 15 translocations were undertaken, in Surrey, Hampshire, West Sussex and the Isle of Coll, which is a little – well, a lot - outside the accepted geographic range. However, the habitat was right and the climate appeared to be suitable and indeed, to this day, the population survives there (though it is being threatened by the grazing regimes being used to manage the dune vegetation there). During the Species Recovery Programme, between 1994 and 1997, in a programme supported by English Nature and Countryside Council for Wales, a further 11 translocations were carried out (Gwynedd, Surrey, West Sussex, Hampshire, Devon and Cornwall). Since 1997 we have undertaken a further five releases (Surrey, Sussex, Devon, Dorset, Merseyside). Significantly only three of these have failed. In two cases, with hindsight, we can see that the habitat just wasn't right, and in the third there is still the possibility that the animals are there but survey effort is perhaps less thorough than it could be. It is also an endorsement of the importance of expert understanding – going back to that 'multi-variate analysis' that allows an expert assessment of habitat quality.

The sand lizard is a species for which captive breeding is an exercise that is worth the effort. Certainly they can breed well in captivity and this avoids the need to take animals directly from the wild. In these cases around 50 hatchlings are released, either

late in the season that they were born (which is preferable), or possibly the following spring after over-wintering them in captivity. Where sites are threatened though, translocation of adults is possible. Where adults are used generally around 20 animals are released. This is repeated over two, or more usually three, consecutive years. Releases are monitored. The aims of the monitoring are to see if the released animals persist (usually by looking for adults in spring) or to establish whether there is any breeding (looking for young late in the year). Monitoring, therefore, might not be needed during the first couple of years after the release of hatchlings.

We have been able to produce a map identifying the current distribution of the species and on it to include areas where we know that the species definitely used to occur based on old records. However, by looking at geology and understanding the past distribution of habitats, we can make assumptions about the species' past distributions and the *likely* former range. We are also conscious of the fact that the herpetofauna have been relatively poorly studied and are prone to misidentifications. Being aware of irreversible losses of habitat in this 'known range' also leads us to look at substitute areas within the biogeographic and climatic range of the species. Notably, we have sought to restore the species as a component of English sand dunes and many of the known former sites of the species are now lost. Consequently, we have felt that it is wholly appropriate to 're-introduce' the species to sites for which confirmed records do not exist.

It is a similar story for the natterjack. It's another species that has been studied long and hard. It's also one of our priority species and has, coincidentally, been recognised as such since day one of the Species Recovery Programme. Like the sand lizard, it is severely threatened by habitat loss, but this species in particular is threatened by habitat neglect. Notably (and in contrast to the needs of sand lizards) lack of grazing and its role in keeping the habitat short and open is a problem. The natterjack has been the subject of a lot of scientific research, and we feel we understand its needs very well. However much of our understanding developed from the fact that early translocations went seriously pear-shaped.

Thirteen translocations were attempted prior to the Species Recovery Programme (between 1970 and 1991) to Lincolnshire, Bedfordshire, Dorset, Surrey, Lancashire, Staffordshire, Norfolk and Suffolk. Six of these were undertaken prior to 1980 and all of these earliest attempts failed. A notable lesson was that natterjacks don't like deep pools. Give them a deep pool (it seemed to be a logical thing to do to avoid it drying up) and natterjacks did very well, in year one. However, in subsequent years, the common toads move in and very soon natterjacks are out-competed by their common cousins. We also took a little while to get to grips with the terrestrial requirements, perhaps in part confused by the different habitat needs of the animal elsewhere in Europe. By the 1980's we were beginning to understand what was needed, and from then until 1994 there was a run of spectacular successes. Eight translocations occurred during the Species Recovery Programme project (1991 to 1995 – in Lincolnshire, Suffolk, Surrey, Dorset, Norfolk, Flintshire).

Perhaps we were getting overly cocky because suddenly, with attempts to release to heathland sites, we had a rapid string of four failures on the trot. It's unclear why these failed. One possibility is genetic fitness – was the stock we were using simply not fit enough to survive? Was the terrestrial habitat poor? Our thoughts turned to the

suitability for survival of the toadlets. This vulnerable stage is, strangely, largely diurnal and perhaps habitat needs are more precise at this age? Here our expert 'multi-variate analysis' of habitat quality let us down just as we thought we knew what we were doing, and we now need to re-appraise the programme and invest more scientific effort. Since 1995 there have been more than seven translocations to Dumfries, Dorset, Merseyside, Cheshire and Clwyd.

Our approach to translocation for natterjacks is generally to use spawn, though we have moved toadlets as well in the past. Spawn is easier to move and provides an aquatic 'bioassay' in that if it hatches and develops then the ponds are probably suitable. In robust colonies many hundreds of spawn strings can be produced, and so it is comparatively expendable when compared to adult animals. We generally move the equivalent of two strings per year. This is approximately 4000 eggs, but taken as segments from several different strings to increase genetic diversity. This is repeated over three years. Spawn is usually taken straight from the wild. Generally, captive breeding is time consuming and less successful; in some years it fails, in others it produces a glut of tadpoles with nowhere for them to go! However, there is a role for captive breeding, especially of the rarer stock.

Again, the objective is the restoration of former range, and translocations tend to be in areas from which the species has been lost or where the range has contracted. The site in Staffordshire doesn't seem to fit the presumed historic range. However, it is a heathland site and provides an example of where we have been a little more flexible in selection of sites given the severe loss of habitat and range of the species in Britain.

Other species of amphibian and reptile have also been moved. The great crested newt is a very widespread species, with very different problems, and is almost certainly 'going down the pan' in terms of loss of populations faster than any of the others. Many of the translocations of this species, and of the more widespread species of herpetofauna, relate to development and consequently this has generated a very jaundiced view amongst conservationists about the role of translocation in wildlife conservation. Frequently 'translocation' is considered synonymous with 'moving problems out of the way of development'. One study done to assess the success of translocations of great crested newts reviewed 53 translocations between 1985 and 1989, and 92 between 1990 and 1994. During the first period 49% of the studies were subsequently monitored; in the later period 64% were looked at after the translocation had been carried out. Using a simple measure of success, namely the continued occurrence of newts, there was between a 62 and 92% success rate.

However, the real test is the long-term viability and if the objective is to see whether translocation as a method is successful, then the fate of these populations also needs to be compared with a similar sample of populations of un-translocated newts. Any population stands a chance of failing, and not just those that have been moved. For example, when people put fish into the pond, which eat the tadpoles. When ducks move in (eating tadpoles and damaging the newts' habitat), or ponds drying up, or becoming too shaded. Many of these problems are common to both translocated and natural populations, and the success or failure of a translocation is more likely to be determined by subsequent management than the act of moving the animals *per se.*

Through the Species Action Plan a target of 100 translocations per year to be sustained for five years has been set. The target is aimed at offsetting natural losses, and consequently mitigation work to offset development losses has been excluded. Even so, firming up on exactly what is meant by this target took a fair amount of intellectual effort. However it is defined, though, it is fair to say we are well off target.

The best way to move newts is to move eggs, and this would be the preferred route for conservation translocations. Eggs can be collected on weed or plastic bags cut into shreds like a grass-skirt and placed in breeding ponds. These are usually taken from the wild, thus avoiding the difficulties associated with captive breeding and the subsequent need to rear and translocate larvae, or the need to prevent adults wandering away from the receptor site.

Orton Brick Pits is perhaps the most famous great crested newt site in Britain, and is possibly the most controversial. Though a European protected site, it is also a site where 5000 houses are being built, and consequently an area of conflict and the site of a considerable translocation effort. Fences are erected both to exclude animals and to trap them. Plastic fences with associated pitfall traps are often placed around ponds and take advantage of the newt's natural desire to migrate to breeding ponds in spring. Once they hit the fence the newts move along it until they meet a pitfall trap. Once trapped, they are easy to relocate. In such large schemes considerable effort can be invested in creating and managing reserve areas that should allow the persistence of viable populations.

Newts are found in a wide variety of habitat, but their value to conservation is not always the same. Garden ponds, for example, provide a refuge for newts and in some cases good populations can be maintained. However, such features are only successful when at the edge of a larger natural population, and certainly the garden pond cannot be considered a mainstay for the conservation of this species.

The smooth snake has also proved to be a successful candidate for translocation, perhaps benefiting from the fact it is a relatively sessile animal, typically moving only around 13 metres a day. Of the five translocations so far undertaken, all seem to have been successful. Where they have been released in what looks like ideal habitat, they tend to stay put (typically up to 10 immatures or adults are released at each site). Monitoring usually involves placing pieces of tin on site, and smooth snakes in particular like to sit beneath them. Quite often we lift the same piece of tin year after year and the same animal turns up time and again. If we accept that a simple criterion of persistence reflects success, then we can say that our efforts have all been successful. However, we haven't had sufficient numbers of translocations for sufficiently long periods of time to be able to say whether there is breeding on all of the sites at which they have been released. Looking at the larger objectives behind the exercise, we are aiming to restore the former range. Target areas are therefore throughout Surrey, West Sussex and Berkshire, and we're still intrigued by the historic reports of the species from Devon.

The pool frog - I haven't said yet that it is a native species, and perhaps I should have. However, the overall conclusion that is coming from the various threads of research undertaken on this species through the Species Recovery Programme and the Species

Action Plan, is that the results are consistent with the theory that the species is, or at least was, a native species. One of the key messages that has come from this work is that the decline of this species went largely unrecorded, sadly without creating much concern largely because it was presumed to have been introduced. And this, to an extent, is a more subtle problem caused by release of non-natives. Certainly, the knowledge that animals from France and Belgium had been released close to what we now describe as the last native population had led, not unreasonably, to the assumption that all of the animals in the general area originated from these releases. Since then genetic work, archaeological studies and studying the calls of frogs – and yes they do seem to croak with a Norfolk accent – has indicated that the species was once native. Having come to that conclusion, the species did the honourable thing and became extinct in the wild just at the time we decided to try to conserve it. To bring it back again to its former glory in England, obviously our only option is translocation and that is something that we are planning to do.

All of the other species of amphibian and reptile have been moved around over time and indeed still are being moved. How many people have moved frogs' spawn from one pond to another? Practically everybody who has had a garden pond has done it. With it there are clearly benefits, not only relating to Chris Baines' observations about bringing animals back into the urban environment, but also, as shown by studies at Sussex University, through creating increasingly diverse genetic stock. Artificial movement of frogs has therefore helped to offset some of the problems associated with the isolation of populations. However, it also brings with it problems. There is the risk of spreading non-native species of plant, something that is worrying a lot of people and especially in the aquatic environment, as well as various animal diseases. For example, the disease commonly termed 'red-leg disease' which may be a virus spread by imported animals and fish.

Common lizards are another species that are moved occasionally, and perhaps these may become the rarities of the future. Locally they are suffering severe declines, and are becoming scarce especially in urban areas with cats (that are major predators). Slow-worms are moved in large numbers every year, largely as part of rescue packages in relation to development. Since they can reach densities of 2000 plus in a hectare we can see why so many are being moved. Again, there is limited monitoring however, where it has been studied, there are mixed stories about its success and the conservation value of these exercises must be questioned if new habitats are not being created. The other two snake species (adder and grass snake) are less likely to be successful than the smooth snake and, indeed, there seem to be relatively few examples of attempts to translocate these species. They are much more active animals; if you release them away from their home area they are likely to try and return.

Translocation is a controversial subject and has generated many reviews and guidelines. JNCC have recently undertaken further work to look in to this issue and all indications are that this topic will remain an on-going controversy. However, I think it is worth emphasising that translocation is just a tool and perhaps that by focussing on this as the issue we are largely missing the point. Rather than debating the methods, we should be spending more time debating what the end point is that we are trying to achieve.

In developing this line of thinking we have started to look at the idea of 'Favourable Conservation Status'. It has the advantage of being a pseudo-legal term, being loosely plucked from the EC Habitats Directive, and for that reason alone should attract some interest. However, more importantly as a concept it can provide a framework within which we can start to define exactly what we are hoping to achieve through nature conservation, not only for individual species, but for all of our biodiversity. The definition of conservation status, and when it is considered favourable, is given in the EC Directive. It picks up on the concepts of maintaining viability, of species being integral parts of their habitats, maintaining a natural range and that the habitats should remain sufficient for the species' conservation. Developing these ideas with an understanding of current and historic distribution, working out what the distribution of the species *should* look like and how abundant it *should* be, helps to define the objectives behind our conservation action. It also allows a much more robust framework for defining targets and allows us to move away from arbitrarily selected targets (or ones that are politically acceptable or simply achievable) to identifying real goals that can achieve the desired results.

So the debate should be to move away from translocation as an issue; moving animals can be made to work, but what we need to be able to define is the framework within which these activities should and should not take place.

But we also need to be bolder at looking at the underlying issues. There is an inescapable threat through increasing human population and the impacts that this will have on both wildlife and on the quality of human life. Current trends in population and demand suggest that we will need another 4 million houses every 25 years or so and with it an associated infrastructure. Now, let's face it, that is a pretty significant constraint on our 'wider landscape' and indeed even on our protected sites network! This is, I agree, a tricky subject and one that will test our ability for 'joined up thinking' to the limit. But shouldn't we start putting this issue on to the agenda now for future discussion?

We also need to consider the basis from which we make our decisions about conservation and about translocations in particular. Increasingly we are looking for scientific justification for our activities. However, while guided by science, we need to accept that much of our conservation work is based on our own opinions and experience and also on value judgements that are difficult to objectively address and to define. It is therefore important that we engender wide support and a shared agenda for conservation. When all is said and done, regardless of the scientific arguments, if enough people want to live in a country full of wildlife then their actions and support will probably make it happen. And perhaps that alone is reason enough for us to continue to work hard to see that it does.

Dr Martin Warren, Butterfly Conservation

Species recovery work on butterflies and moths: an overview

This presentation is divided into three sections: 1) the scale of the problem facing butterflies and moths; 2) two case studies; one butterfly and one moth and compare and contrast progress; and 3) the major constraints on delivery.

The scale of the problem facing butterflies and moths

The UK BAP lists 11 Priority Butterfly Species and 53 Priority Moths. This is a large number of species and one in eight of all Priority Species in the UK BAP is a butterfly or a moth. So we have got a large task ahead, especially as all these species have quite serious problems and need a lot of action.

A key element of Butterfly Conservation's work is involving volunteers. They represent a large workforce, who are very keen to help and we use them extremely well on a number of our conservation projects. About 600 volunteers are directly involved in species recovery work in England and we have another 1,000 or more people who regularly monitor butterfly populations along fixed routes at around 500 key butterfly sites in England. We have developed new software (Transect Walker) so that they can enter their data in a standard way and transfer it into a central database for analysis. The software and details can be downloaded from our website: www.butterfly-conservation.org.

Another major project involving volunteers is the Butterflies for the New Millennium project, which allowed us to produce the Millennium Atlas of Butterflies in Britain and Ireland, published by Oxford University Press in 2001. Over 10,000 recorders contributed information to form an incredibly valuable dataset that is vital in order to underpin our conservation programmes. It has also highlighted serious declines among several species that are not currently Priority Species but certainly qualify.

The results of the survey show that at the end of the 20th century, Britain had lost five of its 59 resident species, while 15 have suffered really big declines (>50%) and another 14 species have suffered declines of more than 20-50%. Of the remainder, five species have suffered major declines within their range, 5 have remained relatively stable, but 15 species have expanded. The broad conclusions are that there is a lot of change in the world of butterflies but a large proportion of species are declining rapidly. Moreover, there is evidence that the rate of loss has increased for most species over the last 20 years.

One example is the high brown fritillary, a Priority Species that has undergone a 77% decline in the last 20 years. The map shows that it was extremely widespread across England and Wales but is now reduced to a very small number of sites. There are now about 50 populations when there were once probably 500 or more. So these species are really in dire trouble and reversing these declines, or even halting them, is an enormous task.

Case study 1: Heath Fritillary

The heath fritillary is a butterfly that has traditionally been associated with coppice woodland. It still survives in coppice woodland in Kent and southeast England where conservation work under the Species Recovery Programme is bringing a steady recovery. It also occurs on moorland fringe habitats on Exmoor, which supported over half its colonies during the 1990s. In 1989 we did a comprehensive survey of this very large region and found that there were 29 populations, concentrated in the eastern half of Exmoor. We conducted a complete re-survey of these colonies during 1999/2000 and found that there had been a major loss of populations of 48% in just 11 years. The results show that some very large populations have been lost in the western part of its range on Exmoor and that the surviving populations are now clustered in the east.

We have also gathered detailed information on population trends since 1984, based on annual population counts using volunteers. This shows that population levels were quite good during the 1980s so we did not feel the need for a lot of conservation effort on Exmoor as things seemed to be going well. Then in 1990 there was a huge drop in numbers, but we know that butterflies respond rapidly to weather, so the drop may not be significant. After the 1990 drop, numbers picked up again and we were not unduly concerned. However, there was another, larger drop from 1996-98 and numbers have remained at a very low level since. Having identified a serious problem, we have begun some detailed studies of how the habitats have changed in these moorland fringe habitats and how this might have adversely affected the butterfly.

On Exmoor, the heath fritillary site breeds in sheltered combes around the edge of the moor where the larvae feed on common cow wheat, which grows amongst the bilberry. This zone is not in amongst the *Calluna* moorland but on the moorland fringe where there are thinner, less peaty soils in the combes.

We looked particularly at the vegetation changes that we had recorded in a very broad way over the last 20 years and at management changes. We also interviewed farmers in some of the main areas and looked at records gathered by the National Trust and English Nature. Finally, we looked at the population dynamics of the species and particularly the impact of site size and isolation on survival.

The first obvious result was that there had been a huge reduction of grazing over the last five to ten years, particularly a decline in cattle grazing within the Environmentally Sensitive Area (ESA), which covers most of Exmoor. This led to rapid scrub invasion particularly in the combes which is exactly where this butterfly breeds. That rapid scrub invasion had undoubtedly been exacerbated by two very wet seasons in 1998, 1999 and also in 2000.

It was quite clear that the best surviving sites had management that either comprised of regular burning and/or grazing. This was the type of management we had recommended when we first discovered the colonies here almost 15 years ago. However, we also found that the size and isolation of sites had a strong impact on survival. The results showed clearly that the smaller, more isolated sites had become extinct more frequently than the larger sites that were connected to each other.

So, the main conclusions are that the decline of the butterfly was due to reduced grazing pressure, caused partly by the measures to encourage heather moorland within the Exmoor ESA. Many of the prescriptions in the ESA had been designed specifically to encourage the maintenance of heather moorland, particularly on the tops of the moor, where there had been evidence of damage caused by overgrazing. This is a familiar story for those that know other upland areas. The down side of these prescriptions is that species that like heavily grazed short vegetation conditions in the combes (like the heath fritillary) are likely to suffer as a result of this reduction of grazing pressure. Our conclusions are that there needs to be a lot more flexibility within the ESA to maintain active management in the moorland fringes, and that management is needed on a landscape scale in order to restore extensive habitat networks. In a nutshell we need to think big and long-term.

Having identified the problem, Butterfly Conservation is now taking action on a number of fronts. Firstly we are working with DEFRA, the National Trust and English Nature staff who manage and arrange management on Exmoor, and are hoping to use conservation plans within the ESA to specify higher grazing levels on the specific areas where the fritillary occurs. However, a major problem is that now farmers have gone out of cattle, it is going to be very difficult to restore any sort of cattle grazing in these areas, especially following the BSE and foot and mouth crises. Once a farmer has gone out of cattle they are not going to go back into them without major incentives. So there is now a really serious issue about putting livestock grazing back on these sites in the future. At the moment there is only light level sheep grazing, which is probably not going to be enough to maintain suitable conditions for this butterfly. So we're seriously thinking about whether ponies, particularly Exmoor ponies (another native endangered species itself) could be used to replace cattle and restore grazing levels that would reduce scrub invasion within the combes.

The study has also highlighted an important issue for national policy in that agri-environment schemes such as the ESA need to truly reward farmers for their efforts. The payment levels on Exmoor are simply too low for farmers to go into grazing at the sort of levels needed to graze these low productivity moorland sites.

We are also working with the National Trust who own a large number of the sites to increase patchy burning, which is part of the traditional management of the area but has recently not penetrated into the combes. We know that the food plant responds quickly to burning and comes back in abundance. The butterfly can also move quite quickly back in if it still occurs nearby. It is also vital to continue the annual monitoring so that we can assess the changes that happen and assess the results of management to identify which methods are working. In order to coordinate the conservation work on Exmoor, and provide feedback to the many people involved, we organise by annual meetings of a South West Fritillary Action Group. This brings together the volunteers who are doing the recording and all the various practitioners within DEFRA, National Trust, English Nature etc.

Our research on other species has shown that a number of threatened butterflies are associated with heavily grazed moorland fringe habitats not just on Exmoor but also on Dartmoor. They include Priority Species like the high brown fritillary and pearl-bordered fritillary as well as other declining species. We are also making links with other Recovery Projects, such as Dave Boyce's, that have shown that grazed

moorland fringe habitats are crucial to many Priority BAP invertebrates including hornet robber fly, a rove beetle, scarce blue damselfly, Kugelann's ground beetle and blue-green ground beetle, and narrow bordered bee hawk moth. There are at least another half dozen priority species of invertebrate associated with those habitats as well. So to me this whole work has uncovered a previously little recognised type of habitat on moorland, which is absolutely crucial for these invertebrates. We have a common aim of reconciling their needs with those of conserving heather moorland on the tops of the hills.

The story on Exmoor is quite complex, but a point I want to stress is that there is often a very big time lapse between identifying the problem, arranging the management, getting the conservation action and then recovering the species. In the Blean Woods where we previously put a lot of effort (because it was the main known stronghold until the discovery of more colonies on Exmoor), it has taken 15 years for the management to be implemented on the ground. It took ten years for a management agreement to be negotiated with the owner, then another five years for the work to be done, and only in the last two years has the butterfly started to recover. We are now hoping to meet the BAP target of restoring 25 interconnected colonies in the Blean Woods in the next couple of years.

Case study 2: dark crimson underwing moth

Butterfly Conservation is Lead Partner for 53 Priority Species of moths in the UK BAP, and we are doing work on one level or another on most of these species. The example I want to pick as a contrast to the butterflies is the dark crimson underwing. The distribution map shows that it has suffered a very big loss of range, well over 90%, and is now reduced to a small area within the New Forest. However, unlike most threatened butterflies, our knowledge of the species as with many other moths is comparatively poor.

The larvae feed on mature oak trees of 200-300 years old, and they need large areas of mature oak woodland. This is undoubtedly a major reason why they are so highly restricted and why they have disappeared from a large part of their range. The reasons for their restriction to large oak trees is not really well understood, although there is a possibility that the larvae need the crevices of large oaks in order to escape predators.

One of the big problems with the study of moths is that they are far more difficult than butterflies to find in the first place. Firstly, a lot of species fly at night so you have to use a variety of techniques to try and catch them, study them, and identify them. The traditional way of catching and identifying moths is with a moth trap, but the dark crimson underwing very rarely comes to light so we have to resort to other techniques. An ingenious method employed by my colleagues Dave Green and Paul Waring is to use wine ropes, which are ropes soaked in various alcoholic sugar cocktails. The ropes are dipped in the sugar solution, hung up on site to attract the moths. It is then possible to identify them and find out whether they are still present on former sites. It is also possible to beat the larvae from oak trees, but this is extremely tricky and we have had to use a professional tree climber in the New Forest to sample larvae high in the canopy. So even discovering the presence of this moth represents a huge logistical problem, let alone understanding its ecology and identifying what sort of management we should instigate to conserve it.

The future action on this species is to continue the surveys and the larval studies, even though these are extremely difficult. However, we know that the species needs old growth oak forests and we are also working with the Forestry Commission to ensure the continuity of old trees in the New Forest. FC have been very helpful and are trying to protect the last known areas for the moth and to make sure that there is a continuity of oak woodland in that area. Unfortunately, there is a 100-year gap in the age classes of oaks in the New Forest, which could be a big problem in the future. Conserving this species also requires long term planning, as any new oak trees that may be planted now are not going to be suitable for this moth for 200-300 years!

Major constraints on delivery of BAP targets for lepidoptera

I was asked to finish this presentation by looking at some of the constraints on the recovery of butterflies and moths. They are many and varied. First of all there are some really big picture constraints on recovery, including changing the whole mindset about how we manage the land in which we live. Our task is to reverse more than 100 years of habitat loss and degradation, a huge task but if that is not addressed then individual species recovery projects are constantly fighting a rear guard action. Although butterflies and moths are small insects, they still have big problems that require fundamental changes in land use and major improvements in land management are needed to reverse their declines.

Perhaps the biggest single issue is agricultural reform. A lot of people recognise that this is absolutely crucial if we are going to first of all stop even more widespread species from disappearing and being added to BAP lists. It is also essential because it provides the context in which we have to organise land management on special sites. We do not want our reserves to become ghettos that are the only bits of decent habitat left in the countryside. A crucial development is thus the expansion of agri-environment schemes, which are targeted at improving the management of semi-natural habitats. These are absolutely crucial to the recovery of butterflies and moths.

We also need to see greatly improved management of SSSIs and all other semi-natural habitats. Another improvement we need is to have more targeted forestry grants, for example to ensure regular coppicing to help species like the heath fritillary. We rely heavily on the statutory agencies to take the lead on this type of work but we also work through Wildlife and Countryside Link, the link organisation that co-ordinates action on policy issues on behalf of the NGOs.

Lastly, there are a few specific constraints on the recovery of butterflies and moths. In particular there is a lack of knowledge about many species. For many moths, even basic biological knowledge is lacking, such as what food plants are used and what type of management is needed. Although the basic ecology of most butterflies is reasonably well known, there is still a big gap in our knowledge is how to manage habitats in the long term. This is a challenging issue because we are often dealing with quite complex ecosystems and deep-rooted problems, as on Exmoor. Following the collapse in traditional grazing, we are going to have to start again with some new types of management, such as bringing in pony grazing. This will be a new management for most sites and we do not have huge experience of its impact on the species concerned. The outcome is uncertain and there may be unforeseen problems.

We will therefore have to set up some long term monitoring and studies of the impact of habitat management.

We also need to meet the training needs of a range of agricultural advisers- DEFRA project officers within stewardship and ESAs, FWAG advisers, ADAS advisers, English Nature advisers, Forestry Commission staff, all of whom need specialist advice in order to help us achieve the BAP targets. There are some very practical issues in ensuring sound management. The foot and mouth crisis has brought into sharp focus the whole future of livestock grazing and particularly livestock grazing on these very low productivity habitats like moorland.

One factor that is absolutely crucial to invertebrates is to ensure continuity of management. Change in management for even a short period can lead to losses. We also need to plan management on a landscape scale because we know that most threatened butterflies need a network of habitats and not just small individual sites. Finally, there is the problem of the lag between acquiring knowledge, implementing the action and achieving recovery. This may take decades and we rely very heavily on the cooperation of a lot of different people. However, our experience has shown that when you get all these things in place, you can turn things around achieve good species recovery.

I want to finish on a positive note because there are some good examples of butterflies that are recovering well. One example is the large blue, which became extinct in 1979 despite a lot of conservation effort at the time. Thanks to some detailed research by Dr Jeremy Thomas at the Centre for Ecology and Hydrology, we now understand its ecology very well. He discovered that it is associated with a particular ant species that requires short-gazed turf as well as the initial host plant, wild thyme. Armed with this knowledge, and with consistent funding over the last twenty years, we have been able to restore its habitats on several former sites. In the last five years the species has recovered extremely well and Britain now contains some of the largest populations in the whole of Western Europe.

We need a similar concerted and long-term effort to ensure the recovery of other threatened species and we look forward to hundred years of species recovery.

Dr Roger Key, English Nature

'Pot' beetles - Cryptocephalus spp.

'Pot' beetles (*Cryptocephalus spp*) are small to medium sized shiny and sometimes colourful leaf beetles and take their name from the small, flask-shaped case made of its own dung that the larva inhabits during its development. A remarkably high proportion of our 19 species are very rare or threatened and five of them are listed on the UK BAP. We have been working longest on the 'hazel pot beetle' *Cryptocephalus coryli*, which takes its name from *Corylus,* the scientific name for hazel but, confusingly, feeds mainly on birch and is now found in very few places in Britain. These are single sites in scrubby heathland in Lincolnshire and on chalk grassland with birch in Berkshire and Surrey, though it was formerly rather more widespread.

Other BAP-listed species in the genus *Cryptocephalus*, also incredibly scarce and difficult to find, include the 'small shining pot beetle' *Cryptocephalus nitidulus* and the '10-spotted pot beetle' *Cryptocephalus decemmaculatus*, as well as a couple of other species. One, the 'six spotted pot beetle' *Cryptocephalus sexpunctatus*, (on hazel) which has only recently been found in Scotland; the 'scarce rock-rose pot beetle' *Cryptocephalus primarius*, found on a single limestone grassland site in the Cotswolds; and the 'Pashford pot beetle' *Cryptocephalus exiguus*, now found only at a single fen in Suffolk. Most of them are rare and declining in Europe. Work to date has been concentrated on the hazel, small shining, and ten-spotted pot beetles.

The small shining pot beetle is found only on a couple of places in the North Downs. It likes the same sort of open scrubby habitat on chalk grassland as favoured by the hazel pot beetle, and feeds on a mixture of birch and hawthorn at different stages in its life cycle. The 10-spotted pot beetle is now found in just three tiny little areas of Wybunbury Moss NNR in Cheshire - each about the size of the average garden - and in a single site in Scotland. This species only has a priority statement and not a full BAP Species Action Plan.

From Victorian times, right through to the production of the Red Data Book in 1987 and the National Beetle Review in 1992, experts maintained that these beetles lived in coppice woodland. However, none of the places any of these species now occur in are coppice and, although they may once have once inhabited coppice, they are basically scrub species, for which coppice was a similar habitat.

In its northern, Lincolnshire population, the hazel pot beetle lives on young birch scrub on heathland and it would have formerly had a wide distribution across the Coversands and Sherwood heathlands of the East Midlands. Unfortunately, heathland management over the last 50 years has either favoured a monoculture of heather, or else heaths have been neglected and turned from heathland, through scrub, to oak/birch woodland. Usually a rich mix of heathland interspersed with many patches of birch scrub with lots of edge has been considered unfavourable as a habitat, and sites have been rigidly parcelled up into heathland and woodland compartments, each managed accordingly, with only minimal interface between them. Fortunately, the

management of the Lincolnshire Trust site where this species survives has been rather more enlightened.

However, attitudes are changing and the 'Favourable Conservation Status Tables' that are being produced to assess the condition of heathland SSSIs recognise that marginal woodland and scrub should be an integral part of heathland habitat.

Similarly, the Surrey chalk grasslands that both the hazel and small shining pot beetles inhabit are recognised as parts of a proposed SAC for orchid-rich chalk grassland. The birch and hazel scrub these beetles need has hitherto been regarded as a rather negative feature of such habitat, and efforts made to remove or eradicate it in some places, no doubt to the detriment of the beetles. The ten-spotted pot beetle also requires scrub, this time sallow on floating valley mire vegetation, again a habitat feature regarded as threatening to the quality of the 'main' habitat interest of sites. There is obviously a circle to square in accommodating the scrub needs of these and other species with 'pristine' examples of the habitats and designations for which the sites are recognised.

In 1995 English Nature set up a series of small survey projects on the hazel pot beetle. Initially, as part of a 'Team Building Day', a group of English Nature staff visited Kirkby Moor, a Lincolnshire Wildlife Trust Reserve and last known northern outpost of the hazel pot beetle, to see if it still survived there. Richard Jefferson, English Nature's Grassland Ecologist, was one of the three people who actually found one (which landed on his neck!). This confirmed that the beetle was still present at Kirkby Moor, while another colleague, Dave Williams, also found a specimen, this time on a tree. We did not know at the time, but he had discovered the key population at this site.

One of these small projects was led by Dr Steve Compton, Senior Lecturer in Entomology in the School of Biology at Leeds University, with both English Nature and Leeds University funding. The University became lead partner for almost all of the pot beetles and, so far, Leeds remains the only University that has actually taken on a lead role for a species. We have now had two Species Recovery Programme funded PhD students at Leeds working on pot beetles; Ross Piper, who took a very innovative approach to the study, and Nicky Hewson who has just started. In addition to the actual studentship, the University had an additional small 'pot' of funding to enable sub-contracting of 'amateur' (in the true original sense of the word - the sort of person who does the work because they love it) naturalists/entomologists to survey for additional sites for the species and to undertake 'classic' observational natural history. This has proved a very successful combination, which has subsequently been repeated in other academic studies to great effect.

In this way, Lincolnshire entomologist Annette Binding and her husband Allen became involved in the project. The classical field naturalist, with incredibly precise observational skills and patience, is now incredibly scarce in Britain. Such willingness and dedication to sit and watch what an individual beetle does for an entire afternoon, making extensive descriptive notes with illustrations, is so rare now. This attention to detail really tells us what the animal does - the sort of activity that Darwin used to do.

Not only did Annette do a splendid job on describing the natural history of the species, she also 'fell in love' with the beasts and started breeding and rearing them in numbers. In Annette's kitchen now are dozens of plastic pots, formerly full of supermarket trifle, which are now used as beetle breeding boxes. So effective was this novel approach that there are now over a thousand beetles in Annette's kitchen, compared to perhaps something like 500 individual adults in the field.

So, what did we learn from all this research and natural history work? First of all, let us look at habitat studies undertaken by the Leeds students. If we consider Kirkby Moor and the other places where the beetles occur, they all have something in common. All of these sites have south-facing blocks of scrub, with open areas in front of them and are sheltered from north winds. What we are finding is that the beetles are very thermophilic - they are not after just any old bit of scrub; they want really nice warm little sun pockets.

However, what the hazel pot beetles also require is bare or very sparsely vegetated ground under its bushes, with occasional patches of sparse moss and shallow pockets of birch leaf litter (on which the larvae feed). Bare open ground is much hotter and supports fewer predators. Wood mice take a severe toll of the larvae in the winter, eating the larvae from their pots in a manner rather like eating an ice-cream cone. Birch scrub on heathland would appear to be and is a very common habitat, but the very specific conditions of young birch, together with bare and mossy ground, is a far scarcer micro-environment. Most birch has a closed grass sward or heather underneath and this is completely unsuitable for the beetles.

We've learned enough of the species' ecology now to carry out specific management, cutting down and opening up maybe as much as 75% of the trees in dense birch scrub, followed by scraping bare of the soil surface to mimic the pioneer-habitat associated with young birch colonising bare ground.

Annette's natural history observations were equally illuminating, in particular about the breeding behaviour of the beetle. The female climbs to the end of a twig and bites off a hazel leaf. She does this about five times, and this has turned out to be a good way to find hazel pot beetles, by looking for bright green young leaves on the ground under birch trees and finding twigs with the apical four or five leaves missing (other insects – and even the wind, cut off individual leaves, but not systematically all at the end of one twig). This may prove useful as a way of monitoring the beetle, which we were unable to do before because we discovered that, as one approaches bushes with the beetle, they see you coming and drop to the ground and are surprisingly difficult to see. They are also almost impossible to find in any weather conditions other than full sunshine, appearing spontaneously to disappear as soon as the sun goes in.

So, having dropped the leaves to the ground, the female then lays an egg and, catching it in her hind legs, she coats it with her own dung so that the larva hatches into a ready-built pot of dung. She then 'throws' the egg out, as much as half a metre from the bush down to the ground, where there is a supply of fresh leaf litter she has just made. This is the only example we have come across of an adult, plant-feeding beetle provisioning for its larvae and, we think, perhaps the main reason why they are only found on young birch scrub. If there is the slightest wind, birch leaves floating down

from 5 metres are likely to land too far away for the larvae to find. There is an indication that the ten-spotted pot beetle might do something similar.

Back at Leeds, Ross Piper proved very innovative and came up with a novel idea for following the larval beetles. We needed to find out about their mobility, worried that they might be very immobile and vulnerable to predation etc. Ross experimented with pieces of very thin stainless steel foil glued to the little pots that the larvae live in. He then used an industrial model of metal detector to follow where in the bare ground/moss/leaf litter mosaic at the base of the birches the larvae spend most of their time, where they overwinter and how far they go. They proved remarkable immobile moving no more than 50 centimetres or so in half a year.

The other piece of information resulting from this study told us of the levels of predations to which the larvae are exposed, especially over the winter. Adult larvae have proved very attractive prey for wood mice, which bite the top off the pot and extract larva inside. The level of predation of larvae has turned out to be in excess of 90% suggesting that in any reintroduction scheme it might be useful initially to exclude small mammals so that a founder population has a better chance of actually making it. Ultimately, of course, their descendents are going to have to take their chances against these predators.

Ross also looked at how far the adults dispersed. Bee tags proved too expensive and bulky and, using a sharpened propelling pencil, he stamped out little numbers, sticking them to the backs of the beetles with nail varnish. This was extremely successful. During an experimental release, we observed that some of Annette's marked captive bred beetles were already mating within about 20 minutes and, later, we found them laying their eggs, throwing them from the trees, and behaving perfectly normally. Following individual beetles proved difficult and Annette used repeated sampling – mark and recapture techniques - to work out how far individual species actually fly. They proved remarkably sedentary. Although the beetles fly well, few dispersed more than a few tens of metres from the original birch bush on which they were released.

It was a similar story with the 10-spotted pot beetle. Ross found that the adults of this species are even more sedentary. The furthest distance from the trees that he found any individual was about 50 metres. The three small clumps of sallow bushes at Wybunbury Moss NNR separated by approximately 100m of open mossland are effectively completely isolated from each other. No individual small shining pot beetle was ever found more than 10m from the release point. This has obvious implications for the likelihood of local extinction and unlikeliness of colonisation.

Ross also undertook between population genetic analysis of the hazel pot beetle finding that the sub-populations along the North Downs are as unrelated to each other as the populations in Lincolnshire are from the ones on the South Downs. This implies that the small populations have been in the same place for a very long time and that there has been remarkably little gene flow between what we expected to have been sub-populations and which have proved to discrete populations.

In the third year of the PhD studentship, experimental releases were undertaken at Whisby Nature Park, another Lincolnshire Trust Reserve site south of Lincoln City.

Ross released a large number of larvae in the autumn, while Annette released dozens of adult beetles the following summer, both in what we hope is the right habitat, so next year we'll find out whether the experiment has worked. (Stop press – several adult beetles were found feeding, mating and egg-laying in summer 2002 – the prognosis is go!)

Ross has now gained his PhD and the future of the pot beetle programme now lies with Nicola Hewson, our new PhD student at Leeds. She will still be working on the three species upon which Ross concentrated, but will expand the work to at least some of the other species of pot beetle on the Biodiversity Action Plan that we have not so far worked on. A population of *Cryptocephalus primarius* was discovered only about two thirds of the way into the time of Ross's PhD, so we were unable to do anything on it. We have no populations at all of *Cryptocephalus sexpunctatus* and it may actually be extinct. *Cryptocephalus exiguus* remains known from only a half dozen specimens in the last few years.

The project has been very successful in bringing publicity to the beetle, to all the organizations and individuals working on it, and in getting over conservation messages about invertebrates in general and importance of scrub throughout the media. One thing we have learned is that a species must have an English name to have any chance of being featured in the popular media. *Cryptocephalus coryli* transformed into the hazel pot beetle in an instant during a conversation with the Guardian's environment correspondent who was unwilling to publicise the story at all without what he called a 'proper' name.

In terms of the publicity that we have had for these species, this project has been as successful as many a charismatic vertebrate. Indeed, it has been more successful than some, perhaps the main reason being that all of the people involved have been prepared not to take themselves too seriously. If one doesn't mind being portrayed as a mild eccentric who spends time gluing bits of stainless steel to the back of beetle grubs, wandering on hands and knees with metal detector on a heath in February or filling your kitchen cupboard with trifle pots full of beetle larvae, the media will want to hear all about you. So far, we've made nine TV appearances talking about the hazel pot beetle, including ten minutes in Annette's kitchen beetle factory, and we've featured twice on Radio 4's Today programme. The project has had excellent coverage in both the broadsheet and tabloid newspapers, and on local radio.

The pot beetle project has so far involved 51 people from 10 organisations across four countries. Personally I have learnt initially how to coordinate seven individual projects, and that it is far better to condense so many projects into a single one. The model of a PhD studentship, with a small budget for subcontracted mini-projects running alongside, works very well; so well, in fact, that we have repeated the idea with a number of other PhD's now up and running.

Dr Johannes Vogel, Programme Leader UK Biodiversity, The Natural History Museum, London

Engaging With the Public – Progress and Perspectives on the English Nature-NHM Biodiversity Co-ordination project

In this presentation I would like to take the opportunity to tell you about an initiative between the Natural History Museum and English Nature that is furthering stakeholder engagement in the Biodiversity Action Plan process. Earlier today Chris Baines gave us a very vivid demonstration of how linking up various strands of society and thinking helps enormously, to achieve better and greater goals. I certainly feel that this approach is the way forward and that we are seeing success in adopting it in this project.

The Biodiversity Action Plan process was conceived, from the very beginning, as an interactive and participatory process with the statutory agencies at its centre. Along side this administrative function are many other stakeholder groups including lead partners drawn from NGOs, national schemes and societies and other specialist scientific organisations, such as the Natural History Museum, species champions, local authorities, local BAPs, local record centres and the National Biodiversity Network. This is an extremely complex process, in terms of both paperwork and whom it aims to involve.

The Biodiversity Action Plan process is essentially made up of a series of published species and habitat plans with targets arranged in five-year cycles. The first targets for the Species Action Plans were concerned with gathering baseline data, conducting surveys, monitoring and research. Steering Groups for each Plan were set up to bring together all the interested parties. So, we have a framework that was set up quite idealistically trying to involve and invite participation, aiming to bring amateur expert societies into the process and galvanise their abilities and strengths to progress the process.

But, is this aspect of the process really working and what, if anything can be done to better this whole process?

When the BAP process was reviewed in 1998, what quickly became apparent was, that for furry, feathery, or beautiful species, support and interest had been built relatively rapidly. 'Attractive' species, such as the lady's slipper orchid or the dormouse, arouse both public and expert interest and opinion, which helps move the process forward. Unfortunately, of the wildlife that exists in the UK (estimated at around 100,000 species in total), few of them have feathers, few of them have fur and beauty is always in the eye of the beholder, (and I don't wish to comment on that)! What was very apparent was that there are groups that have been neglected under the custody of the BAP process (other groups, such as freshwater micro-algae, are not even included). But, two of the groups that have statutory recognition and have seen least progress are cryptogamic plants and invertebrates. Invertebrates often have a repulsion factor to them, and cryptogamic plants are usually very small and difficult to identify; so immediately, there are hurdles to overcome to before we can achieve action on these groups. What the English Nature / Natural History Museum

partnership tried to do was to engage amateur naturalist societies and individual specialists at a national and local level to encourage action on these groups of neglected organisms. Two new appointments were made in 2000 to facilitate this process of engagement. It is widely acknowledged that the amateur naturalists, individuals and specialist societies are very often the custodians of knowledge where such taxonomic groups are concerned. But, this knowledge is not always immediately accessible; it may be in little cardboard boxes under their beds, on record cards in their desks or on computer files on their PCs as well as in their brains. These communities enjoy the challenge of working with difficult groups of organisms – they are the acknowledged specialists that statutory agencies such as English Nature turn to for local knowledge. However, very often their work is driven by their own interest. This is a hobby, usually pursued in spare time, and their efforts may not always be focused in relation to the BAP process. And there, I think, some encouragement is needed.

There is a dedicated UK Biodiversity team of six staff at the Natural History Museum, that tries to engage into this process, including the two English Nature funded facilitator posts. The Natural History Museum has taken its commitment to UK Biodiversity very seriously. We are the holder of the national collections on UK Biodiversity and have been represented on several bodies, such as the National Biodiversity Network, the UK Biodiversity and UK Biodiversity Working Groups to oversee and steer the BAP process. The NHM is probably the largest, and most comprehensive research institute for biodiversity in Europe. We have, as a museum, three different functions: research, exhibitions and education, thus we are well equipped to form fruitful and mutually beneficial links with partners like English Nature, to move nature conservation forward.

If we examine the BAP process that is guiding our work more closely, we can identify some of the obstacles that we are facing. For this I am going to focus on some of the outcomes of the first 15 months of the invertebrate and cryptogamic facilitator projects, where we have attempted engagement on the ground with the various stakeholder communities, trying to collate information and to bring the different actors together in a new setting. Firstly I will identify some problems and impediments to progress, at organisational and institutional levels as well as from the level of the individual, and then present ways forward for the future.

First of all, as I outlined earlier, the BAP process is a highly complex process and it takes quite a long time for anybody to learn the ins and outs of it – what is required, what can be done, what are the incentives to be engaged in it – and so on and so forth. Also, the process was conceived only two years after the Rio Summit in 1992 with a limited period for a wide-ranging consultation process.

The process seems to be directed upwards and it is very legalistic. It may not have been conceived with the amateurs in mind; however amateurs are seen as a vital part of this long-term process. Capacity building in this vital group of stakeholders has not been included in the structure of the BAP process, and this is something that I strongly believe needs to be addressed. A good way forward here is certainly the building of a strong and functioning National Biodiversity Network, but more needs to be done. I think it is becoming ever more obvious that the “learned naturalist” is as endangered, or even more so, than many of the organisms we try to conserve through

the BAP process. He/she is a threatened species without whom, the whole process would not function. How we build capacity to enable the existing people to do their work as much as how are we going to produce the next generation of naturalists, I think, are the pivotal questions.

The level of expertise and knowledge of the natural world in society at large is a problem. It could very well be that this is correlated with the perceived lack of whole organism biology taught at any level of the education system in the UK. Very few universities now teach taxonomy, school classes are no longer taught to recognise trees and common flowers etc. It is therefore difficult to identify at which stage in most people's lives they are going to be 'switched on' to the kind of natural history exploration that is the backbone of the amateur societies that I have been referring to. This is where arousing enthusiasm and capacity building is such a crucial task for the future.

Perhaps the assumptions of the BAP process design were too idealistic, presuming that, if you constructed this conservation process from the top downwards and ask the Government to pay for it, and the amateurs at a local and national level to get involved, they all would come to this good cause and help to push this forward. The statutory agencies have certainly done a magnificent job to move the process forward, but there are still gaps to fill where the amateur communities are concerned. The English Nature / NHM project is capacity building within some of these amateur communities in an attempt to help to bridge the gap.

In this work we are dealing with proud, very knowledgeable communities. They certainly do what they do as a hobby and with their personal enjoyment as their driving force. This should in no way be discouraged. They do have a different value system to that which drives the BAP process and in certain aspects, are set in their ways. There may often be a feeling of being undervalued and unacknowledged by the "professionals" and statutory agencies. There is an obvious barrier between the aspirations of the amateur naturalist interested in their chosen field and the intricacies of the BAP process. There is little incentive to plough one's way through the BAP paper-mountain in an attempt to find out how to make a difference. Thus there needs to be a communication exercise between this piece of paperwork and the knowledge custodians, who are essentially engaged in a pleasurable hobby. Progress so far with our English Nature-NHM project with the British Bryological and British Lichen Societies clearly demonstrates that these groups of people can be encouraged to engage in activities in relation to the BAP process if the value of the process is communicated in the right way and support is being given.

So, what do we have in terms of opportunities to achieve change of working practices and attitude within the amateur naturalist community? We have the appointment of facilitators now, in the Natural History Museum, the RSPB and the Biological Records Centre amongst others. The National Biodiversity Network has been established and is beginning to work. This means we will have a data collection and dissemination mechanism with commonly agreed standards in place. The NBN will provide a natural outlet for the information held in the amateur naturalist societies. This will allow wider communication and information flow between the various information providers and users and the sharing of data will lead to a feeling of being part of a larger picture. From a technical point of view, I think there are now unique

opportunities in terms of influencing the future of the BAP process in relation to capacity building of amateur naturalist societies.

So, what does the Natural History Museum and English Nature project engage in and how far have we got? The first stages of the project have been concerned with distilling down and communicating the information contained within the BAP process. It has involved a process of educating the various councils and committees and general membership of the natural history societies. We had to tell them what the BAP process is, that it is something that they should or could be interested in, and one that they could gain from. The general conclusion we have drawn from this initial communication exercise is that the target audience had heard about the BAP process but they didn't really know how they could get involved. Some societies have active conservation committees, others don't. Our aim was to actively engage in these committees and society councils, but also reach the society membership at large. Again the NBN can help to facilitate this process and may aid/initiate a behavioural change – what the naturalist very often does is to go out seeking personal enjoyment, which is perfectly fair and laudable – but trying to see this personal betterment they receive from studying nature may, perhaps, not just be useful to be stored as personal record cards on a disc, but may, with a little more effort, become electronic data and therefore be available in perpetuity and to a wider audience. So, these are the type of things we try to bring to the societies practically. But we felt that whatever this English Nature/Natural History Museum partnership tries to do should also be observed and evaluated externally and independently. This is because, very often, these initiatives start, they achieve something, but a proper evaluation is then done by the people who do the work themselves, and this may not always reap all the rewards that can be gained from such a project.

How much progress have we made so far? A very interesting study, that attempted to take the route of the furry, feathery, beautiful, was with an insect. We launched the National Mole Cricket Hunt. This is one of Britain's largest insects and is now presumed to be extinct, as the species has not been recorded for the last few years. The National Mole Cricket Hunt received enormous press coverage. It was one or two days after the general election and perhaps people were saturated with politics, but the public really seemed to enjoy the hunt for this insect! We received coverage in four national newspapers, 27 regional papers, BBC Wildlife Magazine, 13 radio interviews, BBC Breakfast News and London Live Television. With the printed media alone we reached more than 8.5M people, so it was a huge success in terms of reaching a wide and potentially new audience. It resulted very quickly in 150 enquiries (nearly 250 enquiries now). So, you can get 250 enquires from the 8.5M people who've read or seen the coverage - but remember, this is a spectacularly large insect. Out of these 250 enquiries, there have been 12 good leads that we will follow up. So, by next summer, we hope that we can report that the mole cricket is still alive and well, and resident in the UK. No crickets have been seen yet, but fresh burrows have been observed, so we this may become a success story after all. This is the result of approaching the public at large and it is very encouraging to see that there is so much interest out there. However, it appears as if it is not the best model to move the whole project forward. While this is specific success story for a creature that fuelled the imagination of the public easily, to initiate such a hunt would be impossible and very inappropriate for probably 99% of the invertebrates and cryptogamic plants that we are involved with.

On the cryptogamic plant co-ordination side we have started working towards a national arable bryophytes survey. This project is being developed in very close collaboration with Ron Porley (English Nature), Mark Hill and Chris Preston (CEH Monks Wood). The purpose of the survey is to address the paucity of knowledge of the bryophyte flora of arable land in the British Isles and has been developed by Ron Porley from a proposal he made to the British Bryological Society (BBS) at the end of 2000. A national survey is planned that will run for four years involving a pilot in autumn 2001 / spring 2002 followed by a full launch and workshop in November 2002. This will provide an opportunity to review the results of the pilot and hold training sessions on methodology and species identification. Survey packs including crib sheets to aid species identification, recording cards and detailed sampling methodology will be distributed at the launch and by post to any interested parties.

As well as the national arable bryophyte survey, a repeat of a regional survey carried out in Kent in the 1970s is planned. This survey provides a unique opportunity to observe the change in not only the bryoflora, but to some extent, arable land use over the last 25 years in Kent. This is a locally driven initiative, coordinated by the South East Group of the BBS with support from Ron Porley and the English Nature / NHM partnership. This survey is planned to begin in this year and be completed within two seasons. It will also contribute to the national survey.

In the Invertebrate Co-ordination project we are aiming to reinvigorate the caddis fly, mayflies and stoneflies recording schemes and community. Many rivers are under threat from human activities, and historical records indicate that the populations of many freshwater invertebrates such as mayflies, stoneflies and caddis flies have undergone large declines. More information is urgently needed to determine exactly why these declines have happened, because if we don't know *why* river invertebrate populations are declining we can't take effective action to conserve them.

This project will train people in river fly identification skills and monitoring techniques. Especially, we will try to engage the fly fishing community to help to record these fascinating but under-recorded organisms. Fly fishermen need to know which of these taxa are in their stream, and accuracy down to species level maybe required, as their bait has to be constructed around the streams species composition to fish successfully. Thus, we could help them to become experts on these groups of organisms, but will ask them to part their data to us in return. Thus, eventually, we will get a state of the art data set on these invertebrate groups. Again, we will start locally and then develop regionally/nationally after an evaluation phase.
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I talked a bit about evaluation of progress and here we have started a major new initiative with the Institute for Environment, Philosophy and Public Policy at Lancaster University, a centre of excellence and activity in the fields of Sociology of Science and Social Anthropology, with a strong tradition of researching social practices in nature conservation and Science in Society relationships. Recently an ESRC grant has been awarded to the IEEP-NHM partnership for a 3-year project to investigate and study the work and impact of the two English Nature-NHM Biodiversity Co-ordinators on their target audiences. Here we aim to gain knowledge and advance understanding of the social dimensions of effective biodiversity

protection in the UK. The results of this study on will, hopefully, directly feed into the 2005 BAP review process.

Seeking out new avenues of approach, engaging an as wide as possible community in the process and effective communications are the key elements to success for the BAP process, as far as the English Nature-NHM partnership project is concerned and I believe that we have gone a fair way, but there is much more to explore and to be achieved.

Dr Valerie Keeble, People's Trust For Endangered Species

The benefits of wider involvement – the case of the stag beetle

The first question to answer was why PTES got involved with stag beetle work. The choice of species was, perhaps, more difficult for us as "endangered species" didn't exactly narrow the field! The main reason, of course, was that we wanted to take part in the new biodiversity process. But we also wanted to champion a species that might be viewed as an underdog, one that the public might perceive as being, perhaps, a little less appealing than many others. We were aware that some people, who didn't know us well, viewed us as only being interested in cute and furry creatures, and we were hoping in a small way to correct this assumption. It wasn't (and isn't) true at all because we support lots of work on un-charismatic species; I always use the example of the project to study snails on the forest floor in Kenya to illustrate the point. We thought that although, many people may not love the stag beetle, many of them would, at least, know a little about it. It was a species we felt we could do something about and really make a difference.

We thought we'd taken on quite a difficult task, spearheading and co-ordinating all the work to implement the BAP, and that it would be an uphill struggle to arouse interest in the species, but the complete reverse was true. The response to our request for help from the general public almost overwhelmed us and meeting the demand for information and advice took up a great deal of more time than we had bargained for.

Let's talk briefly about the species itself. It's our largest terrestrial beetle and males can be 2 ½ to 3 inches long. The male has greatly enlarged lower mandibles that look just like a pair of stag's antlers, hence its name. It flies on warm summer evenings to find mates and the females duly lay their eggs close to good supplies of rotting wood in contact with the ground. Its life cycle extends over at least four years and culminates in one short flight season, usually between mid-May and August.

Prior to the national survey in 1998, there hadn't really been any targeted surveying at all, so at the beginning of the work its current status wasn't clearly known. The Joint Nature Conservation Committee (JNCC) had been collecting records from a variety of sources over a number of years. They had 500 records, which enabled us to draw an initial distribution map. In 1996 when we began work, there was a feeling of unease that, even in the stag beetle's core areas, fewer adults were being seen during flight seasons than in earlier years. Of course, we were mindful that the amount of deadwood on which the larvae are so dependent was no longer as great as it had been. Over the previous few decades supplies had been good on account of the deadwood created by Dutch elm disease and the great storms of 1987, but this was no longer the case.

At the beginning of the project, the stag beetle had no legal protection at all. It is difficult to legally protect a species which is widespread and whose females lay eggs over wide areas of the country. For the record, it was listed as 'Nationally Scarce Category B' and was on Annex II of the EEC Species and Habitats Directive.

So, having agreed to take on the role of Lead Partner for the species, we stood by and waited to hear from the DEFRA and, in due course, we received confirmation that we had been appointed Lead Partner. A quick look at the copy of the enclosed Species Action Plan detailed two main threats, loss of habitat through the removal of stumps and other dead wood and possibly, collection for sale. It also listed the four project objectives, which were:

- To raise awareness of the threats to, and the European importance of the species among local conservation groups and communities;
- To identify a series of key sites and monitor these to establish long term trends;
- To maintain strong populations at key sites throughout the current range; and
- To establish habitat requirements through appropriate research.

Altogether we faced quite a challenge and the first thing we did, of course, was to set up the Steering Group. We invited all those whom we knew to have an interest in the species to join us, and many others offered their skills, time and expertise, and we are immensely grateful to them all. As time went on, of course, the make-up of the group changed, as more people joined us and others attended less regularly.

The main partners with whom we have been working are as follows, and many apologies to anyone I have inadvertently omitted to mention.

- The Natural History Museum
- Colchester Museums
- The Corporation of London
- DEFRA
- The Wildlife Trust, London
- Suffolk Naturalists' Society,
- The London Borough of Bromley
- The Forestry Commission
- Hampshire Wildlife Trust
- JNCC
- English Nature

We held an initial meeting to discuss ways in which we might meet the objectives as outlined in the Species Action Plan and at the end of all our discussions we had a summary of twelve action points.

They were:

- Lobbying to obtain at least partial protection for the species;
- Collating existing knowledge about the stag beetle as a basis for future work;
- Investigating trade in the species;
- Understanding the public perception of the species;
- Producing and distributing attractive information about the species and the problems it faces;

- Carrying out a high profile National Survey and sending out prompt feedback to all volunteers;
- Providing advice for land managers on deadwood issues;
- Providing advice and encouragement to the public and gardeners on stag beetle friendly gardening;
- Promoting and funding research to establish the habitat requirements of the species and a greater understanding of its ecology;
- Finding a cost-effective and simple monitoring method;
- Setting up a monitoring system in 'key areas'; i.e. areas with strong populations, areas on the periphery of the range, and areas where the beetle has apparently become extinct. In addition, sites which have been proposed as Special Areas for Conservation (SACs) were also to be included here;
- Liasing with European colleagues and sharing knowledge.

So, now coming on to what we have achieved since those early days.

The first objective concerned the legal protection of the species. How do you protect a species that is really very widespread, and whose females lay eggs in the vicinity of any convenient piece of dead wood? It isn't at all easy. But there was one area where we thought it might be possible to make a difference, and that was in the field of trade. At the time, we didn't know whether there was any trade at all, or, if there was, what its extent might be. A Quinquennial Review of the Wildlife & Countryside Act was going on at the very time that we had our first meeting, and after a lot of discussion we decided that we would make some representations to try to get, at least, some legal protection for the species. In the event, our representations were successful, and since April 1998 the stag beetle has been protected under Schedule 5, Section 9.5, which means that all trade in the species is illegal and those suspected of trading in the species can be prosecuted.

The next thing we needed to do was to establish some kind of baseline against which to measure progress. As I've already said, the JNCC passed us their data and we were able to draw an initial distribution map. We also needed to collate all current knowledge about the stag beetle, and we were very fortunate that a student, Andrew Tullett at the University of East Anglia, was considering his choice of subject for his Masters project. We suggested that he might like to carry out a literature survey. He took it on very willingly and spent a lot of time searching on the Internet and getting in touch with entomologists both professional and amateur across the continent, in Eastern Europe, Scandinavia, France, and Spain. We managed to twist lots of arms to encourage people to translate papers for us. Andrew studied them all and wrote a very comprehensive report. But the bottom line of his report was that we didn't know as much as we would like to have done. We couldn't even answer some very basic questions. Do adult stag beetles eat? Do females lay all their eggs at one time? What role do fungi play in the development of larvae? How far can males fly in search for a mate?

Continuing down our list of actions, we come to investigating trade in the species. This is also a bit of a tricky one, because how do you find this out without arousing interest in the very thing you really want to stop if, indeed, it exists? We didn't have many ways open to us. So we decided we would ask everyone we knew who was a regular attendee at entomological fairs, to keep their eyes and ears open for anything

suspicious. Fortunately, to date we haven't received any reports of trade in stag beetles I am glad to say. We also spent many hours in front of the Internet tapping 'stag beetle' and 'trade' into search engines, to see what we could find, and, fortunately, we didn't find anything to worry about here in the UK. We wrote to a number of learned societies to ask them for their views on the matter. The replies indicated that, as far as everyone could ascertain, there wasn't a problem and, of course, we were greatly relieved. We did have a slight blip when a Japanese businessman paid £27,000 for one stag beetle. This piece of news hit the front pages of all the broadsheets, so we had a couple of busy days trying to put that into some kind of perspective for the public and we discussed the issue on several national and local radio programmes.

Another thing we really needed to know was how the public perceived the species. What did they really think about it? Were they afraid of it? Did they find it interesting? Would they be willing to take measures to help conserve it? The information was essential because we were just about to launch into our public survey and we needed to target all our materials properly. So we did this in a very quick and informal way. There were about twenty of us on the Steering Group and we all agreed to ask ten of our neighbours, family members and friends what they thought about it. We were very encouraged in that we actually received a very small amount of negative feedback. But what struck us was that many people didn't really know a great deal about the stag beetle at all, so clearly, we had to get some information out quickly and distribute it as widely as possible.

Then we were ready to launch the national survey and it was this that took up most of our time over the next couple of years. We needed to find out the current distribution of the stag beetle and to pinpoint key areas for future monitoring and, of course, to raise the public profile of the species. So we printed up 100,000 survey leaflets and distributed them as widely as we possibly could, early in the flight season of 1998. They contained lots of general information about the beetle, such as where they were found and the threats facing them, and suggested ways in which members of the public could help. The leaflets contained pictures of stag beetles and of other species, too, with which they might be confused, and finally, the survey form itself. We tried to keep this as simple as possible while still giving us all the information we needed. We asked for the date and the time of the sighting and whether the beetle was in an urban or rural area. The sex and the number of beetles seen, details of the surroundings in which they were found, and precisely what they were doing, was all of great interest to us. We also invited any comments surveyors wanted to make, such as 'I've lived here 25 years and I've seen them every year except the last two'. Finally, if they were brave enough, we asked them to take a ruler out into the garden and measure the length of the beetle for us (excluding the jaws). On this occasion, we did not ask for the bodies of dead beetles to be submitted, because we were concerned that some people might harm any live beetles they found. But in our next survey, we do plan to make this request.

We had an absolutely overwhelming response. Having thought that it would be an uphill struggle to engage the public, we received over 7,000 completed forms and many of them had multiple records. Some people photocopied the form and continued recording for the whole season. We had boxes and boxes all over the office. It took us ten months of full-time work for one person to get them onto a

database. 90% of these forms had good quality data. Altogether, we had a great deal to work on. In spite of everything, we were absolutely delighted.

But, before I go on to talk about the main findings of the survey, I would just like to emphasise how important we think it is to give volunteers feedback about the overall results of any work in which they participate. As I've said, it took ten months to get the data onto the computer. But by May 1999, a little later than we had hoped, we were ready to send out some early results and thank everyone for their help. Inside the feedback letter, we printed distribution maps and listed how many records we'd had for each county, and suggested areas that might become key sites. By doing this, of course, we hoped to maintain the enthusiasm of all those people who had helped us.

So, now I'll outline the main findings of the survey. The current distribution has changed little when compared to its historic range, but there's still anecdotal evidence that stag beetle abundance may be declining in many areas. One person told us that, years and years ago, when gentlemen still wore bowler hats and went to the pub on warm summer evenings, if he threw his hat up into the air it would often be full of stag beetles when it came down again! He went on to say that nowadays he hardly ever saw one.

Stag beetles are now mostly reported from urban and sub-urban gardens. 70% of the records came from gardens.

Stag beetles can utilise many types of broadleaved deadwood; oak, apple, ash and cherry being the most common.

Stag beetles prefer areas of Britain with the highest air temperatures and lowest rainfalls

They prefer light soils, as females have to dig down to bury their eggs and newly emerging adults have to dig their way to the surface. Certain types of soil act as barriers to dispersal; for example, stag beetles are not able to cross the North and South Downs on account of their chalky soils. The Weald, therefore, has very few beetles.

They seem to follow watercourses; rivers are often bordered by good deadwood habitats, especially oak. The few beetles that cross the Downs do so along river courses.

By comparing the two distribution maps, it can be seen that the core area for the beetles remains the same as previously – mainly the southeast of England, from the Wash to the Bristol Channel. On the map from the 1998 survey, you will notice that we didn't pick up some of the peripheral areas that appeared on the map drawn with the data from the JNCC. This, of course, was because our survey depended on the public and it wasn't targeted at all. There was no way we could ensure an even amount of effort was put into surveying all areas. We are going to repeat the survey in 2002, and will be making strenuous efforts to concentrate on these peripheral areas.

We were very keen to get some advice on deadwood management to land managers as soon as possible. Deadwood is the habitat not just for stag beetles but for many other invertebrates, too. So we prepared a 'Stags in Stumps' leaflet and worked hard to distribute it as widely as possible. The main piece of advice was to leave fallen trees if at all possible.

Research. There's still so much to find out about the ecology of the stag beetle. We are fortunate in that there is a part-time PhD student at Royal Holloway, Deborah Harvey, who is doing some great work. Among other things, she is looking at diet and at the relationship between soil fungi and the development of the larvae. She has already got some quite interesting results and one thing she's discovered already is that the new adults do not spend the winter in their cocoon, but leave it in autumn and over-winter in the soil before digging their way to the surface the following spring. Of course, now everyone is wondering why this is.

The other area of research that looks promising is on stag beetle pheromones and that's progressing well at Rothamsted.

We needed to find a cost-effective and easily repeatable method to monitor our species, so during the summer of 2001 we trialed two methods, one high-tech and the other dependent on reliable volunteers. For the latter, we carried out a road-kill survey, asking people to walk up one side and down the other side of the same 500 metres of road at least one evening a week for six weeks during the flight season, and to pick up all the dead beetles they found. That's asking a great deal of lots of people. We had 50 or 60 people helping us, which was quite an encouraging number. Even so, the number of records we received wasn't sufficient to allow any reliable conclusions to be drawn.

For the former, Dr Jason Chapman and his colleagues at Rothamsted IACR, in association with Deborah Harvey at RHUL, have also been trialing the use of chemical attractants. It would be so much easier if the beetle came to you and you didn't have to go looking for the beetle. So, scientists at Rothamsted have isolated a male pheromone, which is used to attract females to strategically placed traps, allowing regular counts to be made. Early signs are that this will be a very effective monitoring tool, but there are still some problems to resolve, not the least, the problem of getting our hands on sufficient quantities of the pheromone for use in the field.

We feel that we are making good progress on the monitoring question and will be developing this work further in 2002.

The last action was one of liasing with our European colleagues to put our work into a European context, and share our experiences with continental colleagues. We at PTES had planned to host the second European Saproxylic Beetle Conference in June 2001, but we postponed it for a year on account of the outbreak of foot and mouth disease. This will now take place in 2002.

Another of the questions Dave Stone asked me to talk about was how we managed to engage the public so successfully. We had very little previous experience of this kind of thing and we didn't have a PR department at the time. We just thought, if they read

it, saw it or heard it, let's get the survey written about, shown or spoken about .We organised a launch and Mr Meacher came to Richmond Park. He was a great sport and agreed to be photographed holding a beetle and smiling at the same time. Actually, it was a dead beetle, because it was a bit early in the flight season and we couldn't lay our hands on any live specimens on the day! But he stayed for quite a while and we got lots of press, television and radio coverage. We were on Blue Peter and the story line went on to the Archers. I was interviewed on the Today programme. We got our survey leaflets into libraries and schools. We fielded quite literally hundreds of telephone calls. We found we had to be available at all times to talk about stag beetles, however inconvenient. We tried to be upbeat and enthusiastic and did our best to answer all those awkward questions some people love to ask while retaining our sense of humour. We were very lucky. The whole survey quickly caught the public imagination and we received 10,000 sightings of beetles to help us to write what was a very useful base-line report.

I want now finally to talk about the benefits of wider involvement. There were and still are, of course, many stakeholders in this work of implementing the BAP for the stag beetle and I hope all of them have benefited from joining in.

First of all, we felt that the survey gave the public a real role in helping to conserve biodiversity and for many people even, a way in to begin to understand what biodiversity is and its role in enhancing the quality of all our lives. It is our experience that serious matters like this can be very off-putting for people with busy lives and with other interests. They are often, in fact, made to feel part of the problem because they use their cars a great deal or consume too much energy, for example, and they feel powerless in the face of such serious and wide-ranging problems. They never imagined that they really could make a difference and many people said how encouraging it was to do something practical to help, however small. We made great efforts to ensure they knew how much we valued their contribution to the survey and stressed that their record was not only valuable to us, but it was unique. If they didn't send in the record of the stag beetle in their garden, we would never know about it because nobody else would have done it. They then begin to feel like stakeholders in the biodiversity process rather than an obstacle in the way.

I think that for many people the survey stimulated their interest in the natural world and increased their understanding of wider conservation issues. Many have been asking what they can do to help in future. We have tried to retain their interest by talking, for example, about how by building a log pile they will help not only help stag beetles, but other invertebrates, too, and by leaving an untidy patch in their garden, other species such as hedgehogs will benefit, too, because they can more easily find material to build their nests, and so on

For all of us who need to monitor our species, having large numbers of enthusiastic volunteers is a great bonus as it does keep the cost of the surveying work down. And even large numbers of professionals couldn't possibly cover the same amount of ground as an army of good volunteers.

Looking at it from our own charity's point of view, by leading on a BAP species, we are targeting our conservation work and resources where the need is greatest and using the public money we raise to the best advantage. We're also making a

contribution to achieving wider objectives, the objectives of the BAPs. We're forging relationships with other conservation organisations, which perhaps we wouldn't otherwise have pursued with such determination!

Another important point – it's taught us to question received wisdom. We'd been telling people all year that at the end of the flight season adult stag beetles die. Then we had a phone call in February 2000 and somebody said, 'I've found a live stag beetle'. The person didn't live very far away from our offices in London and so she brought it in. It was indeed a stag beetle – it did have one leg missing but, nevertheless, it was very much alive.

In the same vein, we also lead on the *Gnorimus nobilis*. The Steering Group for this species had decided not to call for sightings from the general public because we thought it was so rare that nobody would ever find one. And one day, I spoke to a journalist on the Daily Telegraph about the BAP work in general. An article appeared in a Saturday Telegraph some months later mentioning the species, and by Wednesday of the following week, I had a *Gnorimus nobilis* on my desk! The public can be a great ally.

Involving business. Tog 24 gave us some money – not a huge amount, but it was extremely useful to us. We hope they benefited from their 'green credentials' and we certainly benefited from the money. By encouraging partnership, the Government see their national and international obligations met.

We were delighted to work so closely with the Wildlife Trusts. They gave us copies of their local records for the national database and we passed appropriate records from the national database to the individual county trusts. Working together has also given us all a clearer understanding of what we are each doing and forging new links that we can develop in future.

Researchers have really enjoyed collaborating with us. John Pickett said to us recently that he absolutely loves working on the stag beetle pheromone project, as most of his work is developing ways to kill crop pests. This is the first time, he told us, that he is actually working to conserve something.

Lots of students have come in to help on short projects for their MScs, for example Andrew Tullett, who conducted the literature search. It helps them with their studies, we get useful results from it and it helps them further their careers.

This is by no means an exhaustive list of the benefits of working together, but like John Pickett, I know that we have all enjoyed the work so far. We just hope that we can maintain the enthusiasm we have generated and continue to move forward towards achieving the goals as set out in the stag beetle BAP.

D A Joyce, S Burke, L A Martin, and A S Pullin

Genetics of Butterflies: Understanding Leading to Conservation

The Species Recovery Programme has funded a team at The University of Birmingham to work on the conservation genetics of various threatened species of Lepidoptera, and this paper summarises the work and the implications it has for the conservation of the species concerned. Three aspects of conservation genetics will be discussed: 1) taxonomic questions, 2) genetic structure and diversity and, 3) species recovery through reintroductions.

Taxonomic questions

An effective species conservation strategy requires a stable taxonomy so that the relative status of populations is understood, allowing prioritising of actions. The following examples of the large heath butterfly (*Coenonympha tullia*) and related work on brown argus (*Aricia*) species illustrates this problem and how genetic analysis can help resolve it.

The large heath is restricted to wet boggy habitats and its larvae feed on the cotton grass, *Eriophorum vaginatum*. This habitat is declining in the UK, so the butterfly is under considerable threat from habitat loss. In the UK, *Coenonympha tullia* is currently split into three subspecies based on wing spot polymorphism. *C. tullia scotica* [Staudinger] is distributed throughout the north of Scotland and is characterised by inconspicuous or absent ocelli. *C. tullia davus* [Fabricius] has large conspicuous ocelli and darker background wing colour. *C. tullia polydama* [Haworth] is intermediate, with 0-6 conspicuous hindwing ocelli. There is, however, considerable intrapopulation variation. Emmet and Heath (1989) note that the genitalia of the three subspecies are indistinguishable in both sexes and suggest that only *C. tullia scotica* should merit the subspecies title since a degree of geographical isolation as well as taxonomic distinctiveness is a prerequisite. Given that the species concept itself is difficult to define clearly, the concept of subspecies is an even greyer area, but this definition is quite useful: a subspecies indicates a group of organisms that is geographically isolated from and may display some morphological differences from other populations of a species, but is nevertheless able to interbreed with other such groups within the species where their ranges overlap.

A conservation question is whether the morphological differences reflect genetic differences that have arisen due to isolation, and therefore reduced gene flow (because reduced gene flow will lead to increased differentiation). If this is the case, it could be argued that to conserve biodiversity, we can use the subspecies types as units for conservation, and therefore place emphasis on the southern *C. tullia davus* populations, of which there are fewer (conserving populations of this form will by definition conserve biodiversity).

Early results suggest that there is no clear genetic basis for the subspecies status of populations although there is evidence of genetic differentiation across the range that may form a cline. Work already completed on two other closely related species, the

brown argus, *Aricia agestis* and the northern brown argus, *A. artaxerxes*, serves as an example of how such taxonomic information can be used in conservation.

A. agestis and *A. artaxerxes* are very similar in morphology and there is some disagreement regarding the taxonomy and distribution of the *Aricia* species complex in the UK. A combination of voltinism and morphology, using the presence or absence of a white wing spot have been used to differentiate species and subspecies within the UK and in Europe. Within the UK, morphological traits are not considered reliable enough to separate *A. agestis* and *A. artaxerxes* so voltinism was used as a defining character, with univoltine northern populations (*A. artaxerxes*) generally having a white wing spot absent in southern biovoltine populations (*A. agestis*). This resulted in considerable uncertainty over some populations with many apparent exceptions to the rule and the splitting of the univoltine populations into two subspecies, *A. artaxerxes artaxerxes* and *A. artaxerxes salmacis*. The white wing spots also differentiated the *A. artaxerxes* from another *Aricia* in Scandinavia, *Aricia allous*. If this classification is correct, *A. artaxerxes* would be considered an endemic species and therefore of increased importance from a conservation point of view.

To resolve this uncertainty Aagaard et al. (2002) sequenced four hundred base pairs of the mitochondrial *cytochrome b* gene from a number of populations from across the UK and northern Europe, as well as two other lycaenid butterflies as outgroups. Kimura's 2-parameter genetic distance was calculated and a UPGMA tree showed the formation of two clear clades (Figure 1). The presence of these two clades indicates that two closely related but separate species are present with clear differentiation between them: *A. agestis* and *A. artaxerxes*. Populations from Scandinavia and northern UK fell into the *artaxerxes* clade, indicating that UK *artaxerxes* are conspecific with populations found in Scandinavia and are therefore not endemic to the UK. Southern populations fell into the *agestis* clade, including some populations that had previously been misclassified as *A. artaxerxes* on the basis of voltinism. These univoltine populations at the southerly end of the *A. artaxerxes* distribution were actually *A. agestis* at the northern end of the *A. agestis* range. It is evident therefore, that neither voltinism nor morphological characteristics such as wing spots can be used to reliably distinguish species.

Additionally, the distributions of the two species in the UK have now been corrected. This simplifies planning for species since geographical location can be used diagnostically. Furthermore, a laboratory check with a diagnostic restriction enzyme has been developed which produces different sized restriction fragments according to species.

An important implication is that *A. artaxerxes* has a more restricted distribution than previously thought, so further population monitoring must ensure populations do not further decline.

Genetic structure and diversity

An issue in conservation management is the scale at which populations should be managed and subpopulations viewed collectively as management units, which may be informed by studying the species' genetic structure. The Marsh Fritillary, (*Euphydryas aurinia*) occupies open, grassy habitats in the UK, most of which are

separated from one another by unsuitable habitat such as agricultural land. Populations are declining and becoming more and more isolated from one another. The east-west decline can be clearly seen by comparing past and present distribution maps (Asher *et al.*, 2001). This is a result of habitat loss due to agricultural development and also incorrect management. For example, cattle or pony grazed land is suitable, whereas sheep grazed land is unsuitable. Any habitat left is becoming more fragmented, broken up by unsuitable habitat and so the populations associated with that habitat also become fragmented. A fragmented population structure means that there may be less migration of individuals between populations, and reduced migration has further implications such as small effective populations sizes, which can lead to inbreeding and a reduction in genetic diversity.

There is also an added factor for the marsh fritillary; a larval parasitoid that can cause individual populations to decrease to extremely low numbers, after which they might recover, having gone through a genetic bottleneck. This bottleneck also leads to small effective population sizes, and in turn to inbreeding depression and reduced diversity. Should a population become extinct, that habitat patch might be recolonised when adult butterflies migrate into it from nearby patches. If the population structure is fragmented, and there is reduced migration, there is less chance of these recolonisation events taking place. Marsh fritillary populations were sampled from range of spatial scales (Figure 2); at a local scale, a regional scale and at a national sale in order to get a picture of the genetic structure of populations in the UK. Allozyme electrophoresis was then used to measure genetic diversity, and to investigate population substructuring.

Two different diversity indices were used to examine genetic diversity in the species, the number of alleles found, and the average heterozygosity (equivalent to Simpson's species diversity index), which measures allelic richness as well as number. Using both measures it is clear that certain populations are genetically depauperate, for example, Lincolnshire, and some are fairly diverse such as the population sampled from Northern Ireland. The Lincolnshire population was introduced (apparently using only 3 founding individuals) by some local enthusiasts about 9 years ago and this founder effect is almost certainly responsible for the low genetic diversity in this population. In natural populations, compared to other lepidopteran species, genetic diversity levels are slightly above average, suggesting that diversity levels are not yet a cause for concern. However, this could be an artefact of not enough time having passed for the genetic structure to clearly reflect the current population structure. Fluctuations in population numbers caused by the larval parasitoid should mean that, even if habitat were not fragmented, effective population sizes are small, so diversity might be expected to be low, as discussed further below.

A genetic measure termed F_{ST} gives an estimate of the amount of population substructuring, by looking at the total heterozygosity of the entire population, and seeing how each subpopulation differs from the entire population. So if populations are completely different, the F_{ST} value is 1 and differences are fixed. An F_{ST} not significantly different from zero implies no substructuring. By using different 'total' populations, and comparing the populations within them, we can get an idea of the scale at which structuring becomes significant (Figure 2). For local populations within about 20km from each other (e.g. 15 and 16, 13 and 14, 10, 11 and 12, 1 and 2), the F_{ST} values were not significantly different from zero, which seems appropriate given

that the dispersal distance of the butterfly is thought to be about 15-20km. At larger scales, the F_{ST} values reach 0.05-0.1 and are significantly different from zero, and the F_{ST} value for the UK populations at a national scale is 0.16, which differs significantly from zero. This implies that at the local scale, as you would expect, there is no substructuring of populations; they're effectively mating at random.

The migration between populations at a local scale is effectively gene flow, and it means that populations are (or have been until recently) well connected with one another through gene flow. The lack of substructuring therefore implies gene flow between populations that could be a result of repeated extinctions and recolonisations at this local scale, and/or migration between populations. If gene flow occurs, differentiation does not, and the effective genetic population size is large. This is probably the mechanism, which maintains genetic diversity. It could be argued then, that in order for the marsh fritillary to retain genetic diversity, local scale (20km) populations of populations or metapopulations need to be maintained, and the best way to do this is to maintain and create close, connected patches of habitat. In fact it is unlikely that isolated populations will have much chance of long-term success. Future conservation priorities may have to lie in areas with substantial numbers of populations remaining in close proximity where connectivity can be maintained or rapidly restored.

Species Recovery

When species recovery involves re-introduction into former habitats it is not always clear which donor populations or stock should be used. Particular concerns can be raised over the genetic similarity between the extinct and donor populations in the context of local adaptation and over the fitness of the gene pool when donor populations have been captively bred. The latter was of greatest concern in the recovery plan for the large copper butterfly, *Lycaena dispar*.

The large copper went extinct in England around 1864 but several attempts have been made to reintroduce it into restored habitat in the East Anglian Fens and Broadland (Webb & Pullin 1997). Captive stock kept at Woodwalton Fen NNR was derived from a Dutch population of *L. dispar* over 70 years ago and the question of whether this captive stock was suitable for release arose because experiments in the field indicated that the survival rates of larvae from this stock are lower than survival rates of wild caught larvae.

This could be a result of loss of genetic diversity through genetic drift and inbreeding depression, so we looked at genetic diversity levels using allozyme analysis. The Woodwalton Fen stock was compared with a wild population from Holland, and two other captive populations obtained from breeders, which are also believed to have originated at some stage from the Woodwalton captive stock.

The heterozygosity value for the wild population was 0.17, and the stock derived from Woodwalton Fen was slightly lower at 0.13. The two captive populations thought to originate from the Woodwalton captive population, showed the lowest diversity levels, as we might expect from populations that have been in captivity for a large number of generations, and are in turn used to found other populations (Table 1).

A similar pattern can be seen when the number of alleles are counted, with the wild population containing the most, and each of the captive populations seeming to have lost alleles, and it is this allele loss that may be detrimental to them, so this may indeed be a factor in the observed reduced larval survival of captive bred individuals, compared to wild stock. Additionally, selection for adaptation to captive (glasshouse) conditions may also have occurred, and this is something that a survey of genetic diversity would not necessarily detect.

The results tend to suggest that if the reintroduction is to succeed, the captive stocks kept in this country are not currently suitable, and should at least be reinforced by adding wild caught individuals in attempt to increase the genetic diversity, thus restoring them as a valuable commodity for the *ex-situ* conservation of the large copper. Given the added possibility that captive populations have become adapted to captivity, we suggest that wild stock should be used preferentially for reintroductions.

A species where the origin of the donor stock was of concern for reasons of local adaptation and similarity to the extinct populations is provided by the chequered skipper butterfly, *Carterocephalus palaemon*, which became extinct in England in the seventies as a result of changes in woodland management causing habitat loss. The species is still extant in Scotland, and the chequered skipper can also be found in continental Europe. In order to reintroduce the butterfly back into suitable habitat in England, a choice between using Scottish or French/Belgian populations as the donor needed to be made.

There are some differences in ecology between the Scottish and European skippers. This could be a result of two separate migration events into the UK after the last ice age, so that Scottish and English butterflies survived in separate refugia at the time of the glacial maximum approximately 20,000 years ago. The basic question we needed to address was, did Scottish and English populations share the same postglacial origins?

We used mitochondrial DNA sequences to look for differences between the European and Scottish populations, and we also extracted DNA from English museum specimens to see how an English population fitted in to the picture (Figure 3). Scottish, English and European populations all seem to come from the same ancestral population, so the ecological differences between them are not historically deep rooted and are more likely to be a fairly plastic response to a change in environmental conditions. An experimental reintroduction has been carried out using Belgian populations as donors since they are most similar to the extinct English population based on ecological differences. Larval survival field trials have been carried out, and second generation adults were seen for the first time last year. Whether the experimental introduction will be a success remains to be seen, and it also remains to be seen whether or not a full-scale reintroduction is viable.

Summary

The work presented here illustrates the use of genetics to resolve issues of taxonomy and conservation priority; issue of the geographical scale of management action, and issues of the choice of donor populations for re-introduction programmes. In our

experience genetic analysis is most useful when combined with ecological (habitat and landscape) information, and in tandem they can be used as powerful tools to formulate species recovery strategies.

Table 1 Mean observed and expected heterozygosity and average Heterozygosity for populations of *Lycaena dispar*

Population	He	Ho	Mean no. alleles/locus	Av. H	% loci Polymorphic
Dutch	0.17	0.15	1.8	0.104	55.6
CAPWY	0.08	0.10	1.3	0.104	22.2
CAPWH	0.06	0.05	1.4	0.104	33.3
WWF	0.13	0.15	1.6	0.104	44.4
Rutilus	0.14	0.13	1.4	0.070	22.2

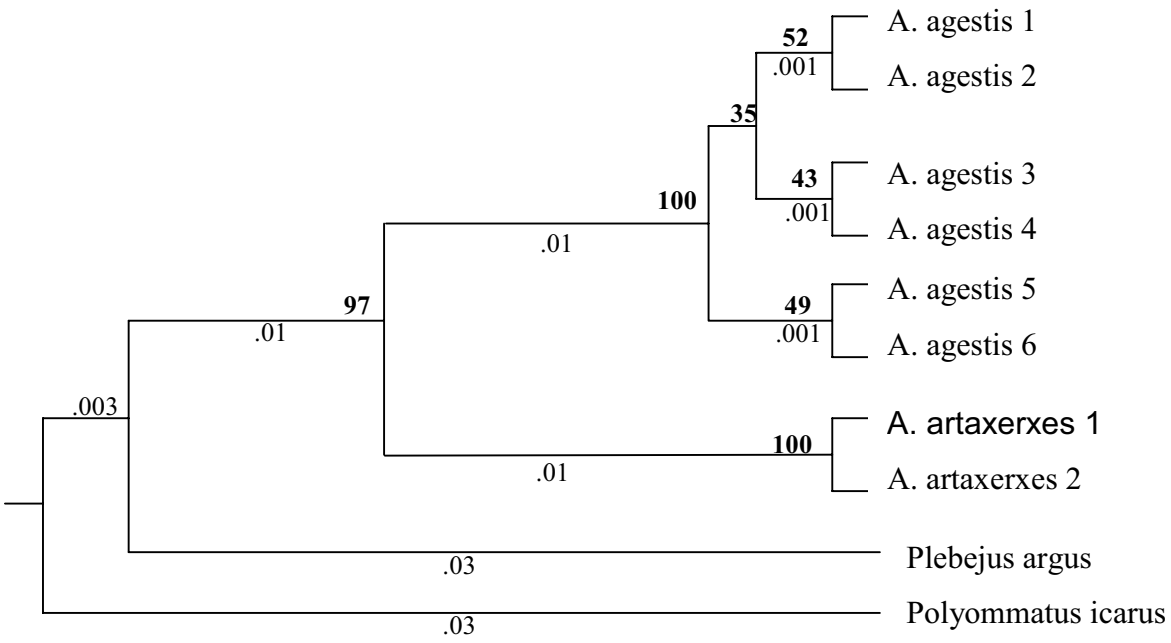


Figure 1. UPGMA tree based on Kimura's 2 parameter genetic distance where numbers below branches indicate branch length and numbers in bold at nodes indicate bootstrap values.

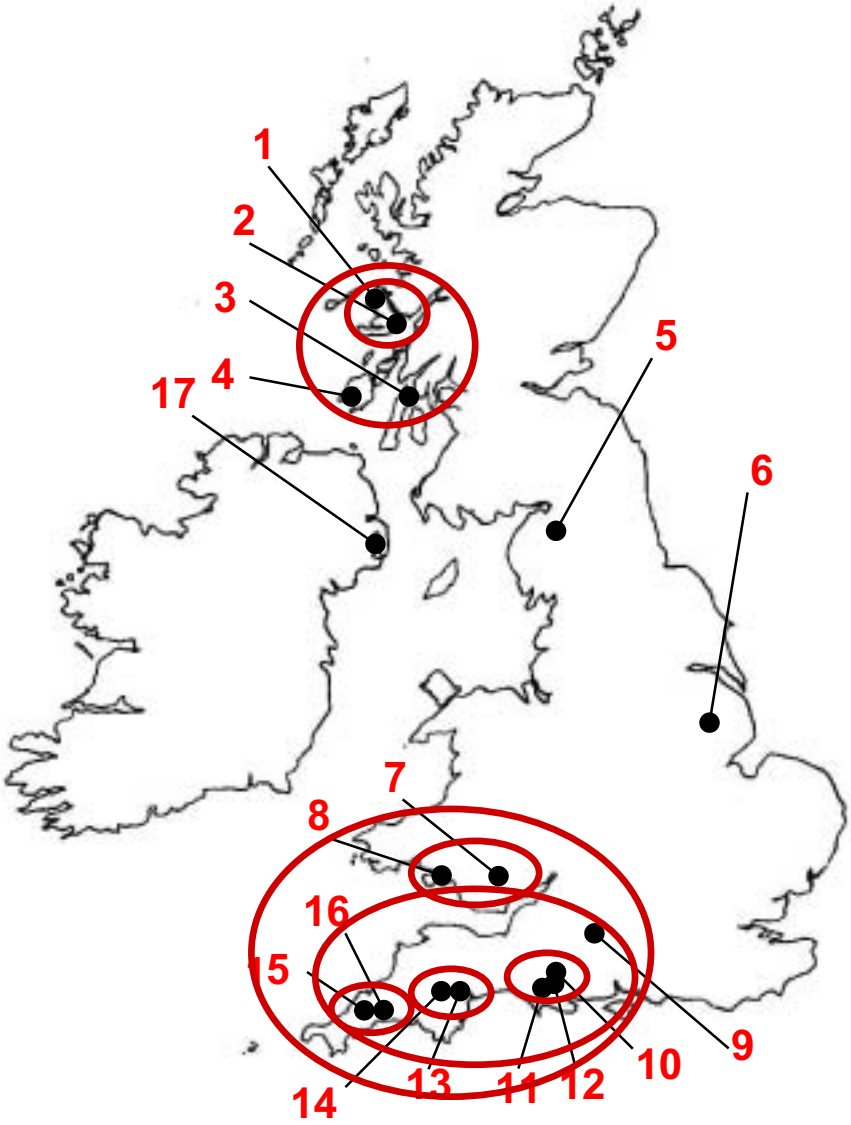
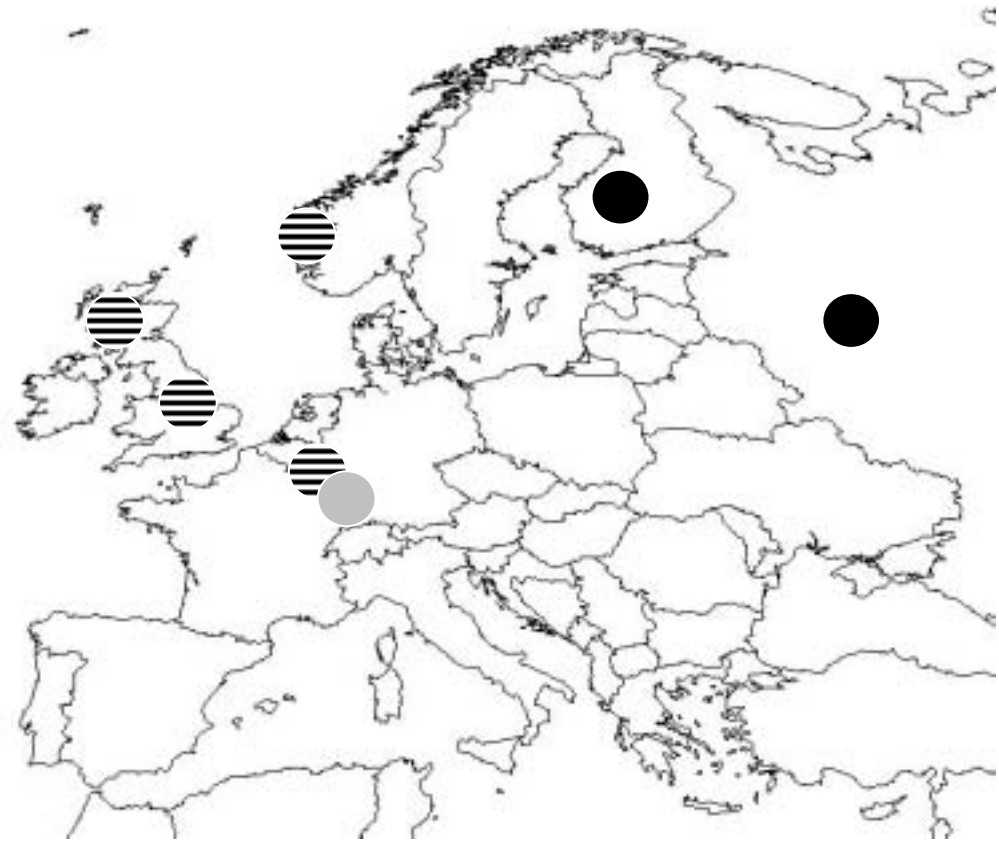


Figure 2. Groups of marsh fritillary populations tested for genetic structure. Population key: 1. Ledmore, Mull 2. Loch Don, Mull 3. Argyll 4. Islay 5. Middlesceugh, Cumbria 6. Chambers Wood, Lincs 7. Aberbargoed 8. Pengwern Common 9. Salisbury Plain 10. Rooksmoor, Dorset 11. Hog Cliff NNR, Dorset 12. Cerne Abbas, Dorset (pictured) 13. Vogwell Cottage, Dartmoor 14. Broadaford Farm, Dartmoor 15. Goss Moor, Cornwall 16. Breney Common, Cornwall 17. Murlough NNR, N. Ire. Circles indicate the different levels at which F_{ST} values were tested.



Haplotype	*Position in sequence*		
	120	129	135
stripes	T	A	T
grey	T	A	C
black	C	G	T

Figure 3. Distribution of mitochondrial DNA haplotypes, where different haplotypes are represented by different colours.

Dr Michael F. Fay, Royal Botanic Gardens, Kew

Conservation Genetics of *Cypripedium calceolus*

The 1990s were an exciting time in terms of the development of different types of techniques and their application to wild species. Many of them were developed as the result of big projects like the Human Genome Project and associated projects. For example, DNA sequencing was something that developed rapidly in the 1990s as a result of those projects. In plant conservation activities, we use some of the techniques for our own projects, although many of them probably wouldn't have been developed if they were just being used in conservation. The ones I want to talk about today are DNA sequencing and two types of genetic fingerprinting (AFLPs and microsatellites).

Most DNA is found in the nucleus. This is divided into chromosomes, half of which come from the maternal and half from paternal background. However, there is also DNA elsewhere in plant cells, in the plastids (chloroplasts etc.) and mitochondria. Unlike the nuclear DNA, these types of DNA are organised in circular chromosomes. In most flowering plants plastid and mitochondrial DNA is only inherited from the maternal lineage. However, in conifers and in a few documented examples of flowering plants, it can be inherited from the paternal side.

Mitochondrial DNA, although widely used in animal genetics, is not much used in plant genetics partly because it has a much lower level of sequence evolution than the plastid DNA. In animals, mitochondrial DNA is used for looking at the differences between individuals and between populations, and in plants the level generally is not high enough for these purposes, and therefore plastid DNA is normally used.

When we started working on *Cypripedium calceolus*, the lady's slipper orchid, we were asked a series of apparently simple questions:

- Was there any variation between the UK plants?
- Are they all native plants?
- Which plant should be used for introduction or reintroduction?

However, the more complicated question, as it turned out, was which technique should we use to try and answer those questions?

Tony Cox (as part of his PhD) used DNA sequencing to study *C. calceolus* and its relationships. He showed that *C. calceolus* in Eurasia is more closely related to *C. macranthos* than it is to the brown and yellow lady's slipper orchids in North America, which have been included in *C. calceolus* by many authors. On the basis of these results, he recommended that the North American taxa should be recognised as distinct species. However, within Eurasian *C. calceolus*, he was unable to detect any variation.

In the mid 1990s, we decided to investigate DNA-based fingerprinting, and the chosen technique, AFLP (amplified fragment length polymorphisms), is one which

has now been widely used with cultivated and wild plants. However, with *C. calceolus*, there turned out to be problems concerning this technique. For AFLP, we extract total DNA from plant tissues and cut the DNA up into pieces using two enzymes, and then, through a series of steps, you end up with a genetic fingerprint made up of a series of bands, which can be visualised on an automated genetic analyser. The bands are scored as present or absent in each individual, and the resulting data are analysed.

However, this technique is strongly affected by the amount of DNA in each cell. This can vary greatly between different species, and the standard technique was designed for taxa with 0.5-6.0 pg of DNA in each set of chromosomes. *Cypripedium calceolus* has 32.4 pg, more than five times the optimal maximum quantity! This means that the standard AFLP technique is not appropriate for use with *C. calceolus*, and the results that we obtained were impossible to interpret reliably.

We therefore decided to investigate another type of marker – microsatellites – to try and get round the problem of genome size. Microsatellites are highly repetitive and highly variable pieces of DNA, and the most widely used microsatellites are found in the nuclear DNA. They are widely used in forensic studies and in crop plant breeding. However, this type of microsatellite requires a period of development of several months before they can be applied to a project. We are in the process of developing nuclear microsatellites for *C. calceolus*, but we do not have the results yet.

A variation, which is now being applied more commonly, is the use of microsatellite-type sequences in the plastid genome. This genome is far better characterised than the nuclear genome, and this means that this type of microsatellite is relatively quick to develop. It also avoids the problem of the large nuclear genome in *C. calceolus*, as there is much less variation in the size of the plastid genome than there is in the nuclear genome.

Plastid microsatellites are simple to analyse, as each individual will only possess one allele for each microsatellite. In simple terms, this means that they produce a fingerprint consisting of only one band. An added advantage of this type of marker is that they can be used with degraded DNA – if you get a band it is the right band, and if you don't get a band then the DNA is too degraded. We have shown that DNA from herbarium sheets more than 100 years old can be used in some cases, which opens up the possibility of using them for looking at historical patterns.

We have identified several of these plastid microsatellites in *C. calceolus*, and have screened them in a wide range of individuals from the UK all the way across Asia to China. In Western Europe, we found two common variants, 'x' and 'y', and all plants of known UK origin represented these types. However, the two plants thought to be potential introductions had different variants 't' and 'z'. One of these plants matches material from Austria in our analyses, but the other had a unique set of markers. In conjunction with other information which suggests that these might be introduced plants, we have advised English Nature these plants should be excluded at the moment from any reintroduction trials because they are likely not to be native.

The unique combination ‘z’ made us suspicious, and we therefore went back to doing DNA sequencing and it turns out that the sequence from this plant is a perfect match for the North American species, *C. pubescens*, and that it isn’t *C. calceolus* after all!

In conclusion, our genetic studies on *C. calceolus* have eventually produced answers to the questions posed at the beginning of this project. Lessons that have been learned are that not all techniques are suitable for all species, and that not all plants are what they seem to be!

Steve Compton, Centre for Biodiversity and Conservation, University of Leeds

Endemic Beetles in Britain: How Many Are There?

The first thing to note is that I am very much a mouthpiece here and that Ross Piper produced the genetical work I will describe. And also, by way of acknowledgement, I wish to say that we can only do the work if beetle collectors like Peter Hodge can actually go out there and find the very rare specimens of these animals.

Rather than talking about the loss of biodiversity, the two themes of my talk are going to be assessing how much biodiversity we've got and also looking at how that biodiversity can actually be generated within the country. We are measuring biodiversity here in terms of species and, specifically, endemic species and endemics, of course, have a very high conservation priority. After all, they have chosen to put all their eggs in *our* basket, so they should be quite important. But, at the same time, if we are putting resources into endemics that, further down the line, turn out not to be endemic at all, then perhaps these resources might have been better placed elsewhere.

You don't have to look very far back in time to realise why we haven't got very many endemic species in Britain. If you go back about 15,000- 20,000 years, much of Britain was covered by ice and most of the species that we have in Britain now have had to recolonise in that last few years. So there certainly hasn't been a long time for us to be generating many endemic species since the Ice Age.

Plants have been reasonably successful at generating biodiversity in Britain and there is a reasonable number of endemic plant species, if you include all the micro species in certain groups. Through their diverse reproductive systems, plants can generate new species more quickly than animals. In any case, many of those species are actually micro-species, although there are some of them that are reasonably well defined including Lundy cabbage, which is a species I will be saying more about as we go along.

The Lundy Cabbage is a cliff-side species and, as far as we know, is only found on the Isle of Lundy in the Bristol Channel about 12 miles from the mainland. How did that endemic species end up on Lundy and why? There are two general ways in which an endemic can be generated. Lundy cabbage could be a last remnant of a very old species, a species that was perhaps pushed to a refuge in southern Spain, where most of the close relatives of Lundy cabbage are today. It may have subsequently recolonised Britain and has then died out in Spain or wherever it used to be. So it might be an old species. Alternatively, it could be a new species that has formed on Lundy or in the area near Lundy, perhaps through being separated from the mainland, and through divergence of the population there. And if it is a new species, then the most likely parent species is the Isle of Man cabbage, which occurs in different habitats. It occurs in sand dunes and is found along the west coast of Britain and is the only native close relative of the Lundy cabbage.

If we take a little step backwards and think about endemic species in general and how we might determine whether something is endemic or not, there are some problems. The first point to note is that we've got a long history of very active taxonomists in

this country, who often describe species based on British material. If they only describe their species on the basis of British material then, at least temporarily, that species is going to be an endemic. To be an endemic, you have to pass two tests, and they are not particularly easy tests for us to give certain answers to. One of them, which I would probably regard as the easier test, is the taxonomic test. Whether it's a distinct species relative to other species in the genus. A more difficult test in many ways is the distribution test. Does it genuinely only occur in Britain? I think my take-home message here is that most of the species that have at least temporarily been regarded as endemics, are largely just transients and after better information they'll fall by the wayside. Secondly, particularly when we're talking about some of the small, more cryptic insects, it's almost impossible to be sure you are dealing with endemics or not because you are having to prove a negative. You have to show that it doesn't occur in France, in Spain or wherever, and maybe in the future the knowledge of those kinds of groups will be sufficient, but it isn't now.

We do have some species of beetles that are potentially endemic to the UK such as the little weevil, *Protapion ryei.* Often they are found mainly on islands, in this case on northern Scottish islands – Orkney, Shetland and the mainland of northern Scotland.

If you have a look at those potential animal endemics you can see why I've chosen the beetles to talk about. This is some data extracted from a very good English Nature report that Peter Hammond did back in 1996, where he looked at the UK endemic invertebrates, and this is really a summary of his conclusions. In terms of terrestrial arthropods, there are five non-insects that might just be endemics, and a couple of non-beetle insects, but the vast majority of those potential endemics are beetles. If you look in a bit more detail, at those 18, some he didn't even consider because he was convinced they were likely to be synonymous with other species. For example, because their closest relatives are in New Zealand, they are very likely to be relatively recent introductions into the UK. There were three small cryptic species that hadn't been found on the continent yet and he thought that, if you spent enough time and money, you might be able to find them there. And he was left with nine species then, which he thought were potentially serious candidates for being endemic beetles.

He'd still got four of them, which he thought were unlikely, once they were studied, to prove to be endemics. There were three species that he thought had a pretty weak case and there were only two species that he thought genuinely looked to be promising candidates for endemic beetles. I'm going to talk about the work we've been doing on those two beetles today.

Cathormiocerus britannicus - first of all, it's a small, grey non-charismatic beetle. We know very little about its ecology. We know something about its status. We know that, until this study, it was known from not much more than a handful of specimens. It's found down in the SW corner of England in short grasslands and we think the larvae probably feed at the root of plants. There are particular complications when you are thinking about its species status because the populations are parthenogenetic, so there are only females anyway and no sexual reproduction. In particular, it's close to *Cathormiocerus myrmecophilus* but separated on some fairly minor characteristics of the external anatomy of the adults. We asked how good is the evidence that *C. britannicus* is distinct from *C. myrmecophilus*, which is an RDB3 species but does get across the Channel.

So, the first thing then was to collect a lot more specimens than has ever previously been done. I think we doubled or tripled the known specimens of this species. Well, Peter Hodge did! We took lots of measurements, particularly measurements with relation to the two or three morphological characteristics that were thought to distinguish it from its close relative. When you look at those characteristics individually you really do struggle to find any differences within this larger data set. What you can also do is put all of that morphological data together and produce a multivariate plots called a principle components analysis. This plot shows very simply that any two specimens that are close together in this mathematical hyperspace are also more similar to each other. What you find is that, in terms of their morphology, the classic descriptions did pick up something. Many of the specimens definitely do cluster to one side, but at the same time there's an awful lot of overlap as well. So the morphological side suggests they are just a little bit different, but there is certainly no discontinuous variation.

Then what you can also do is some simple DNA sequencing and compare just how divergent those sequences are in the species that we are interested in. We have our focal species, *C. britannicus,* the taxon that seems to be morphologically very similar and two much more distinct congeneric species that are morphologically distinct. The key point is that, if you look at the variation within *C. britannicus* and then compare it with *C. myrmecophilus*, it's effectively the same. You can contrast it with the better-defined species in the genus where you are getting 100 times more difference.

Putting the morphological data with this simple genetic data then, our recommendation would be that you should probably not consider *C. britannicus* and *C. myrmecophilus* as being distinct. And if you were going to spend your hard earned money on beetle conservation, then specifically targeting *C britannicus* because it is endemic might not be the best thing to do.

The second of those species had the best chance of being true endemics. This is *Psylliodes luridipennis*, the bronze Lundy cabbage flea beetle. We know rather more about the ecology of this species because we have been working on it for quite a few years, indeed, before the genetic work started. It's classified as Vulnerable and, for me, what's really exciting about it is that it's just one of three species, or taxa at least, that you find on Lundy feeding mainly or only on the Lundy cabbage that are distinct, at least to some extent, from mainland populations. Clearly, there's this cluster of diversity centred on Lundy cabbage.

So, the place where all this action is going on then is Lundy. It's a granite aircraft carrier fixed in the Bristol Channel, with the Cabbage extending along the cliffs and sidelands of its east side. So, the world distribution of the plant and the beetle is about two miles. The abundance of the beetle is obviously going to be closely related to the abundance of the host plant. Indeed, the conservation efforts we've been putting towards this beetle have been centred of making sure it's got plenty of plants to feed on and as Lundy cabbage is a weedy, early successional plant, they fluctuate quite a lot.

One of the first things we did when I started this work with Roger Key was to sort out the insect's life history. We knew that this beetle existed on Lundy and that adults fed

on the plant, but we didn't know anything about the life cycle at all. Early on we bred them in captivity so that we could get all of the stages through. *P.luridipennis* turns out to be a petiole borer initially and then the larva mines the stem once its jaws have got a bit bigger. Rearing the larvae had a bonus as well, in that we could be sure which larva we were dealing with, as opposed to the larvae of a congeneric species that uses the same plant. It turns out that, as in many of these leaf beetles, the larvae are actually more useful taxonomically, than the adults are, as Mike Cox showed when he used some of these specimens in his piece on *Psylliodes* beetles. What he found was that, first of all, *P. luridipennis* was distinct from the other species in terms of the larval setae (the hairs on it), but then also he was the first one to point out that the larva was actually very close to another species of *Psylliodes* called *Psylliodes marcida*. Nobody had thought of *P. marcida* in connection with *P. luridipennis* because it's an awful lot paler. The reason that they don't look alike, perhaps, is because *P. marcida* lives on sand, where it's very well camouflaged. When it drops onto the ground in the sand you really do struggle to find it. It lives on sea rocket (*Cakile maritima)* on sand dunes and shingle edges. So, its larval anatomy gave us a pointer that *P. marcida* was a species that we should have a look at in connection with the ancestry of *P. luridipennis*.

We are currently working on ITS2 and mitochondrial sequencing of the two specimens. To date, it would have been much more useful if we had found more variation in the sequences. But again, it gives us some pointers. If you look at the amount of divergence between *P.luridipennis* and *P. marcida,* it is only a fraction of that seen when you compare it with other well defined species in the genus. So, this early sequencing stuff plus the larval similarities, point to *P.luridipennis* and *P. marcida* being extremely close to each other. If the evidence eventually finds that *P. luridipennis* is a good species, then *P. marcida* is probably going to be the parent of this species.

What this kind of information allows us to do is to paint some scenarios and some ideas about how the genesis of biodiversity happening on Lundy. This is again work in progress, linking the genetical data and the morphological data with paleo-climatic information and so on. These are my guesses as to what may have been going on over the last 12,000 years or so. We have a timeframe, from the post glacial, period, about 12,000 ago, through to the present day. If you go back to the early post glacial period, when Lundy was still part of the mainland, it looks as if there was a very short period of time when it was warm enough for animals and plants to cross before rising sea levels turned Lundy into an island.

Everybody agrees that, shortly after the end of the Ice Age, there was an awful lot of sand around, along with other debris left by the glaciers, so it's likely that there would have been lots of sand on the shrinking temporary flat plains around what was then a flat-topped mountain and today is Lundy. Sea rocket, the host plant of *P. marcida*, is highly likely to have colonised those sand dunes just as it's done on the mainland, but it would have declined and eventually gone extinct by the time the last of the sand was covered by the sea.

Now, what might have been happening to the Lundy cabbage over that period? If the sand dune-inhabiting Isle of Man cabbage is the parent species, then it also would have declined as its sandy substrate declined around Lundy. Some of those plants may

have survived on the cliffs of Lundy, where there were also changes in things like their growth form and so on. Perhaps, aided by some kind of bottleneck, the plants came out at the other end as our new Lundy cabbage. Alternatively, it may simply be that some long distance colonisation by Lundy cabbage took place.

If we add all that together you can imagine a situation where *P. marcida* on sea rocket would have been progressively declining along with its host plant. But alternative crucifers became available, adjacent to its sand dune habitat and a switch of resources took place, a switch onto an alternative host plant. Associated with this there was a change in the colour of the beetle, which makes good sense because it's not much use being camouflaged to live on sand when you are on a dark, cool sea coast.

There are certainly lots of unanswered questions. We need to tackle whether Lundy cabbage is nearest to Isle of Man cabbage or not. Morphologically, it's actually closest to some plant species in Spain, and there is some work contracted by English Nature at the moment, which is answering that question. I'm pretty confident that *P. marcida* is the parent species of *P. luridipennis* but we could do with some more variable sequences to work up and maybe some micro-satellite work as well.

Did those events that I just described happen on or near Lundy? One way of answering that is going to be to look at *P. marcida* outside Britain. Coincidentally, there's a project going on in Germany looking at genetic differentiation in sea rocket across Europe and they have managed to catch a few *P. marcida* beetles for us of at various sites from the Mediterranean through to the Baltic. So, we can look at their sequences and if it turns out that the British, and particularly the southwest England *P. marcida* are closer to *P. luridipennis* than those from elsewhere, then it's going to be very good circumstantial evidence that everything was happening around Lundy.

Finally, while it's difficult to say whether you've got an endemic species or not, it's also tricky to say whether two closely related taxa are distinct species or not. There are morphological differences in the adults and larvae of *P. marcida* and *P. luridipennis* and there are also ecological difference in terms of the food plants that are used, but really what we want to get to know is whether there are differences in their reproductive behaviour. Also, have they diverged to the point where the plants they chose to feed on are different, and how well do their larvae perform on each other's host plants? In other words, to what extent have they diverged biologically as well morphologically?

The answers to these questions are still in the future, but just to round off, I would like to make the point that all this work will be truly academic in the worst possible sense if we fail to conserve the Lundy cabbage and its beetles. In particular, we must succeed in preventing the spread of rhododendron into the only area where Lundy cabbage grows.

Dr David Sheppard, Invertebrate Ecologist, English Nature

The Importance of Scrub and Bare Ground

One of the more crazy ideas that we've had in recent years is to link the Biodiversity Action Plan species with the Biodiversity Action Plan habitats. We've had to progress this very rapidly but the results are deeply flawed. It assumes that we know enough about the biology of the insects to actually put them in a habitat – but the initial part of most UK BAP Action Plans rightly includes an action to conduct autecological research to inform habitat management. At this stage we usually do not know what habitat or management they require. The other assumption is that the habitats we've recognised in the Habitat Action Plans actually have some relevance to the species. I question that and, consequently, I prefer to take an approach that avoids these problem areas. I prefer to examine all the wonderful reports that my contractors send to me and to extract those issues that the research has highlighted. I want to know what the real threats are, as demonstrated from the actual work.

Very early on in the SRP, the entomologists realised that there was a factor, which we at the time called 'disturbance', and which we realised was very important. What we meant was that when there was some event on a site - such as a flood, one of our so-called bulldozer races, or anything that really churns up a site - a lot of the animals and plants respond very positively to this extreme management. It was equally obvious that if you don't do any management at all and just leave it alone, quite a lot of the animals and plants benefit from that as well. So we have these two extremes, drastic intervention and non-intervention, telling us that we need a dynamic system. Habitats shouldn't be managed for continuity; they should be managed for change. So, I'm going to talk about two undervalued and unappreciated examples of these two extremes: the bare ground and the scrub.

If you are dealing with heathland and grassland systems, the most interesting part is where you haven't got all this confusing green, leafy stuff. It is where you've got lovely bare mineral substrate. An ideal situation is a dry system, preferably south-facing, on well-drained chalk, limestone or sandstone, which gets very hot. Invertebrates are cold-blooded. They need heat. If the ground is warm and dry, they can warm up early in the morning if it faces the east, or stay warmer for longer if it faces the west. A lot of animals, which settle on the loose friable substrates, can't run away or take off again. They struggle for hours and some of them get so tired out that they die, and so there is a whole suite of predators hunting these areas as well.

In addition, there is a group of scavengers along the bottom, just picking up the ones that become trapped or exhausted. This is a fascinating system. It is not just the surface of the bare ground that is so important. There are wonderful holes, everywhere! The more you look the more you find! Those holes are homes to lots of solitary bees and wasps. They live in holes, either in vertical surfaces, horizontal surfaces or sub-vertical surfaces– different species have different requirements. Some of them are reasonably widespread but others are very restricted.

An example is the solitary wasp called *Pseudepipona herrichii*, otherwise known as the Purbeck mason wasp. This lives on the Isle of Purbeck in Dorset, and being a

wasp, it doesn't collect pollen; it collects insect prey. In this case, the prey are caterpillars, which it paralyses, puts in its burrow, lays an egg on them, seals the burrow and then does it all over again. What I find really fascinating is that it takes only one species of caterpillar, a button moth called *Acleris hyemana*. It knows exactly where to find it - in spun shoots of *Erica cinerea* - and it requires seven to feed its larva to full growth. So it puts seven in the burrow, lays an egg, seals the burrow and goes off and does something else. Now, I find that worrying. That means they can count! It took me years to count to number seven – this thing can do it within a day! Now that's clever and also a bit spooky. Fortunately, when we try to assess sites for a potential introduction or to monitor existing populations, all we have to do is to walk through the site on a sunny day and count the number of larval spinnings – there's only one caterpillar that does that at the appropriate time of year.

The wasp requires nectar to feed itself, but it only has a short tongue and only takes nectar from *Erica cinerea* flowers, which has a corolla longer than the wasp's tongue. So what does it do? It chews a hole at the bottom of the corolla tube and takes the nectar. Again, we can see how large the territories of these colonies are by wandering round and finding where the *Erica cinerea* has been nibbled. Again, we can assess new potential sites by the amount of un-nibbled *Erica cinerea*.

The point is that you don't just need bare ground. You've got to have the food for the adult and the food for the larva very close by, so you need this matrix. It isn't just a matter of clearing the whole of the grassland or heathland away, taking it back to bare ground. Nature doesn't work like that. Bare ground is part of a complex system.

Now, we're not always talking about large areas of bare ground. Sometimes we are talking about fairly small scrapes. But bare ground colonises over. What we ask is that there are bare ground areas over the site continually, but not necessarily in the same place. If it comes to a restoration phase, then don't plant your bushes and trees in front of a patch of bare ground. Bare ground functions as part of a thermophilic (heat-loving) system. Thermophilic animals require the sun; they require heat, so don't shade them.

In some situations bare ground is a problem. The extent of bare ground created by military vehicles over Salisbury Plain is vast, and in places there are enormous erosion problems. Well, there is not going to be much life in the compacted stuff in the middle of the track. What I like are the edges. This is where the life is going to be. So, restoration of those compacted areas is fine – just leave my edges alone!

A bit of scrub clearance can create good areas of bare ground. These areas are not scars, and it hasn't got to turn green within a fortnight. Leave it alone – it will colonise, and it's the period of time that it takes to colonise and the succession that goes on in that period, which is so very important for a range of species, and not just my insects.

If you have to create bare areas artificially, then small, temporary areas are wonderful too! We don't always need large bare areas. Extremely sparse and short turf can be very important as well. There are species that will only live in that sort of turf. In sparse turf you'll get little volcanoes of soil, where the bees have started to nest. These are all expressions of early stages of succession.

The wet exposed soil systems are different but very valuable, nonetheless. In such wet places eg, marshland, mire etc., bare substrate is just as important, albeit for a different range of species. This is where you do NOT put your pond. That squidgy mess is absolutely heaving with life. All you've got to do is lay down and look across it to see how busy it is. These wet mire systems are very important and these early successional stages, following some sort of disturbance, are absolutely essential to that wetland system.

Let's move on to the other end of the spectrum, to scrub. We all know what scrub is. It's a hell of a mess; it is 'an even-edged canopy of one shrub species - or two if you're lucky - and it's slowly marching across the countryside, turning itself into secondary woodland'. Well, that idea is rubbish. That description could refer to abandoned scrub; scrub that is too old, over-stood, and desperately in need of some sort of restoration. A well-managed scrub system is much more exciting. It has an open canopy with probably a maximum of 25% canopy cover, in most cases a bit less, quite often 10% to 15%, which is absolutely great. Good scrub is a mosaic of sward heights, which creates one of the most variable, dynamic and exciting natural systems. It should be no surprise that it is one of the most species rich as well.

Insects need shelter and, as they're cold-blooded, they've got to remain active for as long as possible every day. So they've got to get out of the wind and the rain. The problem we have in appreciating what insects need is the fact that we are warm-blooded. We are more than 5ft tall and wear clothes. Imagine being 5mm long, cold-blooded and wearing no clothes, and then you will realise how important this shelter is. If the wind blows, you've got to get out of the wind. If it's raining you've got to get out of the rain, but still be active, still be looking for mates, still be feeding, still be growing, developing eggs, sperm, assimilating food, and so forth.

One spring, we were trying to find the adults of marsh fritillary on one of its sites in Cumbria. I quickly became bored with this game and went wandering off trying to find the adults' food – the nectar sources. This was May, and there aren't many nectar sources on that heavy land at that time of year in Cumbria. The only ones that were even beginning to flower were the marsh thistles and a little bit of tormentil, and the only place on this whole site where they were flowering was within the shelter of scrub patches. So, I realised that this scrub is important for marsh fritillaries as well.

Shortly afterwards, I saw the results of some work down in Cornwall where the distribution of the marsh fritillary larval webs on Goss Moor had been plotted. All except one of the webs were within 1.5m of scrub, and the one that wasn't was within 1.5m of a wall. It's the shelter effect that's so important.

Insects need sunshine. They've got to stay in the sun, but the trouble with the sun is that it moves around the sky, so it's no good plonking yourself here, and expecting to be in the sunshine all day long. The sun will move, and you end up in the shade. You need a system such that the insects can stay in the sun all day long from dawn till dusk, but still find all of the resources that they require.

Well-managed scrub has a lot of edges. Insects love edges between two different sorts of structures, and it doesn't usually matter what those are so long as there's an

edge between them. To appreciate this, get down on your stomach and look through the sward. You will see lots of edges. Imagine that you are a tasty morsel trying to move from one place to another without all those nasty feathery predatory things up there getting you. You mustn't stray far from a hiding place, and you've got to stay warm, find enough food, continuously, and still got to make the most of any opportunity to find a mate and enjoy the consequences.

Scrub offers lots of territory markers. Adult insects actually hold territories. Not for very long, sometimes only for a few minutes – they haven't got very long memories – but quite often, if you have something standing up, you'll find insects lurking around the top. What you will quite often find is that the males are up there, waiting to spy the female of their dreams flying around underneath. When they see her they'll go down and investigate whether she was worth the effort or not. Afterwards, they will forget where they were and fly off somewhere else until they feel the urge to set up a new territory. Those spikes of vegetation, whether they be individual tussocks of grass or bushes, are very important. They are not out of place; they are part of the natural system.

There is a lot of structure in scrub, as well. There is the short turf, there is longer turf, there are bushes, and maybe higher up in the canopy, even a few trees. Because there is so much structure and because there are so many different orientations, there are many little hot spots for shelter, and there are lots and lots of niches. There are lots and lots of herbivores eating whatever it is that they need in that particular situation. Consequently, there are all the predators, all the parasites and everything else coming in as well. It's a very rich system.

A project a few years ago, undertaken by a work experience student, set out to find how many of the moth species on three National Nature Reserves (which had a scrub 'problem') were associated with the scrub system and then deduce what would happen to the moths if the scrub was removed. The results were frightening. They showed that there is about an 85% loss of our moth fauna when scrub is cut down on short-turf grasslands.

I was a bit upset with that - and that's just the moths! I've no idea how that applies across the board to the predators and parasites, or the other herbivores and their predators and parasites. Scrub is one of the most species-rich systems in Britain, and I would question whether even woodlands are richer than this.

Now some scrub, like juniper, is appreciated where it occurs, but there is only ever juniper of the same age. It's either all young stock or all old stock – never a mix. Why? Think of your problem scrub. It's all the same age isn't it? Both the juniper and the problem scrub came as a result of some event that somehow released the grazing pressure for long enough for these bushes to grow old enough to tolerate the grazing when it came back. Maybe it was myxomatosis; maybe it was something else, but there's some dynamism in there that we need to know more about.

So, I'm going to end with the thought that all sites must be dynamic. They must change. They must change for the animals, they must change for the plants as well, I think. A lot of these plants in the grasslands are not long lived. They've got to germinate somehow and they won't germinate in a close sward. Wildlife responds to

natural events. Sustainable populations rely on natural events. If modern systems and attitudes soften the impact of these events, then we may have to go in and create some artificial impacts. We must not be scared of change. We must be very afraid of stagnation.

Dr Nigel Bourn, Butterfly Conservation

Habitats, the Landscape & Butterflies

Introduction

My talk covers the comparative effect of habitat quality and isolation on species distributions in modern and fragmented landscapes. The work is the result of collaborative work between Jeremy Thomas and colleagues at CEH Dorset and myself and colleagues at Butterfly Conservation. Much of the detailed autecological data presented has been collected by CEH over the last ten or more years while Butterfly Conservation undertook much of the landscape work as part of our wider conservation programmes.

Over the last 20 years there has been quite a lot of research on butterflies, with a view to explaining the high rates of decline of many of our species, particularly compared to other taxa. There have been two main schools of thought. Professor Illka Hanski, of the University of Helsinki has recently stated that there have been two major re-orientations in butterfly biology and conservation. The first theory, developed in the Seventies and Eighties, is that insects have very precise and specific habitats or niches which have to be maintained, usually, in the semi-natural landscapes of Europe, by active management.

The second theory (substantially developed in the late Eighties and Nineties, and still generating fascinating research) is the idea that insects and other animals function in 'meta-populations' consisting of various local populations, which are connected by occasional dispersal. The key component of meta-population theory is that it is conceptualised as a dynamic system with a proportion of the populations of species going extinct and being re-colonised at a later date. When a species distribution is stable then the rate of extinction equals the rate of colonisation. In Britain we are all to familiar with a system breaking down and the extinction rate, particularly as isolation increases with habitat loss, increases and species suffer catastrophic extinction events. This theory is also perhaps encapsulated in the idea of the living dead, populations doomed to extinction due to a fundamental breakdown, which has not yet worked through the system. This has been postulated for several large mammals, black bears in America for example.

So, for the practical conservationist, one theory essentially emphasises habitat quality within surviving patches, and the other that surviving patches are just too small or too isolated for many of our surviving species. Both theories perhaps indicate that we have an uphill struggle to provide enough of the right habitat, close enough together to conserve our fauna and flora in England. In this research, we wished to explore the relationship between these theories and attempt to assess their relative importance in order to help conservationists in their decision-making.

The study

We studied the distributions of three species, two across the chalk grasslands of north and south Dorset, and one on the southern cliffs of the Isle of Wight. These landscapes have become more fragmented over the last century as areas have been

improved for agriculture. At the same time remaining areas have changed as grazing is relaxed or sites agriculturally abandoned, leading to an increase in the scrub component and changes in the sward structure. Within this system we can measure the area and the isolation of sites, (effectively the distance between them) as well as the differences within sites in terms of vegetation composition and structure and habitat quality in relation to the butterfly species studied. By examining these three components in relation to the butterfly distributions, we can determine their relative importance.

The three species we studied were:

- The Adonis blue *Polyommatus bellargus*, whose larval food plant is *Hippocrepis comosa*. This species suffered a major contraction estimated at around 90% between 1955 and 1980. Since then it's done slightly better, and expanded and re-colonised several sites, but still remains in about 20% of its original range.

- The Glanville fritillary *Melitaea cinxia*, which occurs on the South coast of the Isle of Wight in a very dynamic system. The butterfly's broad distribution has remained stable as the constant slippage of soft-cliffs re-creates the early successional areas necessary for breeding.

- And finally, we looked at the Lulworth skipper *Thymelicus acteon*, which is restricted to the south coast of Dorset. Interestingly, it's larvae feed and create shelters high up in tall grassland vegetation where Tor grass *Brachypodium pinnatum* is abundant. So, while the Adonis blue was declining rapidly following myxomatosis and grasslands became more rank, the Lulworth skipper was doing well. Hence it experienced a slight expansion in the 1950s, 60s and 70s, while there has been a slight contraction in the number of colonies of 20% with the return of the rabbit, and an increase in conservation grazing since 1980.

So, in terms of habitat quality, we can describe the niches of these species very accurately.

Habitat quality assessment

For the **Lulworth skipper** there is a close relationship between the density of larvae and the height of the vegetation. The vast majority of larvae occur in very tall vegetation with the foodplant present. We can use this relationship to describe the suitability of any site surveyed by recording the amount and condition of Tor grass. We can then develop logistic models to describe the habitat quality of sites for this species.

For the **Glanville fritillary** we can describe sites in terms of six successional stages from 1, which is principally bare ground, through to 6 with a very closed grassy sward. Within these stages the amount of *Plantago lanceolata* varies from none in 1 through to quite a lot in stage 2, peaking in stages 3 and 4 before the amount of the plant decreases as the sward develops in stages 5 and 6. So, by recording the amount of *P. lanceolata*, we can actually describe through these successional stages, where the plant grows. The other key factor for the Glanville fritillary is the size of the leaf. This is quite variable through the successional stages.

When we assess the distribution of the larvae within sites we find that the vast majority of the food plant isn't utilised at all by the Glanville fritillary, only the early successional stages on the very small leaved plants. So, by collecting this sort of data we can again describe the precise habitat, and hence assess the habitat quality of each site.

The eggs of the **Adonis blue** are found only on the shortest vegetation (less than 3cm tall) with abundant food plant, *Hippocrepis comosa*, in very sheltered areas of sites. This is particularly so during the second generation in late summer. By recording the turf height and the shelter class we can again use this relationship to explain very accurately, the quality of the habitat for the Adonis blue within sites.

For all three species butterfly densities are very closely correlated to habitat quality, which means that having spent 20 years looking at these systems, people can describe these habitats very accurately in a way that's almost unique in the insect world.

Landscape studies

Looking at the landscape as a whole and how these species are distributed across sites, we can determine the patch size and the isolation of sites (the distance between occupied patches and unoccupied patches). As I have already described we can assess the habitat quality very accurately for these three species and, because these three parameters have very similar coefficients of variation, it is possible to assess their relative contribution to the distribution pattern found.

We can thus plot whether sites are occupied or not according to the level of isolation and the amount of good quality habitat available. For the Glanville fritillary the vast majority of the occupied patches are the ones that are close to another occupied site and also have a very high habitat quality index. If the site is very close to another site of particularly high quality – there is a 100% chance that it will be occupied within that landscape. If a site is more isolated and of poorer habitat quality, e.g. with very little plantain, or it's all very large leafed and its a long way from the next site – then the site is much less likely to be occupied.

The significance of the variables studied

The research presented here has built important habitat quality factors into traditional metapopulation variables of area and isolation. Moreover, we can describe for the first time, the closeness of the relationship. For the Glanville fritillary, habitat quality explains 62% of its distribution within the Isle of Wight and is the key variable within the whole system. Isolation was also a significant variable, so it does matter how much of the landscape is suitable and how close together the sites are. The area of sites, in this system, is not significant at all. This result is mirrored almost exactly by the Adonis blue and the Lulworth skipper distributions, as shown in Figure 1 below. For both these species, the same pattern is shown when these variables are graphed, with most of the occupied sites in the top left hand corner where sites are of high habitat quality and closer together.

In the Adonis blue, a species which has been expanding in recent years, isolation becomes a lot more important. This you would expect because the species is re-colonising less isolated sites first. Again, in these systems, area was not important.

Conclusions

The main ecological conclusions, are that habitat quality is the third main variable within meta-population studies, and equally, if not more important than area and isolation.

The take-home message, from the ecological point of view, is that high quality habitats tend to have larger, more persistent populations that are less likely to go extinct through stochastic processes. Such sites produce more immigrants to colonise vacant patches, so the nearest patches are more likely to become colonised because there is an optimum habitat nearby. Also butterflies are more likely to colonise vacant patches of high quality habitat because they are more likely to lay eggs and the offspring are more likely to survive to also produce offspring.

So, in conservation terms, the message is do not neglect small isolated sites whose habitat quality is high; manage them to maintain this quality. While increasing isolation of sites explains why species have been lost from many sites, this can be mitigated for by appropriate management until such time as we can restore the landscapes we have lost over the last 100 years or so.

In reality there are many additional reasons why we should conserve or restore whole landscapes, in particular, to enable the continued practical management and associated farming systems which have broken down with the structural changes in agriculture over the last 50 years. While metapopulation theory rightly emphasises the need for landscape scale conservation, our study shows that the extinction of species on small isolated sites within a landscape need not be inevitable if they are properly managed.

Dr Jenny Duckworth, Plantlife

A Rolling Stone Gathers No Moss: Discuss

There is a point to the title; does a rolling stone gather moss after all? How important is an element of dynamism in the maintenance of suitable habitat conditions for these so-called lower plants? By lower plants I mean lichens and bryophytes. What do we know so far? What do we need to know? These are the key questions and I'm going to look at these by focusing on three very different species-based case studies. As I'm sure many of you will already know, Plantlife have a Species Recovery Programme supported by English Nature called 'Back From the Brink' and this, itself, is 10 years old. 'Back from the Brink' aims to reverse the declines suffered by threatened wild plants. It's a multi-disciplinary approach with an emphasis on *in situ* conservation, although we do work in partnership with *ex situ* projects, and it's a combination of laboratory and field research and survey, monitoring, liaison, lobbying for policy change and hands-on practical management. One of the mainstays of 'Back From the Brink' is the UK Biodiversity Action Plan. It sets targets for nature conservation and specifically, for particular species and habitats. It lists 168 plant and fungi species that are threatened with extinction or severe decline, and Plantlife act as lead partner in a co-ordinating role for 77 of these, of which just over half are lower plants and fungi – 19 fungi, 15 bryophytes, 11 lichens.

Work is still very much in its infancy for the majority of these lower plant species. They've been part of the programme for only just over two years. We're still at the survey stage, trying to ascertain their status, both in terms of distribution and population size, where possible. From this work, a picture can be built up of habitat preferences and any threats and management issues, and these can then be followed up.

Let's start with *Bryum warneum*, otherwise known as sea bryum. This moss is notoriously difficult to identify. The whole genus *Bryum* is a critical group that needs to be identified by microscopic examination of the capsules and spores, which are only fruiting at a certain time of year, around September, so that's when any survey needs to be done. We have the British Bryological Society referee for the genus, Dr David Holyoak, working as our Project Officer for the species. A few months ago a survey was carried out of recent and historic sites in England and Wales, and we can now confirm that there are three extant sites in England and three in Wales. There are a few in Scotland as well. So it certainly is rare.

Bryum warneum is usually a plant of dune slacks and damp sand by dunes and, more rarely, on the edges of gravel pits, of which more later. It seems very much to be limited to the pioneer stages of slack development, often on their edges and this is where, of course, the vegetation is still open. Here there is plenty of bare sand to colonise and vascular plants have not yet become dominant. It's mainly associated there with other bryophytes and just a few forbs. It's therefore an early successional species. And indeed, the development of vascular plant cover, i.e. succession, in this habitat, could even be viewed as a threat. Over time, with no intervention, the vegetation will change and *Bryum warneum* will get out-competed, and will

eventually be lost. We are not totally sure how long this natural process takes or how it proceeds. This is something we plan to find out more about by some careful monitoring of selected populations at selected sites, and we need to observe changes in the dynamics, not just of *Bryum warneum* populations, but also of their associated species. Dunes are, by their very nature, dynamic habitats, so playing devil's advocate a bit, a very important question is 'should we really view natural succession as a threat?' It's probably not practical nor desirable, to try and arrest succession for every population at every site. You'd be fighting a losing battle from the start. So, what can we do? There are, of course, management mechanisms we could use like grazing to keep it open, but perhaps the most important thing is to ensure that the dynamism of the dune system is maintained and that slack development is encouraged, ideally in the vicinity of existing populations.

At Dungeness in Kent, *Bryum warneum* populations inhabit damp gravelly sand at the edge of a gravel pit within the boundary of the RSPB reserve, on land that had originally been quarried, not sand dunes. This general area was earmarked for tidying up as part of a landscaping programme by those that had undertaken the digging this autumn – that's Hanson – and the RSPB ensured that the needs of this little moss was also taken into account during this process. Plantlife took advantage of the fact that there was one of these ubiquitous yellow machines in the area, and some potential new habitat has been created. A nearby area that was covered with *Salix repens*, has been opened up. This may provide an opportunity for regeneration if there is a spore bank present. If not, it could provide potential habitat for colonisation. Furthermore, some excavated sand and silt has been tipped around a nearby gravel pit lake, hopefully providing a potential area for colonisation.

Moving on to something completely different. The lichen, *Cladonia peziziformis* has the reputation of being one of the most elusive lichens in the British lichen flora. It's been found on only nine occasions since it was first recorded in 1742. The only confirmed post 1960 records are from Sussex, Mull in Scotland, and Pembrokeshire in SW Wales. All post 1960 records are from heathland that had been burned within the last five years, which gives us a clue about its requirements. *Cladonia peziziformis* appears, from what little we know, to be an ephemeral species of a dynamic habitat, which probably accounts for its elusiveness. If you weren't there in the right place at the right time, you weren't going to see it. There have been very few sightings of the species and, indeed, none for over ten years, despite searches of some suitable, or what we think is suitable, post burning habitat. So, regarding BAP implementation for this species, the only thing we can do at present is to encourage lichenologists to keep an eye open. But, if it is found, a detailed investigation can then begin at the site. This should focus on population dynamics such as how its colonisation and growth relates to stages in the heather cycle. Then, we can begin to pinpoint ideal conditions for it. Once this important baseline data has been collected, we can then begin to understand more of its management requirements. But if it is just an ephemeral that comes and goes, and very rarely at that, it may well be very difficult to ensure appropriate management in the long term. What then can we do? It's likely that the best thing will be to try and ensure that there are different stages of post burning succession, including whatever the ideal stage is, represented at sites where it occurs and those nearby.

Finally, moving onto a very different story. *Calicium corynellum* is a crustose yellow/green lichen with tiny black pinhead fruiting bodies. This is a slow growing and very particular organism. In complete contrast to the other species I've talked about, it needs very stable conditions indeed. Until last year, it was thought to be confined to a few stones on a single wall of a single church in Northumberland. A few years ago a stone slab at the base of the tower of the church was replaced with gravel, so that water pouring out of an outflow pipe above it no longer splashed up the wall. Unfortunately this nearly, inadvertently, wiped out the lichen once and for all, since it meant that the microclimate had been altered, and it was no longer damp enough to sustain the lichen. Fortunately, the slab has now been replaced and the desired level of dampness reinstated. Now it's confined to literally – it's about the size of a fingernail – to one stone. But although it was never actually directly in the wet zone, there is humid air around it, which is what was creating the right conditions. Over time, if suitable conditions continue to be maintained - which I am sure they will – this patch should theoretically, be able to spread again. But it's very slow growing.

Fortunately, a new site was discovered for the species last year, about ten miles away, where it grows in a much greater quantity on several gravestones. Here, there aren't any overflow pipes creating damp splashes but it is in a cool misty valley at a slightly higher altitude, which perhaps creates similar climate conditions. Again, it's hard to really build up a picture when you've got so few sites. Now, it is indeed possible, that it may turn up elsewhere in the region. In similar aged churchyards perhaps, with similar stones and similar climatic conditions. This area was affected by the Foot & Mouth restrictions, but we are planning some further searches in 2002.

This has necessarily been a rather brief run-through of some case studies, each with a rather different perspective from a dynamism point of view. We had *Bryum warneum*, a pioneer species of a dynamic environment and a question of how to manage such a dynamic habitat. Then we had *Cladonia peziziformis*, a species so dynamic we cannot even find it, yet alone begin to manage its habitat, but we need to be prepared, and finally *Calicium corynellum*, requiring absolute stability.

So can we begin to understand the role dynamism plays in maintaining populations of these species? It's just not possible to generalise here. Of course, different species have different requirements, although there will be some similar trend according to habitat. There are other organisms we are talking about when managing these habitats and some have different requirements, some have similar requirements. In some case, we now know more about their habitat requirements and we are starting to build up a picture. But for others, we are just beginning, and we've still got a long way to go. But at least we are beginning to ask the questions.

So just to finish with some acknowledgements, 'Back From the Brink' is very much a partnership programme. In addition from the huge amount of support we've had from the English Nature Species Recovery Programme, it just remains for me to thank some of the other people and organisations who have been involved in the work mentioned in this talk.

Colin Speedie, MER Consultants

The Basking Shark: Global Threats & Risks

To put it into perspective, when I started working with basking sharks in 1988, there was already movement to try and engage the public's interest in them, but quite honestly, it seemed to be going nowhere. Which makes it all the more gratifying to see how far we have come in terms of recognising the importance in conservation terms of the basking shark - a success story by any standard.

Current conservation status in the UK and abroad

The basking shark (*Cetorhinus maximus*) has been protected within the UK 12 mile limit since 1999, under Section 5 of the Wildlife & Countryside Act (1981), and more recently has received some further element of protection within the Countryside and Rights of Way Act 2000. The fact that it took so long to achieve this level of protection is indicative of just how the marine environment has been under-represented within the overall conservation view at Government level, at least until now. The further protection within the Countryside & Rights of Way Act introduces new levels of protection. It was decided to place the basking shark and all of the cetacean species – the basking shark having currently achieved a kind an honorary cetacean status – within the CRoW Act because there have been many concerns over what the Act describes as "reckless or intentional disturbance". The new Act, for the first time attempts to provide additional protection against this type of disturbance, which might broadly fall under the term "harassment".

This is all very well but, in fact, the basking shark was quite well protected under the Wildlife & Countryside Act. In fact, what has happened is that we have yet another law that has added a further small measure of protection, but in terms of enforcement and enforceability, very little has changed. When considering the protection of marine species I believe we shall have to look in the future towards an overall view that treats the sea and its inhabitants as an individual ecosystem. Which will require far more substantial legislation in the form of a Marine Act, coupled with a far more integrated approach by all interested parties.

The basking shark is also listed as vulnerable on the IUCN Red List. Perhaps this is due to the fact that the status of the shark is unclear in many areas of the world. Although basking sharks are found in most temperate waters of the world, there are grave difficulties in establishing overall populations as, in many of their range areas, they are seldom seen at the surface. Indeed, I should point out that what we see at the surface around Britain may only be the tip of the iceberg. Therefore, we simply do not have many opportunities to study them except in areas where they may be seen at the surface, and by using some of the techniques that I will be covering in this paper.

At the last CITES Convention of Parties in Nairobi, the basking shark was proposed by the UK Government for a listing under Appendix II. Appendix II of CITES would not necessitate a ban on hunting the basking shark as a species. It would demand that any country trading in basking sharks or their body parts should keep a proper record of the level of that trade, which could then be referenced against the level of species

abundance, to ascertain whether it was sustainable. Regrettably, the UK proposal was defeated, even though CITES commissioners recognised in advance of the Convention that the proposal was very strong and based on sound scientific principles. This was a very narrow defeat – less than five votes – a significant achievement especially when considering that a two-thirds 'yes' vote is necessary to secure victory at CITES. To muster that level of support is hard, especially in the face of Far Eastern opposition to the inclusion of any fish species within CITES.

Happily, the UK Government, although deeply disappointed at the loss, seemed to consider that it had rather been due to fisheries politics than the actual facts of the scientific argument that had been put before the delegates. In addition, there were two other proposals for sharks, which may have weakened the case as they lacked the research background contained in the basking shark proposal. On returning from CITES the Government wasted little time in listing the basking shark under Appendix III of CITES (which any range state is permitted to do). Appendix III is a much more localised listing for CITES, again, focusing on trade, covering Europe in particular.

The positive element is that the Government have decided that they are definitely going to return to the next COP next year (2002) in Chile, with an Appendix II listing proposal yet again. This will be an updated and improved version of the so-nearly successful proposal form the Nairobi Convention, not just because there is very little wrong with it, but in that we have added substantially to the sum of knowledge in the meantime. We believe that there is genuine cause for optimism, and that the Appendix II listing may well be secured, which, if that is the case, will be the first time a shark has ever been listed. This would represent a major achievement, but it will be in the face of determined lobbying by China, Taiwan and Japan, who are determined to defend the lucrative shark fin trade.

Research work under way in the UK at present

Under our Biodiversity Action Plan we have to look at things like potential migratory elements of basking shark behaviour, we have to look at areas which are of particular interest to the basking shark, and we have to cover the element of public awareness by disseminating that knowledge. My friend and colleague, Dr David Sims, who is based at the Marine Biological Association in Plymouth, is currently leading the partnership formed between the MBA and CEFAS (Dr Julian Metcalfe) on satellite tracking of basking sharks with a substantial grant from DEFRA, the first time that we've seen some really serious funding coming into the field of basking shark studies. This level of funding is necessary as the tags are not cheap, and the satellite time is extremely expensive too.

There are currently ten archival transmitting tags attached, five in the English Channel and five in the Firth of Clyde, to give a broad spatial range, and to see whether there are significant differences in the behaviour and the movements of the sharks. Now, the key question will be, where do the sharks go over time, particularly in the winter? So these tags are set to detach – they pop off in actual fact – at intervals, and then transmit their stored data via Argos Satellite uplink, whereupon it's redirected to the research base as an email. There can be a colossal amount of data returned from these tags, particularly as they can be set up to examine different parameters, but the one question that really interests most researchers concerns the migratory patterns of these

sharks. Archival tags promise to answer this age-old conundrum in the most effective manner.

Historically, it was believed that the basking sharks sighted in our waters in summer migrated down off the West African coast, where they hibernated on the bottom having shed their gill rakers, and thus being unable to feed. For years these, and other unsubstantiated theories were perpetuated, but in actual fact, we now believe that they probably do not go anything like that far and also, too, that they actually feed right through the winter period.

I am unable to expand too much on this because this work remains ongoing, but so far, two tags have been detached and initial reports indicate that at least one of the tagged sharks was well out onto the Continental Shelf, and it seems very likely that in winter the sharks feed in currents and upwellings along the Continental Shelf edge, in deep water, on reduced levels of plankton.

Behavioural studies are also being examined in the MBA/CEFAS study, (an area in which we are have an interest ourselves), particularly courtship behaviour, which I will touch on again in a minute, but also too, shark reaction to tagging. If anybody would like to see more about this, there is a very interesting web site at www.cefas.co.uk, from which you can navigate to the shark details. There will be regular information updates coming through over the rest of this year, as the other tags detach.

Our own study has concentrated on South West England. This is a yacht-based project principally funded by The Wildlife Trusts and WWF-UK, and we have just completed our first three-year programme. The funding that we receive is used to cover the boat's costs, so that we can recruit volunteers to join us. The sort of people we are looking for would generally have an existing involvement or interest in marine conservation, with a substantial number of members of conservation organisations and students. We have had three Masters students within the last two years, and have four starting this year. We have trained around sixty volunteers over the three years, and all have made a valuable contribution to the success of the project. It is quite an unusual approach, but it has worked for us.

We have been covering the south coast of Devon and Cornwall, between the Isles of Scilly in the far west and Torbay in the east. This a relatively practical area to work in because there are a lot of ports and safe havens, and is also quite sheltered. In addition, there are many good areas within the region for sighting basking sharks, both inshore and offshore. Our three years of effort related studies have added to one of the first long-term effort related studies of the basking shark, in which we have collaborated with Dr. David Sims since 1995.

Over the last three years we have completed 92 line transects. Some of these are very short with an inshore bias, whilst others are long offshore legs, generally working between headlands or offshore points like lighthouses or, in the case of the Isles of Scilly, out to the islands. Our aim is to cover each transect at least twice a season, during one survey in each month of May, June, July and August to establish a broad temporal scale. In this way we have covered a distance of 2,088kms during that time and 209 hours of observations.

All of our observations have been collected in conditions up to Beaufort scale sea state four. Beyond sea state 4 we believe that it isn't worth making observations of basking sharks, because it will simply be impossible to spot a fin at any distance in those conditions. It is difficult enough working from the deck of a yacht anyway, but at that level, it is simply too rough. That is not to say that we do not see sharks above that level, simply that it is much more difficult.

Findings

During the study period, our encounter rate was one shark per 84kms of travel, but we found that all of our sightings, by and large, were based down in the far west of Cornwall. Additionally, we encountered many sharks elsewhere at other times off transect. In fact, we have found one other area that we almost stumbled upon, where we are regularly seeing substantial groups of sharks. Forty-eight per cent of all sightings were within a 9km radius of Gwennap Head, which is situated at the south western extremity of the Lands End peninsula, with the buoy marking the dangerous Runnel Stone lying over 1km off the shore. This makes it an extremely important site for the species. A further 32% of all sightings were within a 9km radius of Lizard Point, the southern most tip of Britain. Therefore 80% of the total sightings came from this relatively small area.

These are very busy areas of our coastal waters. Looking out from Gwennap Head to the Runnel Stone Buoy, it becomes obvious that this is a natural turning point for shipping. This includes small and large commercial vessels on their way to the Lizard, together with a high level of fishing traffic, from deep-sea trawlers to small day boats, travelling around the Runnel Stone Buoy and heading up to the port of Newlyn. Also too, in the summertime, there is a very high level of leisure traffic in the form of power and sailing yachts travelling from the busy yachting ports of the English Channel around Lands End to go north into the Irish Sea, or west to the Isles of Scilly. Further east, there is a similarly busy area off Lizard Point, and from there up to the port of Falmouth, which is a further area of very high levels of sightings.

It is clear then that these are obviously important habitats for the basking shark, which is almost certainly due to specific physical attributes. These areas, and particularly The Lizard, are close to active fronts. During the early part of the summer, there is a large, warm oceanic front which pushes up the English Channel and passes very close to The Lizard in many years, and pushes up somewhere to an area just between Portland and the Channel Islands in its furthest extremities east. And this warm water, meeting cooler inshore water, sets up convection currents, bringing nutrients up to the surface and encouraging plankton production, including the favoured prey of the basking shark, calanoid copepods. The sharks tend to feed along the fronts, normally in the colder water side of the interface, and a good example of this type of activity may be seen in the area south of Plymouth, some 12 to 15 miles out, along the edges of this thermal front. However, as the inshore water warms up, so a change occurs from mixed water to stratified water. In other words, a layer of warm water on top of cooler water and at this stage the sharks tend to be down feeding at the interface between the two layers lower in the water. Using the sonar on our vessel we can often pick them up and watch them feeding lower down in the water column.

Perhaps the key factor here is that these are areas with strong tidal streams and a rapidly rising seabed, with uneven bottom topography as well. In these areas, much of the work that was done by Dr Alan Southward offers pointers to what may be occurring. He described a 'stratification index', as a measurement of water mixing in coastal waters. Using his formula, areas with a stratification index of less than 1.5 have almost constant water mixing from surface to seabed. In other words, they become turbid areas with high levels of nutrient enrichment, which in turn encourages plankton productivity. So what we are looking at here are highly productive areas in which we might expect to see sharks at the surface throughout the summer season. In most other areas where the stratification index is higher than 1.5, we tend to start to lose them, apart from stragglers and immature sharks, from early July as the water stratifies. But within the areas described here, which we have been visiting on a regular basis throughout the summer, we are actually seeing large numbers of large sharks at the surface right into August.

We are using photo identification as a tool in an attempt to discover whether these are the same sharks returning year in year out, and for tracking them over time. This is an effective benign research tool, which has been successfully employed for many other species, especially cetaceans. More recently, it has been used for whale sharks and the great white shark, and now is being used for some of the smaller shark species. Many of the markings we have identified are believed to be long lasting, and therefore suitable for use in long-term studies. Identification generally focuses on the first dorsal fin, as this is generally the most visible feature above water, and utilises such features as the dorsal fin ratio, fin shape, anomalous pigmentation (such as dark spots), and obvious nicks, scars and injuries. There are some markings such as white scars left by the parasitic lamprey *Petromyzon marinus*, which do not last, and so are discounted and not used as identification features.

During our first year of studies, 43% of the sharks that were photographed had markings in one or more of these identifiable features, which is a perfectly adequate level from which to argue that photo identification can work. We already now have quite a number of sharks that we have photographed over a two-year period, and in one case, we believe, three consecutive years. With the catalogue for the last two years now being reviewed, including many images that have been submitted by members of the public, expectations are high of further re-identification matches.

One of the great advantages of photo-identification is that it can be carried out by members of the public. The only major requirements are a reasonably decent camera and access to the water to get some pictures and send them in to the project. The project named the European Basking Shark photo-identification Project is based at the National Marine Aquarium, Plymouth, and is backed by a consortium of organisations with an interest in marine conservation. We have found that this has been a very powerful tool for keeping the level of public awareness up, particularly in the West Country, the home of our studies. And, in order to further engage the public interest we have a website at www.baskingsharks.co.uk, which is currently being re-jigged and re-vamped, to sustain that interest. In excess of 1000 images have been collected for review, from as far afield as Scotland and France.

During the coming summer, we will actually be taking out volunteer researchers from some of the other EU countries that are involved in shark research and training them

up in the use photo identification as a tool. Interest in exploring the use of photo-id has even been expressed from researchers in the Mediterranean. We certainly do not expect to see some of our sharks turning up there, but we think there is still potential for the use of photo-id if there are sufficient surface sighted sharks in the area to make it viable.

Many people have expressed surprise that individual sharks can have such a different appearance. Younger sharks generally have a very "shark-like" fin, which can be very different from the enormous floppy fins with a rather elongated chord often seen in the very biggest animals. The biggest shark I have ever seen was estimated by us to be in excess of 10.5 metres, and was observed off Land's End last summer. Compared with another shark alongside it, which looked like a toy in comparison, it was a fantastic sight. Subsequent examination allowed us to estimate the second shark at about 7.5 metres length, itself a substantial animal.

In these key areas we have consistently recorded large groups of mature sharks. It has been generally accepted that basking sharks appear in age-segregated cohorts. In other words, groups of sharks of mature size, which would move together over time, follow the best patches of plankton. Basking sharks may not reach maturity until 16-20 years of age, at a length in the case of males in excess of six metres, and in the case of females, perhaps as much as eight metres.

In these areas we have regularly observed courtship behaviour, which is generally recognised as swimming nose to tail, often at times, involving one or more animals. One (or more) sharks follow a single animal at very close range, before sinking below the surface – we have yet to observe actual copulation. We have seen signs such as large white "stripes" on pectoral fins, where the skin has clearly been flayed, which may suggest that sharks may actually pectoral bite, as many other shark species do, to assist in copulation. Two years ago, a large stranded male that we examined had quite a considerable amount of wear on the teeth, which have hitherto been generally accepted to be vestigial.

Basking sharks can actually leap clear of the water completely, an act known as breaching. It has been argued in the past that this was probably a mechanism to dislodge external parasites, such as lampreys. Although they do suffer from lamprey attachment, particularly in the genital area and behind the dorsal fin, this would not appear sufficient to justify such a colossal expenditure of energy for such a light parasitic burden. What seems far more likely is this may be some form of associated social behaviour which enables the group to remain cohesive, as it is commonly seen in these large groups but not elsewhere. The alternative may be that this is a form of sexual behaviour, perhaps males advertising their potency, or females advertising their receptivity and availability for mating. Either way, this type of behaviour is principally associated with these large, mature groups, where it is surprisingly prevalent behaviour. For example, in 1999 we observed 48 breaches in some of these areas, always when in the company of large aggregations of mature sharks.

Every season we record a number of sub 2 metre sharks, which are accepted to be the young of the year. Most people believe basking shark pups are born at between 1.6 and 1.8 metres in length. It would make logical sense for parturition to occur early in the season, so that the young sharks can take advantage of the abundant plankton

available at that time, in order for the pups to gain weight and size as rapidly as possible to prepare themselves for leaner times in the winter months ahead. Therefore it may well be that within these areas parturition occurs, contributing to our belief that they form sites of critical importance for the species. The basking sharks regularly frequent these areas, not just because they are highly productive areas for plankton but also, too, because they may form areas in which a putative breeding stock has the opportunity to give birth or seek a mate for reproductive purposes. If this indeed proves to be the case, then it may well be necessary to seek additional levels of protection for the species within these key sites, as is envisaged in the Biodiversity Action Plan for the species.

Therefore it will be necessary to examine in greater depth the behaviour and population make-up of the sharks within those sites, and this will be the focus of our studies over the next three years, when our project will focus on these areas in the west of Cornwall, between Falmouth and the Isles of Scilly. This programme will be partly funded by English Nature and we will be focusing specifically on population densities in those areas, as well as observing and recording behaviour. We also hope to develop a greater insight into how the sharks react to vessels when at the surface, as well as other anthropogenic threats to the species.

Bycatch

Other potential threats include accidental net entanglement in a variety of fisheries, collectively known as bycatch. Bycatch of non-target species such as the basking shark has always occurred and indeed, has been used in the past in directed fisheries as a mechanism for catching basking sharks. This was certainly the case in the Hebrides, in the ancient and early fishery in the 1700s, for example. Nets were also employed in the most successful (and destructive) fishery of all at Keem Bay on Achill Island in the West of Ireland, where the hunters developed effective ring-necking techniques to entrap the sharks that frequented the Bay, before despatching them with sharp lances.

In recent years a number of strandings have occurred along the south coast of Cornwall, in which the individual animal bore all of the signs of bycatch. These included an eight-metre male on a beach at Polkirt Cove near Mevagissey, in an area that does not generally have an abundance of surface sightings of basking sharks. St Austell Bay is a relatively shallow area, which stratifies early in the season, but in which we believe there to be a considerable level of by-catch, particularly in surface set gill nets. Basking sharks have been landed at a variety of fishing ports over the years that have been caught in deep water. Some of them have been caught in bottom set hake nets from the western approaches; some of them have been caught in bottom trawls out of season, and there has even been the occasional individual that has become entangled in a pot rope – sharks are quite capable of becoming entangled in any and every type of fishing gear.

One particular type of gear that does raise concern is inshore gill netting. Many fishermen have had to turn to inshore gill nets after the demise of other commercial fish stocks that they would normally have targeted. In the south of Cornwall, for example, which used to have hundreds of inshore fishermen long-lining for mackerel and bass, the seasons are now so short and the catch so drastically reduced, that many of the remaining fishermen are turning to setting inshore gill nets wherever they can.

The nets themselves are cheap, can be set from small boats easily, and are an effective and simple means of fishing. But undoubtedly, these nets can cause problems for basking sharks, which frequent many of the same sites as target fish species such as mackerel or bass.

Bycaught sharks often display recognisable signs of their entanglement, such as a rope around the tail, which has been used to drag it ashore, and we have visited a shark in this condition, which was perhaps four tonnes in weight. Typically, too, the tail stock and caudal fin have been completely flayed, despite the durable and abrasive nature of the skin. This is due to the fact that once entangled, the shark will tend to dive to the bottom and carry on swimming and struggling for hours, abrading the posterior section of the body entirely. However, they do not all succumb, as for the first time this year, we actually saw an individual at the surface where the tail stock had been completely flayed, a testament to their ability to survive and recover from net entanglement.

Bycatch is notoriously difficult to quantify. Nobody wants to talk about such emotive issues. Nor, of course, do fishermen welcome such bycaught sharks, which are incredibly destructive of their gear. Most of the small inshore boats that are involved in this type of fishery are incapable of lifting any but the smallest sharks, and so have to use their ingenuity and devise means of doing so, such as buoying them up with oil drums. An alternative is to ask for assistance from other, bigger trawlers to come in and hoist the animal to surface to they can extricate the shark and salvage the net, and in the past, the shark, too. Such specimens always found a buyer in Brixham or Plymouth fish market, usually to go for pet food.

The difficult factor is developing the trust of these fishermen to encourage them to talk about the issue – this is very hard. Nobody wants to be seen to be involved in catching such popular creatures, even though they are caught accidentally. This is a great pity because there is an immense amount still to be learned about the sharks, and much can be gleaned from examination of bycaught specimens. At least in the past, when quite a lot of these animals were coming through fish markets, that enabled researchers to obtain samples. This would have been particularly useful now, because there is a great deal of interest in obtaining samples for DNA analysis. Nowadays, of course, it is illegal to land basking sharks for commercial gain, and so the vast majority of bycaught sharks never reach the shore.

Ship strike

Ship strike, where collisions between surface (or just sub-surface) sharks occurs with vessels, both big and small. An example of this has been seen in an animal that was photographed off Plymouth in 1996 and in North Cornwall in 1999. This animal, nicknamed ‘Stumpy” is a big female, and has lost the greater part of her dorsal fin. Close examination of this animal gives a clear indication that a vessel’s propeller had severed her dorsal fin. We have recorded a number of injured sharks every year, during our surveys, sometimes with very recent wounds that have not healed. In addition, many yachtsmen and amateur fishermen regularly report close encounters and collisions with basking sharks in our busy waters. This is by no means deliberate, as a basking shark could clearly put a small vessel at risk in the event of a collision. Often, they are just at or just below the surface of the water where they are all but invisible to the small high-speed vessels that are often implicated in this type of

incident, and which simply do not have time to see the shark, or to take evasive action.

A recent report of a small cabin cruiser returning into Plymouth Sound after dark, which sank after colliding with an animate object bore all the hallmarks of a collision with a basking shark. This is particularly because more sharks may be feeding at the surface at night due to the nocturnal vertical migration of plankton towards the surface. In our "key" areas, especially around The Lizard, where there is a considerable amount of yacht traffic by day and night a lot of yacht traffic collisions are regularly reported.

So, we believe that there is a strong argument for greater awareness of the likely presence of basking sharks at some of these key sites. This should be focused on the people most likely to frequent these areas at the relevant times of year, not just for their own safety, but also the safety of the sharks, particularly as we believe that these sites may be havens for a breeding stock.

Human disturbance

Forget 'Jaws'. People are now aware that the basking shark is more like 'Gums'. For many years conservationists have been trying to persuade the public that the basking shark is a harmless, fascinating creature. But perhaps we have done our job far too well, and now people have lost their fear of and their respect for these animals. At one of our periodic shark "invasions" I took a wonderful picture of a man on a wave ski laughing his head off, saying, 'take a picture of me!" right alongside an 8m shark. A terrific image, but, nonetheless indicative of a less respectful public who should really take more care because they may be placing themselves in danger. A solid swipe from the tail of such a powerful creature could easily disable an individual on the receiving end.

And, of course, basking sharks can breach, leaping clear of the water, which would cause real harm to any vessel or swimmer in the way. Indeed, this appeared to be what occurred in the Firth of Clyde in 1937, and caused the only known fatalities yet recorded with this species. Talking to a fisherman one night in Newlyn, I learned that his next-door neighbour had a breaching shark land right on the stern of his boat, causing considerable damage. We ourselves have been on the receiving end of a breaching basking shark at less than 30 metres ahead of us, which was a thought-provoking process, so now we keep a good distance when around breaching sharks.

Ecotourism

We are undoubtedly seeing the development of small-scale marine ecotourism in the south west of England that does not necessarily focus on one species, but will most certainly take in the basking shark. Websites advertising the opportunity to dive with basking sharks already exist, and in fact, on one of our surveys last year we encountered a dozen members of a sub-aqua club in a pub one night who had come to Cornwall solely to dive with the sharks, and declared it a fantastic experience. These individuals were all experienced divers, supervised by a local dive charter company, and clearly had a disciplined approach to their own safety and the welfare of the sharks. However, not all visitors are so careful, and there are far too many reports of people simply "jumping in" with the sharks, as if this was some kind of right, and wholly without risk. So, I remain unsure whether we know enough about

unsupervised dives with basking sharks, and I believe it would be of benefit to all to subject the matter to some kind of scientific examination, especially to examine shark reaction to divers. Anecdotal evidence from underwater filmmakers suggests that scuba disturbs them, and that re-breathing apparatus causes less disturbance, as does snorkelling. And clearly, if there is some level of disturbance, then this must be quantified objectively, and its likely impact on the well-being of the animal ascertained. At the moment there is no clear evidence of a severe problem, but clearly, further examination ought to be a priority.

Code of Conduct

A situation exists in the field of cetaceans, where there are many codes of conducts which basically say the same thing, but in a more-or-less watered down or strengthened version. All the evidence from the public suggests that this is confusing, and in fact, the weaker examples may permit activities, which are of no benefit to the creatures they purport to protect. I believe that we have sufficient mass between the groups that are involved in the protection and conservation of the basking shark to actually come up with a viable and robust Code of Conduct, which will work for everybody. This should, of course, recognise the fact that ecotourism activities will not ignore the shark, and should ensure that this element receives the examination it needs, and advises accordingly. It should be borne in mind that at Ningaloo reef in Australia, the whale shark eco-tourism operation is worth something like $8M over a very restricted season. So it is highly likely that we shall see a move towards this kind of thing within the UK, and we should try to be ready for it.

Over the horizon

A big basking shark, seen very close up, is an awe-inspiring sight. Sometimes, the shark may be swimming at about one knot in calm conditions, and it may just be possible to see small flecks in the water ahead of it, which are in fact, its favoured prey, calanoid copepods. When these sharks are actually into feeding mode like this, they seem almost locked into their feeding patterns, and are completely unaware of boats. We have done some initial work to examine shark reaction to vessels at close quarters, and our basic impression is that when the plankton density is high the sharks are almost oblivious to any vessel in the vicinity. However, when the plankton densities are low they may well dive at about 10 or 15 metres distance, which is a safety net for them, helping to avoid collisions. We hope to re-visit this area over the coming seasons, to better understand this crucial element of shark behaviour.

Basking shark sightings come in cycles. In the 1930s in the Hebrides, there had been very few basking sharks recorded for many years when suddenly, big numbers started appearing. This is probably connected to plankton distribution, driven overall, by changes in the North Atlantic weather systems and movement of currents. Basking sharks are capable of foraging for the most productive patches of plankton on a local basis, so it may also be the case that they can orientate themselves to the thickest and most dense plankton aggregations over a broader spatial scale. Being so dependent on plankton may make the shark highly vulnerable to climate change. It has been predicted that there will be changes to the presence of some of the thermal fronts that push up into the English Channel, for example. And if that were to occur, what might that do to the number and distribution of basking sharks that we see at the surface each year in the English Channel? And also, too, what might it mean for the "key sites" that we believe may be of such importance for the species?

It is well known that most important zooplankton in the North Atlantic *Calanus finmarchicus* has declined considerably over the last forty years, a factor which may affect many of our most popular food fish, as well, of course, as the basking shark. Very recently a story appeared in the press that the RRV 'Discovery', currently out in the North Atlantic conducting one of the regular zooplankton sampling cruises was only recording about 20% of the levels they expected to see in deeper water. Given the current hypothesis that basking sharks migrate offshore in winter into deeper water to feed on plankton at reduced levels, this may have implications for their winter survival. Additionally, if these reduced levels are reflected in summer plankton abundance, then that might be far more serious indeed.

The way forward

So, to build on the work we've done so far, we need to increase our understanding of the temporal and spatial distribution of basking shark populations around the UK through the development of effort related data collection. There is a need for more hard data. This may be partially achieved through enhanced public sighting schemes that give a "barometric reading" of where and when sharks are being sighted, which allows researchers to better focus their efforts, and to conduct more fine scale studies. Public sightings schemes are effective at engaging the public and involving them in the work that researchers are carrying out, an important factor that should not be ignored.

Further work is needed to evaluate site fidelity and shark activity at key sites. Are they as important as we believe them to be? A better understanding of what levels of disturbance may be sustainable is urgently required, particularly in these times of greater public awareness of the species. A unified Code of Conduct based on sound science and practical reality must be developed, as a matter of urgency, and must be spread to all users of the waters in which the sharks can be found. This should be an integral part of our drive to assess the need for greater protection of the species at sites of critical importance around the UK. Better defence of these localised sites may prove to be the best conservation strategy we can devise for this magnificent creature, in the short term, with additional global protection to follow.

Peter Richardson, Marine Conservation Society (MCS)

Saving Turtles Together: The Partnership Approach

The Marine Conservation Society (MCS) is the UK charity dedicated to the conservation of the marine environment and its wildlife. MCS is a joint lead partner in the Marine Turtle Grouped Species Action Plan (SAP) and coordinates the Turtle Implementation Group (TIG), a coalition of organisations committed to the SAP implementation.

The majority of the British public are completely unaware that marine turtles occur in UK waters. Indeed, the largest turtle ever recorded was washed up on the UK shores in 1988, which I will describe later. The implementation of the SAP began in 2001 and, to date, there has been no significant scientific research into the habits of the marine turtles found in UK waters. However, marine turtle sightings and strandings have been recorded in an ad hoc way and collated in a database known as TURTLE.

According to the TURTLE database, five species of turtle have been recorded in UK waters, including the hawksbill turtle and the green turtle, both primarily tropical species and rarely recorded here. More frequently recorded is the Kemp's ridley, the world's scarcest turtle, of which there are probably only a few thousand breeding females left in the world, restricted to a small complex of nesting beaches on the Mexican and south Texan coasts of the Gulf of Mexico. Like the loggerhead turtles that strand in the UK, these Kemp's ridleys are stray juveniles, often blown off course by adverse westerly winds. Our waters are too cold for these hard shell species (they can't digest food at temperatures lower than 15°C), and once they enter our cooler seas they become moribund and often wash up on shore alive, but very weak. The loggerhead juveniles that occur in the UK probably originate from rookeries on the eastern coast of the USA, the Caribbean and possibly from rookeries in West Africa.

From the UK perspective, the most interesting species is the leatherback turtle, which is now widely held as a regularly occurring member of the UK's fauna. The leatherback is physiologically adapted to flourish in cooler water temperatures and has been recorded in water temperatures as low as 5°C. The leatherback is the largest of the marine turtles, and the largest of any species of turtle ever recorded is known as the 'Harlech turtle', a male leatherback that stranded dead on a beach near Harlech, in northwest Wales in 1988. It measured 2.91m in overall body length and weighed 916kg. Some leatherback populations around the world have suffered rapid declines due to a number of threats, including exploitation for meat and eggs, habitat destruction and incidental catch by the world's fisheries. There may fewer than 26,000 nesting female leatherbacks left and the World Conservation Union (IUCN) now lists the leatherback as critically endangered.

Table 1 Numbers of records in TURTLE database at 05.05.02 and percentage of total of marine turtle occurrence in UK waters (earliest record dated 1748, TIG, 2002).		
Species	**No. of records**	**Percentage of total**
Leatherback turtle	502	65.4
Loggerhead turtle	97	12.6
Kemp's ridley turtle	29	3.8
Green & hawksbill turtle	4 & 1	0.7
Unidentified	134	17.5
TOTAL	**767**	100

Based on a JNCC analysis of the TURTLE database, since 1980 there has been an annual average of ten live sightings of turtles and six dead strandings per year. As shown in table 1, over 65% of records in the TURTLE database are of leatherbacks, which appear to visit UK waters on a seasonal basis, arriving in May and departing or moving northwards in November/ December. Most records are from the SW coast of England and Wales, but leatherbacks are often recorded off the west coast of Scotland and occasionally off the eastern coast of the UK. For example, in November 2001 a leatherback was spotted upstream of Firth of Forth, at Alloa.

One record of a dead, tagged leatherback that stranded on the west coast of Scotland indicates that some of the leatherbacks that visit UK waters are migrating from nesting beaches in French Guyana. Furthermore, satellite telemetry studies of post-nesting leatherbacks tagged in the Caribbean indicate that, after nesting, some of these turtles cross the Atlantic into European waters.

As previously mentioned, all turtles face a variety of threats throughout their range. For example, data from observational studies aboard Pacific High Seas swordfish and tuna longline fisheries suggest high levels of incidental leatherback by-catch. Data from the Atlantic high seas fisheries is scarce so, as yet, we do not know the impact of these fisheries on Atlantic leatherback populations. However, given the potential for by-catch in these fisheries, as well as the threat posed by the direct exploitation of leatherbacks for eggs and meat documented in the Caribbean and, to some extent, West Africa, it is important to keep any threats in UK waters in perspective. It may be folly to expend vast resources on mitigating against threats in UK waters when those resources may be better placed mitigating against more significant threats elsewhere. However, by endorsing the SAP, the UK statutory agencies have acknowledged the UK's responsibility to make the UK's seas as safe as possible for our visiting marine turtles.

As far as we know, the two main threats in UK waters are fishing by-catch and the marine litter. The Harlech turtle is believed to have drowned as a result of entanglement with fishing gear. Since 1980, there has been an average of 4 leatherback entanglements per year reported by UK fishermen, 62% of which involved entanglement in buoy ropes. It is not understood why leatherback turtles are particularly prone to becoming entangled in the buoy ropes of bottom-set gear such as tangle nets and crab pots. However, 61% of rope entanglements result in turtle mortality.

Entanglement in buoy ropes may occur due to chance or, alternatively, the turtles may be attracted to the gear, perhaps mistaking the ropes and buoys for jellyfish. The turtles may also be attracted to the soft-bodied marine organisms, such as ascidians, that colonise the gear. During an MCS survey of Cornish fishermen this year, I spoke to a sport fisherman who had hooked a leatherback turtle in the mouth after it had taken his salted-mackerel shark bait. Most of the Cornish crab potters use salt mackerel in their crab pots, so the leatherbacks may even be attracted to the bait. The MCS survey also revealed that fishermen have to regularly clean large amounts of marine litter from their gear. The litter gets snagged in their gear and buoy ropes, and it could be that the leatherback turtles are attracted to this marine litter. More research is needed to investigate this phenomenon.

Because there are relatively few records of by-catch reported each year, it is important to keep the significance of UK mortalities in perspective when allocating limited conservation resources. However, leatherback by-catch in the UK is probably under-reported and these entanglements may represent the 'tip of the iceberg'. Little is known about turtles in UK waters and the TIG has agreed that the thrust of UK leatherback conservation efforts must focus on research. In order to assess the significance of UK mortality to the Atlantic leatherback population, we need to know more about levels of by-catch, origin and relative abundance of leatherbacks in UK waters as well as abundance at the origin (breeding) populations.

Necropsy studies conducted on stranded marine turtles have revealed that marine litter poses a threat to turtles worldwide. For example, over half of the marine turtles that wash up dead on the US shores (mostly greens, loggerheads and Kemp's ridleys) have large amounts of plastic in their gut. Leatherback turtles have evolved a diet consisting almost exclusively of jellyfish and soft-bodied marine animals, and have a complex of spiky projections lining the interior of their mouth and throat to ensure that, when slippery food items, such as jellyfish, are ingested, they go down the oesophagus. Sadly, leatherback turtles can't distinguish between jellyfish and plastic bags and, once ingested, plastic and other marine litter must be swallowed. Plastic is indigestible and can block a turtle's digestive tract leading to death by starvation.

The necropsy of the Harlech turtle revealed quantities of plastic sheets in the turtle's gut. DEFRA are now funding a UK-wide necropsy programme of stranded marine mammals and turtles, and several stranded leatherbacks examined under this programme have had plastic in their gut. One specimen that stranded at Wigtown, Scotland in 1998 was diagnosed as having died of starvation due to a large accumulation of plastic packaging blocking its gut. There are also documented cases of stranded marine turtles in USA found to have partially inflated latex balloons and balloon pieces in their guts. In the UK, relatively few turtles have been necropsied and so the number of records of plastic ingestion in the UK is low. However, because marine litter is ubiquitous in UK seas and because the existing data indicates that turtles visiting UK waters are ingesting marine litter, this is potentially a serious problem that MCS takes very seriously.

The Species Action Plan was published in 1999 by English Nature, on behalf of the UK Biodiversity Group. The SAP describes actions to enhance the conservation of marine turtles in UK waters and in the UK Overseas Territories. Due to the lack of

biological data on marine turtles in UK waters, the Action Plan objectives and targets are rather broad and include:

- Avoid accidental harm to, and by-catch of marine turtles when present in UK waters
- Contribute to international measures for the conservation of marine turtles.

In the recent review of targets for the Species Actions Plans, the TIG agreed and acknowledged that progress towards these targets is difficult to measure as they stand, as we know so little about turtles in UK waters that we can't define biological targets. The targets will therefore remain as they are until the next target review in five years.

The Species Action Plan includes 26 separate actions under seven headings. The eight actions under 'Policy and Legislation' involve a review of existing policy and legislation in the UK and the Overseas Territories to ensure that marine turtles are adequately protected. For example, while turtles are protected under the Wildlife & Countryside Act, they are not protected under Northern Ireland's domestic legislation. Some of the Overseas Territories allow a directed harvest of critically endangered species such as the hawksbill and endangered species such as the green turtle, without any monitoring of the impact of those harvests on local populations. 'Site Safeguard and Management' involves just one action to ensure the enforcement of existing marine pollution legislation, an issue that MCS has long had an interest in. 'Species Management and Protection' includes two actions to ensure that, when turtles occur in UK waters, people know how to deal with them. For example, the UK Turtle Code is currently in production, which I will describe in detail later on. The two actions under 'Advisory' relate to advising the fishing industry about turtle-friendly practice and advising local authorities on dealing with marine turtle strandings. This latter action will soon be satisfied with the production of an Advisory Note, which is in production and which I will describe later. Before we know how to advise the fishing industry we need to have a clearer understanding of marine turtles in UK waters and implementation of the nine actions described under 'Future Research and Monitoring' should facilitate this. There is an awareness aspect to the SAP described under the three actions under 'Communications and Publicity' and because the SAP has cross-cutting issues like by-catch, which is addressed in Action Plans for other large marine species such as small cetaceans and basking sharks, the action described under 'Links with other plans' advises that the plan is taken forward in conjunction with other relevant plans. The implementation of the SAP is therefore reported to the DEFRA-chaired Marine Turtle & Cetacean BAP Group.

In 1999 the joint lead partners and contact agencies for the SAP were nominated, and MCS was nominated as joint lead partner with the Herpetological Conservation Trust. In 2000, MCS secured funding from the Cheltenham & Gloucester, the UK's third largest mortgage lender and, by committing two years of funding to the implementation of the marine turtle SAP, C & G became the first champion for a marine species under the UK Biodiversity Action Plan.

The other joint lead partner is the Herpetological Conservation Trust (HCT), which has an excellent history in implementing Species Action Plans for UK reptiles and for campaigning for reptile protection at a European level. The contact agency for this SAP is Scottish Natural Heritage (SNH), which has a history of involvement with

marine turtle conservation in the UK. MCS, HCT and SNH then organised the Turtle Implementation Group (TIG), which currently includes English Nature, Countryside Council for Wales, Environment and Heritage Service, the Marine Turtle Research Group (University of Wales, and without doubt, one of the best marine turtle research bodies in the world), Prof. John Davenport at the University College of Cork (one of the UK's foremost turtle experts), Euroturtle (an educational web site, which has done a lot of work in putting materials on line for school use), the Wildlife Trusts (who have carried out various educational programmes in Cornwall) and Marine Environmental Monitoring (the current custodian of the TURTLE database).

The TIG members bring together their individual skills and expertise in a partnership to further the implementation of the plan. The TIG has a good geographic spread and represents a wide range of opinion and views that must be considered when we are making decisions about SAP outputs. Such a range of input can require a lengthy decision-making process and the TIG strives to meet twice per year and regularly communicates by phone and e-mail when deciding on outputs. While it can take time, this decision-making process through the partnership does lead to quality, balanced outputs.

The first SAP output is the UK Turtle Code and accompanying Advisory Note. The Code (Appendix 111) is a double-sided laminated document, aimed at fishermen and other sea users. It was produced by the TIG in consultation with the Department of Environment, Food and Rural Affairs (DEFRA), the Sea Fish Industry Authority (SEAFISH) with funding from English Nature, Environment and Heritage Service and the Cheltenham & Gloucester, and will be distributed through the MCS. The Code encourages the reporting of marine turtle encounters to the appropriate regional contact and gives information on how to deal with entangled or stranded turtles encountered in UK waters.

The Advisory Note has been designed for use by Local Authorities, veterinary practices and public aquaria and expands on the information given in the Code while providing information on the preliminary care of live, stranded turtles. Using these documents, the TIG hopes to accumulate more data on marine turtles in the UK. The logo of each TIG member is on both documents - when applying a partnership approach, it is vital that everyone involved is correctly credited. This can present problems when promoting SAP outputs to the media because journalists with limited column space may not be interested in mentioning every contributor, especially commercial sponsors. When participating in a partnership of 11 member groups, one has to appreciate that your organisation might not make it into every newspaper article about the work.

The production of the Code has set a precedent for future outputs of the TIG partnership process. While some members of the group wanted the Code to be a very forceful document, with statutory backing to ensure it was carried by every fishing vessel, other members of the group were more interested in introducing the Code to fishermen through the fishing industry itself, and promoting voluntary acceptance of the document on to boats, i.e. a less heavy-handed approach. While deciding on the best approach, the production of the Code was delayed. But the final output was a positive compromise in that, although there is no statutory backing for the Code, it has been fully endorsed by DEFRA and SEAFISH. The range of views and attitudes

within the TIG resulted in a document that has all the necessary official endorsement without appearing too heavy-handed.

The TIG has prioritised certain actions within the SAP. Because the leatherback turtle is a regular inhabitant of UK waters, and we know very little about it, the TIG has prioritised UK leatherback turtle conservation and research. MCS has commissioned the Marine Turtle Research Group to have a satellite tag on standby to opportunistically tag an incidentally caught, healthy leatherback turtle if the opportunity arises. While this may be a 'long shot', it is possible. If this isn't achievable, the tag will be attached to a nesting leatherback turtle at an Atlantic rookery. The skills of Euroturtle will also be employed to facilitate an educational aspect to the satellite tagging, whereby school pupils can track tagged turtles on-line. Euroturtle has already carried out a similar project in the Mediterranean.

In March 2002, MCS will be running a 'Fisheries/ Marine Turtles Interaction Workshop' in Swansea, with funding from the Countryside Council for Wales and support from the Marine Turtle Research Group. UK fishermen who have caught turtles will be invited along to the workshop along with turtle biologists, conservation NGOs and government agencies to compile a concrete plan for marine turtle research in UK waters and to investigate why turtles are entangling with certain types of fishing gear. Hopefully, this workshop will begin the process of understanding turtle by-catch and possible preventative solutions.

In spring 2002, the TIG will launch UK Turtle Watch, a sightings and strandings scheme for turtles in the UK. Using the Code and other publicity, the public will be encouraged to look out for turtles in UK waters and to send their records to the TURTLE database. Public sighting schemes of this sort are useful because they engage the public and provide some idea of where turtles are found. However, in order to get some idea of abundance of turtles there has to be some effort-related surveys carried out in UK waters. Hopefully, next year, MCS will be working with Colin Speedie and other sea watching groups, to complement UK Turtle Watch with effort related monitoring of turtles and their environment.

In order to tackle the marine litter issue, MCS will continue its anti-litter campaigns with programmes such as 'Adopt-a-Beach' and 'Beachwatch', whereby local community groups are encouraged to clean-up their local beaches and monitor the type of litter that is being washed up. 'Beach Watch' is carried out each year and analysis of the data regarding litter on the UK's beaches suggests that much of it is tourism related. MCS will also be carrying out surveys of fishermen to discover the extent of marine litter in UK seas.

The TIG has also prioritised education and awareness to ensure that people are aware of the threats facing not only the UK's turtles, but also by turtles at popular holiday destinations. MCS will conduct a marine turtle education programme aimed at junior school-age children and, in cooperation with Euroturtle, will carry out a tourism awareness programme aimed at tour operators and UK tourists. The campaign will highlight the threat of illegal international trade in turtle products, such as stuffed turtles and tortoiseshell jewellery. The campaign will also target UK tour operators to educate them about the potential dangers of insensitive development at turtle nesting

beaches and will attempt to persuade them not to patronise tourism developments that are known to threaten important turtle habitat.

The actions within the SAP pertaining to the UK Overseas Territories are also being addressed through the partnership approach. In October, MCS and the Marine Turtle Research Group were commissioned by DEFRA to assess the status and exploitation of marine turtles in the UK Overseas Territories in the Caribbean. This three-year programme of participatory training and research in the six territories of Anguilla, Bermuda, British Virgin Islands, Cayman Islands, Montserrat and the Turks and Caicos Islands will be carried out with local partnerships in each Overseas Territory. Through extensive surveys, habitat monitoring and genetic stock analysis, this project, known as TCOT (Turtles in the Caribbean Overseas Territories) aims to assess the nesting and foraging turtle populations in each Territory and measure the impact and socio-economic value of legal and illegal turtle harvests. At the end of the three years and in collaboration with the local partners, TCOT will produce recommendations to the Overseas Territories governments, as well as the UK government, on how they can reform their marine turtle conservation management strategies and legislation.

The work has only just begun! It is in an embryonic stage, and we still have many lessons to learn. The partnership approach is not always easy and requires time, patience and a lot of diplomacy. It does, however, facilitate well-balanced, quality outputs and the TIG believes it is the correct way to proceed. But I must emphasise that this process depends completely on Species Champion funding, which really makes things happen. If it wasn't for the Cheltenham & Gloucester's support, I wouldn't be here telling you about the TIG partnership's progress with the Species Action Plan.

Barry Collins, UK Ecology Manager, Center Parcs

Species recovery and commercial development

I would like to thank English Nature for inviting me to present a few of the ecological successes of Center Parcs in the UK, something I am very proud to have been involved with, over the past thirteen years.

My presentation will describe the biodiversity gains and species recovery triumphs that are possible from commercial development.

The Center Parcs villages contain many examples of how these gains can be achieved. Through these I would like to explain why and how wildlife has benefited. However, before I begin, the one thought that is usually at the top of peoples' minds at this stage. Why does Center Parcs put all this effort into biodiversity conservation? The answer is simply that biodiversity is critical to our concept, our very reason to exist as a business.

For those of you not familiar with the Center Parcs concept it is important that I identify why nature conservation is so important to the Center Parcs Village. Indeed the Center Parcs experience and the conservation of our natural heritage share a common goal. The most important word in nature conservation today best describes this goal: 'biodiversity'.

Without biodiversity the Center Parcs experience would be lacking its vital component: the diversity and density of wildlife that enforces our guests' perception of truly being "at one with nature". The very essence of the Center Parcs concept is to allow our guests, essentially families, to be in close contact with nature with all its restful and restorative qualities that are, sadly, too often missing from modern urban life.

In order to realise our concept, whilst every village does have it's own nature sanctuaries for sensitive species such as nightjar, there can be no boundaries between nature areas and people areas. To achieve this, management for wildlife extends right up to the villas and buildings with each villa patio being a vantage point for a wealth of wildlife from birds to dragonflies.

Center Parcs was launched in the Netherlands some 30 years ago and whilst the formula to provide the experience has evolved to offer an outstanding short break, the principal pillars have remained constant throughout this evolution, essentially they are: -

- Cleverly designed, very comfortable accommodation.
- A mix of restaurants and bars.
- A few appropriate retail outlets.
- A range of both indoor and outdoor leisure and sporting facilities.
- And critically, the natural back cloth of woodlands and water with all its tranquil and restorative qualities.

In summary the Center Parcs village offers a chance to experience the beauty and excitement of our natural world in an atmosphere of safety and luxury far removed from the mud and driving rain that represents an acceptable burden to the wildlife enthusiast. It is this opportunity to escape the hustle and bustle of everyday life that attracts over a million people to stay with Center Parcs in the U.K. annually.

The value our guests' place on their interaction with nature at Center Parcs is substantial. We compile the top scoring satisfaction ratings from our guest analysis. These are collected from a questionnaire that is placed into every villa. The natural environment is the top scoring element even outstripping our impressive and highly enjoyable sub-tropical swimming paradise.

I hope in this section of my presentation I have adequately described the Center Parcs concept and provided tangible links to the importance that biodiversity represents to the experience. It is clearly critical to our concept that our villages are wildlife havens, but it is also critical to our company's philosophy and reputation that we are not seen to be exploiting and damaging natural areas of our countryside.

We satisfy these contradictory goals by choosing areas of the landscape, where the wildlife potential has already been damaged. To help achieve this we develop our villages within commercial coniferous woodlands. We are all aware that plantations such as this are relatively poor in wildlife diversity and also that the potential for enhancing these habitats is tremendous, and we are not the only organisation to have discovered this. Further to this, these plantations are evergreen and as such provide screening and colour 365 days a year; Center Parcs never closes, so this is a distinct advantage.

Once we have identified a site it is important to identify what habitats and species are natural to the local vicinity. Here documents such as English Nature's Natural Area Profiles, and liaison with the local wildlife trust can help. For example, at Sherwood lowland heathland and acid grassland were identified as the priority habitats for the forest rides and clearings.

Once you have identified the desired habitats of the landscape it is then critical that you find out what is actually living on the site. Even in some of the most damaged areas of our countryside, there can often be remnant habitats and species of great value. If you have not thoroughly searched your site you cannot be certain that your actions will not damage something of value. We achieve this element by carrying out detailed ecological monitoring of a site before and after development. For example, at Longleat Forest we recorded just one nationally scarce species, the woodland grasshopper, in one remote location of the site prior to development. This area was protected from damage during development and now this animal is thriving not only in its original location, but also across the site as a whole.

At Longleat Forest we protected all the valuable natural areas by the installation of some 40 kilometres of landscape protective fencing. To conclude, once you have both selected an appropriate location for the development and built it ensuring anything of value is protected, the next area, which is critical, has to be implemented.

The Long-term Care of the Landscape

The philosophy and objectives that we use mirror that of species action plans. From the information gathered on the actual and potential wildlife features of each village, we develop a Forest Management Plan. This includes specific biodiversity action targets. Each village has up to 30 targets covering habitats, species and interpretation. We implement this Biodiversity Action Plan by an annual cycle of monitoring, action and review. The cycle starts with all the findings from the ecological monitoring for the year being presented as prioritised recommendations. These recommendations effectively summarise the status of the biodiversity of the village and highlight species or habitats that are in need of management intervention.

For example, Elveden Forest is one of only three sites remaining in the UK for the nationally endangered micro moth *Coleophora tricolor*, the basil thyme case-bearer. This moth is entirely dependent on the presence of its host plant, basil thyme. It is an excellent example of the importance of ecological monitoring. If we had not carried out any monitoring this moth would not have been found and probably would have died out. Whilst this would have led to the loss of this moth from the village, more dramatically it would also have led to its potential extinction from Suffolk.

I would like to use this moth as an example of how our management system works. Over the 2000 season, the host plant was noted as being at risk of over-shading by trees and scrub. As such an area of management need was clearly highlighted by the monitoring. The action required was simply to remove the regenerating scrub from the area containing the basil thyme. This recommendation joins other actions for other habitats identified by the annual monitoring. At the end of the ecological year all the recommendations are analysed as part of the ecological monitoring report. They are then prioritised and in this case included in the 2001 annual work plan for the landscape management team. The specific actions and equipment needed are then all agreed upon and the annual plan instigated. Throughout each ecological year performance to the plan is reviewed on the site by the entire management team quarterly.

Returning to my example, over the 2001 season the site meeting checked the implementation of the basil thyme works. These meetings contain all the key people in the organisation. On this occasion it also included an external specialist to help advise the ecological surveyor from the Butterfly Conservation Society.
If a management system is to remain effective it must be flexible and able to respond to instant change. The site meeting concluded that not only had the works not been as intense as required but host plant and hence the moth was under severe threat and the removal of tall dense grass from around the plants was also urgently needed. This work was implemented immediately and we are now awaiting the result in the form of an increase in this important micro moth. Following this, a new list of actions for inclusion in the annual work plan for 2002 will be determined.

Those of you who are familiar with environmental management systems will recognise this sequence of events. In fact we are extremely proud to have our companies' biodiversity action plan certified to ISO 14001. This results in these

specified actions being audited by an external environmental auditor in accordance with the standard, and places an onus on the organisation to achieve the specified biodiversity targets.

What I hope to have demonstrated is that our forest management plan has delivered our corporate goal. To provide for a mass of biodiversity that will enforce our guests' perceptions of being "At one with Nature".

However our system has led to us going well beyond this. Remember that each Village was a commercial, coniferous woodland before the arrival of Center Parcs. Typically dark, dank environments with limited opportunities for wildlife. Today each village is a valuable nature reserve, containing many important species and assemblages. Longleat Forest has now recorded over two thousand species of flora and fauna. The gain continues annually demonstrating the sustainability of these wildlife gains. To add to the single nationally scarce species recorded at Longleat Forest, prior to the arrival of Center Parcs, we have now attracted some 33 locally scarce invertebrates, a further 35 nationally scarce invertebrates and 8 red-data book species. The wetlands have achieved the threshold for consideration as a SSSI due to their dragonfly assemblage. So too have woodland breeding birds, with up to 7 pairs of firecrest breeding each year being the main highlight. Less than 100 breeding pairs of firecrest breed in the UK annually. This figure clearly highlights the importance of Longleat for this breeding bird nationally.

Our Sherwood Forest village is equally as good, with 33 locally scarce plants and animals, 42 nationally scarce and three red-data book species. However, Sherwood is perhaps most proud of its bird life. Every year over 1,300 pairs of birds from up to 56 different species breed. Amongst these are seven species recovery or priority BAP birds. Perhaps the most successful is song thrush. Between 1995 and 2001, up to 55 breeding pairs of song thrush have been present. This is an outstanding assemblage when compared to the results of the BTO's breeding bird census analysis. This analysis identified that in 1995, in their most favourable habitat, 15.7 breeding birds were recorded per square kilometre. At Center Parcs on average 49.7 breeding song thrush have been recorded per square kilometre from 1995 to 2001. This is three times as many as the BTO found in the best habitat and six times as many breeding birds as the BTO found in coniferous woodland, the habitat that the village represented prior to Center Parcs arrival

Its not just song thrush that is recorded breeding in such large numbers. The following are examples of other species of conservation concern. These are all species that have declined by over 25% in the past 25 years.

Dunnock; this bird has declined nationally by 35%. The largest assemblage of this bird recorded by the BTO was 33.6 breeding birds per km2 in its favoured habitat. At Center Parcs on average 58.7 birds have been recorded breeding per km2 over the past seven years, a 75% increase on the best findings and ten times as many as were found in coniferous woodland. Similar results were noted for linnet, blackbird and bullfinch, all species included in the Amber or Red list of birds of conversation concern. In fact, across the UK all of the UK Biodiversity Action Plan species I have discussed are continuing to decline. The recent decline reported from 1993 to 1998 is

between five and thirteen per cent. As you will note on Sherwood, most of these declining birds are bucking the national trend. The exception is linnet, which is the subject of special habitat management on the Village.

Moving to Elveden Forest, this is formerly a coniferous plantation in the heart of the Breckland region of Suffolk, a place known for its rare and specialised wildlife. We consider it a major achievement that the Elveden Village has become one of the valuable nature reserves of this region. This remarkable site has now recorded over 2,000 animals and plants. Amongst these are 73 species of local rarity, 104 nationally scarce species and 26 red-data book species. Some of the highlights are:

- The endangered basil thyme case-bearer moth – the only remaining Suffolk site, one of only three in Britain and six in east/west Europe.
- The largest known breeding centre of the nationally endangered robberfly *Machimus arthriticus.*
- The only remaining native Suffolk site for the nationally endangered fingered speedwell.
- One of only six sites for dingy skipper.
- The largest stand of the nationally rare plant white horehound in Suffolk and the first record since 1937 of the plant specific plume moth *Pterophorus spilodactyla.*
- The village contains over 174 species of bee and wasp, including six red-data species and 29 nationally scarce. The national expert Steven Falk recently stated "Few Breckland SSSIs seem to have examples as good as Center Parcs Elveden Forest".
- Over 200 species of spider, only the famous Minsmere has recorded more in Suffolk with 241 species.

One of the highlights of the village is the wildflower meadow. On this meadow we manage a species recovery plot in partnership with the Suffolk Wildlife Trust and English Nature. This includes a role call of wonderful plants of both local and national importance, perhaps perennial knawel and small alison being the highlights.

As a result of all these successes both species recovery programmes and biodiversity conservation have grabbed the imagination and enthusiasm of the top management of Center Parcs.

After donating around £150,000 to Plantlife's "Back from the Brink" campaign from 1998 to 2000 we have now joined forces with the RSPB and have become species champions for the bullfinch. In this, we are supporting the PhD study to identify the reason for this bird's dramatic decline nationally. As we saw earlier this is another bird that is thriving on each village.

Further to this we are corporate sponsors of the dormouse, helping to fund the Great Nut Hunt, the national survey in 2001. We are also encouraging our guests to get involved to help boost the survey results. This passion in the organisation has been recognised by several prestigious awards.

There is now a collective pride amongst all the 3500 staff in the organisation for both the biodiversity success and species recovery projects we are continuing to foster.

Philippa Roberts, Earthwatch

The Business & Biodiversity Resource Centre

I've been at Earthwatch for the last seven years. For the last six years I have been involved very closely in our activities with business. Firstly, Earthwatch's involvement and how we got involved to start with. Earthwatch is generally known for its biodiversity field research projects. We have about 130 projects per year, 100 of those relate to biodiversity issues internationally. And all these projects are designed to use non-specialists as volunteers. But as a research based, non-confrontational organisation, we have increasingly found that we've had an interface with the corporate sector. We currently work with about 40 companies through our Corporate Environmental Responsibility Group and increasingly, many companies are sending their employees onto our research projects as part of a programme of raising awareness on the environment within the company. So, as we have been increasingly working with business it's meant that, in addition to being a biodiversity NGO, we are an NGO that's got some experience of working with business and a fairly extensive knowledge of how companies actually work.

One thing that we've come across when we've been talking to companies is that they know they need to do something about biodiversity and they often want to get involved, but they're unsure about what they want to do. So increasingly we are working with companies to help develop their understanding of biodiversity issues. This has led to a series of publications on business and biodiversity, which we have produced jointly with DEFRA. And recently, we've become the Business & Biodiversity Resource Centre.

One of the first questions we get from companies is 'you might think I need to do something about biodiversity, but what's the business case? What's the justification for me, as a company, getting involved with biodiversity?' And these are just some of the reasons why we believe that it does matter very much to business. Some cases are very obvious, where you have industries with a very clear connection between biodiversity and the actual business operation. For other companies it's much harder to be able to make that direct link. So, here are some of the reasons that we've put together.

Firstly, most companies use a huge variety of natural resources during their operations, whether that's food products, pest control, genetic material, and companies depend on the services that biodiversity can provide in helping to maintain a stable and healthy environment in which business can operate. If we look at wetlands, for example, reducing the risk of floods, or the need to use microbes to decompose solid wastes. They're services we can't get in any other way except by using biodiversity, or if we tried to, it would be hugely expensive. So, the conservation of biodiversity is used increasingly by scientists and economists as a key part of economic stability.

Regulation and licensing; there are national and international laws and regulations relating to biodiversity which might affect any business, and it's in a company's

interest to know about them and to comply with them. We've also had experience of companies who have had their licence to operate in an area that's sensitive to biodiversity be granted because they have a very good past record on managing that particular issue.

In operating any businesses, the liabilities incurred during past operations and risks posed by continuing operations need to be taken into account. There are many aspects to these factors, but a key one can be biodiversity. Obviously, you don't want to engage with biodiversity in a way that looks very superficial because you are going to attract criticism. But if you are engaged with biodiversity, it's the sort of issue people can get to grips with and to have a sound environmental record on this particular issue, can potentially help the company's risk management if there is an environmental incident.

Investor relations we've touched on already, and it's certainly of growing interest to Earthwatch to see that the environment and biodiversity specifically, is coming up the agenda. I think there are English Nature, Earthwatch and all sorts of other groups going around the City and turning up at the same organisations and saying 'you've got to be thinking about biodiversity', and there is a lot going on out there. We've heard about FTSE for Good, the Business in the Environment Index on environmental performance and biodiversity is one particular area of environmental performance. We've got more general environmental things, which will help us all, which are things like the Pensions Disclosure Act, which means that pension funds need to disclose the extent to which they consider environmental, social and ethical considerations in their investment decisions. We've got the Turnbull Report on corporate governance, which encourages companies to take a wider view of risk and start looking at ethical, social and environmental issues more closely, and the Company Law Review, which outlines the responsibility of company directors to external stakeholders and stresses the value of corporate reputation. They are all things, which are helping us to put environment very firmly on the agenda with the investment community.

Lastly, we come across companies, which are very refreshing because they do see biodiversity as a real opportunity. It's the really interesting bit of the environment. You can shout as much as you want about cutting your emissions but it's pretty dull! If you can get your staff and your customers and your stakeholders involved in what you're doing for biodiversity, it's a really good opportunity to be able to gain the opportunity to communicate other things about your environmental performance.

So that's why I think biodiversity matters to business. Why should business matter to us as NGOs? What should we try and engage them in, in biodiversity? As landowners – we've heard of Anglian Water, for example – talking about their role as owning a fair chunk of the UK and certainly having the possibility of helping biodiversity on the areas that they own. As a purchaser through their supply chain, where are they getting their supplies from and are they considering biodiversity in those decisions? As a lender or insurer, as a user of energy and therefore the impact that might have on climate change, which comes back to an impact on biodiversity. As an employer – and I should also put there what they said about the visitors, you know, a million visitors coming to Center Parcs, a million to Rutland Water. There are lots of other people out there as well beside the employers, who can be influenced

by a company's activities. We get the point at Earthwatch that it's not just about money, but there is money in companies for sponsorship activities. How can we get it to come to biodiversity?

Some of the challenges that we've had as an organisation talking to business about biodiversity. One is terminology. This is not a new comment to say that, is biodiversity really a good choice of word? It's something that people do struggle with and is not the most accessible word. But there are also bits of terminology. We talk about BAPs and we talk about SPAs and CBD and all these role off the tongue, and, if companies haven't come across them they'll look at you as those they are completely mad. So we need to be careful that we're using the right terminology for business. We also need to be careful about how we're using that terminology. When Earthwatch talks about a Corporate Biodiversity Action Plan it meant something completely different to a company we were talking to, because we were looking at it as a sort of plan across the company and across all departments. Their interpretation was very much about managing a particular site, managing a land holding. So there are different ways that different NGOs and different companies are using the same sort of terms.

I do get the feeling that biodiversity is often seen as an NGO and Government thing, and less of a corporate thing. It's owned by scientists, it's owned by other groups out there and it's not really seen as something that business can necessarily get involved with. It's also difficult to measure and difficult to quantify. There are so many unknowns, that it's also quite difficult for companies to get a grasp on. There's the what's in it for me angle, the business case, and the need to come up with really strong arguments about why in well run business, biodiversity should be on the agenda.

Partnership versus fundraising, making sure that when we are talking to companies, it's not just 'oh, by the way, can we have X amount of money?' It's about trying to engage companies in the whole biodiversity process.

Who should we talk to? There are so many groups out there. There are lots of different NGOs, all doing fantastic work with slightly different expertise in different areas. There is some overlap. Who can companies talk to? Where should they get started?

The Business & Biodiversity Resource Centre is run by Earthwatch. It's resourced by DEFRA and ENERGY and supported by English Nature. We have a steering committee that also involves all of those groups and a member of the England Biodiversity Group, and the reason that we went to DEFRA to suggest that we'd get some money to do this was that we felt there was a real need for an organisation that could bring some of this information together. As I have mentioned, most of our work is overseas. We are not a competitor for funds in the UK as a lot of our biodiversity work is elsewhere, so it does mean we are in a position potentially, to act through the Resource Centre being a bit of a broker between business and other NGOs, because we do have a good network of companies that we already work with.

There are various things that the Centre aims to do. Firstly, to be a central source of information on business and biodiversity. Secondly, to be able to sign post companies

to organisations and agencies that can help them engage in biodiversity conservation. We are undertaking research into key issues. We've mentioned, for example, that we are looking into the business case, but we will continue to be looking at those sorts of aspects, and the more arguments we can come with to convince business that biodiversity is something they need to be involved with, the more we can put those arguments out to other groups for them to be able to use.

The website is the main resource currently available. It's divided into 2 sections, 'Understand' and 'Take Action' and, in the 'Understand' section we cover things like 'what is biodiversity?' 'what's a biodiversity action plan?' We cover aspects of the business cases that I have already discussed today. But also, we wanted it to be really practical, full of ideas and advice for companies. It would mean that whatever size of company they were, whatever industry they were, there is something they could to contribute to biodiversity in the UK. There is a section on different sectors, so you can, as a business, go in and find the sector that's relevant for you, find ideas for things that you can do. And those ideas are graded 'Acorn' or 'Oak' depending on whether they are hugely resource intensive or whether they are quite easy and accessible. Just to look at the 'Utilities' section, for example, we appreciated that most of the utilities are going to have some degree of land holding and so there is a section there on developing a habitat species action plan for your particular site, and some ideas of how to involve your employees and so on.

We are extremely lucky in the UK in that we have got this structure. We've got this framework of the UK Biodiversity Action Plan. We have local Biodiversity Action Plans that companies can feed into. There is information here, which takes you through to the UK Biodiversity Action Plan and the different local plans.

Very quickly, some emerging trends. A growing development of partnership, and I will just mention something very quickly as an example of this. That it's not just about funding. In our relationship with ENERGY we have had co-funding for the Business & Biodiversity Resource Centre. They have also seconded their Environment Manager to us for 35 days a year. She has set up a Biodiversity Action Plan at one of their land holdings, so it's a fantastic resource for us to be able to use the expertise from companies to help us to develop better examples of better practice and information and so on. Increasingly, biodiversity is on the list as one of the things that we need to consider in sustainability. A growing number of companies are getting their employees involved, maybe instead of funding, but to make their staff available. More and more companies are developing their own Biodiversity Action Plan which, even if they are not standardised yet, there are things actually going on paper, and I do think there is a growing business case which we will, as we get more experience working with companies and talking to companies, hope to convince even more of them to get involved.

http://www.earthwatch.org.uk/

Leigh Lock & Cath Jeffs, RSPB

The Case of the Cirl Bunting

Introduction – breeding status and range

The cirl bunting is widespread across the western Palaearctic, but there have been major declines in the western European population, with extinction in Belgium and range contractions in France and Britain. Within Britain, the range contraction over the last fifty or so years was so massive that, at the end of the 1980s, there were fewer than 130 pairs and the birds were concentrated in south Devon. On that basis it became a UK BAP species – a priority for conservation action.

UK BAP objectives for cirl bunting

- In the short term, maintain the upward trend in numbers and increase in distribution (within the current range) in the UK.
- Increase the UK population to 550 territories by the year 2003.
- In the long term, ensure a wider geographical spread of the cirl bunting by re-establishing populations outside the current (1997) range.

Species' requirements and reasons for decline

Why had this bird declined? The RSPB started research in 1989 and quickly established the reasons:

- Loss of winter food and particularly winter stubbles through changes in farming practice and the switch from spring to winter cereals,
- Loss of summer food in the form of invertebrate-rich grassland and also changes in the management of those grasslands,
- Loss of hedgerows and scrub which form the nesting sites of the birds,
- Loss of mixed farms – enterprises comprising both arable and grassland.

The cirl bunting is very sedentary and not very dispersive. As a result, it needs all of its habitat elements in close proximity. It needs arable, low intensity managed grassland, hedges and scrub all within the same farm or cluster of farms. Cirl buntings declined through a loss of low intensity mixed farming systems. An example of good cirl bunting habitat is at Prawle Point in south Devon. Here there is a mixture of agricultural habitats but also, because of the maritime effects and rather thin soils, they are under low intensity management. The south facing slopes have various hot, sunny pockets with thin soils, rock exposures and patches of scrub. The complex of scrub, thin patchy vegetation and bare soil habitats is excellent for invertebrates that are a critical part of the summer food for cirl buntings.

Putting the habitat back – designer stubbles

To secure the future of the cirl bunting, the key issue was restoration and management of these habitats. The Countryside Stewardship scheme started in 1991 and was initially run by the Countryside Commission (and now by DEFRA). One of the primary objectives of this scheme was to restore arable land on the coast to low intensity managed pasture. Whilst this was being driven by landscape objectives, for the cirl bunting (and for other species), losing the low intensity arable component was potentially a big problem. Fortunately in 1992 the RSPB was able to persuade the

Commission to run a special project as part of the Stewardship package. This special project funded a spring barley crop with reduced herbicide input, which was then left after harvest as a weedy stubble until 1 April. So, rather than losing arable, the scheme would be encouraging the management of a low intensity arable system within those coastal areas. This gave us a major opportunity to address the decline of the cirl bunting by supporting a farming system that was benefiting the birds and encouraging a more low intensity system around its core areas.

The work of a project officer

The next step was to employ a Project Officer to go out and provide the advice to the farming community. Much of the area was National Trust owned so it was a key partner in this. The National Trust drew up Countryside Stewardship agreements and looked for other opportunities for management agreements to enhance wildlife. This really raised the whole profile of the issues and the cirl buntings themselves.

The cirl bunting is quite a dull brown bird, and a species that most of the farmers will not really see. Therefore, it is a difficult species to promote. However, following the employment of a Project Officer for nearly 10 years (initially just through an RSPB project but via the Species Recovery Project since 1995), the profile of the species has been raised successfully. The project officer contacts and visits farmers in the target areas, draws up Countryside Stewardship agreements and advises and encourages others to put management agreements in place to help cirl buntings (eg, WES). Over the years, the project officer has also organised many events for farmers and advisers, often centred on a farm already in Stewardship and combining `talks and walks'. Events have also been organised for the local community, inviting people to see cirl buntings, and much has been done to raise the profile of the cirl bunting and the conservation work of farmers through articles and features for the local and national media.

This approach has really been worthwhile. Now we are in a position to look back at several years of progress and some interesting developments.

Advising farmers and countryside stewardship

In the beginning farmers with key cirl bunting populations were targeted and persuaded to enter management agreements, chiefly Countryside Stewardship. We started with a few people going into the scheme. Some of these farmers were already growing spring barley (which is why they still had cirl buntings), and so it was a matter of giving them an incentive to continue that practice and do a little more. Interestingly, our 'selling' approach has modified over the years. What began with a handful of agreements has since snowballed. Now, instead of the RSPB having to go out to farmers, knock on doors and ask "Did you know you have a rare bird on your farm, have you thought of doing management to help it?" farmers approach us and ask for our help in going into Stewardship.

Farms that do not have cirl buntings at present but are in strategic areas (eg, for links between existing groups of cirl buntings) are also targeted. If one influential farmer can be persuaded to enter a scheme, it is likely that his neighbours will also think about going into the scheme. In this way, we can build corridors of habitat between

cirl bunting populations and we are getting to the stage where most of the birds are within or very close to agreements.

There are now more than 180 agreements in south Devon that are putting cirl bunting habitat management in place: growing spring barley, which is vital for the birds in the winter because they feed on seeds in the stubble; managing grasslands rich in invertebrates, including grasshoppers for feeding to growing chicks; and restoring hedges for nesting sites. Countryside Stewardship is the major means of delivering cirl bunting habitat. If this year's Stewardship applications are successful, over 50% of the population should be under an agreement, which is good news. Other agreements used include WES, RSPB and voluntary, and 6% of the population are on land managed under these other agreements. 90% of the cirl bunting population is now within a kilometre of land being managed under agreement. This leaves only 5% of the population more than 2km from agreement land.

Does countryside stewardship work?

We have been promoting Countryside Stewardship successfully and there are many management agreements in place, but the crucial question is "Does it work for cirl buntings, and does it work for the farmers?" The scheme lasts for only 10 years, and then farmers have an opportunity to leave. Obviously, the RSPB wants to know that the management is helping cirl buntings and that farmers benefit too, so that we can then persuade farmers to renew agreements and continue to provide habitats to help the birds.

The RSPB did two pieces of research in 2001 that indicated that Stewardship and the cirl bunting project was working. The first was field-based – counting cirl buntings and looking at how they are responding to Stewardship agreement land. We found a strong positive correlation between agreements and an increase in cirl bunting numbers (83%), while numbers remained stable on adjacent, non-CS agreement land (2% increase). So the good news is that the population is going up. This work also indicated that the increase is not due to good habitat on one farm pulling in birds from other areas. We are not simply moving birds from poor areas to good ones; cirl buntings are increasing where land is managed for them.

This is the first conclusive demonstration that an agri-environment scheme is successfully delivering target biodiversity at a regional scale. It is good to find out that spring barley is the key and that leaving the stubble enabled the birds to survive – and to be able to tell farmers that their management has been successful. We were pleased to see conclusive proof that the management we have been promoting and DEFRA has supported really does work.

This research also showed a positive relationship between cirl buntings and arable grass margins – the wider the better. Cirl buntings are doing very well on farms with 6m grass margins. As mentioned, this species is very sedentary. We found that there needed to be links between all the farms and between habitats to see any movement of birds at all, with sites further than 2km from cirl bunting populations unlikely to be colonised. Though the population is increasing in numbers, the problem remains that we are still not seeing any real range expansion.

The other piece of research was going back to the farmers who have gone into Stewardship, with quite a lengthy questionnaire to find out what they thought of the scheme. Farmers' reasons for liking the scheme were varied and included:

- The payments made the work worthwhile for the farm's finances
- The farmer was doing a lot of the management anyway
- The scheme enabled farmers to do work, eg, hedge management, they wanted to do but could not afford to do without Stewardship
- The scheme helped with continuity of staff employment, eg, hedge works enabled staff to be kept on over winter and other management meant the employment of extra staff.
- The scheme enabled farmers to feel good about the environmental benefits.

The research showed that farmers felt good about Stewardship and the management they were doing to help cirl buntings. They were pleased to have a rare species on their farm. In fact, some were proud to have more cirl buntings on their farm then their neighbours - it produced a bit of friendly competition. The responses from farmers also showed how the scheme had enhanced their self-esteem and repaired the image of farmers as `guardians of the countryside'. As we know, farmers have been heavily criticised in recent years with regard to subsidies for production at the cost of wildlife. Participating in a successful agri-environment scheme made them feel better about what they were doing and enhanced their standing in the community. Our research among 'cirl bunting Stewardship farmers' showed that 94% of them felt pleased that they had gone into the scheme, and that is really good to know. We were also told that our *Cirl Bunting Bulletin*, the newsletter produced for farmers and others involved in the project, made them feel more involved in this work as well as keeping them updated with progress. Farmers also appreciated the continuing availability of advice and help from the project officer.

Population recovery

We are at the stage where the cirl bunting population is recovering. In 1989, there were fewer than 130 pairs in the whole of the UK and the last comprehensive survey in 1998 showed 450 territories, a trebling of numbers in just 10 years. Foot and mouth disease prevented any monitoring in 2001 but this year we will be selectively monitoring the population.

Problems - range expansion and built development threats…

As stated, cirl buntings are still restricted to south Devon and the birds are mostly found in the areas they occupied when this project began. This lack of range expansion is worrying and makes the species vulnerable. While Countryside Stewardship management benefits the birds and the RSPB continues to work successfully with local farmers to draw up new agreements and improve existing ones, we know that we cannot rely solely on this land management work to conserve, let alone expand the population.

Much of the population, especially in the northern part of the range, is close to the edges of towns and villages, including areas where new built development is proposed. Some of these birds are thus extremely threatened by new housing and roads and, as cirl buntings are very sedentary, they are unlikely to move when habitat is lost to development. We know that cirl buntings are reluctant or unable to seek new areas of suitable habitat even if replacement habitat is provided close to that

which is developed. I have returned to sites which have been developed, and seen the birds still sitting in the gardens of new houses.

RSPB analysis of development plans shows that 2.5% of the population could be lost directly to the built development proposed, with 25% of the population suffering adverse impacts. Consequently, the RSPB is working with the relevant planning authorities and individual developers to devise a more positive approach to planning for cirl buntings. We want development located away from areas important for cirl buntings. We also need to develop best practice for new developments so that cirl bunting habitat is retained where possible and, where not, adverse impacts are reduced through mitigation and compensation with sufficient replacement habitat (quality and quantity) provided nearby so that cirl buntings do not die out in developed areas. More work is required so the RSPB can develop effective guidance and ensure that cirl buntings are not always the losers in development matters.

…and lack of breeding success

Cirl buntings are also hampered by poor breeding success. It is probably another reason why we are not seeing as great an increase in numbers as we would have liked and expected with all the suitable habitat that now exists. Unfortunately, the species' poor breeding success is linked to something beyond our control - the cold, wet summers of recent years. As well as resulting in chicks becoming cold and wet, this weather makes it more difficult for adults to find enough invertebrate food to feed the chicks. Hungry chicks call more, so are more vulnerable to predators. The RSPB is therefore concentrating on getting plenty of food-rich habitat in place. We feel positive that this is the most effective way of getting the numbers up, but it is a long-term project.

The future

The project will continue to work with the local farmers. We will promote habitat management for cirl buntings with new farmers, but also re-visit the farmers who have existing agreements. However, there is a problem with this approach. With the 180 agreements in place, it gets harder and harder to maintain a sufficient level of contact with farmers. Regular newsletters are useful but nothing is as effective as meeting farmers on their own land. Very often, a discussion over a cup of tea will reveal problems or aspects of the agreement or management that need to be changed. The question is, how do we maintain the contact with farmers already in agreements, to maintain their quality, and yet also bring new farmers into the project and into Countryside Stewardship to increase the amount of habitat for cirl buntings?

As regards threats from built development proposals, we will develop protective mechanisms with the planning system. This will include a comprehensive alert system whereby the RSPB will highlight important cirl bunting areas to local authorities who will in turn alert RSPB to proposals within critical zones. We will also seek habitat gains as the desired outcome of any development, rather than accept loss of cirl bunting habitat. The response from local authorities has been good but, to be successful, this aspect of the work really demands the time of another dedicated member of staff.

The lack of range expansion has prompted plans for translocation.

Cirl bunting project – elements of success

The cirl bunting project shows how to use research to establish the problems and identify solutions, and then use (and modify) an agri-environment scheme to deliver the core habitat types and management required. It is also a fine example of the benefits of continuity of contact and effort. The majority of farmers we work with still may not be able to identify a cirl bunting – to them it is a small bird that grovels around on the ground in the stubbles, and the only view they get is of it dashing into the middle of a hedge. However, the project shows it is possible to enthuse farmers about a bird so that they want to do more for it. This project is also about the value of partnerships; it is a well-worn phrase, but partnership projects are very effective. The cirl bunting project would not work without the co-operation of individual farmers and landowners, DEFRA, the National Trust, English Nature and many others. All have joined forces with RSPB to turn around the fortunes of the cirl bunting. While I do not know whether I will be working on the project in five years, I know that the project will continue. There is still much to be done, including expanding the range and protecting the birds from development threats.

Dr Phil Wilson, Wessex Environmental Associates

The Arable Flora

Contrary to public opinion, arable farmland can be an extremely rich place for wildlife. Many people think arable land is a wildlife desert but it doesn't have to be that way. It can be full of plants and animals, not just cirl buntings but also a wide variety of plant species. An arable field is not an easy place for a plant to live. It is a highly stressed habitat with extreme disturbance. In fact, complete churning up of the soil more or less every year. It can be very drought stressed. There are often attempts to control the non-crop vegetation. The crop itself is highly competitive. There are lots of pressures on anything that tries to grow in an arable field.

Some of the basic features of the biology of plants that live in arable fields allow them to survive the pressures of this habitat. Most arable plants are annuals. In order to cope with annual disturbance the plants themselves have adopted an annual life cycle. They germinate from seed every year and they produce seed before the crop is harvested, so that between the time of ploughing and sowing in autumn or spring and the time of harvest in July or August, these plants will have completed their life cycle.

There are of course exceptions to this general strategy. A few arable species are of low stature and grow below the level of harvest. These species need stubble to be left unploughed after harvest to produce seed. There are also some perennials, which grow in arable habitats, surviving by means of vegetative growth from small pieces left after ploughing. For the most part, these perennials are very common and have actually become some of the widespread pests of modern agriculture. Many arable annuals are poorly competitive plants, some of the exceptions having become the pests of modern agriculture. I'd like to distinguish between relatively non-competitive, often uncommon arable plants that we want to conserve, and common, competitive arable weeds that we don't.

I would also like to make another distinction between two groups of annual plants found in arable fields. There are ruderal species that tend to be the more common widespread ones that spread easily and produce lots of seeds – light, mobile seeds, which colonise waste ground and newly created arable fields quite happily. They often have a very short-lived seed bank. These colonists are often opportunist. The species that are of interest to conservation, the ones that are getting very rare, are the real arable specialists called segetal species. They usually produce very few seeds. The seeds are often very heavy, very immobile and don't spread easily. Once they have been shed from the parent plant they stay where they are. Seed banks are often very long lived. This is extremely important and is one of the great saving features of these plants. Even when the plants themselves appear to have been lost from a field, they might still be there. Seed banks are very poorly studied, but it is thought that some species may form long-lived seed banks that might last more than a hundred years. A long-lived seed bank is obviously a great adaptation for growing in an unpredictable environment like an arable field where conditions can be suitable for a plant to set seed one year, but in the course of a crop rotation, may not be suitable for another five years. This important feature means that it may be worth trying to

resurrect some of these plants where we have seen them in the past because they might still be there in the soil.

These species are actually quite well adapted to traditional arable farming. They are annuals, they survive disturbance well, and they can live through periods of adverse conditions in the seed bank. Nevertheless, they have suffered a catastrophic decline. Why has this happened? This returns us to the theme of this session, 'Changes in Agricultural Practice'. Things have changed rather a lot over the last 50 years in arable farming. The main and most obvious change is the adoption of herbicide use for weed control. Fifty years ago efficient weed control was carried out through crop rotations, hand weeding, fallows and cultivations to destroy seedlings. Then along came things like herbicides. Since their introduction there has been continual improvement in the efficacy of these compounds. When they were introduced there were only a couple of herbicidal chemicals. They weren't very efficient– you had to use gallons and gallons of the stuff mixed up with water. Now you can buy things that come in tiny packets containing enough to spray 50 hectares or so. There are some very effective compounds now; they work over a very broad spectrum and they're easy to use. Spraying has killed off an awful lot of arable plants – the nice and the nasty.

Another important change is the use of nitrogen, especially coupled with the use of crop varieties that utilise the nitrogen efficiently and grow quickly, out-competing and shading out other plants. Modern crop breeding is an important factor in the elimination of many plants that used to grow in arable crops. An experiment looked at different rates of nitrogen application and effects on the numbers of arable plants that survived to produce seed. There was good survival of plants when no nitrogen was applied, but some species like weasel's snout *Misopates orontium,* mousetail *Myosurus minimus* and lamb's succory *Arnoseris minima* did not survive at all at the full rate of nitrogen. All others were significantly disadvantaged by the application of nitrogen at a level that is supplied to conventional arable crops.

Another important development has been ever increasing sizes of farm machinery. Whilst this doesn't affect these plants directly, it has led to the enlargement of fields. Nowadays it is common to find prairie-sized fields of up to a square kilometre in size. This means that the refugia around the edges of fields, and field corners where arable plants could have escaped applications of herbicide and where crop competition is less, have been lost. Increasing efficiency of farming operations means that many opportunities for arable plants are no longer there. Drainage is another problem. There is a whole suite of arable plant species like *Myosurus minimus*, which are dependent on wet conditions in arable fields.

Many of arable plants are now on the Biodiversity Action Plan Priority List and on the list of species of conservation concern. It is interesting to note the proportion of species on the Priority List. Of the 62 vascular plants, 12 are arable ones. This is more than from any other habitat, which goes to show the extent of official recognition of the problem. When I started working on this 15 or 16 years ago, people just laughed when you suggested the conservation of arable plants, it was just not on the agenda at all. I am really delighted to say that things have changed.

On farmland, you don't just have the arable fields although they are obviously one of the most important elements of farmland habitats. There are many other species that rely on arable field edges, which are occasionally cultivated and then left, hedge bottoms and other marginal habitats. We will concentrate on the plants of the arable fields themselves however.

Silene gallica, the small-flowered catchfly, now restricted to very few sites in the South of England, mainly on coastal arable fields.

Cornflower – the charismatic megaflora! Again, this used to be very common – it's a plant that's in the folk memory of most people in Britain. You can buy tins of cornflower blue paint, but not many people have seen a wild cornflower.

One of our few endemic plant species, *Fumaria occidentale,* restricted in the whole world to arable fields and hedge banks in Cornwall.

Filago pyramidata – the broad-leaved cudweed growing there in its only remaining arable site in England, which is in Kent. Much more commonly a species now of chalk quarries, where it tends to grow about 0.5cm tall. In its full glory in an arable field it gets to 0.5m, scrambling through the crop.

Galeopsis angustifolia – the red hemp nettle. Tank tracks on Salisbury Plain are now the most important site for *Galeopsis angustifolia* with many thousands of plants in a good year.

Corn buttercup, growing on an organic farm that has completely escaped herbicide use, illustrates how useful a seed bank is in maintaining populations. The field where the corn buttercup grows comes round to the right crop once every five years; for the rest of the rotation it is under grass and legumes. Once every five years it is in winter cereal, and corn buttercup comes up in quantity.

Pheasant's eye – a plant of chalky fields in Wiltshire and Hampshire. Rather spectacular but now down to a handful of sites in the country.

So, what can we do to keep these plants and what can we do to try and make them spread around a bit more and return to their former glory? Well, it's quite easy in theory. All you need to do is to put farming back to what it was about 50 years ago! It's possible within the current Countryside Stewardship Regulations to do this – to have uncropped wildlife strips on the edges of arable fields. It's down in the small print at the very end of the Stewardship Regulations, and now we are seeing the extension of some of the arable stewardship special options to Countryside Stewardship throughout the country. At the moment there is no increase in funding but, nevertheless, these options will be there and they will be more heavily promoted. I did some costing of the various options in arable field margin management, and the yields go down as you take these various inputs out. Take herbicides out and things don't go down too much, take nitrogen out and things go down a lot. Take the crop out and unsurprisingly it disappears completely! But it's not quite as catastrophic as it looks because, at the same time, you have variable costs, like the cost of applying the herbicide and fertiliser. If you can show that to land managers and farmers then they may be not quite so discouraged about wasting corners of their fields. Experiments

have shown that you could actually make more profit by not applying herbicide to winter wheat at all!

This is great only for more widely distributed uncommon species. Countryside Stewardship is not targeted on rarities, and they have to take their chance on whether the farmer who owns the land is interested in them. One of the gaps we have at the moment is in the scheduling of SSSIs for some of these species. English Nature is being very wary about doing this and, I think, rather mistakenly so. It's at the point now where several of our rarest plants are not featured at all in the SSSI series – a great omission. There may have been perhaps poor understanding in the past of some of the issues, by both conservationists and by farmers, and perhaps a lack of communication. I think there is a great role in the conservation of these species for intermediary groups, like FWAG, the RSPB and Countryside Stewardship project officers, both in interpreting arable plant conservation to farmers and in going back the other way and training conservationists as well. So we need, I think, some improved SSSI protection for these species, otherwise some of the really rare ones are going to miss out and slip through the stewardship net.

What else do we need? Well, we need more landscape based solutions and a more strategic view of farming and conservation. We need more collaboration between various interest groups. The RSPB-led scheme for Cirl bunting conservation in south Devon is also doing some wonderful things for arable plants. There are populations of *Valerianella rimosa*, *Fumaria vaillantii, Silene gallica* and *Ranunculus parviflorus* – these are amazingly rare things. This is rather astonishing, as these plants were never known there before, but then the RSPB came along and did birdie things and all these plants came up.

Collaboration between interest groups is good. There may be a slight difference in emphasis but we are all after the same thing and we can all use the same methods as well. I don't want to go back to the situation we were having, say, ten years ago, when birders and various other people were advocating universal grass strips around every field margin in the country, which would have been death for a lot of these plants. We need more communication, and it's happening, which is very encouraging.

Another thing we need is better information to target some of these rare species. Every movement of every stone curlew is tracked to the nearest square inch, but with vascular plants we are working, usually, with out-of-date 10 kilometre square information. We need information that is targeted to precise fields in order to be able to target management properly and the BSBI are going to start approaching that with some pilot surveys starting in 2002.

This could all be potentially futile, of course, because there are global and geopolitical forces, which we are all having to resist as best we can, and some of which are potentially irresistible – climatic change, for instance.

If everything else has been managed properly, arable plants could do quite well out of some climatic change scenarios. They tend to be plants of warmer places in the south of England and, if the whole country warms up a bit, then they could go up to the north of Scotland. At the same time as climatic change there is immense commercial

pressure – the commercial farming world is changing rapidly, facing the increase of global free trade. It's quite possible that in 100 years time, if global free trade proceeds to its conclusion, there won't be any farming in Britain anyway, because we will be undercut by other countries, where labour is much cheaper.

I would like to see, in the end, a fundamental change in our approach to farming, towards a much more sustainable system, towards the return of low intensity arable in which arable farming, food production and conservation were all linked. In which there is room for food and wildlife as well, and in which we are adopting the best of organic and conventional practice and integrating conservation within that.

Brian Banks – English Nature

American Bullfrogs in Britain

I am going to describe a project concerning the eradication of the population of North American bullfrogs in this country. It's being funded largely by English Nature with help, mainly in kind, from the Environment Agency, who have helped by supplying pumps to drain ponds, and rescuing the fish as the ponds dried out. FrogLife has carried out the work on contract. The final person to mention is Michael Evans, the landowner, without whose help the project would not have been possible.

The North American bullfrog comes originally from the eastern United States, ranging as far south as northern Mexico, and just into southern Canada, but has spread widely from there. It now occurs in the western parts of the States, and has been introduced to Southern and Central America. It's got into Asia including Japan, and is becoming established in Europe, most recently in France and this country as well. It's a large, highly aquatic frog, and if it can be confused with anything it would be with the marsh frog, which has similar habits, and superficially resembles it. Both tadpoles and adults are very large, the latter reaching 20cm in length, and we have found 14cm long tadpoles. Interestingly, the tadpoles appear to be immune to fish predation. They survive very well in ponds stocked full of trout, which are very nasty predators to many amphibians. In the States, they are regarded as a pest species where goldfish are bred commercially.

Sound is one feature that you might use to identify this frog. It has a very distinctive call, resembling a bull, hence the name. But the other notable feature is the size of the eardrum in the male, which is a big circular disc just behind the eye. If you look at a British common frog, you can see down either side of the back from behind the eye to the base of the hind leg, there is a glandular fold of skin called the dorsal lateral fold. All the European species of *Rana* have that fold down either side of the back. On the bullfrog it appears not to be there, but it is. It starts just behind the eye, curves round the back of the ear drum and disappears at that spot. That is probably the best identifying feature. Like most frogs, they are variable in size and colour, so these are not the best means for identification.

Behaviour. The animals we have found in this country tend to be active from about April to October, depending on temperature. In one year, they didn't appear in large numbers until late April. They are most active between June and August, when it gets really hot and they breed. They're quite an aquatic species, most often seen on mats of floating weed on ponds, and they also sit on the banks where they bask in the sun, leaping into the water when disturbed, much like marsh, edible or pool frogs in Europe. The juvenile has a distinctive, high pitched squeak, and when we went to the ponds for the first time, there were literally hundreds of these little green frogs all sitting on the surface of the water, which leapt as soon as they saw you. You hear a high-pitched squeak followed by a splash. I don't know any of any European species that make that noise.

Although they spend a lot of time in the water, they do come out and forage on land. We found that when it was getting dark in the evening they would leave the margins of the pond, presumably in order to disperse, but probably also looking for food. That was particularly the case on warm and damp evenings. The adults seem to hibernate mostly in water. When we drained one of the ponds we found something like 500 or 600 frogs in the mud that was left behind. Ten animals were found hibernating on land, adjacent to the exclusion fence that was put up to restrict their spread. The fact that draining the pond had a huge impact on the population suggested that most animals hibernate under water.

If we look at the issues with this particular frog, there are three main problems. The first one often mentioned is the possible impact of this species as a predator. Work done in the States' includes dissecting large bullfrogs and a range of interesting animals has been found inside them. One contained a number of crayfish, another had a prairie vole and, most interesting of all, one had a young female mink! They also eat goldfish. They are pests in fish farms, and it's estimated that an adult bullfrog will eat something like 120 goldfish a year, which is why the goldfish breeders don't like them. In this country they seem to prey heavily on dragonflies, although one dissected individual was found to have eaten a common frog.

The most significant problem is competition with native species, particularly in the tadpole phase. British frogs and toads are afflicted by a unicellular organism, something between a protozoan and a fungus, called *Anurafaeca richardsii*. This is eaten by the tadpole, passes through the gut, and appears in their faeces in enhanced numbers. When tadpoles appear in a pond, this micro-organism occurs in high densities, and when another species, such as the toad, breeds in a pond that supports large numbers of early-spawning frog tadpoles, the growth rates of the late-spawning tadpoles are very slow, and some of the tadpoles die. This is due partially to competition for resources between the tadpoles, but the micro-organism also seems to affect growth rates of the small tadpoles. This is why common frogs will affect the growth rates of common toads if they are present in large numbers, and both of those species will affect the natterjack. One concern with the bullfrog is that, given that its tadpoles take perhaps two to three years to develop, a pond will contain large numbers of potential competitors. Finally, there is the issue of non-native pathogens, parasites and diseases that might affect British species.

Now let's turn to evidence of problems these animals have caused. Most work is being done in USA where, for two frogs in particular, *Rana aurora* and *Rana boylii*, there is evidence of declines associated with the introduction of bullfrogs. That being said, there may be complicating factors such as the introduction of fish, and habitat change, so things aren't 100% clear-cut. However, it's still a worrying issue. There is also the evidence of another American frog called the green frog, *Rana clamitans*. If you introduce bullfrogs into ponds supporting that species, the populations of the smaller frog decline, so it does have the potential to affect populations of our amphibian species.

Let's look at the story of its import to the UK. I first became aware of it back in the 1970s, when goldfish were being imported from America, and amongst them occasionally were huge tadpoles, presumably by accident. By the mid 1990s, trade had developed and these things were being sold quite openly in garden centres.

Although it's illegal to release them, people were taking them home, sticking them in their garden ponds and the animals were getting out. Poole Aquarium received a lot of reports of these animals appearing in gardens. In 1997 live importation into Europe was banned, and it seems to be having an effect because at Poole they have had no recent records of these animals turning up.

We have had reports of lone bullfrogs from the Norfolk Broads across to Devon, and quite a lot in Kent and Sussex. I don't know how far north they have reached but releases have been widespread. Initially I thought it was unlikely that they would breed in this country. Generally, our summers are fairly cool and that doesn't favour amphibian breeding. Let's look at the case history of the site we have been working on, which is between Tunbridge Wells and East Grinstead.

Back in 1996 an adult was heard calling at the pond and the owner initially thought it was a bittern. He told all his friends about it and was really excited until its true identity was confirmed. He was not very keen on American frogs hopping about in England, so he shot at it. Two weeks later he saw the frog again and, again, shot at it. This time he retrieved the body, so he knew that it had definitely been killed. After then, there was no more calling. Then, in 1999, he started to see really large tadpoles. As it was three years later, he didn't associate the two incidents until August, when he saw large numbers of strange, squeaking, bright green frogs, about twice the size of juvenile common frogs, sitting all over his pond. That's when he called in the Environment Agency and they called in Jim Foster and myself. I was given a budget to isolate the pond with frog-proof fencing.

The ponds were a pair of trout breeding ponds managed by the landowner, who trains people to fly-fish, and are in a landscape of scattered and isolated pools. Had it been somewhere else, like the Romney Marshes, the North Kent Marshes or the Broads, with quite extensive wetlands we just wouldn't have known where to start. Once frogs are in that landscape, as we know from the marsh frog introduction, they are very difficult to control. Here, at least, they were relatively contained. Around the outside of the ponds, we put up a big black fence about 500 metres in length, and a metre high, ordered the day we saw them, which took a week to properly install. Interestingly, bullfrogs were not the only non-native species at that site. The pool was full of Canadian pondweed, rainbow trout were cruising around the place, there were Canada geese on the pool and it was visited by mink. Growing in and around the pond were American pickerel weed and Himalayan balsam. It is notable how much our fauna and flora has been added to already.

We started to attempt to remove the froglets by patrolling the pools on a nightly basis in September and October, and one night we caught 477 frogs. They would be coming out, meeting the frog fence and just sit there while you picked them up. There were one or two which, significantly, leaped back into the pond the minute they saw you. The rest were relatively easy to grab hold of. In November and December, we drained the ponds in an attempt to try and kill off all the remaining tadpoles and tried to catch as many of the remaining frogs as possible. The end result of that year's activity was that we captured 4,700 tadpoles, all just at the point where their back legs were starting to grow. There were over 2,000 froglets and one adult female, totalling 7,066 animals.

Having drained the ponds, we went across them on hands and knees. When the water level dropped we thought all the frogs would go down to the central puddle at the bottom. Well, the tadpoles did but the frogs didn't. They just holed up in the mud. So, we raked off all the Canadian pondweed, picked the frogs out and removed the tadpoles. When we drained the second pond we used a mechanical digger to remove the silt layer, which was buried in a deep pit.

There were one or two practical problems associated with this project. When we first went to the site the frogs were already there, and I am sure by that stage the animals had already dispersed. In fact, after the fence was put up, we found some animals on the outside of it. Then there were problems with the fence. The minute it went up the local hunt went through it, and then we had storm damage during the autumn as well. Although it held up for most of the time, the fence had to have regular visits to be kept in place.

The final problem we had was that the landowner needed the fence down by 19 May for business purposes, and this was a condition of its original erection. If you are training people to fly-fish you don't want a big plastic fence getting tangled up with your hooks. Neither was it a very aesthetically appealing feature. That spring was cold and most of the frogs did not emerge until May, giving little time to capture them.

That year, FrogLife surveyed all the ponds within 2 km of the site, to assess how far the frogs had spread. We started publicity, both local and national. A poster was produced explaining why bullfrogs were bad news, and how to identify them. This was partly to help find out how the frogs had dispersed around our site, and to see if they were located elsewhere in the country. Given the numbers of animals that were imported into the country, it seems strange that we haven't had breeding populations establishing anywhere else. As things stand this is the only known breeding population in the UK. Several bullfrogs were reported at another site but the ponds were drained and they seem to have gone. It is not proven whether or not these were European water frogs, which occur in the area, or bullfrogs.

At our site the frogs had dispersed to six ponds in the locality, all within 600 metres of the breeding pools. Most of them were following a stream away from the site.

We then experimented with different methods of control. We tried netting, electro-fishing, trapping and also shooting. That year, we accounted for another 106 frogs, and captured 61 animals in 2001. Draining the ponds had proven to be very effective at reducing the population size, but there were still enough frogs to maintain a breeding population.

The first calling was heard in August 2000, presumably from frogs that had metamorphosed the previous year. This year we had the first evidence of spawning in two sites. One lot of spawn was completely removed, the other, unfortunately, wasn't spotted and the pond is in the process of being drained as I write.

We found shooting to be the most effective form of control, organised by local landowners. Initially air guns were used but they did not give a clean kill. A shotgun was tried, which was effective, but the noise scared the other frogs in the pool.

Ultimately, a 0.2 rifle equipped with a silencer and hollow tipped bullets was used and was found to very effective indeed.

This has not been a cheap project. Over the last three years we have spent £25,000. The expense went into putting up the frog-proof fence, the pond drainage exercise, and monitoring. I would anticipate that we are probably looking at further expenditure of about £12,000 before this problem is sorted out.

We have learnt a lot of useful points in relation to future bullfrog establishments. The calls of both the young and adults are helpful in terms of identifying bullfrogs. I have had reports over the phone of squeaking frogs where we have subsequently found individual bullfrogs.

The long tadpole development period is helpful in terms of controlling populations. If you've got a year or two to act, you are under much less pressure, but it is vital to act before any froglets start to metamorphose.

One problem is that the spawn, which is laid when the temperature is around 70 or 80F, hatches really rapidly – literally within a few days - so it is very difficult to control this species by removing the spawn. If you miss a spawn mass the tadpoles will hatch rapidly. Bearing in mind that these frogs lay 20,000 to 25,000 eggs, it becomes clear that this species has the potential to establish large populations quickly.

We were also lucky to have rapid authority from English Nature to put up the exclusion fencing and a budget available to cover the cost of the work. This restricted the colonisation of the surrounding countryside by larger numbers of frogs.

It is sensible to have strategies worked up in advance to deal with this sort of problem. Who has responsibility for action in these cases? Hopefully, our work has indicated the best methods of control that can be employed.

Prevention is better than cure, however. Why do we import these things? We need to look closely at other species currently being imported into the UK with similar potential to cause problems.

Co-operative landowners are essential. We were exceedingly lucky and we have gone out of our way to keep him on our side.

Monitoring is going to be essential. Even if we apparently eradicate these frogs in 2002, we are going to have to keep surveying the countryside to check that small numbers of breeding animals have not been missed.

The final point is that it's difficult to enforce legislation. This particular introduction was probably the result of an escape from a biological supplier, 300 metres away from the site. He admitted to the landowner that the bullfrog was his but there was nobody else who witnessed this, and when he was reported to the police he changed his story. It was one man's word against the other and the police wouldn't take forward a prosecution. Interestingly enough, when we were draining the pond again this week, we came across *Xenopus* in the bottom of the pool, so there has been another escape of exotics in that area!

In conclusion I think we're down to a small number of animals and I am hopeful that we are going to eradicate this population in the next year. We are monitoring dispersal and, thus far, we are reasonably happy that it is unlikely to spread much further into the immediate surrounding countryside. However, the frogs may have dispersed more widely already– the site is close to quite a fast flowing stream going down to the Medway and it's possible that the animals have moved 20 or 30kms. There are also, of course, animals that may be around elsewhere so, if anyone does hear anything that sounds like a bullfrog, or sees unusually large frogs, please report them to FrogLife quickly.

Jason Reynolds, Durham Wildlife Trust

Squirrels: Grey Versus Red

I work at Durham Wildlife Trust in partnership with Northumberland Wildlife Trust in the North East of England, as part of the Red Alert Campaign to save the red squirrel. I am writing from the Wildlife Trust's perspective, but it's worth mentioning the involvement of our two funding partners Northumbrian Water Environmental Trust and English Nature, and the likes of the Forestry Commission, Forest Enterprise, landowners and local authorities. Whenever I use the word 'we', I'm referring all of us.

The project has been running ten years now, but we have only had a project officer for the last 2½ years. I was lucky enough to be the person to get the job. We have received £175,000 in funding over three years through landfill tax credits from Northumbrian Water Environmental Trust, an important part of our funding. English Nature contributes £5,000 per annum that enabled us to lever in the NWET money. It's also important to have the statutory agencies signed up to and supporting what we are doing.

I became involved to see how biodiversity action plans get translated into actual delivery for the species. While I'm red squirrel fan, I also want to see if the methods we use are able to save them. After all, if we can't be successful for a species as high profile and charismatic as the red squirrel, then which species can we save?

Although it's our only native tree squirrel, since 1876 we have had two squirrels in Great Britain when the North American grey squirrel was introduced to spice up the wildlife in some of our country parks. The Victorians thought they were rather nice. Since that time there has been something fairly dynamic happening with squirrel populations here in Britain, as grey squirrels slowly push north ousting the native red squirrels. Greys have now been seen at the County Durham/Northumberland boundary.

Why on earth are we in this situation? Why have reds been declining? The first idea put forward was simply that there's been a lot of fighting going on. Is it that grey squirrels are turning up in our woodlands, seeing reds and being bigger than reds, beating them up, or something to that effect? No. People see them chase and they think it's very bad. However, when you see two red squirrels at a feeder chasing, everyone says, 'Oh, how delightful'. If you see a grey and a red interacting at the feeder, everyone immediately thinks that the greys are being beastly and are fighting with the reds.

Another idea put forward was that grey squirrels are getting a bit too friendly with reds, so that we are ending up with a dilution of coat colour. I can say that they are not getting too friendly; they are totally different animals and are not interbreeding!

The real reason why reds have been disappearing is down to food competition. When we look at the habitat of the red squirrel we see that they are quite happy in native oak

woodland. We also see they are happy in beech and, similarly, they are happy in native and non-native conifer woodlands. The interesting point with regard to grey squirrels is that they also turn up in conifer woodlands and in our broad-leaved woodlands. The nub of this is that grey squirrels very quickly out-compete red squirrels in our broad-leaved woodlands. It is known that a broad-leaved wood can support six times the density of grey squirrels than of reds. The reason for this is down to where they come from. There are more than 30 species of oak tree in North America, where grey squirrels evolved, and there are also several other species of tree squirrels all vying for food in the same forests. The result is that greys are incredibly good at getting energy out of acorns. In contrast, red squirrels have been the only type of squirrel in Britain for several thousand years, and we have only two oak species. In this situation reds never had the need to become effective at getting energy out of acorns.

Thus, when reds and greys arrive in the same woodland the grey squirrels get the upper hand, because they are basically just getting more energy out of the available food. The other thing is that greys have got a bigger body weight, so when there's more squirrels in a wood and less food, the bigger, fatter animals hang on a bit better. The reds are out-competed. That's the real crux, and later on, I'll deal with conifer woods and broad-leaved woods a little more, because in conifer woods, greys and reds occur in equal densities.

The other big problem that we have in addition to food competition is one of disease, parapox virus. This expresses itself in red squirrels and looks a bit like myxomatosis, with red squirrels sitting on the ground shaking. They develop lesions around the eyes and face and keel over pretty quickly. Grey squirrels are carriers, but totally unaffected by parapox virus, and that's a real problem in areas where greys and reds interact. The outcome is that if the grey acts as a vector you lose your red squirrels.

One of the other reasons why parts of the country have lost their red squirrels could be loss of woodland. In the northeast we have been fortunate in that we have had about 75,000 hectares of forestry planted during the last century, representing a massive increase in woodland cover. Loss of habitat has not been an issue in our part of the world, but it can only hold a certain number of squirrels. Any squirrels forced to leave are either going to get run over, starve or picked off by a predator.

How on earth do we save red squirrels? This is where we turn to the Biodiversity Action Plan, published in 1995. Our goal, once we'd recognised that red squirrels had a problem, was to maintain and enhance populations of the red squirrel through good management. The BAP gives us a template with which to try and save the reds. The first thing you need is a policy, a frame in which to work so, in the last six years, a national strategy for the red squirrel was published explaining the recovery work in addition to the BAP. We also have regional strategies through local Biodiversity Action Plans.

From a species protection point of view, this is where red squirrel conservation gets a little bit controversial. The BAP says a key method for preventing a further loss of reds is to prevent grey squirrel expansion. What we are involved with in the northeast, are quite extensive grey squirrel trapping programmes. We use words such as 'grey squirrel control', 'management', 'culling', 'killing'; it's all the same thing,

and we are actually very up-front about that. Everyone knows that the Wildlife Trusts are involved in this and it's only carried out in locations where we think we've got a realistic chance of doing something positive for red squirrels. So, where there's a good red squirrel population, we will trap greys and get rid of them. Trapping them is far more effective than shooting.

In addition to grey squirrel control, the other fundamental is site safeguard. You need to know where to do your grey squirrel trapping and, in order to do this you need to have identified the really good sites for red squirrels. Between 1995 and the present we've been working towards a stage where we've got red squirrel reserves throughout the region, and to get management planning for red squirrels in order that we can really achieve our goals. When I talk about 'reserves', we're fairly restricted in the types of woodland we are interested in. We know that resources are limited, and that red squirrels are hammered by greys in broad-leaf woodland. We know that red squirrels stand a far better chance in conifer woodlands. So, what on earth are red squirrel people doing, by saying we need large tracts of conifer forestry for their conservation? Well, it's simply because that is where we stand the best chance of saving them. The sort of scale we are talking about is hundreds and, in some cases, thousands of hectares of large conifer forestry for red squirrels.

We are hoping to try and exclude certain broad-leaved species from those woods. I appreciate this sounds dramatic – by saying we don't want oak, beech and hazel in and around some of these conifer forests seems absolute madness, because we've all spent the last 20 years being told how very bad conifer forests are for native wildlife. Fortunately, there are plenty of small seeded broad-leaved trees we can put in and around the conifer forests when we open up glade areas, and when we plant along rides and improve the skylines of these forests. We can put our birches in, we can put our alders in, and we can put our willows in. So what we need for red squirrels is not as draconian as you first might assume. However, there are those few species – the oaks, the beeches and the hazel – that we really wouldn't want in our key red squirrel reserves in order for reds to persist. I have been involved in looking at forest design plans because squirrels eat seeds, and we need to make sure we've got the right ages and the right species mix of trees, in and around these conifer forests.

Why do we need reserves? We had known since 1995 that we needed to start conserving squirrels and the BAP said we needed to select key sites, but by 1999 we still didn't know where those key sites were so, effectively, we still couldn't start trying to save the red squirrel! I became involved with helping to identify the best sites, which was really important, because having an idea of a network of reserves also provides something for people to focus on.

So, we have several criteria that we look at in identifying where the best red squirrel reserves are. The first question we ask – and I'm always surprised at just how simple these questions seem – is 'are there red squirrels in your wood, are there grey squirrels nearby and what is the magnitude of threat?' This question is asked in a paper we give to land owners, and they can tick the boxes themselves.

The next question, of course, is 'what is the size and the type of forest?' We give better weightings to conifer forests with a small percentage of large seeded broad-leaf trees in. Large seeded broad-leaved woodland would get a very low score. We are

challenging the tide of opinion about habitats as well for red squirrel. This is because we are looking to find fairly isolated woodlands for red squirrels rather than linking woodland together. I am sure this sounds crazy because you've no doubt all heard the supposed issues about genetic bottlenecks and inbreeding that face isolated populations. For red squirrels we are faced with a dilemma. We could worry about the genetics of the red squirrel but, quite frankly, we have more pressing problems just stopping this animal from going extinct. If we can find isolated woodlands that are going to be as far away from grey squirrel incursion as possible, that's likely to be our best hope. Maybe at some happy day in the future, we will look at expanding and connecting woodlands again so that red squirrel populations can maintain some diversity, but at the minute, we just need to try and keep the greys out and reds in forests as far away from them as possible.

We couldn't achieve anything unless we took into account the attitude of the landowners and the managers. There are some nice conifer blocks in parts of Northumberland, which are due to be felled in 20 years' time. It would be a waste of my time to try and declare them as a red squirrel reserves. So again, it's just finding out where we can and where can we can't do it. We have been fortunate in making progress with this site selection idea and we are aiming for about 75,000 hectares of forest.

So it's about getting the right sites and killing grey squirrels in and around them. There are other elements to the BAP as well, including a big advisory element. Guidance to owners and occupiers of woodlands I provide through the project. We have a massive interest in the northeast of people wanting to feed their red squirrels, and we provide information on how to go about doing that the best way, such as decent sources of peanuts, sunflower seed mixes, and calcium supplements. Local people absolutely overwhelm us with their interest, and so giving them the right sort of information on road kills, for example, is important.

Population monitoring is absolutely essential to what we do, but we haven't done any population monitoring yet because we are only monitoring red squirrel populations in the woodlands that we are going to manage. There's no point starting to count red squirrels in a bit of deciduous woodland in County Durham because I can tell you they won't be there in five years time. But, where we have got a block of conifer forest that looks like there's a long-term opportunity, then we will start the monitoring and we will do it properly, year after year. We haven't started monitoring bits of woodland willy-nilly yet as it would be pointless.

The grey squirrel contraceptive is a crazy sounding idea, but it's one that's actually being looked into. Foresters don't like grey squirrels, any more than do red squirrel conservation officers because forest is a commercial crop and squirrels cause damage to your timber, whether they be red or grey, in high densities. At the minute, grey squirrels are killed using warfarin, and if the use of warfarin isn't allowed in Great Britain, as the EU suggests, we will need an alternative, because there will be a lot of grey squirrels that we'll be unable to kill. The contraceptive may well deliver benefits for timber growers, but it'll also benefit red squirrel conservation. When I started working on squirrel issues around 1998, we were told it would be about ten years before we got the contraceptive. In 2001, I am still told that it's going to take about ten years, so that's why we do the trapping. We want to ensure we've still got red

squirrels in those forests before the contraceptive arrives. We are definitely not going to assume it's on the horizon. Similarly, a vaccine to defeat parapox disease in red squirrels is a nice idea, but we don't really have the cash for that.

Very importantly, there are issues such as communication. What is red squirrel conservation about and what are the conflicts and interests? We do talk about killing grey squirrels and we are very up-front about that. We do TV, we do radio, we do newspapers and we distribute leaflets of sightings and I, through the project, provide overall liaison. We have had over 10,000 squirrel sightings generated over the last two years, so there is pretty significant public interest. The website is a great tool, as well. I don't put my 'phone number on leaflets any more because people called too often, but we do steer people on to the website, and they send us sightings via that. So we provide the public with the information they're after, and we get the information we are after.

Communication is also well served by the dreaded red squirrel rope bridge. I say 'dreaded' because everyone wants them everywhere. We haven't really put many of these up yet because we have been focusing on the strategic network of key sites, but this is the sort of thing that we can do quite easily, which generates massive media interest and also local community interest, and reds genuinely do use them.

Current issues and suggestions for red squirrel conservation. I don't think anyone involved in red squirrel conservation would disagree with me, in that we've probably all been sat around 'bum-scratching'. This is understandable as red squirrels have a big problem and, conceptually, it's been hard to get our heads around what needs doing. It's probably only the water vole people that sit around looking more depressed than the squirrel people, and I think that all partners involved have been a little bit guilty of thinking it's too big a problem. Our challenge now in 2001/2, is that we need to ask ourselves some hard questions such as 'is this going to continue, with us just trundling along, or are we really going to deliver?'

We have gone through the BAP and how we are implementing things. In this next part, I will go through the BAP and the ways we are constructively criticising things.

This is a really interesting one – the National Park's attitude towards broad-leaf and my attitude towards conifer forests. There is a conceptual issue about the broad-leaved conflict with red squirrel conservation, although it's not a very difficult one. From a squirrel's point of view, it's a geographical separation of our aspirations. I think that biodiversity delivery is about looking at your particular local resource and targeting what's most effective to it at that particular point. And if that means we've got to adopt some creative thinking or some new thinking, then let's do it. Biodiversity everywhere isn't a prescription that's going to work for everything, because we won't end up achieving very much. Red Alert promotes the geographical separation of our aspirations for large-seeded native broad-leaf, and if we also have some conifer forest for red squirrels, then we will deliver that much more. But if we deliver large-seeded native broad-leaf all over Northumberland, let's forget red squirrels. We must not deceive ourselves on that one. So, that's an interesting conflict and one I think we can resolve. It's just going to be exciting to get there.

Site safeguard. Without question, there is going to be massive emphasis placed on the Forestry Commission and Forest Enterprise for this work. On the map of prospective red squirrel reserves, about 60,000 hectares of that 75,000 are within Forestry Commission and Forest Enterprise management, so there is a disproportionate emphasis on that statutory agency. We have very good relationships with the FC and FE, so it is going to be an interesting one to pursue – this site series.

From a species protection point of view, I can be fairly confident in saying that grey squirrel culling has been non-existent. It has been token, to put it mildly. We know that the grey squirrel is the biggest part of the red squirrel problem. It's a bit like the bullfrog scenario. You can either get on with it and put some decent man hours into it, or you can pretend you are doing something and get the ranger to occasionally shoot a grey squirrel. That's not grey squirrel control, in my point of view. A dedicated keeper working in a forest may just have an impact, which is a start. It's pretty obvious why we're so scared of grey squirrel culling, and why we haven't really done any. You have to trap them to be effective and, at the moment, we consider that it is expensive. I would question that, because we are only just starting to get an idea of what it might cost. We need to find out if it really is expensive, and we haven't had any red squirrel forest challenged by grey squirrels, with trapping from day one.

However, if it is expensive, then perhaps we shouldn't be looking at the overall problem. Maybe it doesn't help to look at the whole of the North of England and say it's going to cost us £300,000 a year to do it. Let's start off with just a key woodland, and employ a keeper. It's just a scale of perception.

Just as trapping is potentially quite controversial, so is our strongly held conviction that landowners hold the solution to the problem and not community groups. In black and white terms, landowners manage the large forests and community groups are very good at telling us they have seen squirrels. Landowners will help us there. As for community groups – I think we've got to be creative about how we engage with these - but landowners probably hold the key for the red squirrel.

Similarly, communication. I question this one, because I wonder if our argument is just too simple and causes problems. We know that we've got to kill grey squirrels once we have got the management right. That's too direct. I think the funding bodies just want to see a list of 30 different things you require funding for, and they'd be happy to give you the cash because you are also producing a website etc. I don't really think we would get funding just for grey squirrel trappers. We need a national fundraising effort to help things progress.

Do red squirrels have a fluffy future? Well, six years on from the launch of the BAP, all of the strategies are pretty much in place. We know what we've got to do and are getting an idea of where we are going to do it. It's a hackneyed phrase, but it's time for action. We haven't actually started saving any red squirrels yet because we haven't got our forests network, and we haven't started managing them properly. That may sound pretty depressing, but actually, I think we're close to starting to save red squirrels.

Greys, we can be certain, will spread throughout the whole of mainland England. I don't have any problem with that *per se*; we just want to keep two squirrels in our woods rather than one. Realistically, in the northeast, I think we might get a handful of managed reserves. There are going to be trade-offs with other wildlife and landscape issues. But if we can get a few sites and maybe three or four keepers in, that's probably realistic. I would like to see 10 or 12 keepers, but I am not sure it will happen.

I guess the final thing I'd like to say, even if you forget everything else, is this. If you take me to one side – which people often do after meetings, and say "Red Alert is all well and good Jason, and it sounds very nice, but red squirrels haven't got a cat in hell's chance, have they?" - I would like to say this. When people mention red squirrels, you say, "Ah, no – it's not a *fait accompli*; they're not going to become extinct." When you look at a map of England, look for the large conifer forests on it. Telephone the managers and people involved in those large forests, and ask them "Have you got, or did you have reds, and when did the greys turn up?" They'll say, in Thetford, "The greys turned up years ago and we've still got a few reds." At Cannock Chase they'll tell you, "Yes, the greys turned up 50 years ago and we lost the reds about five years ago." In North Wales they'll say, "Yes, greys turned up 50 years ago and we have still got a few reds." In Hamsterley Forest; "The greys turned up in 1969 and we have still got a few reds." These are all big conifer forests.

What's really great about that is that it's taken 30, 40, 50 years of no one doing anything for red squirrel conservation for the reds to go extinct. We know that if we've got reds in the right kind of habitat, as we have in the North East, then even if nothing is done we know we've got a fairly long time-scale before they become extinct anyway. We see this is as a positive thing, because now we can start acting to prevent this from happening. It might not take too much of our management input to change the balance of that slow decline into either a plateau, or even a slight increase in red squirrels in those conifer forests. It's for this reason I'm confident that given the effort we will have red squirrels in the northeast, now and in the future.

Paul Bradley, Department of Animal & Plant Sciences, University of Sheffield

White-clawed crayfish *Austropotamobius pallipes* at Craven Limestone Complex SAC, North Yorkshire

Introduction

This short paper summarises interim findings of a three-year research project investigating white-clawed crayfish (*Austropotamobius pallipes*) at Malham Tarn, its feeder streams and outfall stream, which together comprise the major wetland component of the Craven Limestone Complex SAC, North Yorkshire. Field investigations were carried out in 2000 and 2001, and are continuing during 2002, with funding from the English Nature Species Recovery Programme.

The primary focus of this research is concerned with aspects of the pathogenesis of crayfish plague (*Aphanomyces astaci*) in riverine populations of *A. pallipes*. Crayfish plague has not been confirmed at Malham Tarn, but *A. pallipes* have virtually disappeared from this site, and the cause of this is currently unknown. One element of the current research is attempting to establish whether crayfish plague may have contributed to the loss of *A. pallipes* from this site.

Site description

Malham Tarn is a largely natural headwater lake, situated at an altitude of *ca.* 376.6m. The catchment covers an area of only about 600ha. The Tarn is fed principally by an inflow stream in the northwest corner, and the outflow stream flows only a short distance (*ca.* 500m) above ground, before sinking into the Great Scar limestone in several places, and emerging downstream of Malham Cove as a headwater tributary of the River Aire. The Tarn takes much of its inflow from springs at the base of the limestones to the north, but there are also a number of smaller inflows, including a line of springs emerging along the shallow margins of the northern shore of the Tarn. The Tarn is a large but relatively shallow upland lake. The Tarn covers an area of 62 ha, but its maximum depth is only 4.4m, with an estimated mean of 2.4m. The surface water temperature rarely exceeds 15^{0}C, and because of its exposed location and shallowness, thermal stratification is rare and transient. The water of the Tarn is base rich (alkalinity ranges from 62-142 $mg.L^{-1}$ $CaCO_3$), and typically shows pH in the range 8.0-8.6 (Woof and Jackson, 1988). During the summer months, higher water temperatures and increased photosynthesis in the Tarn lead to a reduction in carbon dioxide concentration and subsequent calcium carbonate deposition onto the floor of the Tarn (Pigott and Pigott, 1959).

The water level of the Tarn currently varies by no more than *ca.* 0.15m during the year. The water level would have been much higher in the early Post-glacial, when the outflow discharged over Gordale Scar. The level would have dropped when the outflow took a more southern route towards Malham Cove, but was then artificially raised by *ca.* 1m following construction of an embankment and sluice gate in 1791. Malham Tarn and its associated wetlands were designated as a National Nature Reserve in 1992. The area is part of the Malham and Arncliffe SSSI, first notified in 1955, and was listed as a Ramsar Site in 1993. The Tarn is the highest and best-

known marl lake in Great Britain (Ratcliffe, 1977), and is one of only eight upland alkaline lakes in Europe.

Craven Limestone Complex was first submitted as a candidate SAC in 1998. SACs for white-clawed crayfish are those that are considered to:

- give a representation over a wide geographical area;
- cover a variety of habitats, including rivers, natural lakes and some `refuges` of artificial origin that contain large isolated populations with a good chance of remaining free of crayfish plague; and,
- have recent (post-1990) records of healthy, recruiting, white-clawed crayfish populations free of plague.

Research progress

An historical review carried out for the current research found that white-clawed crayfish were apparently abundant at Malham Tarn until the 1970s. Holmes (1965) commented that crayfish, "...are plentiful on the stony exposed shores. They attain a good size... Large numbers of crayfish remains have been noted around the edges of the Tarn when otter have been recorded in the area." Ratcliffe (1977) stated that white-clawed crayfish are amongst the "most abundant species" on the rocky shores of Malham Tarn. But it appears likely that this was based upon collated information, which was out of date when the Nature Conservation Review was published. Fryer (1993) commented that crayfish, "...have not apparently been seen at Malham Tarn since 1976. Formerly plentiful there, they have obviously declined in abundance and may even be extinct. The reason for the decline is unknown".

There have been a small number of records of white-clawed crayfish at Malham Tarn over the last 20 years. However, it is clear that a very substantial decline occurred during the 1970s, leaving only a small fragment of the former population at this site. A survey of white-clawed crayfish at Malham Tarn was carried out by English Nature in 1997, to assist assessment of Malham Tarn as part of the Craven Limestone Complex candidate SAC. The survey located a total of seven white-clawed crayfish at only two locations on the margins of the tarn. Malham Tarn is an isolated headwater, and the 1997 survey report considered that, as such, the possibility of a plague outbreak at this site would be very unlikely. However, the survey report recognised that crayfish plague can be carried by fish transfer between waters (Alderman and Polgase, 1988).

Detailed surveys carried out during 2000 and 2001 have located a total of 44 white-clawed crayfish at Malham Tarn. All were found to be mature animals. Biometrics have tentatively aged these from 5 to 15 years of age. However, at this altitude the growing season for crayfish is likely to be shorter than low altitude populations, and it is possible that these animals may be older than biometrics suggest.

Fieldwork carried out by FSC Malham Tarn Field Centre during the 1950s found densities of white-clawed crayfish within the range 1 to 5 crayfish.m^{-2}. The Tarn covers an area of 62ha, and this density range would give population estimates of 620,000 to 3,100,000 at Malham Tarn. Based upon the number of marked/unmarked crayfish recorded during 2000 and 2001, it is estimated that the total population of trappable individuals at this location may now be less than 100 animals.

White-clawed crayfish are one of the interest features for which Malham Tarn was notified as part of the Craven Limestone Complex Special Area of Conservation. On the basis of these investigations, the condition of the *A. pallipes* population at Malham Tarn is *Unfavourable* (JNCC, 1998). This category allows that recovery may be possible, and may occur either spontaneously or as a result of effective conservation actions being identified and implemented. At this stage, it remains possible that the population may have stabilised at a low level, or may have begun to recover. Studies are continuing during 2002 to further examine the status of white-clawed crayfish at Malham Tarn, the possible causes of population decline, and the factors that have enabled this remnant population to survive.

Dr Gillian Gilbert – RSPB

Reedbeds & Bitterns

The Bittern Ecology Project has been now running for about ten years. Ken Smith and Glen Tyler have been involved in the project from the start. I was involved early on, left and returned to the project from about 1998. Thanks are due to the research assistants, who ably helped us to collect a lot of the data. English Nature's Species Recovery Programme has funded the research since 1997/98.

The bittern ecology project is a research project to develop a better understanding of the bittern population and what's limiting the British breeding population in particular. The results are quickly used to advise habitat management at sites around the country. I am going to describe the three phases of the research, and what the management consequences of that research have been. Someone suggested this morning, that working on birds is easy - much easier than working on other species. While that maybe true sometimes, the bittern is a very rare, enigmatic bird as I am sure a lot of you will know. It is very seldom seen and very little of the breeding biology, was known before we started the project.

The history of breeding bitterns in Britain is one of an incredibly interesting species, and its changing fortunes in association with man. From the Middle Ages, it was surrounded in superstition and, in some places, was actually loathed because the low frequency "booming" vocalisation of the males was thought to be a sign of impending doom and gloom. This even led to bitterns being driven out of some marsh areas. It was mainly due to this persecution that, by 1886, breeding bitterns had become extinct in Britain. The numbers of booming males increased by up to 80 after they re-colonised in 1911, and then crashed to about 20 by the late 1980s. The Norfolk Broads held the core breeding population and, once that declined, there was no longer the recruitment into the other populations. So, after a time lag, these other populations also declined. Having been forgotten for many years, bitterns are now seen as a fantastic, sexy species at the pinnacle of wetland conservation in Britain. Wardens and site managers who now have bitterns breeding on their sites are quite rightly extremely proud.

In terms of conservation status bitterns are 'top of the pops' in Britain and on the Red List of birds of conservation concern. It's considered as a vulnerable species in Europe, but ¾ of the population is found in Russia and the Ukraine. The Biodiversity Action Plan targets are fairly ambitious, apart from the first one – arrest the decline. After that there is a target of 50 booming males by 2010 and 100 by 2020. We need to provide an additional 1,200 hectares of reedbed habitat suitable for bitterns by 2020. Those are our longer-term objectives.

The first phase of our research project was to develop an accurate monitoring method for bitterns, and the spin-off from that was to use vocal individuality to look at adult survival. Often, the only indication of the presence of the birds in a reedbed is their booming. Since 1990, we have recorded the sound of booming males, and used the spectrogram pictures to tell us which male is which.

To get an accurate gauge board to tell us how successful the habitat management has been, every year we determine how many booming birds there are in Britain. The core monitoring areas for the project, until 1995 have been the North Norfolk coast, the Norfolk Broads and the Suffolk coast, and an isolated population in the north of England at Leighton Moss. Since 1996, our monitoring areas have grown with a slight expansion of the range of booming males. We now have a much greater area to cover, but the greatest breeding success is still in the traditional East Anglian stronghold.

There was a decline in numbers between 1996 and 1997, which we think was attributable to the severity of the winter and the subsequent drought in the spring of 1997. But, due to all the habitat management work going on, the birds have been increasing since 1997. This year we had at least 30 booming males in Britain, the most since the 1980s. And, the numbers of sites occupied by booming males have doubled since 1990. This is a good success story.

We've been able to use our library of vocalisations to identify males from one year to the next, and this has allowed us to come up with the magic figure for adult survival. This would otherwise be impossible to work out, as the life of a radio tag is only a year. If you put a colour ring on a bittern, you would struggle to see it again! We use these sound recordings to build up a life history of the birds and we've discovered that, from 1990 to1999, the annual survival rate of these East Anglian adult booming males is quite variable. This gives us another measure to see what has been affecting adult survival, something we have not really been able to look at before for the breeding population. Initially, we thought, winter temperature would determine whether an adult male would survive from one year to the next, but, in fact, it was spring rainfall and this understanding has been important. It indicates that the water levels in the reed bed are extremely important, not only when the birds start to boom – (from March through to June while the birds are breeding) – but from January to March, when birds are coming into breeding condition. This has enabled us to advise our wardens to raise water levels earlier, at the beginning of the season.

This leads me into the second phase of the research, which was really to work out what the broad habitat preferences of bitterns were, and then to look more specifically at birds within the sites. Which parts of the reedbeds were the birds choosing to spend most of their time feeding in?

Initially, we looked at 17 sites, six of which were sites where bitterns were increasing in number, and 11 where they were either decreasing or no longer existed. This broad characterisation of preference showed that bitterns preferred early successional reedbeds, and persisted at sites where management had kept the reedbed at a fairly early, and wet stage. This was either specific conservation management to keep a wet reedbed for bitterns and other wildlife, or regularly-cut reedbeds kept wet and open for commercial purposes.

Strumpshaw Fen is one of the sites that had lost its bitterns. Reedbeds are a good example of dynamic systems, which want to become woodlands. That's usually their natural progression, and without management the reedbed will gradually litter up and become drier, making it unsuitable for bitterns. So we knew what the bitterns were

looking for, but we wanted to know what the birds were doing within those sites. Glen and Ken were able to catch a number of adult booming males. Once caught, they were fitted with a radio tag (weighing about 9 grams on a 2kg bird), attached above the tarsus. The tag has a lifespan of a year. The birds were released and accurate fixes were taken on them three times a day for the life of the radio tag.

We discovered that the birds spent most of their time within a 30 metre margin around the pools within the reedbed. Perhaps some of you have seen bitterns feeding right at the edge, but 90% of the time they are feeding inside the reedbed. They are the only fish eating bird, certainly in this country, which uses that habitat – feeding inside the vegetation. So, that wet 30 metre margin is obviously extremely important to them.

We found from the radio-tracking that they are actually avoiding some reed edges such as dykes, which have been managed by slubbing out every year – a normal management procedure at many sites. The slubbing is put on the side of the ditch but, very gradually, a lip builds up on the edge of the dyke. The water can no longer get into the reedbed, the fish can't get in and the bitterns avoid it.

In 1994, researchers were able to give a number of general habitat management guidelines to warden and site managers, based on the radio tracking information and the broad characterisation of what bitterns like. This was fed into the first British EU Life bid for bitterns, which was entitled 'Emergency Restoration Action For Bitterns'. In all, 13 sites that had bitterns, or were close to bittern sites, were restored to try and do something immediately to help the population. That project has now finished.

At Minsmere, work began to lower the dryer part of the reedbed, some 60 hectares, by about 30cm to create a massive muddy puddle. The reed came back as expected, and the water levels throughout the system were much more manageable because of the bunding and water control structures. Furthermore, it came back at an early successional stage with all the structural pools and dykes. We now have a number of bittern nests and booming territories within those areas. It took about four years for the birds to boom and five years for the females to start nesting and feeding. There has been a most encouraging increase, from 1 or 2 nesting females to the 10 we had this year. We now use this site to demonstrate how successful habitat management work can be.

The third and final stage of the research part of the bittern ecology project has been to gain a better understanding of the breeding demographics of this species, particularly looking at the habitat preferences of females and their diet when feeding chicks. Most of our advice, up until now, has been based on information gained from males, who have nothing to do with the raising of their young. If we are going to have a sustainable population, we need to know the correct habitat preferences for the females as well.

We know now that females usually raise two broods in one season, and we were able to show that, in their first year, the females breed and the males boom and hold territory successfully. For a big bird, that's quite surprising and encouraging, and means that the population has the potential to recover quite quickly.

The bad news is that less than 50% of these sites of sites with booming males are also occupied by females that get to the nesting stage. We want to improve on that figure. The females that do reach the nesting stage have a productivity of around two or fewer than two chicks fledged per bird. At the moment we don't know how good or bad it is but, from a back-of-the-envelope model of population viability, we reckon that bitterns need to be fledging two chicks per nest in order to increase their numbers by 10% a year, which is what we would obviously like them to do.

So, why is the productivity not so good? Whole nest predation is a factor, but at the moment we think that starvation is to blame. This information came from finding and examining the dead bodies of chicks, but we felt we needed further proof. So we put tiny little cameras disguised as reed stems at some of the nests and we were able to get more evidence on the starvation theory.

Another indication of the importance of food availability is seen by relating productivity against prey density, the prey being the density of fish at each site producing young bitterns. This correlation shows that the more food there is the more successful the females are at fledging chicks

So, what do bitterns eat? Basically, rudd and eels are the two main fish species that are being fed to chicks, but the only way we can successfully quantify what they are eating is by examining the regurgitates from the chicks. Rudd is a surface feeding cyprinid fish and, with eels, are also the only species that penetrate naturally into the reedbed, and become available to bitterns.

We have found that the composition of the diet changes through the season, with the numbers of rudd declining as the season progresses. However, the numbers fed to the chicks increases as the chicks get bigger, so this indicates to us is that females are finding it increasingly difficult to get enough rudd to feed their bigger chicks. This suggests there could be some seasonal change in the rudd behaviour.

So we have done a lot of electro-fishing at all of our sites for a number of years, to assess what is generally available to the birds. We don't just have an understanding of what they are eating, even if we have an understanding of what's available to them. This allows us to focus in and say whether they are choosing particular size classes of fish.

The most important information we get from radio-tagging of the youngsters in the nest is the productivity. There's no way of discovering that otherwise, but we also get some first-year survival information, and a picture of the dispersal of the youngsters. They leave with a 'star burst' effect, going quite considerable distances. We are finding birds from Suffolk turning up at the Ouse Washes, in the Lee Valley, Rutland Water, and down on the south coast. We had a bird turn up in Birmingham but, unfortunately, we couldn't confirm which individual it was. Another one, probably from Leighton Moss, turned up in Wigan. They will go quite a distance looking for alternative sites, it seems. A proportion of these youngsters will return to breed at the site they fledged, whereas a proportion will choose to breed at new sites they find during the winter. Some birds, unfortunately, we don't find again.

So EU Life 2 is, hopefully, going to look at the problems of increasing female productivity, increasing the numbers of females at booming sites and creating a strategic network of reedbed sites across England to give these young birds somewhere to go, and to get them out of the core of East Anglia. We would like East Anglian youngsters to colonise the fantastic new wetlands in Somerset, in Lincolnshire and on the south coast. The next phase of habitat management work aims to create stepping stones of sites and creating a new meta-populations around the country.

George Barker MBE

Nature in Cities? You Can't Be Serious!

I want to start off by drawing some parallels between history as a topic, and nature conservation. You will see the reason for this as I progress.

Both of those topics purport to be objective and factual and, if you look at them, they are both, in fact, human constructs which use information selectively to fit the needs of the moment. Both, in particular, use confusing terms; ones which, in fact, can be taken in pejorative ways and that hinder understanding rather than help. An example I would like to take from history is the two words "civilisation" and "barbarism", and Kristiansen says:

"Concepts such as civilisation and barbarism reflect culturally determined preferences and value judgements that may deprive us of the ability as historians, to understand and recognise significant features of both civilised and barbarian societies."

If you substitute for "civilisation" and "barbarism", the words "native" and "alien" and you put ecologists instead of historians in that sentence, you've got the same sort of thing. In both of those examples there is an implication of good and bad without any critical analysis being made of good for what and whom and bad for what and whom. So, there are things there, which you tend to skate over in both topics and they just muddy the waters. Both may be dupes of pure mythology. In history the story of Christopher Columbus being hauled in front of the Inquisition and accused of heresy for suggesting that the world was round is a total fabrication, and it's based on a historical novel written by Washington Irvin in 1828. Aided and abetted by the more scientifically heavyweight Antoine-Jean Letronne, it got mixed into the argument going on in the middle of the nineteenth century between Church, on the one hand, and scientific realism on the other. It was held up as an example of the triumph of scientific realism over the Church. Now unfortunately, the facts were overlooked; that Columbus never appeared in front of the Inquisition; no educated person in his time believed that the world was anything other than round; and the only argument against him was that he got his calculations about the circumference of the earth wrong, which he had by a huge margin. If the West Indies hadn't been in the way, they would all have died.

Now, of course, in nature conservation, things like that can't happen can they? Let me give you the example of Chief Seattle's famous speech "This earth is precious." He gave this, in 1854, in answer to George Washington's offer for land in part of his tribal area. Now, it has been called the most beautiful and profound statement on the environment ever made, and it begins:

"How can you buy or sell the sky, the warmth of the land? The idea is strange to us." And it ends up:

"Where is the thicket? Gone. Where is the eagle? Gone. The end of living and the beginning of survival."

Now it may well be the most profound and beautiful statement made on the environment, but Chief Seattle didn't make it. It was, in fact, written by an American called Ted Perry in 1971. If you look at it, you will find that there are internal conflicts and reasons why he couldn't have written or made that speech. There were no buffaloes living within hundreds of miles of where he lived and yet he talks about buffalo being shot. He has seen them being shot from trains: the railways never reached his area until after he made the speech in 1854. He talks about telephone wires blotting out the views of the hillsides but the telephone was not invented until after Chief Seattle had died. So, you have here, one of the real foundations of the American conservation movement and it is a lie.

Now, what is the relevance of all that to species in urban areas, which I am supposed to be talking about, rather than giving you a history lesson on philosophical discussion? Well, from early in the Industrial Revolution, the idea was of a rural idyll, that was good – and industry was bad. In fact, it's probably not going too far to say that some of the biblical descriptions of cities were equated with things that were evil and, in particular, the industrial cities were seen as bad. Now, in practice, what urbanisation, coupled with industrialisation, was doing was bringing about rapid change in this country at the time, and this change involved many of the places beloved of naturalists. The change was not welcomed and was therefore bad. The battle against eco-terrorism continues with ever-shifting coalitions and ever-shifting targets, but, all the time, urbanisation is still in the vanguard of the enemy.

In 1978 the Nature Conservancy Council published a booklet by Bunny Teagle, who some of you may well know, called "The Endless Village". It was about the wildlife of the West Midlands conurbation. This, when it was published, caused a tremendous amount of media interest. The newspapers sent in crack teams to investigate and television cameras came. The Nature Conservancy Council staff and local naturalists were in much demand. Cities held wildlife. Shock, horror! Now, of course, naturalists knew this, especially the naturalists who lived in the cities, but somehow this wildlife was seen, even by them, as anomalous and somehow it just didn't count. They were just anomalies, if not phantasms, of the fevered imagination. It shouldn't have been there. In fact the 20 years previous to the publication of "The Endless Village" had brought about quite considerable advances in the understanding about how cities affected the environment around them and within them, and the plant and animals species of the communities, which they supported. But in 1960, I remember going with another undergraduate at Oxford University, to see the Linacre Professor of Zoology, Sir Alister Hardy, to get his official blessing for a student expedition to Iceland. He asked us "is the purpose of your expedition to advance the frontiers of scientific knowledge?" So, of course, we said it was. He said in that case it would be far more profitable for us to mount an expedition to the wastelands of Manchester. He did let us go to Iceland, I hasten to add, but he was right that there was more to be gained from studying the ecology of a place like a wasteland site in Manchester than going to Iceland; less was known about the wasteland than was known about Iceland. In 1980, there was the first major symposium held in Europe on urban ecology – it was held in Berlin where a lot of this earlier work was done – and that symposium has been the launch pad for everything else that has followed.

By the time this symposium was held in 1980, it was possible to say quite a lot about the environmental characteristics of cities. If those characteristics were understood and also the autecology, as you have been hearing at this conference, of the desired species, it should be possible to cater for desirable species to a certain extent, within urban design and management. As my American colleagues are fond of saying to me: "If you give a critter the places it needs to breed, feed, rest and nest, it's gonna move in." Now, of course, for some species it's not possible to do this in a city whilst the cities are used by us.

How do they differ from their rural surroundings? What are the main differences? The first one I would think of is the amount of rock faces they present. They present a variety of different orientations of rock face and a huge range in chemical composition of the rocks. In the lowlands they may be the only sort of rock surfaces available for plants and animals. If you think of the suburbs as light woodland with boulders dropped in it, that's a fairly good way of looking at it objectively, from the point of view of wild plants and animals. As you reach the centre or move into the centre, the woodland becomes sparser, the boulders become larger and there are canyons between them. Now, the normal use of cities by us, in fact, retards any natural succession beyond that sort of skeletal stage I have just described. Abandoned cities, of course, revert quite rapidly to forest. The pre-Mayan cities they are now finding in the so-called virgin Amazonian rainforest, are quite good illustrations of that.

Secondly, I would say that the area is enriched by gasses and particulates. Again, at the edge the enrichment is relatively light and towards the centre it goes up. I remember one study that showed there were 2,000 different gaseous enrichments of the air of any industrial German city. So, there's quite a lot there in the air that you don't get outside the city. The whole general situation is complicated by the fact that you have pockets of these high levels of gasses and particles around industrial units on the outskirts, so you may get some odd anomalies, and there are some similarities there to active volcanic areas in the terms of dust content and gas content in the air. This favours some species, but it will make it impossible for others to live. The lichens have probably been the best studied in this respect, in this country, at least, and whilst some were just wiped out in the cities, there were others, that were very rare previously which became very common. The obvious example here, is *Lecanora conizaeiodes*, which was rare at the beginning of the Industrial Revolution, and now you get it everywhere. So we are talking not just about local extinctions, but also about previously rare species becoming commoner.

The climatic differences are probably the most important, though. You will find that a combination of the particles in the air, the actual physical structure of the city and the generation of heat within the city, raises the temperature quite considerably above that of the rural surroundings and the temperature difference may be as much as 10 degrees Celsius at night in the centre of the city, when compared with the rural surrounds. The amount of particles and smog in the air mean that between 5% and 30% less ultraviolet light reaches the ground levels and, although there is more rain because the particles encourage precipitation, the relative humidity in fact in the summer, is 8% to 10% less than the rural surroundings. There is much more fog, there's much more smog, there is less wind, although you do get the canyon effect, where you get very savage gusts and vortices as the wind forces it's way through

between the buildings. However, the heat island itself, in flat calms, will generate breezes as it draws air into and up from the centre of the city.

In addition to that, you will find that the urban landscape is an extremely disturbed one. The substrates are the items most affected here and they can include quite dramatic additions to the soil, for example, basic slag, alkali waste, ash and things like that. There are also big areas spread with ballast - railways sidings are the obvious example of that - and building rubble. Now, even without these more dramatic additions to the soils, a cultural layer will build up in a city over the centuries which separates the surface that we are on now from the original soils, so you've got a totally different sort of chemical composition from the original, over lots of the city area on this cultural layer. The other form of disturbance is quite different. It is human movement through the area; things like pet animals and strays; and concentrations of animals which love us, like brown rats. These make conditions in cities impossible for certain species and ground nesting birds, for example, are very uncommon there because of this.

The fifth point I'll pull out here, as a characteristic of cities, is the water budget. This is vastly different from that of the surrounding areas. You get greatly increased run-off because 40% of the surface is sealed and so the water just comes down and runs away, carrying with it, pollutants into the watercourses. Added to that, you have a massive import of water for consumption, industry and amenity use. To give you some idea, here are some figures calculated in the 1970s (so these are a bit out now). Stockholm – 1M people, 150M cubic metres of water imported per annum; Hong Kong with 4M people – 1,600M cubic metres; and Brussels with a million people – 61M cubic metres per annum. Now this, of course, is used and then put back into watercourses carrying with it, just the usual mixture of chemicals and organic matter in the form of sewage.

Finally, I would say that urban areas are very fine mosaics of contrasting habitat. This is slightly different to the more homogenous surroundings. You've got this very small-scale mosaic and, on top of that, you will have linear sites of one kind and another. According to their character and according to the species concerned, these can act either as conduits or as barriers to plants and animals moving from one place to another.

So, all in all, there are substantial differences between the city and what was there before, and these differences may favour some previously rare species. I have already mentioned *Lecanora conizaeiodes*. If we go to Papua New Guinea where, in fact, towns as we know them, have only been in existence for 120 years, there is a very rare species of the original rainforest called Goldie's lorikeet, and this is now the commonest bird in towns in Papua New Guinea. But to be fair, only 4% of the rainforest birds use Papua New Guinea towns, so you've got perhaps 4% that either, don't mind towns or like them but 96%, in this case, which don't.

We are looking at – and I would emphasise this very strongly – not just at species loss as a result of urbanisation, which are inevitable because of the kind of changes I have been talking about, but we are also dealing with species gain. Some of this is due to species in the general area, finding within the cities, what they need. Others – and this is where the fun really starts in an audience of ecologists and conservationists –

come in as hitchhikers on goods or in vehicles as we travel around, and these are often species which are unable or unlikely to travel from where they were to where they end up, thanks to our help. For example, crossing the Atlantic Ocean is something, which a Michaelmas daisy is unlikely to do by itself, but it has managed quite happily because we have uprooted it and brought it here.

Now, this isn't all just doom and gloom. If you think of some of the species that use gardens and ornamental plants in gardens, they can, in fact, help to expand the range of species that are already here, and it isn't just a question of things hanging on. The Columbine leaf-miner, for example, is one which would probably would be in a very poor way if it had to rely just on the wild populations of *Aquilegiae*. Because it uses garden columbines, it's all over the place. The same with the Solomon's seal sawfly, and with the mullion moth, the figwort weevils and *Aphis verbasci*, which have all moved over from *Scrophulariaceae* to *Buddleja*. Jenny Owen's work shows the value, which quite ordinary suburban gardens can have for invertebrates. Also, as I am sure many of you are aware, for birds and bats and amphibians, and it is not just a case of clinging on, it can be a case actually of expanding ranges.

Going away from the ornamental planting side of things, most people think of rubble wastelands when they come to think about cities, especially the industrial cities that have gone down the tube a bit, now. Those rubble sites have many of the characteristics of actively eroding coastlines and banks. So, you get, for example, things like *Chorisoma schillingi* and *Paroxyna absinthi*, which are thought of instinctively, by ecologists here, as coastal species. You are finding them now in the Midlands on industrial sites in places like Leicester and Birmingham. The reason for this is straightforward. These are not maritime species, they don't depend on maritime conditions, they depend rather on eroded landscapes, and in fact the wasteland sites of the Midlands can supply these, and allow these species previously thought to be restricted to the coasts to expand their ranges into them.

Now, with vertebrates there are other factors involved. Birds such as house martins and swifts, as everybody knows, are associated with buildings and no doubt, in the past, they increased their ranges into the lowlands simply because the rock faces which they use for nesting on were not there until the buildings were placed there. So there's an example of something that probably expanded its range because of the cities. Robins – and this is another example going way back in time – found gardeners as acceptable alternatives to declining herds of wild boar, whose rootlings in the forest used to supply them with food. Now they find people like me substituted for herds of wild boar!

The more recent changes, though, have allowed some more scientific studies to be made of the actual mechanisms by which this works. The blackbird is probably the best studied of these and, 200 years ago, there were none in cities. Now, of course, it's one of the most common birds, particularly in the suburbs and into the centre of cities. The first records of urban blackbirds were made in West Germany and in Eastern France along the Rhine, in the early nineteenth century. From that point their habit spread quite rapidly across France to the Atlantic Coast and up into Britain. In about 100 years it advanced 1,000 km eastwards and by 1980 had moved about 2,000 km and you had urban blackbirds in places like Sophia, St Petersburg and Kharkov. The mechanism seems to involve intra-specific competition for nest territory, forcing

some blackbirds into towns – the less favoured places at that time. This was coupled with partial migration. As the young birds had been imprinted with urban landscapes, they then sought out the same landscapes for their own nest sites and the habit gradually spread from that particular starting point. So good is urban life, in fact, for blackbirds, they will have ten times more pairs per unit area nesting, and we are talking about 20 to 50 pairs per 10 hectares within suburban areas of towns. The same mechanisms here of imprinting probably apply - although they have not been looked at in that degree of detail - to the herring gull, which started off down in the Black Sea as a roof-nesting bird and has gradually spread throughout the Northern Hemisphere like this. The raven is moving westwards across Eastern Europe at the moment. Magpies started in this country up in the NW, and went down across the country and wood pigeons, which started in Brighton and went the other way, and of course, peregrine falcon. The work done in the United States on peregrines is very well known, where some of the release programmes were, in fact, targeted on the East coast, on the urban areas. In fact, they abandoned that after a few years because the birds were doing so well. They didn't have to give them a boost any more. Almost any bridge, you will find now, has got a pair of peregrines on it.

In this country the red fox is an example of a mammal which did the same sort of thing, and which does much better in towns in terms of population densities and so forth, than it does in the countryside.

So, the significance of all this is that you can imprint selected species to use urban areas provided, of course that their basic requirements are found there. If they are very rare species that may be the only way of getting them in, because the intra-specific competition won't be there to drive them in naturally, as it would be in the much commoner species.

I hope I have made it clear – cities already favour some species. Most of these are ubiquitous species; they are highly mobile early stage colonisers. But, in fact, the mosaic nature of many sites may favour some very rare species too. There are many, many examples around the country. The one I will take is formerly part of Binley Colliery in Coventry. It's a site now that's a mixture of dry and wet, early stage woodland; more advanced woodland; bare ground (the kids slide down banks on sheets of corrugated iron); and it's a Local Nature Reserve. There are 12 species of soldier fly there, which is a very large number for any one site. They include one national rarity, two nationally scarce species and there are about four or five other species – not soldier flies – which are pretty uncommon too. The key point on a site like that is 'don't tidy it up too much', and the huge temptation, particularly when the way of safeguarding the site is to bring it into public use, is to tidy it up. If you lose that early stage succession and diversity over that site, you are going to lose a lot of these species too. The main problem is that a lot of these species' requirements are not fully known, but if they are there now, they like it as it is now. Keep it like that for the time being, until your studies can catch up with you.

Industrial waste, and alkaline waste in particular, supports peculiar communities of plants and animals, and these are now under threat as the processes have become obsolete, which produce the waste. I think you can draw a parallel here between the highly valued southern heathlands, which are left, and coppices and pollarded woodlands. These were dependent on archaic, now obsolete agricultural and forestry

practices, just as these industrial sites were formed by a process, which has become obsolete. They are under threat, and this is something that anybody involved in nature conservation in urban areas, is well aware of. The way to safeguard them is to bring them into use and get them used and valued by the local community. Otherwise they are going to go.

Now, if you look at the urban landscape in general and forget about these rather anomalous sites, either bits of the original countryside or things like these peculiar waste tips – some relatively minor tweaking can, in fact, make it possible for species to live there which wouldn't be able to do so otherwise. Bats and birds in buildings are good examples. A bat, as you know, will often use a building as a substitute for a cave or a hollow tree, depending on the species. So long as the bat can get in – that, with modern building techniques, is not always easy – isn't poisoned when it does get in, and isn't disturbed by the human occupants, then they will make quite considerable use of buildings in certain orientations, and these details are all fairly well known. The key is obviously to design things so that the bats won't impinge on the lives of the human occupants of the house and, conversely, the humans won't impact too badly on the bats. The same is true of birds. For the house martin, for example, it is known that the angle of the eaves is important, the distance from water is important and which way the building is facing is important. If therefore, you can target, particularly in new developments, the particular lines of houses which are pointing in the right direction and you can put in some of these favourable features as well, then they are going to be encouraged.

Moving up a scale, the design and layout of entire developments is important and important for the kinds of wildlife which will be able to survive, or which will be able to come in and colonise after the development has been done. There are sophisticated GIS systems that can be used to tweak up design, and these are used in the USA to quite a considerable degree, and in Eastern Europe too. The unfortunate thing here is that you're feeding in often very suspect data, particularly when it comes to the autecology of some your desirable species, and as they say so eloquently when you are dealing with computers, "crap in: crap out!" Therefore, it's only as good as the stuff you are feeding in, which is where the work of the sort of people I've been listening to this afternoon is so important.

When it comes to really large-scale modifications to cities, then that becomes politically extremely fraught. We all know now, particularly, that you shouldn't build in a flood plain. If you do, you are going to get wet sooner or later. Now, who's the politician whose going to stand up, for example, and say, 'Right, we are going to rip out all the development alongside the River Thames, the whole bloody lot?' I don't think that would win very many votes, but that's the kind of thing that's ideal. It requires a crisis for that sort of thing to happen and these crises have happened all around the world. The example I would take is Denver, which is a fairly minor incident. The centre was just blasted out of the City when a flood came through, rolling its usual mountain-sized boulders, and just took out the buildings and, in some cases, the occupants with them. That way, as one cynical American put it, the politicians didn't have to pay. The insurance companies did and, of course, the people who died did. But it's not realistic to expect major change of that kind to be actually planned, however advantageous it might be for wildlife or people.

My message, therefore, would be: industrial cities have been around for a millisecond of evolutionary time. The astonishing thing is that they are already so rich in wildlife. A little thought can improve things quite a lot and in things like species recovery, don't just write cities off, because they do offer opportunities for some of your target species. What it requires is a change, not just in the management of cities, but a change of mind set amongst nature conservation practitioners because we tend to be imprinted, ourselves, on the rural idyll myth. The only disturbing thing I find in all of this is that the recommendations that Bunny Teagle and I wrote into "*The Endless Village*" in 1975, are still as relevant today as they were when we wrote them the best part of 20 years ago.

Alfred Baldacchino, Head, Biodiversity protection Unit, Malta

Species Action in Malta- the beginning

Conservation of nature is the wise use of the environment, biotic and/or abiotic, in a way and at a rate that it does not lead at any time to the disappearance or decrease of biodiversity, so that it will not lose the potential to meet the needs and aspirations of present and future generations. This is the final aim of any action or recovery plan. My talk will be based on species action plans and the would-be obstacles and threats in achieving this aim in the Maltese islands. These can be grouped under three headings: the surface area of the islands, its use by the population, and the level of appreciation of biodiversity. These are the main obstacles that have to be overcome to reach the aim of the protection of species and their natural habitat through species action plans.

The Maltese archipelago is made up of many islands. The largest inhabited ones are Malta, Gozo and Comino. Just two people live on Comino, and there is a hotel, which is very popular during the summer months. There are other islets like Filfla, off the southern part of Malta, Fungus Rock off the southern part of Gozo, and St Paul's Island off the northern part of Malta. The surface area of the whole archipelago is 330 square kilometres – very small indeed, with a coastline of 190kms. Southern Sicily is 96 kms, and the Libyan coast is 290kms away.

In 1990 the population was 355,910, which is 1126 people per square km. This increased to 1177 per square kilometre in 1995 and again rose to 2116 persons per square km in 1998.

Most jobs and centres of population were around the harbour areas. The British Services were in Malta for 150 years, and activity was around the docks and the main harbours. One small city, Senglea, had as many as 6,400 persons per sq km. After the Services departed there was a move from the harbour area to the inner harbour region with new industries coming up. Fgura, one of the newly built up areas, has 9,500 persons per sq km. In 1957 housing took up 11.1 sq kms, (3%) of the surface area of the islands. In 1990 this rose to 51.2 sq kms, (that is 16%) and in 1990 there were 111,572 houses. It is estimated that by 2010 there will be 140,871 houses, an increase of 26% on the present number.
Population generates waste and Maltese households generate 265 metric tonnes per year. 212 metric tonnes of industrial waste is produced, which is 7.2 kgs per person per week. The impact of the population on such a limited surface area is great, and this has an impact on the biodiversity of the islands.

The houses in Malta are built from the local globigerina limestone. Hard stone is quarried from the upper coralline limestone, which forms open rocky expanses of calcareous rock with small pockets of soil, known as karst. This is one of the richest habitats, where a number of wild flora and fauna can be found. This type of habitat is known as garigue. In 1997 there were 60 quarries and in 1993 there were 70. Ten per cent of the surface area, equivalent to two point seven square km of the surface area of the islands, is taken up by quarries.

Once Malta was dominated by the Holm oak (*Quercus ilex)*, which subsequently gave way to Aleppo pine (*Pinus halepensis*). Man settled on the island at least 7,000 years ago, when agriculture was the first means of living, slowly but surely exerting pressure on the wild spaces of the Maltese islands. In 1901 there were 108 square kms of agricultural land, which is 34% of the surface area of the island. Today, agriculture has been modernised with the use of herbicides, pesticides and fertilisers. Domestic animals, also contributed to the pressure on the biodiversity of the Maltese islands. In the past there were numerous herds of goats, which speeded the loss of wild flora because they graze at ground level, making it difficult for the plant to regenerate. In 1983 the area of land taken for agriculture was 13,000 hectares. This decreased in 1986 and again in 1991 as a result of encroachment by built up areas.

The main industry in Malta is tourism. The British form the largest percentage of tourists to the island. In 1959 the number of tourists was only 12,500. In 1997, it was 1,200,000. Tourists have an impact on biodiversity. They need houses, they need hotels, they need food, and they create waste, all of which is an additional pressure.

Another threat to species is the appreciation of biodiversity, or lack of it. Unfortunately that which is genuinely appreciated, like birds for example, is caught or shot. Fragrant wild flowers, like the French daffodil (*Narcissus tazetta*) are picked and taken home. This is genuine appreciation but it is expressed negatively. There are a number of factors that contribute to this phenomenon and these must be taken into account in any species action plan. There are social, traditional, cultural, political, recreational, economical, and religious factors, but I would say that appreciation for wildlife is in the most part genuine.

Wild flowers which need action plans include: the Mediterranean thyme (*Thymus capitatus*), which is a fragrant medicinal plant of the garigue, much frequented by honey bees which produce the renowned Maltese honey; the sea daffodil (*Pancratium maritimum*), which grows on sand dunes, which are also frequented by tourists. The Mediterranean heather (*Erica multiflora*) is another garigue species, which also attracts the attention of wild flower pickers; the pheasant's eye (*Adonis microcarpa*) is an annual so it depends on its seed to propagate. It used to be picked up in such great numbers to be sold on the Sunday markets that now it is very rare and the flowers, which are seen, are very stunted and are very small. The star of Bethlehem (*Ornithogalum arabicum*) is another beautiful spring flowering bulb, which is picked for its fragrant flower.

Exotic trees also threaten the biodiversity of the Maltese islands, especially indigenous trees. There is a view that indigenous trees are not beautiful enough so these have to be supplemented or replaced by exotics. A number of indigenous trees are endangered, like the Sandarac gum tree (*Tetraclinis articulata*), the national tree. The habitat of this tree is listed as a special habitat of European interest in the European Habitats Directive with reference to the Spanish population, the only population on the European mainland. It was so common in the Maltese islands that there are a number of places named after it. Furthermore, there is documentary evidence that the Romans, during their stay on the Maltese islands, used to cut it down to build their ships with. But today there are only small pockets of these trees.

Another endangered indigenous tree is the Mediterranean willow (*Salix alba*). There is only one wild specimen, a male tree, which is very old and which has suffered the wrath of farmers, because it is believed that it competes with crops for water. The only propagation that can be done is through cuttings. There is a kind of rudimentary action plan for this tree, which nonetheless has given some good results.

Another endangered indigenous species is the myrtle (*Myrthus communis*). The myrtle grows in the maquis habitat type of the islands. Unfortunately, because of past importation of the same species from Italy, the local gene pool has been contaminated.

The holm oak (*Quercus ilex*) used to dominate the islands before man arrived. Now the wild population is a very restricted and localised. A small copse holds the oldest tree in the Maltese islands. It has a trunk with a circumference of 9 metres. It is estimated to be about 1,000 years old. The Aleppo pine (*Pinus halepensis*) was also eliminated from the wild and the pines that are now found in the Maltese islands mostly originate from Sicily.

Slowly but surely, exotic trees entered the country and today they are more conspicuous than indigenous trees. As if this is not enough, there are empty niches, which have been occupied by invasive exotics. The castor oil tree (*Ricinus communis*) was important and used as a pot plant some 30 or 40 years ago. It escaped and now it dominates valleys and competes with indigenous trees. The Brazilian pepper (*Schinus terebinthifolius*) grows wild as its seeds are dispersed by birds attracted to its red berries. The tree of heaven (*Ailanthus altissima*) is a very nice deciduous Asian tree, but because of the number of seeds and the suckers it produces, it's spreading at an alarming rate. The Cape sorrel (*Oxalis per-caprae*) is a South African wild flower brought to Malta by a botanist some 100 years ago to be put in the botanical garden of the University of Malta. This species has tubers, which divide and are easily dispersed. In spring, the Maltese islands are now covered with yellow carpets of this exotic, introduced, invasive species, which has taken the place of indigenous plants.

The Maltese islands, being 96kms away from Sicily and 290kms away from the Libyan coast, has a number of endemic species. Because of today's sophisticated means of transport, the barriers are being slowly dented and the numbers of species brought over are a direct threat, not only to endemic species, but also to all the indigenous species.

Species action plans are also needed where wild birds are concerned. A number of species have become extinct or are on the verge of extinction. There are empty niches that can still attract and accommodate a number of wild birds, like the barn owl (*Tyto alba*). There is still adequate habitat, and there is still a good supply of food. Another empty niche is that left by the kestrel (*Falco tinunculus*), which also used to breed. The Maltese falcon was the rent the Knights of St John had to pay when the islands of Malta was given to them by Charles V. Today, this bird, the peregrine falcon (*Falco peregrinus*), is no longer breeding on the islands. The jackdaw (*Corvus monedula*), a sedentary bird, disappeared off the list of breeding birds in 1956.

Freshwater is conspicuous in Malta by its absence. Nonetheless there is a freshwater crab (*Potamon fluviatile lanfrancoi*). It is found in valleys on the highest part of the island where water flows from perched water aquifers. This freshwater crab is an endemic sub-species, and it is only found in Malta and Sicily. The availability of water depending on the rainy season makes it an endangered species. But the modern methods of agriculture utilising herbicides, pesticides and fertilisers threaten to cloud the bright future for the freshwater crab.

The killifish (*Aphanius fasciatus*) is a species of brackish water. This type of habitat is found on the northern part of the island, close to the tourist areas. The killifish is under great pressure and again an action plan for its conservation is urgently needed.

The painted frog (*Discoglossus pictus*), found on the Maltese islands is also an endemic sub-species. It occurs in Sicily and in Malta and it is found in any type of water, even brackish water. It is listed in the Berne Convention and the Habitats Directive. Like all the native species mentioned previously it is protected in the Maltese islands.

Religion too plays a part in the appreciation or lack of appreciation of biodiversity. In the Bible it is documented that St Paul was shipwrecked on one of the islets in the Maltese archipelago. The first thing he did after swimming to shore was to get around an open fire, pick up a log and throw it in the fire to warm himself. In doing so, a snake came out of the log and bit his hand. The inhabitants at that time thought that he would not escape death, but he did not die. He survived, and they thought he had taken the poison from the snake. There are four snakes on the Maltese islands and none of them is or ever was poisonous because they don't have poison glands. Today all of them are protected. One can imagine the raised eyebrows when the snakes were protected. This is a religious facet to the threat of conservation.

An endemic lizard (*Podarcis filfolensis*) is found in the Maltese archipelago, on a number of the islands, and having been isolated for so many years, they are regarded as different varieties. One of these varieties is found on a small islet the size of an aircraft carrier. In fact, during the presence of the British Services, this island served as a site for target practice. Such activities made the islet dangerous to land on, and so offered adequate habitat for the biodiversity, which thrives on it. For example, it harbours the largest colony of storm petrel (*Hydrobates pelagicus*), it is estimated that there are about 4,000 nests there. The islet of Filfla is also the home of a variety of the endemic lizard (*Podarcis filfolensis filfolensis*), an endemic mollusc, an endemic plant, and Manx shearwater (*Puffinus puffinus*) and Cory's shearwater (*Calonectric diomedea*) breed there.

Formal and informal education is needed to ensure the proper conservation of the biodiversity of the Maltese islands. Such a need is felt within all the social institutions, whether they are political, religious, judicial, commercial and even voluntary. Wider appreciation can be achieved by the production of more accessible information which is scientifically correct, more knowledge on local and international legislation, better awareness of nature protection policies such as international obligations, the need to protect endemic and indigenous species and the control of introduced species. Species action plans need to be drawn up on species of

international importance and the need to protect their habitat. More scientific research, inventories and databases, law enforcement, control of the exportation of wildlife and control of the introduction of alien species are also urgently needed.

One other thing, which is urgently needed are popular publications in Maltese on flora and fauna. It is important that such material is in Maltese because when such a publication is available in the language of the people, they associate more with it. The more so, too, if the pictures are taken locally by the locals. The publications available in Maltese are very popular and are published both by Government and by NGOs. The Department of Environment organises yearly seminars on subjects like the control of the introduction of alien species, desertification, cetacean strandings, the use of Maltese trees, flora and fauna and it has also launched the State of Environment Report available in printed and also electronic format.

Henry Ford once said that obstacles are those frightful things one sees when one takes one's eyes off one's goals. The above may be frightful only if the sight of the goal of the conservation of biodiversity is lost.

I would like to thank you for inviting me here to your annual meeting to share experiences with regards to species action plans. I would also like to thank you for your interest and attention. It has been a good experience for me. I have made new friends and I hope that we can meet again one day, perhaps in Malta. Thank you very much.

Martin Harper, Conservation Director, Plantlife

A worldwide vision to save England's threatened plants

Introduction

Derbyshire has many claims to fame: Bakewell tarts, Derby County Football club, and the English Nature Chairman to name but three. Yet I was amazed to learn that the Peak District National Park is now one of the most visited areas in the world. I knew it was popular but apparently it clocks up to 30 million visits each year - only Mount Fuji National Park in Japan has more!

I should not have been surprised as Plantlife owns and manages Deep Dale, one of the many beautiful landscapes that the Park has to offer. Deep Dale is a spectacular limestone grassland, which is of international significance, designated as a Special Area of Conservation under the Habitats and Species Directive.

Plantlife manages the site for its extraordinary botanical richness. Yet we are dependent on the knowledge and enthusiasm of local people. We have advisory groups for our flagships reserves and benefit considerably from their expertise to inform the management. Staff from English Nature and the National Park authority, and local representatives from Butterfly Conservation and BSBI, provide us with advice, while local Plantlife and BTCV members help to manage the site on our behalf. It is a great partnership, which helps to ensure that the importance of the site is maintained.

These are people with varying expertise, working in partnership to protect and manage an internationally important resource.

A global strategy for plant conservation

Exciting things are happening in the strange world of plant conservation. Last month, in Montreal, Government scientists agreed that the threat facing the world's plants was so great that a more strategic response to the problem was needed. They therefore recommended that, at its sixth meeting in April 2002, the Conference of the Parties to the Convention on Biological Diversity should consider the adoption of a Global Strategy for Plant Conservation. And what's more, this strategy should include targets, which can be used to help monitor progress, and be achieved by national governments by 2010; targets such as:

- Protection of 70% of the world's most important areas for plant diversity assured;
- 50% of the world's threatened species conserved *in situ*.

This is grand stuff and begins to put real flesh on the bones of the Convention on Biological Diversity.

The Governments of the Council of Europe (which consists of 48 countries) also voted last week to support this Strategy and to try and integrate it into their national biodiversity strategies. In the UK we are quite used to targets and have benefited from a focused approach to saving our threatened species and habitats. Throughout this conference we have heard about progress made in delivery of BAP targets.

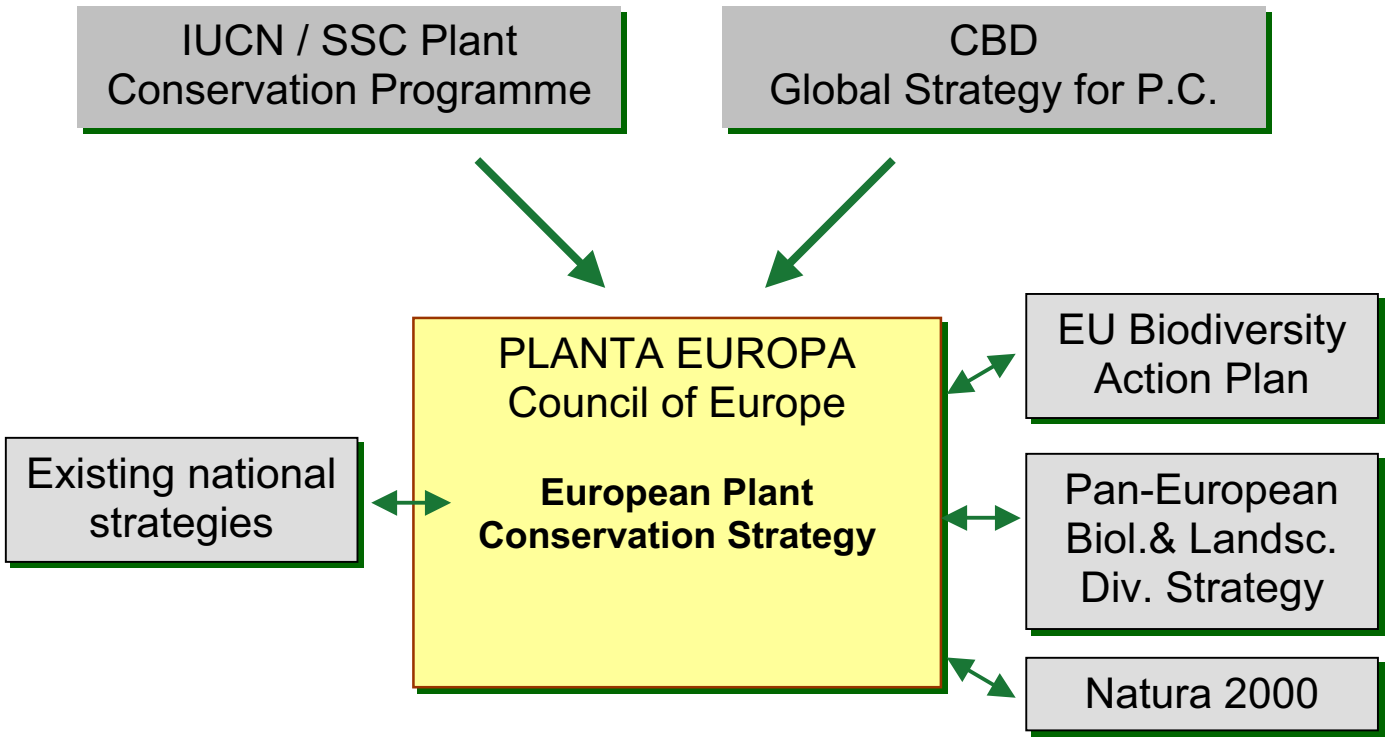
Targets are the best way to concentrate effort and to evaluate success. There is, of course, a message here for the planned England Biodiversity Strategy.

The Government scientists in Canada went further by recognising regional initiatives as a valuable contribution to global plant conservation. In particular, they pointed to an initiative here in Europe. To halt the loss of plant diversity across Europe, a 'bottom-up' strategy has been developed by Planta Europa, the European network of organisations working together for plant conservation, in collaboration with the Council of Europe. Plantlife acts as the secretariat for Planta Europa, and we are delighted that English Nature has recently agreed to join this august network.

European plant conservation strategy

This draft European Plant Conservation Strategy was developed at the third Planta Europa conference held in June 2001 in Pruhonice just outside Prague in the Czech Republic. Delegates from 38 countries worked hard to develop the strategy through a highly participative process. Forty-one clear and realistic targets have been developed, within the framework of the Convention of Biological Diversity, to be achieved by 2007. These targets have been linked to and will contribute to the delivery of the targets in the draft Global Strategy for Plant Conservation.

The following diagram briefly describes the relationship between international frameworks, the European strategy and national programmes.


IUCN / SSC Plant Conservation Programme
CBD Global Strategy for P.C.
PLANTA EUROPA Council of Europe
European Plant Conservation Strategy
Existing national strategies
EU Biodiversity Action Plan
Pan-European Biol.& Landsc. Div. Strategy
Natura 2000

The targets in the European Strategy fall under three broad headings:

- Improving our knowledge base
- Promoting and influencing change
- Developing capacity at community and government levels

If attained, they will help to meet the goal which is '*to halt the loss of wild plant diversity in Europe'* and therefore contribute to the vision which is '*a world in which wild plants are valued, now and in the future*'.

The targets themselves concern for example the need:

- To identify and conserve the Important Plant Areas of Europe, for which guidelines have already been produced. IPAs are effectively an objective assessment of where the best sites are for plants. They are not a designation, but, as with Important Bird Areas, will be used to support, inform and underpin initiatives to conserve biodiversity.
- To determine species conservation priorities by developing a Red List for the plants of Europe, which will no doubt include *Cedris brevifolia*, which is restricted to one population on Mount Tripolis in Cyprus.
- To promote the sustainable sourcing of medicinal and other useful species; Plantlife has begun to look at the medicinal plant industry in some detail with partners such as WWF.
- To share expertise and experience through working in partnership; EN participated in and was one of the funding partners of the conference this year.

Species recovery – a European perspective

They also include the need to develop species recovery programmes. The three most relevant targets here are targets 14, 15 and 16:

- National programmes to identify and monitor non-red listed rapidly declining species promoted in 15 European countries and species included in recovery programmes as appropriate.
- To have promoted the development and implementation of recovery programmes in relevant countries for 50 priority plants across all taxa, their selection to be informed by European Red Lists and lists of rapidly declining but widely scattered species as these become available.
- Flagship trans-boundary partnership projects for the recovery of at least 5 priority species to have reached implementation stage.

It was clear that Europe has a great deal to learn from the English approach to species recovery, but it was also apparent that the expertise and experience within Europe could greatly benefit our work here. Here are a couple of examples.

Starfruit *Damasonium alisma*.

This old stalwart of Plantlife's 'Back from the Brink' programme is beginning to show signs of recovery, thanks to the increasingly successful partnership with English Nature. It has been teetering on the brink of extinction in England for the last three decades, and only the efforts of conservationists are keeping it alive. Starfruit was once found regularly in ponds on the grazed commons of southeast England, where trampling cattle reduced competition from other marginal plants. However, a sorry tale of neglect and mis-management of ponds, cessation of traditional use of ponds by

livestock and the loss of ponds through infill led to a major decline through the twentieth century. In total, it was known from over 100 sites in 16 counties, but since 1985 it has been recorded from just ten, all in Buckinghamshire or Surrey. The national starfruit population is almost always less than 100 plants per year, and often only four or five plants.

Plantlife has been involved with the starfruit since 1992, when a JCB was first used to clear a former site in Buckinghamshire, and we have now started a reintroduction programme in that county. The recovery programme has come a long way and it was hugely symbolic to see red kites flying overhead as we seeded two new ponds earlier this year. We are desperately keen to ensure that starfruit becomes the flagship recovery programme for the plant kingdom.

Outside England, starfruit occurs in southern and southwest Europe (France, Spain and Italy). Closely related subspecies occur in North Africa, Asia Minor, southern Russia, Ukraine and southern Europe. In England, it is on the edge of its range and, quite possibly, surviving in marginal conditions. Plantlife has recently started work to examine starfruit habitat in France, where some substantial populations of the species exist and where it is hoped we will be able to see it growing in ideal rather than degraded conditions. This is particularly important if we are to make sure that we are introducing the plant into places where it has the best hope of future survival.

We now know that starfruit grows in a range of ponds associated with disturbed or cultivated habitat and, much to our surprise, population sizes can reach up to 10,000 plants per pond. In the Paris basin starfruit occurs in arable fields, and so it is the plough, rather than livestock, which provides the necessary disturbance. In the Loire Valley, starfruit flourishes in woodland tracks and rides, where the disturbance is likely to be caused by walkers and forestry vehicles.

To be successful we are convinced that we need to restore or create the right metapopulation dynamics for the species. We need to establish a complex of small populations, which have the potential to inter-breed so individual groups of plants can appear and disappear over time, whilst the whole remains undiminished in viability and size. If such a metapopulation could be restored or created, we might at last be able to claim that starfruit was off the critical list.

The French experience should help us to find ways to implement our vision.

Early Gentian, *Gentianella anglica*

My second example is a lovely plant, once thought to be endemic to Britain, and listed on Annex II of the Habitats and Species Directive. Yet genetic techniques are now telling us a different story about its origins. Far from being an 'endemic species', early gentian appears to be almost identical at the genetic level to a much more common flower, the autumn gentian *Gentianella amarella*. For the ordinary plant lover or field botanist, it is hard to understand how two plants which look so different, flower at different times of the year and grow in different kinds of places can be genetically indistinguishable.

Yet, if we can begin to explain this, we might begin to understand more about the relationship between genes and their *expression* in complex environments and, in the

process, we might be able to say more about what it is that makes us value biodiversity. Fortunately, we are not the only ones struggling with *Gentianella* genetics. At the Planta Europa conference in the summer, a Czech botanist expressed interest in the problems surrounding the correct classification of *Gentianella* species, their status at a European level, and conservation implications. We have therefore decided to run a joint meeting to discuss these issues.

As yet, our knowledge of the relationship between environment, genes and their expression is too limited for us to understand the significance of what we have observed through genetic tests. This ignorance should make us cautious about abandoning our interest in early gentian, now that it can no longer be called a species, and has a bearing on how we manage the conservation of the *Gentianella* genus. Biological diversity, whether visible in the genome of an organism, or elicited by subtle and intricate environmental variation, is, after all, what we have pledged to conserve. Fortunately, there is little doubt that the management practices, which favour early gentian, are also beneficial to its grassland habitats. We can continue to use this plant as an incentive to good conservation management with a clear conscience, regardless of its taxonomic status. Plantlife hopes that the continued study of its biology will one day yield results, which will be useful in many other ways to the conservation of our flora.

European co-operation

These two examples clearly demonstrate the importance of co-operating across Europe over the science of species recovery, and it helps to provide best practice in terms of management. We need to know what is happening in both the core and edge of a species range in order to provide the appropriate management for a species.

Prioritisation of effort

We also need to work with our partners in Europe to determine the significance of the proportion of resource we are interested in. Given the limited pot of cash available for plant conservation we should be increasingly prepared to identify and channel efforts towards the right priorities.

We therefore need to determine at what level a species is important, and then take action according to the nature of the threat it is facing. Hence the desperate need to produce a European Red Data Book for all the plant groups. This may seem like motherhood and apple-pie to many of you, and particularly those in the bird world, but plant conservation has only recently dragged itself from the dark ages.

Some 25 years after the Council of Europe published the first List of Threatened Plants of Europe, it is encouraging that most European countries have up-to-date and well-researched lists of their threatened plants. Yet, despite the inclusion of some 573 plant species on Appendix 1 of the Bern Convention and 484 species Annex II of the Habitats Directive, there is still not:

- An up-to-date list of threatened vascular plants for Europe;
- Threatened plant lists at European level for any lower plants except bryophytes;
- Information on which of the listed threatened species have been or are being rescued.

A new threatened vascular plant list for Europe is about to be started, as a 3-year project funded by the European Union. It will be part of the Euro+Med plant checklist and be implemented through Planta Europa, in collaboration with the IUCN-SSC global Red List Programme.

In a way these publications should be used to underpin decisions about prioritising species conservation. This is why the European Plant Conservation Strategy sets the following target:

- European Red List for vascular plants, revised list for bryophytes, and preliminary Red Lists for lichens, macro-fungi and other selected groups will be published by 2007.

Understanding the status of species at different levels is crucial to enable prioritisation of conservation effort. Take the following suite of species:

a) shore dock
b) bluebell
c) cornflower
d) chamomile

These species are each important, but their significance in the global, European and national context varies.

a) Shore dock

This maritime plant is rare and declining throughout its range in Europe. During the last century, the number of mainland UK sites declined by over 80% and the species is now found in ten 10 km squares. It is listed on Annexes II(b) and IV(b) of the Habitats and Species Directive. ***The UK populations are of global significance*** and, as threatened in the UK, are listed on the Government's Biodiversity Action Plan. The survey work we have done recently in Cornwall and South Wales suggests the species may have a more promising future than we first feared.

b) Bluebell – Important in a European context

In several of the older botany books, bluebells are described as too well known to need any description. They have been around for almost as long as we have records. In fact, Britain has 20% of the world's population and, therefore, has a duty to protect them. It is still common in Britain, although is vulnerable to habitat destruction, collection, and invasion by the Spanish bluebell *Endymion hispanicus*. Listed on Schedule 8 of the Wildlife and Countryside Act in 1998, it is also found in other parts of Western Europe in woods, scrubs and heath. ***The UK populations remain globally important.***

c) Cornflower – Important in a national context

Cornflower once occurred throughout the UK, and was a troublesome weed of arable land. But, like many arable flowers, it suffered major declines as agricultural practices changed throughout the twentieth century. Between 1930 and 1960 it was recorded from 264 ten km squares, but by 1985 it had declined to fewer than 50 ten km squares. Today, self-sustaining populations are confined to only a few sites. Isolated plants still occur over a large area of the south and east of England and in Wales, although many are due to introductions from wildflower seed mixtures and most persist for no longer than a year. In Europe as a whole, cornflower is not

threatened and still widely distributed, although it has declined in much of northwest Europe. In the UK, cornflower is now classified as *Endangered*. ***The UK populations are therefore of national significance.***

d) Chamomile – Important in a local context

Chamomile is widely distributed in Western Europe. It is listed as "LOWER RISK – nationally scarce" using the current IUCN criteria (Wigginton, 1999). In Britain, the species was previously widely recorded in the south and central regions (albeit less common in the East), but has suffered a dramatic decline in this century. It has been recorded in total from 315 10km squares. However, when it was last assessed on a national basis, it was recorded from only 96 of these (Winship and Chatters 1994). Stronghold areas remain in the Southwest, in Hampshire, and parts of Surrey, whilst the species appears to be extinct from many counties to the North and East. It is not listed on the BAP but ***the remaining UK populations are therefore of local significance.***

The significance of each of these species should help to determine conservation priorities. Locally abundant species of international importance should be celebrated and their protection secured. But if not threatened, resources should be diverted to those species of national importance whose populations are vulnerable. The same applies for locally important species. National and local strategies should therefore complement international obligations and responsibilities.

This is, therefore, a strong argument in favour of further integration of the local and national BAP processes.

The BAP is essentially the emergency health care programme for our threatened species but, as with the National Health Service, more effort needs to be invested in preventative measures to reduce the suffering in the first place. Policy solution and workable legislation are obvious keys to address the three major problems facing wild plants; non-native invasive species, eutrophication and climate change.

Assessing progress

The European plant conservation movement is growing up fast. People have developed strong working relationships in Europe, and organisations have signed up to a strategy with 41 targets to be achieved by 2007.

At the fourth Planta Europa conference in 2004, we will undertake a mid-term review of the plan to assess progress towards delivery of the targets. It will be in Valencia, so will, no doubt, be a gastronomic experience of some merit, but also a true test of how much we have learnt from each other.

What of the future of plant conservation? Well, I could say that the future is bright, the future is Plantlife, but that would not be strictly true. The future is bright, the future is Plantlife, English Nature and other Planta Europa partners. Less snappy, but closer to the truth.

Mike Harley, English Nature

Climate Change & Nature Conservation In Britain & Ireland

The MONARCH project, which stands for Modelling Natural Resource Responses to Climate Change, is a phased investigation into the impacts of climate change on the nature conservation resources in Britain and Ireland. It links established climate impact models to climatological classifications to provide a framework for studying the responses of key species and habitats to climate change. The recently completed first phase of the project was an essential first step in developing our understanding of broad scale responses across England, Scotland, Wales and Ireland.

This is a multi-partner project, both in terms of funders of the first phase and research partners, and an important component of this work has been the very close relationship between the 15 or 16 organisations.

The objectives of the study were fourfold:

- Looking at ways of dividing Britain and Ireland into regions of similar climatic characteristics;
- Adapting models so that climate change impacts on the distribution and abundance of species in terrestrial, freshwater, coastal and marine environments can be studied;
- Quantifying the direct effects of climate change on the habitats of critical species and geological features, and;
- Integrating these results with the results from other research.

To start with, a framework was developed for impact assessment by constructing a bio-climatic classification for Britain and Ireland, using statistical techniques to investigate the spatial variability of some 89 climatic variables considered to be of biological importance. Principle components analysis was used to reduce the number of variables down to seven, which together explained 97% of the variation within the 89 climatic variables, including rainfall, temperature, wind speed, sunshine, evaporation and transpiration. A cluster analysis programme then classified the data into areas of similar bio-climate. Twenty-one bio-climatic classes were developed for the study area. These 21 classes are essentially a statistical optimum - small fragmented classes that represented less than 1% of the land area of the study area have been discarded.

The characteristics of the bio-climatic classification were then described in relation to the present and future climate, and nature conservation resources. In terms of future climate, increases in mean annual temperature - based on the UK Climate Impact Programme's 1998 Climate Change Scenarios - range from 0.4 to 1.6 °C by the 2020s, and 0.7 to 2.6°C by the 2050s. Bio-climatic classes located in the southeast of Britain will experience consistently higher temperatures to those in the northwest. Changes in total annual rainfall range from 0 to +7% by the 2020s, and –1 to +6% by the 2050s. In winter, rainfall will increase in all of the bio-climatic classes, with only a slight variation in magnitude across the country. In summer, rainfall will always

decrease in southern bio-climatic classes but either increase or decrease very slightly in northern and western classes.

Nature conservation resources were summarised for the bio-climatic classes in terms of geology, geomorphology, protected site networks and priority BAP habitats. The latter were used to identify a range of dominant, sensitive and threatened species to study with what we call the SPECIES computer simulation model. These included 33 plant species, five insects, two amphibians, one mammal, and 17 water birds. Six geomorphological types were also selected for study.

Looking in a bit more detail at terrestrial environments, and using the SPECIES model for predicting changes in climatic suitability, each species showed an individualistic response, with some experiencing a potential increase, some a decrease and others showing little change. This varying response makes it quite difficult to assess the impacts on the habitats they represent, but some general conclusions have been drawn. For example, in wet heath, the dominant cross-leaved heath appears to be unaffected by climate change and marsh gentian remains stable in Britain, but has the potential to expand in Ireland. This habitat could, therefore, be robust in terms of climate change impacts. For montane heath, all species show a loss of climate space, the mountain ringlet butterfly to the point of extinction, and this is the most sensitive of the habitats that we modelled. In beech woodland, the dominant species loses suitable climate space from southern and parts of central England, whilst two associated species, yew and sanicle, show little change under the climate scenarios.

As well as the variations, there were marked differences within species under the range of climate change scenarios. For example, moderate climate change may have little effect on the willow tit. Application of the SPECIES model operating under 2020s low, 2020s high and 2050s high scenarios, shows how the willow tit's range is affected by climate change, leading to a major range contraction in the south of Britain under the UK's 2050s high scenario.

Here are a few examples of species from the Species Recovery Programme.

The turtle dove shows a gain in climate space with time towards the north of England.

The red squirrel actually gains climate space in a southerly direction with climate change.

The Norwegian mugwort occurs up in the very northwest of the Scottish islands, but by the 2050s, under the high climate scenario, it loses all climate space in Britain and Ireland.

The great-crested newt shows little change in terms of response to climate change.

The natterjack toad gains climate space in the south of the study area.

However, there are reasons to be cautious about these predictions.

- Firstly, several species are predicted to expand into Ireland, including some such as the willow tit that are currently absent or are only occasional breeders there. These species may not have the behavioural abilities to colonise Ireland.

- Secondly, the models take no account of the present or future distributions of suitable habitat. Some species require very specific habitat types, and their future distribution will be affected by the availability of habitat as well as by climate change.

- Thirdly, populations and ranges of several species examined are currently changing, often for reasons unknown. The models don't take account of these trends and assume a steady state situation.

- Fourthly, it is possible that some species may adapt to climate change and the model parameters based on current relationships between distribution and climate will not be relevant in the future.

Let us now look at freshwater environments. It's important to understand how wetland habitats and species might not just be affected by climate change, but also by related changes in water level. A water availability model was used to calculate the difference between the current baseline and future levels under the UK Climate Impact Programme's 1998 Climate Scenarios. This showed an increase in water availability of up to 60mm in winter in all parts of Britain and Ireland, which could lead to increased flooding and prolonged surface water. In summer, however, only the extreme southwest of Ireland and northwest Scotland would experience a small increase. Elsewhere water levels would be lower, leading to a drying effect, which would be particularly significant for wetland habitats, and could lead to changes in species and habitat composition. Combining the outputs of the SPECIES model with those of the water availability model showed that seasonal changes could be regionally significant for certain habitats. For example, raised bogs, wet heaths, coastal dune slacks, drought-prone acid grasslands and beech woodland could all be adversely affected by lower water availability in the east of England. Also, some chalk grassland species will lose suitable climate space in the southeast and could be further affected by decreased water availability.

As for the coast, the assessment of impacts of climate change on estuarine and non-estuarine water birds and coastal geomorphology, took account of changes in both important climatic variables and sea level. Sea level rise may affect the shape of estuaries, which largely determine intertidal sediments and, in turn, influences the abundance and availability of invertebrate prey for water birds. Managed realignment of sea defences and coastal squeeze may result in more extensive intertidal flats at the expense of marshes. In such cases, intertidal sediments are likely to become sandier, improving habitat quality for species such as the oystercatcher, but reducing quality for species such as the redshank. However, loss of salt marsh and freshwater marsh is likely to be a serious problem for most species, in particular wildfowl and waders that do not feed on intertidal flats.

Long-term climatic trends are also likely to have a direct impact on water bird distributions. The distribution of six or seven of the studied species of non-estuarine waders, present in internationally important numbers, has shifted northwards between

the years of 1984/85 and 1997/98. These distributional shifts coincide with changes in regional weather patterns during this period, in particular, decreases in the days of frost, days of snow and days of sleet. A broadly similar relationship exists for estuarine water birds that have moved eastwards since the 1980s with the increasingly warm winters.

If we extrapolate from the water bird/weather relationships, the UK Climate Impacts 1998 Climate Change Scenarios would lead to the expectation of a continued change in the distribution of water bird populations in Britain and Ireland, and a decline in internationally important populations over the period of the study here.

From the marine habitats listed under the Biodiversity Action Plan and the Habitats Directive, five were chosen for conceptual study in the MONARCH project. Major threats to marine habitats include human activities such as dredging and pollution, and natural events such as storms. The potential impacts of climate change include a range of direct effects such as sea level rise, temperature rise and increasing UVB penetration, and indirect effects such as changes in circulation, changes in nutrient supply, wave climate changes and storminess. Because of the lack of information about the exact nature of many of these, only changes in sea surface temperature and sea level were considered in any detail. Three examples were tested.

The horse mussel, *Modiolus modiolus*, is sensitive to higher sea temperatures and might become stressed in the more southerly parts of its distribution.

The honeycomb worm, *Sabellaria alveolata*, will benefit from warmer waters, but sea level rise may affect its growth in shallow sub-tidal and lower inter-tidal areas.

On maerl beds the polychaete worm, *Sabellaria spinulosa*, and serpulid worm, *Serpula vermicularis*, will all be sensitive to increased storminess.

Summarising so far, for terrestrial and freshwater species, we see species with northerly distributions generally contracting, such as the mountain ringlet butterfly, the capercaillie, and the globeflower. Species with southern distributions are generally expanding, with the great burnett, sea purslane and reed warbler being examples. For terrestrial and freshwater habitats; montane heath will lose suitable climate space, while upland hay meadows, upland oak woodland, beech woodland and pine woodland will have changed species compositions, as several species or dominant species will lose climate space. Blanket and raised bogs, coastal dune slacks and salt marsh will show mixed responses. Southeast England will start drying out, and wet heath and lowland calcareous grassland will have low sensitivity to climate change.

For coastal water birds, sea level rise will result in decreased densities of curlew, dunlin, redshank, and increased densities of oystercatcher as the relative availability of the sandy and muddy substrates on which they live change. However, climate change will negatively affect the sanderling, whilst the oystercatcher, purple sandpiper and curlew may be positively affected.

In the marine environment, sea surface temperatures will negatively affect *Modiolus modiolus* and may positively affect *Sabellaria alveolata*. And storminess – maerl

beds, *Sabellaria spinulosa* and *Serpula vermicularis* are the most sensitive benthic habitats to the impacts of climate change.

That's a snapshot of the first phase of the MONARCH research, which provided a very necessary broad scale assessment of responses carried out by the research team. But it doesn't help define impacts at the ecosystem level, and an understanding of ecosystem response is essential when setting nature conservation objectives for species and habitats within the context of climate change, and when reviewing specific implications for nature conservation policy.

We've recently begun a second phase of the MONARCH programme, developing methodologies at a final spatial resolution in order to predict local scale changes. The research team is much the same, with the addition of CABI Bioscience, and we have new partners, including the Forestry Commission, Scottish Executive, the States of Guernsey & Jersey and the Woodland Trust.

The project comprises two research modules, the first of which is developing the methodological framework for application in a second module, which will apply these methodologies to four or five case study areas selected from the participating countries, again England, Wales, Scotland and Ireland. The important thing here is that, once we've tested the methodology that is implicit in module one on these case studies, the tool kit will be available to any of the funding partners; and more widely, to use in any part of the study area.

The results from the first phase of MONARCH provide us with evidence to support the need for a more dynamic approach to nature conservation. Connectivity and flexibility are key concepts here. The existing networks of protected sites will, of course, continue to support important areas of semi-natural habitat and be essential reserves for biodiversity. This will be the case, even as particular habitats and their species compositions change over time. However, further emphasis will be needed on the management of the wider countryside for biodiversity, and to allow species movements to take place as climate changes.

This has raised a number of immediate challenges for both nature conservation policy and practice, and these are going to be addressed in a number of short-term actions by the Inter-Agency Climate Change Group. A costed work programme to take forward six policy actions is being developed:

- There is a need to raise awareness in the country agencies, with JNCC and wider still, about the significance of climate change for biodiversity. This presentation is, hopefully, moving in that direction. We need to promote a culture of a more dynamic vision for nature conservation.
- Secondly, we have to promote the need to accommodate, explicitly, climate change impacts into the Biodiversity Action Plans and BAP process.
- Thirdly, to provide advice and guidance to those involved in conservation management on the ground, both at designated sites and in the wider countryside.
- Fourthly, working with DEFRA, on how to press for regulatory and policy change to allow the effects of climate change to be incorporated within, for example, the Habitats Directive, UK legislation and wider global agreements.

- Fifthly, we want to work with DEFRA to see if we can stimulate change in the targeting of agri-environment schemes to manage the wider countryside to provide "stepping stones" or "corridors" to allow species and habitats to move in response to climate change.
- Finally, to work with DEFRA and others again, to put in place a conceptual framework – a set of rules – which will allow us to make some decisions about how far we go in mitigating for the effects of climate change. For example, restoring ecological damage after extreme weather events, such as blown-down forests. And, I mentioned the drying of the southeast of England. How far do we go in trying to sustain a wetland habitat in the southeast of England, before we say "enough's enough", and direct our resources elsewhere?

Dr Mark Avery, RSPB/Biodiversity Challenge

Species Conservation – Future Challenges

What I was asked to do was to come up with some challenges for us to discuss. But if you thought about any of these things on your way home, I'd be dead chuffed. So, I've got four future challenges for us. You'd all come up with a different number and a different list, but let's go with these four.

Let's start with the species. They're great, aren't they? Don't you just want to go and cuddle a natterjack toad? I stand here unashamedly an enthusiast for species and I would regard myself as a naturalist, interested in all taxa. If I weren't talking to you I'd like to be out looking at plants and animals. I imagine I'm in a room full of like-minded people. As well as liking these things – which we really shouldn't be ashamed of – it is fundamentally true that what we do, what we achieve for species, is the measure of our success or failure. If you were working for a commercial company your bottom line would be how much money you were making. Our bottom line in the conservation business is how individual species are doing. So, unless you can look back at the end of a day, week, month, year and think, yes, what I've done has led to an increase in the number of some threatened species, then we are just not doing it right. The cirl bunting is a BAP species of farmland bird in long-term decline and, because of conservation action taken by a number of organisations, this species is now increasing quite rapidly. We need to replicate this for many other species.

So, the first challenge is, just let's make sure we don't take our eye off the ball. We are here to create graphs like that one, of species going up in numbers, and everything else ought to be directed towards that. It may be obvious, but there have been times when we have wondered in the NGO community, whether English Nature was losing the plot on this, although that was under previous management, I hasten to add! So we are quite happy that English Nature has regained its clear focus on the fact that what it's about is species conservation and getting species numbers up.

The second challenge concerns habitats. Talking about species doesn't mean that I think habitats are unimportant. In fact, if we are to achieve our targets, the targets in the BAPs, the targets we have in our heads, our ambitions for species, we are going to have to do more and more exciting things for habitats. The reason we have to do that is that there have been huge losses of wildlife-rich habitats. Our vision ought to be that, where habitats are still in good nick, wildlife-rich, we ought to protect them. (That will mean fighting to protect them sometimes.) We should maintain them in good condition. Where habitats still remain but are in poor condition, we have to put the effort in to make those sites regain their biodiversity potential. So that might mean doing more management or less management, but it means getting involved and intervening.

I want to pay more attention to the third item, which is to try and put back some of those areas of habitat that have been lost. They have been lost during our lifetimes and those of our parents and grandparents. The agenda for us, as nature conservationists, has to be, not that we'd like everything to stay the same, not that

we'd like to stop the decline, but that we want to make things better. That means re-creating some large areas of habitat. At Minsmere in Suffolk, there are loads of cereal fields, which have eaten into the lowland heath. Now the RSPB is attempting to restore these areas back to heath. It's going to take quite a while – we haven't got very far – but we're working on it.

At the moment English Nature and the RSPB are giving evidence at a public enquiry in Dorset, the Holton Heath Public Enquiry, where you have a vaguely similar situation to this. It's not quite the same, but there's an area of former heath, which has been designated in the Local Plan as a suitable place to put housing. So this would be putting housing on an area that, mostly, isn't heath, but would run right up against the remaining bits of heath. Our argument (and we might actually win this one!) is that, if we are to meet the targets set in the Biodiversity Action Plan then that site is exactly the type of site that needs to be designated as an area for heath re-creation. We'd rather see that site turned back into heath because there aren't many places you can do it, and, if we're going to get large scale habitat re-creation, we need to get that type of thinking embedded into policy planning guidance notes and into the thinking of local authorities and central Government.

To reinforce the point I started with, we'd also want to see, not just the vegetation back, but also a full suite of the invertebrates and the odd bird that lives in that habitat. That will be the measure of our success.

At Lakenheath in the Fens, there is quite a large habitat re-creation project in which the RSPB is involved. Gradually we are seeing the plants and birds coming back. It looks cracking from the air and it looks quite good if you go past it on the main line from Peterborough to Norwich. But again, from our point of view, this will not have been a complete success until there are some bitterns back on this site, because that's the main reason we are investing this amount of money on a site like this.

So, habitat re-creation is our second challenge and it clearly needs partnerships. All of our conservation work increasingly needs partnerships, because this is big stuff. Chris Baines has been talking about exactly this type of thing, and it is the visionary large-scale habitat re-creation agenda that Chris is helping to push forward. But it's also completely embedded in the Biodiversity Action Plan. This isn't incredibly new. It's written down in rather boring civil service speak, but all the excitement of habitat re-creation, restoration and protection is in the BAP targets. It's in the habitat plans and the species plans. So, what we need to do is make it more exciting so that more people think they've just invented it and can join in. But let's get on with it.

The third challenge is climate change. I won't say much on this because a previous speaker has covered it so well. My message would be climate change is very important, but let's not go overboard and panic too much. It would be quite easy to panic. This is what we are doing to the small blue planet on which there are 1.4 million recorded species of life – we are heating it up. It is <u>us</u> that are doing it, through a variety of means. An awful lot of what we want to do because of climate change - improving the connectivity of the landscape, having larger protected sites that are buffered against the effects of climate change, having more protected areas to make a more efficient network so that species can move between them - these are all things we want anyway, but their need is enhanced by the fact of climate change.

The fourth of these challenges is integrating biodiversity conservation into the sustainable development debate. What do I mean by that? Well, I think there are two points that we ought to be pressing as nature conservationists. One is that we must continue to argue that the maintenance of biodiversity is a key test of sustainable development. The second is that because conservation is seen by many people – with justification sometimes – as a brake to development, we have to be better at promoting the fact that our agenda overlaps, to a large extent, with the agendas of others. There is money in biodiversity conservation. I'll expand on those two ideas as I go through.

One of the official UK Government indicators of sustainable development shows what's happening to bird populations from 1970, up to 1999. It shows that overall, breeding bird populations in the UK have stayed more or less similar over this 30 year period. Obviously, some of them have gone up and some of them have gone down, but overall, those two things cancel each other out. Some species and groups of species are doing really well, and some species and groups of species are doing very badly. In the last 30 years or so, the population levels of a suite of 20 farmland birds have declined by about 40%.

So, why is it birds? Well, it's birds because you can't produce a graph for anything else, really. You ought to have started 30 years ago, like we did! You have to allow a bit of ornithological arrogance to creep out, I'm afraid. Obviously the people who did put this information together are largely the BTO. This doesn't look like a very encouraging graph.

One of the species doing badly is the skylark and this is where we begin to get the idea that wildlife is something to do with sustainable development because skylarks are found everywhere, and therefore everything we do might affect their numbers, and their numbers should reflect the impact of many human activities. And whereas almost nobody has heard of a bittern, with a skylark you are in with a chance that the person you meet at a party, in the pub, or in the street, has some vague idea of what the skylark is.

Everywhere in Europe, farmland birds are declining but, in some places, they are declining faster than others . One of the best ways of explaining this variation in species declines is to plot those declines against a measure of agricultural intensification. The more intensive your agriculture, the faster your farmland birds are declining. This links, on a European-wide scale, an environmental measure (which happens to be farmland birds) against a social and economic driver.

The UK has seen the biggest declines in farmland bird species, so we lead Europe in the rate at which we are getting rid of our farmland birds, and the next time you hear Ben Gill on the radio talking about stewardship of the countryside, just remember that.

My guess would be that, if we could do the same type of analysis for plants like cornflower, for invertebrates and for a range of other taxa, we would probably find similar patterns. We would certainly expect to find similar patterns for these rare

arable weeds – bizarre, isn't it? Rare arable weeds – that's what we call these things now. So this was a weed and it's almost disappeared in the UK!

So, I think this type of data, which brings together changes in wildlife with the big economic factors driving landscape change, does bring wildlife into the sustainability debate. What we've been saying for ages is that changes in wildlife are good indicators of how we are managing the countryside in a sustainable manner - it's true if you look at these graphs.

Another example is flooding. We ought to be trying to tie this kind of event – which brings it home to real people that there's an environmental problem – with our whole agenda of creating fantastic places for wildlife. Now, we can't say that re-creating and restoring wetlands is the only way to stop water getting into places like Shrewsbury, but this is one of the best ways. We have to sell the idea that you can get wildlife benefits and benefits for people, places that they can go and see panoramic views, places to walk, places for recreation and reduce flooding problems. You could reduce flooding problems by having an ugly great big lake that you just fill up with water. But you can also do it by creating a wetland nature reserve, and this is where you get other benefits too.

I said that you can also make money directly out of wildlife. People are making a living out of showing a bottle-nosed dolphin to visitors in the Moray Firth. Brilliant!

Ospreys have been at Loch Garten for 50 years, and people want to go and see them. They're a big tourist attraction and bring in £1.5m to the local economy every year, in an area where there is not that much going on outside the skiing season. So, it was great news that wild ospreys have come back to the Lake District, an area hit by Foot & Mouth, and maybe these economic benefits will be spread around a bit more.

The reserve at Titchwell brings more money into the local economy per unit area than the cereal fields next to it! It's a real benefit. Not that we want the whole of the countryside turned into nature reserves, but where you have them - you ask the hoteliers, the people who own petrol stations and shops in that area, whether they'd like that nature reserve to expand and thrive, and they'd say yes.

How about this for an example? If you could put a penny on the price of a loaf and make sure that all that money went back to the farmer who produced the wheat that went into that loaf, that would be the equivalent of £20 per tonne of wheat. Now, with wheat prices last year being £65 per tonne – this year they are about £75 per tonne – that would be a huge increase in returns for farmers who were farming in an environmentally friendly way, if they could cash into it. But a penny on the price of a loaf, that's not much of a disincentive to the shopper if you're to get a warm feeling that you're doing something for the environment.

So, we have to persuade all sorts of people to follow the route that I've gone through in this talk, really. We want to get as many people as possible to be enthusiastic about wildlife. We need to bring wildlife to people including kids. My interest in birds started when I was a kid. So, let's give more children that opportunity. But we also have to try and get decision makers to understand that wildlife is not the enemy of

development but that, by looking at wildlife and habitat re-creation, this can form a main part of a more sustainable way to manage the countryside.

We have to persuade Margaret Beckett to love wildlife. We have to persuade her that this is not just some naff subject that a bunch of nerds like us are interested in; it's mainstream stuff. We have to persuade her that, if she loves an amphibian like a natterjack toad, and gives it a kiss, then it will turn into the handsome prince of sustainable development.

Alex Kirby, BBC News Online Environment Correspondent

Key note address

This is a celebration, and I was tempted to say that, professionally, I wanted to celebrate the Species Recovery Programme until I realised you can't use the words profession and journalist in the same sentence because they're antithetical. But as a journalist I am very grateful for the Species Recovery Programme. When I worked in radio I was down to do a story on butterflies and it was called off on the grounds that butterflies don't make much noise and therefore there wasn't much point in trying to do them for radio, so that fell flat. I did a story this week for BBC News Online about ten years of the Species Recovery Programme, and we had five pictures on there -- starfruit, orchid, spider, butterfly and only one dormouse, and I say that with some pride. I suggested a possible working title for tonight could be 'Thank God for the Dormouse', which I do and I'm sure you do. But I think we can over-indulge, we can gorge ourselves on dormice and get a bit carried away with them.

For a website, for BBC News Online, all sorts of things, even relatively inert things like insects and plants, work just as well as dormice. So that's why, having finished up on a website, I'm really grateful for the Species Recovery Programme. Of course, radio not being able to cover butterflies happily is one thing, but television is quite different. Once I got there I found I could happily have spent my time being the correspondent for things with cold wet noses and appealing brown eyes. Editors would have lapped that up. They would have been really happy if I'd have done that and nothing else at all.

However, let's celebrate what the Species Recovery Programme means for people like us. I have to say that with what the programme does, I do take a lot on trust. In fact I take almost all of it on trust. I once spent a morning going round a wood in Buckinghamshire looking for a starfruit, and we were going to record a wonderful thing about the chap I was with suddenly saying "Good heavens, there's a starfruit!" and me recording this, and playing it in the piece I was doing. Well we never found one and even I didn't have the gall to fudge it totally by getting him to make it up. I'm sure you know you can make up an awful lot on radio, though it's harder on television. I remember another day going round a wood in Cambridgeshire looking for even hints or traces of dormice or nuts, and finding nothing and going back empty-handed.

I was talking this evening to someone who swears there is a species called the New Forest cicada. I don't believe a word of it. But, I believe in the dormouse and the starfruit on the basis of absolutely no evidence, because I think English Nature and its partner organisations are probably telling the truth there. I even believe you about Edmonds ground beetle, which, at 1.5 millimetres, I don't expect ever to see, but they're good, they're valuable, they're important.

Many of us will seldom or never see what you are protecting through the Species Recovery Programme, not just short-sighted old gits like me, who will never be an ornithologist because I can't see anything smaller than a heron. Many of us will never

see these things, but we feel better for knowing or at least believing that the basking sharks and the red kites and the wart-biter crickets are out there somewhere.

I think we value English Nature and the partner organisations for a number of reasons. First of all, I personally value you all for the science that goes into what you do, and that underpins what you do. I think that shows through in things like the debate over genetically modified organisms, where you can get all sorts of versions from all sorts of people. But, you know if you're coming to English Nature or one of the groups working with you, that what you hear will be based on science. So that is one thing that I think is key to the esteem in which you're held.

We value you for two other things as well. One is for preserving green spaces and making us feel there is room to breathe, and the other is for re-populating the countryside. The man who works on the desk next to me at News Online sometimes erupts in a whinge and says "Why is it that in East Anglia we live in an outdoor desert? We go around and there's nothing there, it's empty." And it's the Species Recovery Programme and it's English Nature and it's the partner organisations who, in the perception of most of us, are doing something to change that. *But* . . .

But . . . species have always been slipping over the edge to extinction, I find working for a website that people are far, far more prone to criticise you and to complain at you and to whinge about you than they ever were in radio and television. In broadcasting, you could get away with saying things down the years, which hardly anyone would ever challenge for a moment. On the website you say things and you get people coming at you from under stones, and from out of corners all over the place. There is one man who I've actually got to know quite well and to like. He's a sort of professional contrarian, and he has this theory that species have the right to become extinct. He would say, I think, that there is an arguable case for genosuicide. Perhaps that's far-fetched, but if species have always been slipping over the edge to extinction where are we going to draw the line? On what basis can we say 'No, this must not become extinct, this is where we're going to halt a natural process'? So that's one of the 'buts'.

How do we, or rather how do you, decide which species should be helped to recover? Is it the species we like to have around? Is it the dormice of this world, the wet nose and the big brown eye brigade? The charismatic mini-fauna? Is it the ones most easily translated into memorable logos? Is the choice of species to be helped to recovery influenced by the marketing department? What about deserving species, which have had a charisma bypass?

I do some work for a Radio 4 programme called 'Costing the Earth', and one of the programmes I really enjoyed doing, about two years ago, was on soil. I don't remember much in detail about the programme, except that it involved standing around on freezing hillsides in Scotland, and then looking down microscopes at things whose names I've forgotten. Things which are not charismatic, things which most of us have probably never heard of, but things which are crucially important to the life of the soil and therefore to the life of everything else. And if we believe that the English countryside is, or was, or ought to be an interdependent web, do we have to admit that some species are more important, are more worth recovering than others?

My third and final but is to say "but you can't preserve species without preserving habitats." Most of us are going to respond more readily to the prospect of losing the dormouse or the basking shark or an orchid than to the likelihood of a mud flat vanishing, and so I can see the argument for having a *Species* Recovery Programme. I was once at an editorial meeting at the BBC, and I was trying to illustrate a point about the value of some species as indicator species, and I started talking about salmon in rivers. I was fool enough to say "Well you know, salmon, they're like canaries in a coal mine." One of my colleagues fancied himself as an artist and he drew this picture of an expiring fish in a birdcage, which he then presented to me and I had on my wall. But salmon *are* like canaries. If I can risk mixing metaphors totally, I think species for groups like you are the baked beans in the supermarket. You've got to have them there in order to attract people in, to know what it is you're really about. Recovering endangered and probably charismatic species helps us to realise what's at stake, but I do believe that they're the start and not the be-all and end-all of what you're about.

To finish, let me stick in a commercial and it's this. I sometimes think that English Nature and the other organisations gathered here are a well-kept secret, in that we don't know much of what you're doing. But if you weren't doing it we would miss you. So you're a secret in that sense. You're a secret in another sense too, in that you are sitting on a whole host of important stories, which it's the job of people like myself to try to interpret, to popularise, to simplify, to put before a mass audience. And the commercial is this: however unappealing the prospect, please try to steel yourselves to talk to people like me; to tell us what you're up to; to give us the stories you're doing, to enable us to put your work in front of the wider public, because I think that helps to feed into a virtuous circle. When people know what's at stake, when people know what you're doing to save the species that matter to them, to save the habitats that matter to them, then they're going to be more inclined to translate their concern into political action, political pressure, going to see their MPs, putting pressure on ministers. And that, I think, is the only way in which we're going to find the very real concern of many people in this country translated into something that has a political bite.

So please do talk to us, please do tell us what you're doing. More than likely we'll get it wrong, more than likely we will over-simplify, but many of us won't do it gratuitously. We will stitch you up by accident, but we won't go out of our way to do so. So I look forward to the day when we appreciate the work of all your organisations, not only for pulling species back from the brink, not "just" for guarding wild places, but for pushing back the mental frontiers as well - for helping us to see that it doesn't *have* to be like this, that we're not compelled to live in a sterile outdoor factory. The Species Recovery Programme is a key way to helping us to realise that and to act on it, so I celebrate it, and I hope very soon we can all go back and celebrate it in the proper place. Thank you.

Appendix 1

Species Recovery Programme Founder Awards

Dr Tony Whitten, author of *Recovery*

Lynne Farrell, the first Programme Manager.

Andrew Deadman, the second Programme Manager.

Lady's slipper orchid
Margaret Ramsey (Micro-propagation unit, Royal Botanic Gardens, Kew)
Phyl Abbott (Cypripedium Committee)

Fen raft spider
Roger Key (English Nature)

Field Cricket
Mike Edwards

Large blue butterfly
Martin Warren (Butterfly Conservation)

Starfruit
Jenny Duckworth (Plantlife)
Ron Porley (English Nature)

Dormouse
Paul Bright (Royal Holloway)

Reddish buff moth
Paul Waring

Natterjack toad/spangled water beetle
Tony Gent (Herpetological Conservation Trust)
Neil Pike (Lincolnshire Wildlife Trust)

Red squirrel
Tony Mitchell-Jones (English Nature)

Stinking hawk's-beard
Brian Banks (English Nature)

Wartbiter cricket
Oliver Cheesman (CABI Bioscience)

New Forest cicada
Jonathon Spencer (Forest Enterprise)

Red kite
Pete Newbury (RSPB)

Keith Duff

Roger Mitchell

Appendix 11

References and contacts:

Dr Johannes Vogel.
For further information please contact ukbiodiversity@nhm.ac.uk or visit the NHM and NBN websites under http://www.nhm.ac.uk/science/; http://www.nhm.ac.uk/botany/; or National Biodiversity Network at http://www.nbn.org.uk/, and http://www.lancs.ac.uk/depts/ieppp/amateurs/

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Dr Nigel Bourn, Butterfly Conservation

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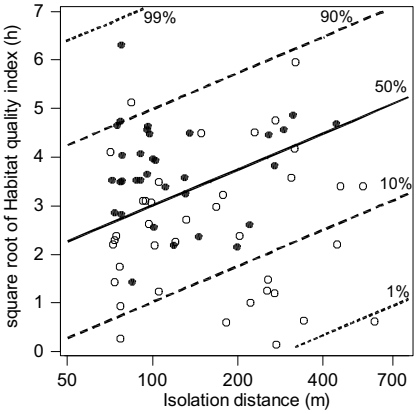
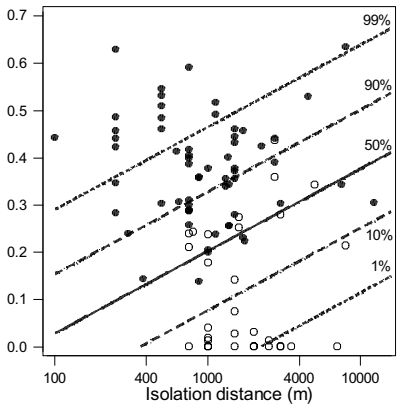
Figure 1. The distribution of occupied (solid circles) and unoccupied (open circles) habitat patches for three species of grassland butterfly in relation to the patch quality (*h*) and isolation (*i*). Lines indicate logistic-regression-model predicted probabilities (P) of a patch being occupied by a species. (a) *Melitaea cinxia*, log (P/1-P) = 2.16 + 1.11ã*h*-2.74*i*. (b) *Polyommatus bellargus*, log (P/1-P) = 9.72 + 1.59ã*h*-3.52*i*. (c) *Thymelicus acteon*, log (P/1-P) = 4.00 + 7.55ã*h*-2.36*i*.

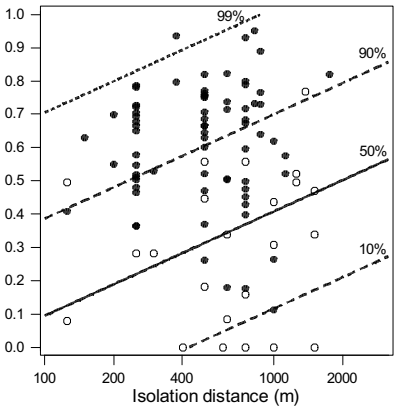
a *Melitaea cinxia*



b *Polyommatus bellargus*



c *Thymelicus acteon*



Paul Bradley

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Alfred Baldacchino

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Appendix 111

Marine turtle information sheets

The United Kingdom Turtle Code

Advice for sea users on how to deal with marine turtle encounters

As a sea user, you can help in the effort to protect endangered marine turtles by providing information about your encounters with these spectacular creatures in UK waters.

MARINE TURTLES ARE LEGALLY PROTECTED

There is no offence if turtles are caught accidentally in fishing gear. Nor is it an offence to help turtles if entangled or stranded, or temporarily to hold dead turtles for later examination by experts.

However, marine turtles are protected in Britain. This means that:

- turtles may not be deliberately killed or caught
- live turtles may not be landed unless for the purpose of tending them or enabling their subsequent release
- dead turtles or shells obtained from turtles in UK waters may not be possessed unless the animal was lawfully acquired
- turtles and their derivatives may not be sold or offered for sale without UK government permission unless they are antiques acquired before 1st June 1947 (with documented proof)
- turtles and their derivatives may not be imported or exported without UK government permission

The following legislation pertains to marine turtles:

- Wildlife and Countryside Act (1981, as amended)
- Conservation (Natural Habitats, &c.) Regulations (1994)*
- Control of Trade in Endangered Species (Enforcement) Regulations (1997)
- Council Regulation (EC) No. 338/97

* transposes EC Habitats Directive 1992 to domestic legislation

PLEASE REPORT ALL ENCOUNTERS

ENGLAND/WALES

ALL RECORDS
Rod Penrose, Marine Environmental Monitoring
01348 875000 (24 hrs)
www.strandings.com

LIVE STRANDINGS/ ENTANGLEMENTS
RSPCA 08705 555999

REPUBLIC OF IRELAND
Prof. John Davenport
00353 (0)21 4904140 (w)
00353 (0)21 4897392 (h)

SCOTLAND

ALL RECORDS
Dr Martin Gaywood, Scottish Natural Heritage 0131 4474784

DEAD STRANDINGS
Bob Reid, Scottish Agricultural College 01463 243030/ 07979245 893

LIVE STRANDINGS/ ENTANGLEMENTS
SSPCA 0131 3390111

N. IRELAND

ALL RECORDS
Lynne Rendle, Ulster Museum & Botanical Gardens 02890 383144

LIVE/DEAD STRANDINGS / ENTANGLEMENTS
Ian Irvine, Portrush Countryside Centre
02870 823600
07770 570350 (24 hrs)

This code is available online at **www.mcsuk.org**

RECORD THE FOLLOWING DETAILS

All information is valuable, but the following details are particularly useful:

- **A description** of the turtle (alive or dead), identification of species (at least to leatherback/hard-shelled level) and overall straight length. Note any damage e.g. cuts, scars
- **Location** (longitude & latitude/ OS grid reference), **date** and **time** of sighting
- **Other observations**, such as turtle's behaviour, whether caught in fishing gear (including exact nature of entanglement, gear involved) etc
- **Presence of tags**. Many conservation projects place plastic or metal tags on turtles' flippers, which display identification numbers and a return address. Record any tag details if this can be done without causing disturbance to the turtle

Please report all dead turtles, even if they have to be discarded at sea. Records from diaries or logbooks, however old, are also of interest.

WHAT TO DO IF YOU FIND A SICK OR ENTANGLED TURTLE

Immediately report the turtle to the relevant contact. Marine turtles will drown if trapped underwater. However, prompt action can save them. A turtle that is entangled or trapped is likely to be stressed. Large turtles deliver a serious bite and a blow from a flipper can be painful, so be careful. Due to possible health risks involved in handling turtles, always wear rubber gloves.

TURTLES ENTANGLED AT SEA

Approach calmly and cautiously and ensure first of all that the turtle's head is above water so that it can breathe if it is alive.

ALIVE

AVOID TOWING TURTLES TO SHORE. THEY SHOULD BE DISENTANGLED AND RELEASED AT SEA WHENEVER POSSIBLE

Alert & active

- Do not use a gaff to pull the turtle alongside and do not haul leatherbacks aboard
- Avoid pulling hard on the turtle's flippers as they may dislocate or break
- Carefully disentangle the turtle, making sure that as much net and line as possible has been removed before the animal is released
- Make sure that the vessel is stopped and out of gear before carefully sliding the turtle back into the water
- Ensure that the turtle is clear of the vessel before moving away

ONLY if disentanglement at sea is impossible should the turtle be brought ashore

Tow leatherbacks very slowly and make sure the animal's head is above water so that it can breathe. Release leatherbacks in shallow water, not on land. Other species should be retained and reported.

Traumatised/inactive

(no or slight manoeuvres, limbs flexible and limp, no decomposition)

Severely traumatised hard-shelled turtles can be saved if they are small enough to fit on your boat.

- Wrap the turtle in a towel soaked in seawater. Do not cover the nostrils
- Place the animal in a sheltered and secure place on its belly. To drain the lungs, raise the back end of the shell so the turtle is resting at approximately 30°. Keep it in this position until you return to shore
- Leatherbacks should **not** be hauled aboard. If inactive, they can be towed to shore very slowly, ensuring they are able to breathe at all times

DEAD

There may be serious health risks involved in handling dead turtles. Inexperienced individuals are advised not to touch them. Where possible, record the details listed above and, only if the specimen is fresh, bring it back to shore and place in cold storage. Always wear rubber gloves when handling turtles.

TURTLES STRANDED ON LAND

Leatherback turtles

Leatherbacks found stranded on beaches are usually very weak, dead or dying, but might still be saved.

If apparently uninjured:

- Carefully drag the turtle back to the sea and release it (enlist the help of several people and pull the shell rather than the flippers).
- Do not drag the animal over rocks, as this will cause severe damage.
- If stranded on rocks, it may be better to wait for the incoming tide to provide some buoyancy before dragging the turtle back to sea.

Other species (hard-shelled)

Loggerhead, Kemp's ridley, green and hawksbill turtles encountered on UK shores are usually cold stunned juveniles and should not be placed back in the sea.

- Wrap the turtle in a towel soaked in seawater; do not cover the nostrils
- Place the animal in a sheltered and secure place on its belly. If inactive, raise the back end of the shell so the turtle is resting at approximately 30° to drain the lungs. Report the turtle as soon as possible.

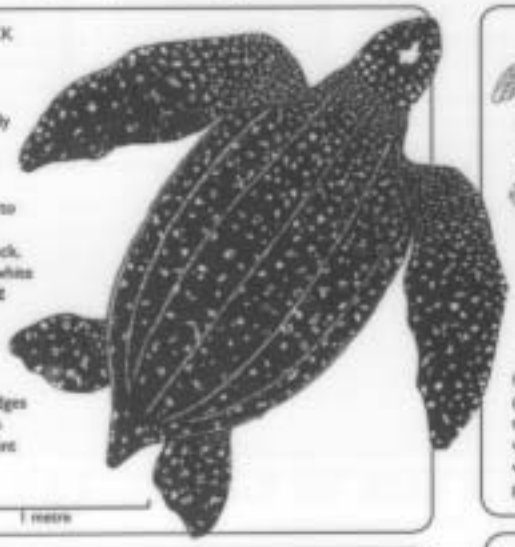
Dead turtles of all species are valuable for research and should be reported as soon as possible. Fresh specimens should be preserved in a cold store where possible. These animals will undergo a full post-mortem examination within the DEFRA-funded UK Cetacean and Turtle Strandings Project.

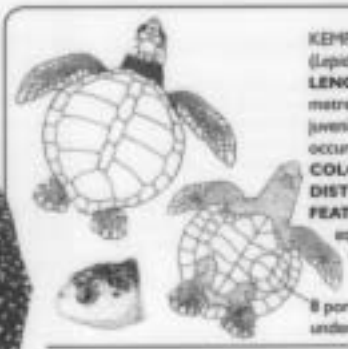
Marine turtles in the UK

Endorsed by
DEFRA
Department for Environment, Food & Rural Affairs
SEAFISH

Of the world's seven marine turtle species, five have been recorded in UK waters. They are the leatherback, loggerhead, Kemp's ridley, green and hawksbill turtles. The leatherback, the largest marine turtle, is the species most frequently recorded in UK waters. Leatherbacks have a flexible, leathery shell and are unique among reptiles in that they are able to metabolically raise their body temperature above that of their immediate environment, allowing them to survive in colder waters. Each summer leatherbacks migrate from tropical nesting beaches to UK waters where they feed on jellyfish. The other four species have hard shells and are less frequently encountered in UK waters, where they usually occur as stray juveniles carried by currents from warmer seas.

LEATHERBACK TURTLE
(*Dermochelys coriacea*)
Most frequently recorded species in UK waters
LENGTH: up to 2.91 metres
COLOUR: black, spotted with white
DISTINCTIVE FEATURES: large, up to 916 kg, pronounced longitudinal ridges on shell, which tapers to a blunt spike



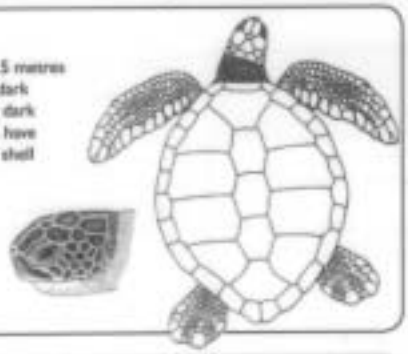


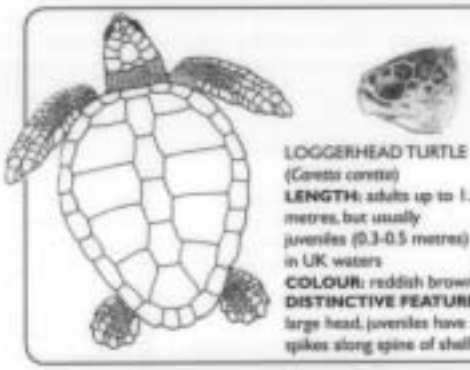
KEMP'S RIDLEY TURTLE
(*Lepidochelys kempii*)
LENGTH: up to 1 metre, but usually juveniles (0.3-0.5 metres) occur in UK waters
COLOUR: grey/olive
DISTINCTIVE FEATURES: shell width equal to or greater than shell length.

8 pores visible on underside (4 either side)

NB: The olive ridley turtle (*Lepidochelys olivacea*) occurs in the Atlantic, but has not been recorded in UK waters to date. Similar to Kemp's ridley with 8 pores on underside, but has 5-9 pairs of costal scales on shell.

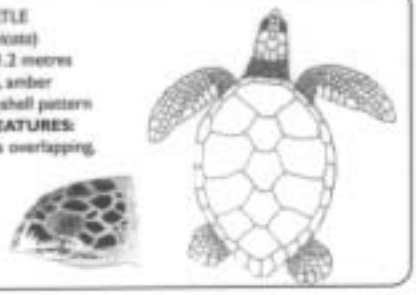
GREEN TURTLE
(*Chelonia mydas*)
LENGTH: up to 1.5 metres
COLOUR: adults dark olive or grey with dark blotches, juveniles have chestnut coloured shell
DISTINCTIVE FEATURES: smooth shell, rounded (not angular) facial profile





LOGGERHEAD TURTLE
(*Caretta caretta*)
LENGTH: adults up to 1.5 metres, but usually juveniles (0.3-0.5 metres) occur in UK waters
COLOUR: reddish brown
DISTINCTIVE FEATURES: large head, juveniles have small spikes along spine of shell

HAWKSBILL TURTLE
(*Eretmochelys imbricata*)
LENGTH: up to 1.2 metres
COLOUR: brown, amber and black tortoiseshell pattern
DISTINCTIVE FEATURES: central shell scales overlapping, narrow tapered head with bird-like beak



MARINE TURTLES ARE ENDANGERED

In UK waters threats include:

- **Marine litter,** especially plastic, which turtles mistake for jellyfish. Once ingested, plastic can block a turtle's gut leading to starvation
- **Boat collisions.** Turtles often bask and must surface regularly to breathe, leaving them vulnerable to boat strike
- **Entanglement in fishing gear.** Although turtles can dive to great depths, they become stressed and drown when trapped underwater by fishing gear. Fishing gear discarded at sea may also entangle and kill turtles

PLEASE DO NOT DISCARD FISHING GEAR AT SEA

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