TAIB
The Albufera International Biodiversity Group

TAIB Project S'Albufera: A Mediterranean model for the study of biodiversity and environmental change

The Albufera International Biodiversity Group Annual Report 2002

Edited by Nick Riddiford

March 2003

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PART I

TAIB Project S'Albufera in 2002

Introduction

Project S'Albufera: Monitoring for Biodiversity and Environmental Change has been running for 14 years. Throughout that time, the Project has involved volunteers from many walks of life and

most parts of the globe working alongside scientists from *The Albufera International Biodiversity Group* (TAIB) within the Mediterranean wetland of s'Albufera on the Spanish Balearic Island of Mallorca. Many studies have been undertaken and some of the long-term ones have been running for over 10 years. The pattern of work has become familiar: fieldwork teams in spring and autumn, specialised investigations by Masters students during the summer, occasional out-of-season visits by TAIB scientists and supplementary collection of data by local members of the TAIB team throughout the year. After 14 years, it might seem tempting to rest on our laurels. Not so! This has never been the case for TAIB, and the project continues to evolve and set new targets year upon year.

The year 2002 was no exception. In March, a biodiversity training course was piloted for students undertaking a Masters Research Degree in Ecology and Environmental Management at the University of York, England; and the first training course for wetland managers in collaboration with MedWetCoast was launched in October. Further information above these and other developments are given below. The research programme is summarised in Part II. The results of a number of studies are reported in Part III. Plans for 2003 are presented in Part IV.

The Field Season

Team participation

Two TAIB teams were organised in collaboration with the Conselleria de Medi Ambient and Parc directorate in spring 2002 and one on autumn: team 1 was from 30th March to 12th April, team 2 from 14th to 26th April, and team 3 from 12th October to 2nd November.

Four Balearic volunteers (including one from Menorca) participated with team 1. Other volunteers hailed from France, England and Scotland. The scientific team was largely derived from Britain, but was augmented by joint-participation events involving members of the PN S'Albufera staff.

Team 2 attracted volunteers from Almeria (three), Vigo, England (2), France and Sweden. Several Mallorcan members of TAIB participated as part of the scientific team, alongside scientists from the UK and PN S'Albufera staff.

Team 3 was run in conjunction with the MedWetCoast project and the French training specialists ATEN (*Atelier Technique d'Espaces Naturels*). Invitations were extended to wetland managers and biologists from six countries around the Mediterranean. Obtaining visas was a problem for some potential participants, but 3 Egyptian protected area managers took part. Two arrived late because of visa delays, so the fieldwork period was extended for a third week to allow for their full participation. Participating alongside them were volunteers from Mallorca and Barcelona. The scientific team was drawn from Mallorca, peninsular Spain, France and the United Kingdom.

In addition, a pilot biodiversity and environmental management course from 14th to 29th March was attended by 17 students, one lecturer and one demonstrator from the University of York's *MRes in Ecology and Environmental Management* programme.

Training

Inevitably, the Project team has built up an expertise in biodiversity studies and monitoring, including their practical application. We were therefore delighted to be able to offer a training

course in collaboration with MedWetCoast. Training is an important element of the MedWetCoast project. The first S'Albufera MedWetCoast course was designed to give field experience to participants of the kinds of practical conservation and management issues which confront wetland managers of Mediterranean protected areas. The participants were introduced to a wide range of field techniques and methodologies linked to the needs and management requirements of S'Albufera Natural Park and based on the standard approach established in the MedWet Guide: *Monitoring Mediterranean Wetlands*. The course benefited from the participation on the training side of TAIB scientists from Britain, Spain and France, Parc staff, visiting Balearic scientists and technical specialists from the MedWedCoast network. The Egyptian volunteers also contributed with their efforts and their own experience and expertise in conservation management. The venture was well received, including by the Parc authorities and the Balearic Government's Environmental Ministry (who were joint sponsors of the course).

Seminars and presentations

The training element of TAIB fieldwork sessions was further enhanced in 2002 by a series of seminars and presentations given by Parc staff and invited specialists. Both Juan Salvador Águilar, Director of the Parc Natural de s'Albufera, and Gabriel Perelló, the Parc's Technical Assistant, introduced and put into context the various issues and constraints which shape and determine management design and practice at s'Albufera de Mallorca. Mari-Angels Ferragut and Marga Roig of the Parc's environmental education team made a very valuable interactive presentation and demonstration of the environmental education programme in place at s'Albufera and other natural areas in Mallorca. Pere Tomàs of Tour du Valat Biological Station, France, led a demonstration and brain-storming session on procedures, steps, structure and format for designing a monitoring programme which responds to management objectives and needs. TAIB scientists gave presentations and laboratory demonstrations on taxonomy, identification and ecological methodologies for groups ranging from beetles, slugs, spiders, odonata, lepidoptera and orthoptera through to amphibians and bats. Another new development was a participatory project which involved the volunteers working in groups to design and implement a simple monitoring study or activity, leading to the production of a short, illustrated synthesis of the results. The structure and outcome of this participatory project is evaluated in Part III of this report.

The Parc staff contributions were very important, because they gave a management team viewpoint of s'Albufera and put all the fieldwork carried out during the two weeks into Parc management perspective. The various other presentations and demonstrations outlined the essential background work and knowledge which is required for planning and getting maximum benefit from fieldwork. The participatory project showed that with a little guidance, local people and other volunteers can become a powerful force in collecting simple information that staff and scientists may not have time to collect. As an added benefit, learning is imparted through participation, and it instills a sense of "contributing" and "ownership" amongst those involved in such projects.

Bryophyte study

Immediately prior to the period of team fieldwork in spring, Rod Stern of the British Bryological Society, accompanied by Nick Riddiford, undertook a six-day investigation of the mosses and liverworts – from 6th to 12th March. The results of this study are presented in Part III of this report.

Summer activities

Two extensions of TAIB investigations took place during summer 2002 in the form of Master's studies, both successful. The first was a study of odonata ecology and the second an investigation

of reedbed birds with the aim to develop suitable methodologies for their study and population monitoring.

The odonata ecology study was undertaken by Mayumi Sato, a Japanese student from the University of York, England. Her fieldwork period spanned the period 6th June to 17th August. Amongst her achievements was the discovery of a new species for s'Albufera, *Erythromma viridulum*. The title of Mayumi's study is *Notes on Dragonflies and Damselflies (Insecta: Odonata) in the S'Albufera Natural Park, Mallorca: Status, Conservation Priorities and Bio-indicator Potential*. The project proposal for this thesis appears in Part III of this report.

The reedbed bird study was undertaken by Ditta Greguss, an Hungarian student from the University of Wageningen, Holland. Her fieldwork period was 10th June to 6th September. She employed a series of test methodologies, including for elements of vegetation and invertebrate availability for birds. Her work was unexpectedly hampered to a degree by unseasonal heavy rain and high water levels. Nevertheless, interesting methodologies and recommendations for monitoring reedbed birds, and for management beneficial to reedbed species, have emerged from the investigation. Her dissertation is entitled *Impacts of Human Disturbances on Vegetation and Bird Populations in Reedbeds in s'Albufera Natural Park, Mallorca (Spain)*.

Other events

Coastal issues

The impact of the hurricane of November 2001, mentioned in the 2001 TAIB report, continued to have ramifications during 2002, whilst at the same time highlighting the difficult issue of physical and environmental conservation of the coastal fringe. Acting under the banner of emergency measures, the central Environment Ministry (Madrid) enacted activities which were not supported by adequate environmental impact assessments. The most significant were a considerable re-structuring of the Gran Canal exit to the sea at S'Oberta and the dumping of substantial amounts of submarine sand on to the beach at Ca'n Picafort. Considerable knowledge has accrued in recent years about the role of physical and environmental systems in the maintenance of ecological and coastal integrity and these emergency measures risk disrupting these systems.

The impact of such measures on the long term sustainability of these systems has not been assessed but could be considerable. The project has already undertaken baseline studies of the seagrass *Posidonia* beds in the bay, the erosion of the dune face and damage to dune face vegetation (see TAIB 1999 report for references). The dune face study included recommendations prompting the Balearic Environment Department to establish a campaign for the recuperatation of the coastal dunes. In response to the new "emergency" developments, a programme was put in place by TAIB in 2002 to monitor the situation, using foredune-beach profiles at fixed points to assess levels of erosion or recuperation of the dune interface with the beach and sea. This programme is being developed in collaboration with Dr Jaume Servera of the University of the Balearic Islands and Javier Alcántara of the University of Vigo.

The coastal ecosystem is a complicated and fragile system. Its many parts are inter-related and inter-dependent. Events at sea, hidden below the waves, have implications not just for the marine but for beaches, dunes and other elements along the shore – including human infrastructures. To illustrate this, the role and importance of *Posidonia* to the ecosystem at s'Albufera are discussed in Part III of this report.

Detecting the level of impact by inappropriate measures in the maritime zone may require long term study. However, one impact has already come to light. Biologist and conservationist Cristian Altaba, undertaking a survey of molluscs dumped with the sand on Ca'n Picafort beach, discovered a species of mollusc, *Glycymeris inflata*, hitherto only known from the fossil record (between the Miocene and Upper Quartenary). The sand was dredged from submarine beds off Banyalbufar, on the north-west coast of Mallorca. Some individuals stranded on Ca'n Picafort beach were up to 12 cm in maximum diametre. By counting the annual rings, Cristian was able to calculate that *Glycymeris inflata* have a life expectancy of 100 years or more. This is of great significance because only about 15 mollusc species have such longevity in the entire world. The interest in the discovery is tempered by the thought that, apart from the age span, nothing is known of the species ecology or population status; or how threatened it might be by dredging activities in its only known extant site. The dredged site itself is composed of maerl, which is listed by the European Union as a priority conservation habitat; and its biodiversity value is clear. Cristian found no less that 150 mollusc species displaced from this habitat to Ca'n Picafort beach. Clearly the protection of this EU priority site, and the diverse and notable species it harbours, from damaging operations is a wider conservation issue. Returning to the Parc and its catchment, the introduction of fauna into Alcudia Bay as a result of this dumping also has implications for the local maritime-coastal ecosystem.

The weather

If weather, and particularly rain, is the main topic of conversation among the British, then 2002 was a year when that topic extended to Mallorca. It was the second wettest year since records began in 1987, and was only eclipsed in 1990. The Parc was flooded on several occasions to the extent that circulation was restricted or suspended, particularly in spring. Surprisingly, some of the heaviest rain was in May and again in August, which posted the highest rainfall levels of any month during the year. This meant that the water table remained high for much of the year. It also resulted in some unusual patterns, especially amongst invertebrate populations but also in reed growth and waterbirds. The combination of warmth, rain and above average water levels may have been major contributors to excellent breeding success for waterbirds. Shoveler *Anas clypeata* bred for the second consecutive year, there were two pairs of the globally endangered marbled duck *Marmaronetta angustirostris*, and marsh harrier *Circus aeruginosus* was one of several species of conservation concern which fledged good numbers of young. Not to be outdone, the autumn was particularly spectacular for abundance and variety of insects. Some of the outcomes are described in Part II of this report.

TAIB "open evening": an introduction to bats and moths

In a departure from its normal activities, TAIB led a "*Jornada oberta*" for bats and moths in April 2002. This attracted over 30 keen local naturalists. The evening began two hours before dark, and during this period presentations were made in the laboratory by Richard Green on bat calls and bat detector boxes; and by Nick Riddiford on the value of light traps for systematic study of moths.

A net was erected for bats, and light traps and other trapping systems set for moths. Unfortunately, the night was rather windy and no bats were caught. However, visitors were able to try for themselves the bat detection boxes, and there were sufficient bats flying and calling to keep them interested. One of the most vocal bats during the evening, and clearly common at s'Albufera, was *Pipistrellus sopranus* – a species which has only just been discovered and can only be distinguished from its sibling species *Pipistrellus pipistrellus* by its higher pitched call.

The various invertebrate traps were more successful at catching, and a range of interesting moths and other insects were shown to visitors including the spectacular Iberian endemic *Cerura iberica* and several of the North African species *Mythimna zeae*.

People

Mayumi Sato (see Summer activities, above) has recently given a presentation of her thesis results to a panel of 20 professors and instructors at Kyoto University, Japan, and on the strength of it was accepted as a Ph.D student – again working on Odonata. She wrote: "this PhD thing would not have happened if you had not invited me to S'Albufera and suggested the topic."

It is always gratifying to receive comments from those associated with the project and now making progress in the world, and in particular the environmental world. Mayumi is one such example, though TAIB cannot claim too much credit because she deserves her opportunity through her own excellence as much as anything. Another person who has progressed in the environmental world is Carlota Viuda. She is now responsible for Important Bird Areas in the Conservation Department of SEO-Birdlife in Madrid. I met up with her at a Balearic Ornithological Congress in Ibiza in November. She reminded me that she and Juan Salvador Aguilar, now of course Director of PN S'Albufera, were the very first volunteers on our project – in spring 1989.

Future developments

Because of the success of the field training course in collaboration with MedWetCoast we have agreed to repeat the experience in 2003. A further course is, therefore, planned for 13th to 27th April 2003. An invitation has been extended on our behalf by ATEN to all MedWetCoast participants, and we are hoping that other member countries will follow Egypt's example in sending wetland managers, biologists and others involved in the MedWetCoast initiative, as the course is designed to be of relevance to them all.

Two milestone publications also appear in 2003. For several years TAIB reports have drawn attention to the final stages and imminent appearance of a guide to the plants of s'Albufera tracks and a catalogue of the floral and fauna diversity of the Parc. Both have now been published, the biodiversity catalogue at the end of January 2003 and the plant guide in March 2003. The catalogue is number 3 in the *Inventaris tècnics de Biodiversitat* series of the Govern Balear Environment Department and is entitled *"Catàleg de Biodiversitat del Parc Natural de s'Albufera de Mallorca"* [*Biodiversity Catalogue of the Albufera de Mallorca Natural Park*]. The flower guide is entitled "*Albufera de Mallorca Parc Natural: Guía de les Plantes/Plants of Paths, Marsh and Meadows*".

The plant guide is the culmination of years of dedicated and painstakingly careful work by the authors. The result is a very attractive guide which hugely achieves its original objective of providing interpretive material for the parc. The illustrations, by Dinah McLennan, are works of art as well as serving their purpose of guiding visitors to the identification of plants they see as they walk round. The text is in Catalan and English but Jo Newbould, by clever use of charts and colour coding, has constructed it to be accessible to users of any language. The guide will be on sale at the Parc.

The Biodiversity Catalogue has drawn on the work of numerous scientists and observers to compile a list of all the flora and fauna (in excess of 2400 species) recorded at S'Albufera. The catalogue is not on general release, but an electronic copy can be downloaded from TAIB's website.

Publications notified in 2002

The following publications partially or entirely based on work done at s'Albufera were notified in 2002.

MAUCHAMP, A. & MESLEARD, F. 2001. Salt tolerance of *Phragmites australis* populations from coastal Mediterranean marshes. *Aquatic Botany* 70: 39-52.
GREGUSS, D. 2002. *Impacts of Human Disturbances on Vegetation and Bird Populations in Reedbeds in s'Albufera Natural Park, Mallorca (Spain)*. Dissertation, MSc. in Environmental Sciences, Wageningen University, Holland.
ROTGER AMBRÓS, C. & DÍAZ PALMER, A. 2002. *Valoració quantitativa i qualitativa des efectes de la regeneració artificial a la badia d'Alcudia*. Report to Consell de Mallorca, Departament de Ciències de la Terra, Universitat de les Illes Balears.
SATO, M. 2002. *Notes on Dragonflies and Damselflies (Insecta: Odonata) in the S'Albufera Natural Park, Mallorca: Status, Conservation Priorities and Bio-indicator Potential*. Thesis, MRes. in Ecology and Environmental Management, University of York.

In addition, a short summary of the work undertaken by Brigitte Poulin and Gaëtan Lefevbre as part of our *Monitoring Mediterranean Reedbeds* programme appeared in the "Mediterranean reedbeds: Reedbed birds" section of the Station Biologique de la Tour du Valat Annual Report for 2001, published in 2002. It stated:

'In the context of the wider Mediterranean, trapping sessions for reedbed passerines were carried out in autumn 2001 in three reedbeds at S'Albufera, Mallorca, two years after an initial sampling and one year after burning of one of the three sites. This supported a bird community comparable in abundance but with a greater diversity of species than in 1999. Analysis of regurgitates in the laboratory enabled the impact of "fire" management on the feeding regime of insectivorous birds to be evaluated.'

Acknowledgements

It is a pleasure to acknowledge the support of the Balearic Conselleria de Medi Ambient in meeting the logistic and provision costs for teams 1, 2 and 3; the Park authorities and Balearic Conselleria de Medi Ambient and in particular the Consellera Margalida Rosselló for permission to continue with our studies, and for helping to develop and financially support the training programme for Balearic and Spanish students of the environment; and Parc director Juan Salvador Aguilar and his staff for their encouragement and help, and for making us all feel so welcome, as usual. Especial thanks go to Biel Perelló in his vital role as adviser, problem-solver and liaison officer to the project throughout the spring and summer (and for many years previous).

As usual, the project only moves forward thanks to the participation, support and interest of a whole host of people and organisations. The list gets longer every year, and every year the danger of leaving someone out grows greater, so apologies for anyone inadvertently omitted. Sincere thanks are proffered to: our many Balearic friends at the University, Environment Ministry and GOB; Dr Rudolf de Groot and his associates from the Environmental Systems Analysis Group & Aquatic Ecology and Water Management Group at Wageningen Agricultural University, Netherlands; scientists and friends from the Tour du Valat Biological Station, France, including their Mediterranean projects officer based in Mallorca, Pere Tomas; the MedWetCoast Regional Faciliation Unit, also based at Tour du Valat; the French training specialists from the Atelier Technique d'Espaces Naturels, and in particular Naïk Faucon and Emmanuel Thévenin; the numerous specialists who advise us and give opinions on matters scientific; Max Nicholson and Pat Bishop for their continued support and close interest in the development of the project; and last but far, far from least the TAIB scientists and volunteers whose enthusiasm and dedication makes the project so enjoyable and worthwhile for me and, I know, for many other people. Finally, I gratefully acknowledge the various contributors to this report.

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PART II

Project S'Albufera: summary of work in 2002

Human and management impact studies

Aquatic invertebrate communities in relation to water quality

This study was conducted by Juana Garau during the Team 2 period in late April and Team 3 in October. This is an ongoing monitoring study which relates the aquatic invertebrate communities found at fixed sample sites with water quality measurements taken at the same site. Different invertebrate groups have different levels of susceptibility to variations in water quality, and can be used as bio-indicators for water quality and, in some cases, pollution events.

Certain groups (e.g. odonata), are particularly good bio-indicators, but different species may vary in sensitivity to changes or declines in water quality. One of the challenges, therefore, is to achieve identifications down to species. Another challenge is to produce material, in the form of checklists, keys and named reference specimens, which assist volunteers with the identification process.

In addition to recording invertebrate groups collected at each sample site, Juana has been working to improve identifications and to extend the on-site reference collection. She has been helped in this by a number of people, including Henry Stanier in identification of odonata larvae. In spring 2002 she was also able to call upon Brian Eversham and Oscar Vorst, two coleoptera specialists, to assist with improving our knowledge of s'Albufera water beetles. Both took away samples to identify which will eventually return, named, to s'Albufera. This will help considerably with the study, which is a long-term investigation.

Vegetation re-colonisation after fire, Es Comú

This is an annual study, first conducted in spring 1995 to investigate vegetation re-colonisation after fire, the fire having occurred in April 1994. Annual changes in terms of cover and species composition were large during the first five years, but have since slowed. Open areas characterised by a wide range of annuals, many of them tiny, have given way to grassland and bushes. Nevertheless, two of the three species present in more than 75% of quadrats in 1995, *Cistus salvifolius* and *Smilax aspera*, have maintained their pre-eminence. Both were recorded in 100% of quadrats in 2002. Two other species are now present in more than 75% of sample plots. They are *Dorycnium pentaphyllum* and *Teucrium dunense*. *Pistacia lentiscus* was recorded in just 8 (27%) plots in 2002, but where it occurred it dominated the quadrat – accounting for up to 70% of cover. The dominant grasses were *Piptatherum miliaceum* (recorded in 50% of quadrats) in more vegetated hollows and *Brachypodium retusum* (in 47% of quadrats) in more open, drier sites. Despite the tendency towards continuous cover, bare ground still amounted to 40% on average per quadrat (compared with 75% in 1995) and this gave opportunities to a range of annuals. The number of species recorded within the quadrats, 46, was only four short of the 1995 total – so overall diversity remains good. There is still just one plant of *Pinus halepensis* within the study area. It did not occur in the random quadrats in 2002. However, there are signs of slow colonisation toward the study site from a row of mature trees immediately to the west.

Dune regeneration in the foredunes of Es Comú

This study, originally established to monitor the recuperation of Es Comú foredunes following environmental restoration work, took on a new urgency in 2002 because of emergency measures put into place by the central government (Madrid) in the aftermath of the hurricane. The impetus for this study came from three events: 1) recent efforts implemented by the Balearic Government

Conselleria de Medi Ambient to recuperate the coastal dunes of Es Comú; 2) the hurricane of November 2001 which did such damage to the coastal fringe; 3) the dumping of imported sand on a tourist beach adjacent to the Parc, as a response to the hurricane.

The normal procedures of environmental impact assessment were not applied because of the "emergency" designation. This provoked considerable concern amongst conservationists, ecological groups and the Balearic Conselleria de Medi Ambient because of the unconsidered consequences on such a high profile internationally important conservation area. One particular action which caused controversy was the dumping of sand on Ca'n Picafort beach. This was marine sand dredged from off the north coast of Mallorca.

The long-term implications of this measure on Alcudia Bay and the coastal fringe are unknown. In order to establish a baseline, we undertook a preliminary survey of beach width and the dune face and beach profile – using the obelisks as fixed reference points. A pilot study in the spring was followed in autumn, after consultation with Drs Jaume Servera of UIB and Javier Alcántara Carrió of the University of Vigo, by application of a methodology for long-term monitoring. The methodology and implementation tasks are being led by Maria Cantallops (Balears) and Laura Royo (Univ. Vigo).

Impacts on the ecology of Es Comú dune systems

This is a much needed study and we hoped to initiate it in the spring, as a joint project with Dr Macià Blazquez and his team from the UIB Department of Earth Sciences. Unfortunately, the funding we had identified to launch this new study failed to materialise, and we had to drop it from our programme. Despite this setback we are still hoping to identify funding sources which will allow us to conduct this study in the near future.

Biodiversity studies

Herbarium development and curation

Several additions were made to the herbarium, including *Gagea iberica* which is a new species for the Parc. A number of plants were in flower in March in more open areas of Es Comú Baix. *Parentucellia latifolia* was also new for the Parc. It was flowering abundantly in March in open areas of Es Comú Baix, and specimens were taken for the herbarium. The opportunity was taken to demonstrate to volunteers the preparation techniques required for the herbarium. Volunteers also assisted in curation duties.

In the summer, Dr Llorenç Saez very kindly reviewed the plants in the herbarium and made a series of helpful comments on material therein.

Development and curation of the Albufera invertebrate collection

Volunteers helped with the task of integrating and labelling the major fly (diptera) collection prepared for the Parc by Dr Martin Ebejer. The Lepidoptera collection has been well curated and organised by Martin Honey, so the only additional work was to integrate a small series of new species identified over the winter 2001/02. Considerable work was done with the help of volunteers to verify and cross-reference specimens from a range of other orders in the collection.

Fieldwork during the spring by Tony Serjeant (spiders and pseudoscorpions), Henry Stanier (odonata and some coleoptera groups), Brian Eversham (coleoptera, especially Carabidae) and Oscar Vorst (several small, less studied coleoptera groups) and in spring and autumn by Florent Prunier (orthoptera, coleoptera) led to substantial collections of invertebrates which are currently with the collectors for identification. This will eventually lead to a considerable input of new material to the reference collection.

Bryophyte studies

A six-day investigation of the mosses and liverworts in March 2002, led by Rod Stern, was a follow-up to initial surveys undertaken in November 1994 and May 1996. Early spring was chosen as an appropriate time for finding fruiting bryophytes. Fruit capsules were required to confirm or clarify identifications for some species found during the earlier visits. The results of the visit are presented in Part III of this report. The results include confirmation for several species and a small number of additions to the Parc list. Reference material has been prepared and will be added to the Parc's bryophyte herbarium in spring 2003.

Lepidoptera and habitats

Develop of this study was limited by the unfortunate absence through illness of the leader of our Lepidopterist team, Martin Honey. Some information on the ecology of lepidoptera associated with reed *Phragmites australis* was gathered during the course of more general invertebrate studies on that plant species. Otherwise, data gathered under this heading were restricted to casual observations made by team members during the course of other activities.

Diptera survey and reference collection

Diptera survey work was undertaken using the Malaise interception trap purchased in 2001. The trap is a very proficient means of catching flying insects. The trap was set in suitable sites for periods of six days, and the collecting bottle emptied every two days. In spring, trapping was interrupted on several occasions by severe weather and floods, so only two periods of six days were achieved. Nevertheless, the volume of captures was immense, and sorting them into size and species groups after two days of captures took several hours. Dr Martin Ebejer has very kindly agreed to look at the material with a view to identifying the groups he knows and distributing the other diptera material to specialists in those particular groups.

Laboratory work centred on integrating and labelling the fly (diptera) collection prepared for the Parc by Dr Martin Ebejer from specimens taken in 2001.

Coleoptera survey and reference collection

Knowledge of s'Albufera coleoptera is more or less restricted to some work done in 1992 by Miquel Palmer and Joan Vives on Carabidae and Tenebrionidae. This is about to change. Brian Eversham, a coleoptera specialist, joined TAIB for the first time in April and set out to survey coleoptera in a range of habitats within the Parc. He was assisted in this by Henry Stanier and Florent Prunier. Carabidae were the main target, but other groups were also taken. In this we were ably assisted by Oscar Vorst from the Netherlands. Oscar is a specialist in a number of small,

poorly known coleoptera groups and joined us after making contact through the Albufera/TAIB website. Our coleoptera specialists were here during a period of flood, in April, which flushed out a lot of species. The flood line debris proved a profitable source for beetles, and other invertebrates. The full results of this survey are not yet at hand. It takes time to process all the specimens and much of this is done during the winter months. There is some early feedback however. Oscar Vorst has reported the first pselaphid beetle for s'Albufera, *Brachygluta schueppeli* (Aubé) – a widespread coastal species from Southern Europe – and, more excitingly, a *Cyphon* species (Scirtidae) previously only known from its type locality in Morocco. So, s'Albufera claims yet another new species for Spain, and of course for Europe. Individuals were found in samples taken by Oscar and in those taken in the Malaise trap. This suggests that the species is well established in the Parc. A familiar pattern is emerging. Each time a specialist in a little studied group joins us, new and notable species are discovered. This underlines yet again the international importance of s'Albufera not just for birds, but for many species groups.

Biodiversity monitoring techniques

Because of the wide range of biodiversity studies now being undertaken, and because of the availability of specialists in various fields, the opportunity was taken to demonstrate a range of field techniques for monitoring notable elements of biodiversity amongst the fauna and flora of s'Albufera. This involved survey work, trapping techniques, identification of notable species and identifying suitable bio-indicators for testing impacts, change and the success of management objectives. Many of these field techniques were employed in conjunction with studies already taking place within the programme.

Extension of the aquatic invertebrate reference collection

Henry Stanier assisted Juana Garau in extending the aquatic invertebrate reference collection. Henry is developing techniques and expertise in the identification of odonata larvae, which are particularly difficult to identify to species amongst some sub families and when not mature. Oscar Vorst was able to name, at least to genus, some of the water beetles taken in the aquatic invertebrate survey, and took some away for further investigation. Brian Eversham took a series of water beetles (coleoptera) to try and get them identified by a specialist in Britain. The reference collection, therefore, remains far from complete but the work of specialists in 2002 may fill some of those gaps.

Arachnid studies - spiders

Tony Serjeant returned to continue his spider studies. Previous work has been mainly baseline, to establish a list. This time, Tony targeted spiders in relation to habitats and, with the volunteers, collected data on the invertebrate communities (including spiders) of reedbeds. He also took advantage of flood line debris to search for spiders flushed out by the heavy April rains. Tony's investigations led to the capture of considerable numbers of pseudoscorpions, which have been sent to specialist Dr Gerald Legg (Booth Museum of Natural History, Brighton). Tony also met with Guillem Pons at UIB and was able to glean a lot of useful information from Guillem which will be of assistance to the furtherance of his studies.

The pseudoscorpion sample may include the Balearic endemic *Dactylochelifer balearicus*. One found previously, on 31st October 2000, appears to be the first for Mallorca, previous records being in Minorca and Ibiza. Both individuals were found in dry open sand dune habitats.

Biodiversity catalogue – extension

Nothing stands still in the environmental world. The biodiversity catalogue (publication date: January 2003), is an annotated list of all s'Albufera species known to TAIB up to 1999. There have been considerable additions since. The largest extension of knowledge has been in the diptera group, but other groups (e.g. beetles, orthoptera) are now being targeted and further boosts to our knowledge are expected. This is inevitable in any active process. Additions are carefully noted and databased, and this will allow for updates to the catalogue in the future. The publication of the catalogue will also serve as a reference to gaps in our knowledge, which can then be targeted, and to identify errors – which can be corrected through vehicles such as Parc bulletins, TAIB annual reports and the website.

Ecological and monitoring studies

Bird population studies – transects

There were two major points of interest in this spring's transects. The first was the state of the bird communities using Es Rotlos and Es Ras reedbeds following the fire of November 2000; and the second was the state of bird communities in areas of Es Comú coastal woodland following the hurricane of November 2001.

The moustached warbler *Acrocephalus melanopogon* was the most badly affected by the reedbed fire. Decreases along the Camí d'en Pujol transect line compared with the same period in 2000 averaged 69% (42% in the first ten-day period of April, 85% in the second and 73% in the third). Reed buntings *Emberiza schoeniclus* were also down, though sample sizes were small and the population may already have been depressed prior to the fire.

Some very interesting results emerged from the coastal dune transects, reflecting large changes in woodland structure following the fire. Surprisingly, there were no significant changes in numbers of woodland species in the first week of April compared with previous years. Counts for serin *Serinus serinus*, greenfinch *Carduelis chloris* and house sparrow *Passer domesticus* were virtually identical to the comparable count in 2000 for instance, while goldfinch *Carduelis carduelis* numbers were up. Chaffinch *Fringilla coelebs* showed a decrease, but sample sizes were low. In the middle ten days of April numbers for all species apart from serin and house sparrow declined. In the last ten day period, however, there were marked declines for all the above mentioned species. Other species which showed a similar pattern included blackbird *Turdus merula* and sardinian warbler *Sylvia melanocephala*. This pattern may have been caused by breeding season or climate differences between years, or by the more open habitat allowing good feeding opportunities (in early April) but fewer breeding sites. However, there was one additional factor which may have contributed considerably to the change in numbers, and that was human disturbance. The declines occurred during a period when mechanical operations to remove fallen trees and other debris were at their peak – and this disturbance factor may have discouraged birds from using the area. The biggest loser was firecrest *Regulus ignicapillus*. None was recorded on any of the visits – the first time this has occurred in 10 years of regular transects.

Finches were scarce in the Es Comú section of the coastal dune transect in autumn, perhaps a reflection of the more open structure of the woodland following removal of fallen trees. Both transects produced unexpected species. A North American vagrant wader, long-billed dowitcher

Limnodromus scolopaceus, was seen at ses Puntes (transect 1) on 13th October and a ruddy shelduck *Tadorna ferruginea* at ses Salinetes (transect 2) on 14th October.

Butterfly and dragonfly population studies – transects

There was a dearth of most butterfly species, probably a combination of the effects of the November 2001 hurricane and some particularly heavy rainfall in late March and April as adults were emerging. The worst affected appeared to be the small white *Pieris rapae* which is normally abundant in April. Speckled wood *Pararge aegeria* numbers were down but not spectacularly so. Two species did better. Record numbers of wood white *Leptidea sinapis* were recorded in the coastal dunes in March and there were good numbers of wall browns *Lasiommata megera* too. Both probably benefited from a spell of unseasonally hot weather in March and the wood white may also have found the increase in open woodland habitat following the hurricane to its liking. Unfortunately, there are no comparative data for previous March periods to ascertain whether the wood white abundance was exceptional.

There were few dragonflies before mid April, but good numbers and range of species occurred in the last week. Being aquatic species in their pre-adult stages, the impact of heavy rain and floods is likely to be low or nil.

An atypically "wet" summer was probably the main contributor to exceptionally large numbers of butterflies and dragonflies during the October transects. However, one dragonfly species, *Sympetrum fonscolombei*, which had been common in recent years was unexpectedly scarce in October 2002. The autumn highlight of the butterfly transects was a female Moroccan orange tip *Anthocaris belia* on 29th October on transect 1. This is the second Balearic record. The previous record was also at s'Albufera.

Ecology, phenology and habitats of Odonata

Henry Stanier continued with his study of the ecology, phenology and habitats of odonata at s'Albufera, concentrating mainly on larvae, and on copulating/egg-laying adults. Henry's visit also gave us the opportunity to identify further work required on this group and methodologies to achieve this. Outcomes from these discussions were used to advise a more detailed ecological investigation during the summer, undertaken by Mayumi Sato of the University of York.

Carabid beetles and their habitats

A number of techniques were used to investigate the carabid beetle fauna and their habitat utilisation at s'Albufera. Pitfall traps were used to give some quantitative information for a range of habitats, and targeted searches were employed – in daylight and at night by torch. Brian Eversham, who led the study, also devised a methodology which would allow for repeat investigations at different times of year in order to obtain phenological information about adult activity periods.

Ecological associations and habitats of Orthoptera

This study was established to extend our knowledge of ecological associations and habitats of s'Albufera Orthoptera – a prominent element of s'Albufera biodiversity. Information was gathered using a wide range of methods and techniques to gather as much material as possible relating to

orthopteran distribution, associations and habitats. Particular attention was paid to orthopteran communities and abundance in relation to management activities, and in particular grazing. As a new study, it established a baseline for this under-studied group. In addition, it aimed to test how orthopteran species responded to habitat management and to provide preliminary data on the value of orthopterans in the assessment of habitat quality and the effects of habitat management measures. The rationale for the study is described more fully in Part III of this report.

Survey of mollusc distribution and habitats

Pam Hill undertook an investigation of mollusc communities in relation to habitats. She was using as her baseline, studies undertaken by Dr Chris Paul 10 years earlier. One of her objectives was to ascertain whether any marked changes in distribution or community composition had occurred. She also took advantage of other studies to widen her collecting opportunities, including searches of flood line debris and participation in the reedbed invertebrate communities investigation.

Habitat descriptions and communities

Chris Donnelly continued with this study, which links to the whole range of investigations being carried out by TAIB. Indeed, the various invertebrate and habitat studies all contribute strongly to the habitat based approach being employed by Chris. The study also links to the biodiversity and conservation management programme, also being prepared by Chris (see ***Programme Development*** below).

Systematic light trapping for moths

The weather was unpredictable and rather atypical this spring: hot summer weather in March, followed by heavy flooding at the end of March and again in April. Moth trapping results were similarly unpredictable. Several species which are normally common in spring were caught in well below average numbers, most notably *Nola squalida* and *Acrobasis obliqua*. By contrast, numbers of *Mythimna zeae* were consistently above the recent average. *Mythimna zeae*, along with *Mythimna joannisi*, are considered to be North African species which have begun to colonise the coasts of south-west Mediterranean Europe in recent years. In the early to mid 1990s, *Mythimna zeae* was common but from the late 1990s numbers declined dramatically. This all changed again in spring 2002 when the species was often the commonest moth in the trap. The spring was characterised by steady numbers of species known to be migrants. This led to better than average numbers of *Udea ferrugalis* and *Nomophila noctuella* and, in the second half of April, regular captures of *Mythimna vitellina* – normally considered more of a summer and autumn species. One of the higher counts of *Mythimna zeae* coincided with an exceptional arrival of the micro moth *Plutella xylostella*. This was on 30th March when 48 *P. xylostella* and 12 *M. zeae* were removed from the trap. *Plutella xylostella* is a classic migrant species, often descending on sites (even isolated north European islands) in very large numbers. The simultaneous occurrence of *Mythimna zeae* suggests that they may have been primary migrants, rather than locally bred individuals.

The unpredictable nature of the weather continued into summer, which was unexpectedly wet. Many invertebrate groups seemed to benefit, not least the moths. Phenomenal numbers of moths, and other invertebrates, packed into the moth trap at Sa Roca throughout the October fieldwork period and on some mornings it took up to three hours to empty the trap and count its contents. The biggest night was 15th/16th October when 794 moths were caught, including 185 *Spodoptera exigua*, 146 *Scopula minorata*, 82 *Nodaria nodosalis* and 65 *Eilema rungsi*. Other abundant species

included *Pyrausta aurata* (maximum 137 on 11th/12th) and *Spodoptera cilium*. Both the maxima and mean captures were markedly higher than previous autumn capture rates. The numbers of *Eilema rungsi* were gratifying as it is a rare and little known species. Equally gratifying were the numbers of *Pelosia plumosa*, peaking at 24 on 12th October. *Pelosia plumosa* is an extremely rare species of Mediterranean wetlands. It is only known in numbers at s'Albufera, which may be its world stronghold.

In contrast, some species were noticeably scarcer – in particular species of *Mythimna*.

Monitoring the structural evolution of Mediterranean reedbeds

This study, begun in 1997, is proving very worthwhile. The major observation emerging from the fieldwork is the dramatic and rapid response of individual reedbeds to changing circumstances. This was never more evident than in autumn 2002, following an exceptionally wet period which had lasted from early winter 2001/02 into summer 2002. This had important consequences for the reeds of Es Cibollar and Es Colombar. At Es Cibollar, flushing out with freshwater of a generally saline, tending to hyper saline, zone led to considerable growth of fresh "green" Phragmites. Normally, dead stems from previous years predominate and flowers are rare (none at all within the 70 sample quadrats in two of the previous four years). By contrast, up to 5 flowering stems were recorded in some 25 x 25 cm quadrats in October 2002, with a total of 50 in the entire 70 quadrats. In 2001, salinity levels in Es Colombar were relatively high, giving strongly brackish conditions, and the reedbed looked to be disintegrating, with few flowers and a predominance of old, broken stems. Rapid recovery of new growth was recorded in 2002, and salinity levels were generally low to very low. There was little noticeable change in the other two reedbeds both of which, however, are in consistently freshwater parts of the Parc.

This study is an international collaboration with Tour du Valat Biological Station, the Camargue, France; and part of a Mediterranean-wide study being carried out in 40 reedbeds in France, two in Greece and Albania, and 4 in s'Albufera (the only Spanish site participating)

Park management

Census of migrant and breeding birds

This part of TAIB work contributes to the bird records maintained by the Parc. With the return of Parc ornithologist/biologist, Pere Vicens, the need for intensive census activity by TAIB was no longer necessary, particularly in relation to breeding birds, but records were still supplied to the Parc database of interesting bird counts and observations. TAIB teams also contributed to a series of census sessions jointly with Parc staff, notably to census calling bitterns *Botaurus stellaris* and to census numbers and nest sites of marsh harriers *Circus aeruginosus*.

Leading on from reedbed bird study investigations by Ditta Greguss (University of Wageningen) in summer 2002, a ringing study was piloted in the autumn, focusing on post-breeding utilisation of reedbed edge.

Bittern population studies

Investigation into fluctuations in bittern numbers began in 2000 with the visit of RSPB bittern expert, Glen Tyler. Methodology devised by Glen was again employed to pin-point calling birds and possible breeding terrritories. Fire and drought probably contributed to a marked decrease in numbers to just one calling bird in 2001. The spring 2002 censuses gave some sign that a partial recovery may be underway, with between two and four territories detected.

Marsh orchid Orchis palustris *census*

Anticipation was high before this study because a livestock grazing regime had been devised for the marsh alongside Camí des Polls whose objective was to promote the growth and flowering of marsh orchids *Orchis palustris*. This species fell to a modern low in 2001 when more marsh orchids were found outside the parc than at sites other than Camí des Polls within!

The results of the 2002 census showed that the new grazing regime was beginning to bear dividends. A total of 645 flowering marsh orchids was recorded in the Camí des Polls site, more than double the number in 2001 and 18 times more than in 1998. Indeed this is the highest count at that site since 1997, the last time appropriate management had been applied. In that year, 1173 flowering plants were counted. There are a number of other marsh orchid sites scattered through the Parc, but the total count of 909 (including 13 outside the Parc) indicates that Camí des Polls remains the only major site in the Parc (71% of the total flowering population). Other sites held much higher numbers until 1999. Still, the 2002 results are an encouragement after several years of decline (see table) and augurs well for the future at Camí des Polls.

Marsh orchid flowering success, 1997-2002

	2002	*2001*	*2000*	*1999*	*1998*	*1997*
Camí des Polls	645	320	132	313	35	1173
Other sites within PN S'Albufera boundary	251	64	24	133	958	510
Outside PN S'Albufera boundary	13	103	7	3		
TOTAL	**909**	**487**	**163**	**449**	**993**	**1683**

Programme development

Biodiversity and conservation management studies: forward planning

Over the years, about 100 investigations have been conducted by TAIB and its associates. Many of these investigations are inter-related and are more powerful if used in conjunction with others, both at the PN S'Albufera level and more widely in the Balearics, Mediterranean and beyond. One outcome of all this wealth of information is that it becomes harder every year to retain knowledge of what has been done, where the information lies and who is responsible for it. This is particularly relevant to new members of the team. They have real difficulties in picking up the threads of a project which has been going since 1989, and identifying exactly how their skills and expertise can best be applied to the needs and interests of the project.

To counter this, Chris Donnelly has been working very hard to draw together an overview of the entire project, with the long-term aim to develop relational databases which provide ready reference

to the various investigations and people involved. It is a challenging task. The investigations fall into a series of categories designed to meet all the TAIB objectives. These are biodiversity studies, environmental change, international co-operations, education, interpretive materials and training.

Interpretation and education

Guide to the birds of the Park

As a follow-up to the guide to the flowers of Parc paths (published in March 2003), Nick Owens and Pere Vicens have been working on a guide to the commoner birds of the Parc. As with the flower guide, the primary objective is to provide interpretive material for the general visitor to the Parc. It will not, therefore, be an identification guide in the modern sense. There are plenty of these, which the keen birdwatcher will already possess. Instead, the guide is intended to help the non specialist get the most out of his or her visit to the Parc. Identification features will be covered, but information will also be supplied on aspects of the birds' ecology as they apply to the Parc.

A draft has been completed in English, and the Catalan version is well advanced. The focus in 2002 was on identifying funding for its publication and finding a suitable artist to illustrate the guide. Further progress towards completion is planned for 2003.

International initiatives and collaborations

International volunteer biodiversity training

The Conselleria de Medi Ambient of the Balearic Government sponsors the training element by the provision of facilities and the award of grants to support the participation of volunteers. The volunteer participation scheme is widely publicised beforehand. Selection is based on merit and experience, candidates being asked to apply with accompanying *curriculum vitae* and supporting letter. The volunteers awarded places under the Conselleria de Medi Ambient support scheme in 2002 were Maria Cantallops Alba, Maia Peressini, Juan Angel Orfila Jiménez, Florent Prunier (Team 1); David Méndez Miras, Laura Royo Marí, Vanessa Mora Fortes, Ester Cazorla Barranco (Team 2); Inmaculada Férriz Murillo, Federico González (Team 3).

The wide range of activities and studies in which the volunteers took a full part is given above. The volunteers not only had the opportunity to work alongside some of Europe's most skilled specialists but benefited from first-hand experience of a variety of field methodologies which will stand them in good stead if they continue into environmental careers. For those who do not, the experience will have widened their appreciation of conservation issues and the need to safeguard the environment.

International collaborations: training

TAIB continues to promote and develop new ventures in biodiversity and environmental management studies. A new international departure in autumn 2002 was the initiation of a practical wetland management training course for Mediterranean wetland managers, biologists and conservation officers. It was run in conjunction with the MedWetCoast project and the French training specialists ATEN (Atelier Technique d'Espaces Naturels). The MedWetCoast project

promotes wise management of wetland sites in the Mediterranean. Participating countries are Albania, Lebanon, Palestine Authority, Egypt, Tunisia and Morocco. Although excellent, well structured training modules have been developed for Mediterranean wetlands, this is the first time that a course has been run specifically to give intensive, hands-on experience to those involved in wetland management.

Another new departure in 2002 was a biodiversity training course for a foreign university. The course, which took place on 14th to 29th March, was led by TAIB - again with considerable input from Parc staff (particularly Pere Vicens) and local members of TAIB - and involved the University of York Masters Research Course in Ecology and Environmental Management. This course is one of the most prestigious of its type in Britain and attracts students from all over the world. Thus, the biodiversity course at s'Albufera included students from Canada, Cyprus, Germany, Ghana and Japan.

S'Albufera proved an ideal field laboratory for the course, and studies were conducted on a number of subjects, including feeding preferences of grazing livestock, roost numbers and activities of herons and egrets, diversity and foraging behaviour of hymenoptera, purple gallinule *Porphyrio porphyrio* distribution and the impact of the November hurricane on insect populations. Interim results for several of these studies are presented in Part III of this report. The course was deemed a great success and, it must be added, the participants were very impressed by the facilities at the Parc, which they nominated as far superior to anything they had met on other field courses!

Participants and field dates

Team 1: 30th March to 12th April 2002

Scientists
Nick Riddiford (Principal Investigator, TAIB)
Biel Perelló (Geographer, Parc Natural de s'Albufera), Liaison officer
Pere Vicens (Ornithologist, P.N. de s'Albufera), Park scientific collaborator
Ingirid Eunson (TAIB Logistics)
Chris Donnelly (TAIB Biodiversity & Programme Development)
Henry Stanier (Beds, Cambs, Northants & Peterborough Wildlife Trust; odonata ecology)
Brian Eversham (Conservation Director; Beds, Cambs, Northants & Peterborough Wildlife Trust)
John Hollingdale (TAIB Entomologist)

Volunteers
Maria Cantallops Alba, Maia Peressini, Juan Angel Orfila Jiménez, Florent Prunier, Carme de Oleza Marin

Team 2: 14th to 26th April 2002

Scientists
Nick Riddiford (Principal Investigator, TAIB)
Biel Perelló (Geographer, Parc Natural de s'Albufera), Liaison officer
Pere Vicens (Ornithologist, P.N. de s'Albufera), Park scientific collaborator
Ingirid Eunson (TAIB Logistics)
Chris Donnelly (TAIB Biodiversity & Programme Development)
Henry Stanier (Beds, Cambs, Northants & Peterborough Wildlife Trust; odonata ecology)
Brian Eversham (Conservation Director; Beds, Cambs, Northants & Peterborough Wildlife Trust)
Juana Garau (TAIB Aquatic Biologist)
Angela Medina (TAIB butterfly transects; lepidoptera studies)

Tony Serjeant (TAIB spider studies)
Pam Hill (TAIB mollusc studies)
Richard Green (TAIB bat & other small mammal studies)

Volunteers
David Méndez Miras, Laura Royo Marí, Vanessa Mora Fortes, Ester Cazorla Barranco (Peninsula), Barbara Aldridge, Kate Hockley (Enfield Lock BTCV; UK), Ai-Li Au-Duong (France/Vietnam), Anna-Liise Warden (UK/Sweden)

Team 3/MWC Training Course: 12th October-2nd November

Scientists
Nick Riddiford (Principal Investigator, TAIB)
Pere Vicens (Biologist, P.N. de s'Albufera), scientific collaborator
Mari-Angels Ferragut (PN S'Albufera/Balearic Environmental Education Team)
Marga Roig (PN S'Albufera/Balearic Environmental Education Team)
Juana Garau (TAIB Aquatic Biologist/Balearic Govt. Environmental Scientist)
Florent Prunier (TAIB Entomologist)
Angela Medina (TAIB Ecologist)
Laura Royo (TAIB Coastal Studies/University of Vigo; coastal processes)
Maria Cantallops Alba (TAIB Coastal Studies/University of Balearic Islands; coastal processes)
Javier Alcántara Carrió (University of Vigo; Dept of Geociencias Marinas)
Elizabeth Riddiford (TAIB Biodiversity Studies)

Support personnel
Charlotte Francis (logistics)

Volunteers
MedWetCoast wetland managers/environmental planners/biologists:
- FROM EGYPT: Fayed El Shamly (Burullus Protected Area), Mohamed El Essawy (Omayed Protected Area), Ehsan El Hady (Abu Galum, South Sinai)

Spanish volunteers:
- Inmaculada Férriz Murillo, Federico González, Catalina Sebastiá

Visitors
Pere Tomàs (Tour du Valat Biological Station; wetland monitoring planning)
Santí Pèrez Segú (Parc Natural Ses Salines d'Eivissa & Formentera)

University of York MRes in Ecology & Environmental Management course: 14th to 29th March

Leaders
Nick Riddiford (Principal Investigator, TAIB); Dr Calvin Dytham (Univ. York)

Demonstrator
Tim Morrissey

Students
Ben Collen, Gareth Fisher, Sarah Gwillym, Iain Hartlet, Mairead Maclean, Andy Marshall, Leanne Mason, Daniel Morrish, Ian Morton, Dan Nussey, Jo Phillips, Alex Thompson (UK), Augustus Asanoah (Ghana), Monika Böhm (Germany), Felix Eigenbrod (Canada), Martin Hellicar (Cyprus), Mayumi Sato (Japan)

Visitors
Juana Garau, Maria Vidal (TAIB Ecologists)

TAIB
The Albufera International Biodiversity Group

TAIB Project S'Albufera: A Mediterranean model for the study of biodiversity and environmental change

The Albufera International Biodiversity Group Annual Report 2002

PART III

Study reports

Human and Management Impact studies

Towards the use of bio-indicators to assess the anthropogenic impacts on aquatic biodiversity and water quality in s'Albufera Natural Park by Jeroen Veraart

Foundation for Sustainable Development
International Center for Environmental Analysis

Preface and acknowledgements

During spring 2001 I visited s'Albufera Parc Natural de Mallorca for the third time. I really enjoyed my stay. Thanks to the help of the volunteers of TAIB and the Balearic university it was again possible to sample the zooplankton and aquatic vegetation community of s'Albufera de Mallorca. Special thanks go to Nick Riddiford and to Biel Perelló because they create every year the opportunity to me and many others to explore and to enjoy the Albufera!

Wageningen, December 2001

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Contents

1. Introduction

Parc Natural s'Albufera de Mallorca is an international recognised resting area for a wide array of migratory birds, and like most wetlands it has many other ecological functions and socio-economic values. In the catchment in which the wetland is situated, expanding tourism and intensification of agriculture place much pressure on a limited amount of freshwater. The freshwater supply to the wetland has decreased due to water-extraction, mainly driven by intensification of agriculture in the catchment. As a result, saltwater intrusion has increased since 1983-85. This has had considerable impacts on the ecological integrity of the wetland as reflected by changes in the state of the aquatic ecosystem. Submerged plants less tolerant of salinity declined or disappeared, while the distribution of species known to prefer high salinity increased. As a contribution to the development of monitoring programmes and management strategies that address both socio-economic and natural water demand, this study will formulate ecological criteria to assess the natural water demand by selection of (bio)indicators within the aquatic ecosystem.

1.1 Research objectives

As a contribution to the development of monitoring programmes and management strategies for sustainable water use within the s'Albufera catchment area, this long-term study provides ecological data within the aquatic ecosystem of s'Albufera de Mallorca.

A) Identification of the diversity and abundance of Charophyte taxa at the baseline monitoring sites in the Albufera (Martinez-Taberner, 1988; Veraart, 2000). The inventory will be compared to the inventory of the period 1983-85 (Martìnez-Taberner, 1988). It is an objective to reconsider and to improve the formulated monitoring objectives and hypotheses for charophytes (Veraart, 2000) in relation to water quality, temporality and biodiversity.
B) It is an objective to prolong the monitoring of the community structure of the aquatic vegetation in a selection of the baseline monitoring sites (Martinez-Taberner, 1988; Veraart, 2000).
C) It was an objective to formulate recommendations and provide background information for future zooplankton sampling. It is an objective of Project s'Albufera to include zooplankton sampling into long-term monitoring and research (N. Riddiford, pers. comm.).
D) It was an objective to discuss the results of the fieldwork of 1999 (Veraart, 2000) with park management and Project s'Albufera in order to facilitate the incorporation of the selected bio-indicators and hypotheses (Veraart, 2000) into long-term monitoring programmes and research.

This data can be applied to assess the impact of land use change and tourist developments on water resources and natural values within the Albufera watershed. It is an aim to demonstrate how ecological monitoring of the aquatic ecosystem can provide applicable information for integrated water resource and water management. It is an aim to develop monitoring and information tools for planning and decision-making procedures within integrated water resource management to address the amount of freshwater needed to maintain ecological and natural values (Veraart et al., 2001). In an ideal decision-making procedure socio-economic water demand and the amount of freshwater necessary to maintain natural values are both considered (formula 1).

$IS48_{adj}$: 1

$$\frac{Average\ groundwater\ recharge + Man\text{-}made\ water\ resources}{Average\ socio-economic\ water\ exploitation + Natural\ water\ demand} > 1 \qquad (2)$$

(all variables in Hm^3yr^{-1})

With the following constraints:
1) $IS_{adj} > 1$
2) The freshwater supply to ecosystems, like s'Albufera, should be optimised before man-made water freshwater resources are incorporated.
3) The indicator is calculated for a system with an ecological and socio-economic integrity, which is in agreement with the objectives of current EU directives for integrated water management (IUCN, 2000).

1.2 Research methods

Water quality
Salinity, conductivity and pH were measured at all the sampling sites with WTW conductivity and pH meters. The locations of the visited sampling sites can be found in appendix A.

Aquatic Vegetation
Specimens were collected at some selected baseline monitoring sites (Martinez-Taberner, 1988; Veraart, 2000). The species were identified and their abundance was estimated in terms of (R)are, (M)oderate or (D)ominant. For a more detailed description of the vegetation mapping method see Veraart (2000).

Zooplankton
The zooplankton community was sampled in the ephemeral ponds. At least 4 samples between 0.5 and 1.0 litre were taken at each site with bottles. It was not necessary to take vertical migration of zooplankton into account as the sites were very shallow (<20cm). The collected volume was measured in the laboratory. Samples were filtered through a 250 µm mesh net. Preparation of the samples was done with formol (4%). The number of Cladocera and Copepoda taxa were counted for each sample. Cladocera/copepoda ratios and concentrations (individuals/litre) were calculated for each sample.

2. Fieldwork results

2.1 Water quality

Table 1: Salinity, Conductivity and pH levels at the sampling sites on the sampling date. The habitat description is based on salinity modifiers (Vives, 1996; Veraart, 2000) based on salinity time series (1994-1998) measured by Park management

Sampling Date	Location	salinity (g/l)	conductivity (mS/cm)	pH	Habitat description
Dried up	C12N1_B	-	-	-	oligohaline
16-04-2001	Ses Salinas	38.7	52	-	mixohaline
Not sampled	Estany Canyissar	-	-	-	mixohaline
	Canal Sa Siurana (C4N3)				Oligohaline
	Pont farm Margalida (C1N4)	3	4.96		Oligohaline
	Es Ras				No water quality data, based on ecology: oligohaline
	Frog pond (C2N1 comp. With C12N1)				Oligohaline
	Gran Canal Sluice (C3N4)				Mixohaline
	Gran Canal, Sa Roca (C3N3)				oligohaline

2.2 Zooplankton

Zooplankton samples were taken at Ses Salines (mixohaline habitat), at the frogpond (oligohaline habitat) and at the bridge near Margalida's farm (oligohaline habitat) in April 2001. These areas were chosen to discuss the following hypothesis:

Cladocera are dominant in the freshwater habitats (salinity <3.5‰, Stephen et al., 1998) and the copepod species are dominant in salt-water habitats. The increased number of turbid locations in the Albufera is a result of salinisation because phytoplankton grazers (Cladocera) are restricted to the freshwater habitat.

(Left: Daphnia, a Cladoceran)

Increasing salinity can change the structure of the zooplankton community (Stephen *et al.*, 1998). Several species are not able to survive under saline conditions because they have to spend more energy for osmoregulation (Stephen *et al.*, 1998). Cladocera are generally restricted to freshwater habitats with a salinity lower than 3.5‰ (Stephen *et al.*, 1998), consequently copepod species are often dominant in the more saline habitats.

Some cladocerans however, appear to be more tolerant. Large zooplankton species, like Cladocera, can contribute significantly to the control of phytoplankton biomass. The grazing pressure on phytoplankton is a function of community structure, number of individuals, body size of the individuals and the niche of each species. As a result of salinisation cladocera can become extinct while copepod species become more abundant (Irvine *et al.*, 1993). The grazing pressure of copepod species is smaller than cladocera species because they have a smaller body size. Copepods also predate other aquatic fauna, in contrary to cladocera species (R. Roijackers, *pers. comm.*). These potential structural changes in the zooplankton community may increase the impact of eutrophication and could result in a sudden decline of aquatic vegetation and promote phytoplankton dominance.

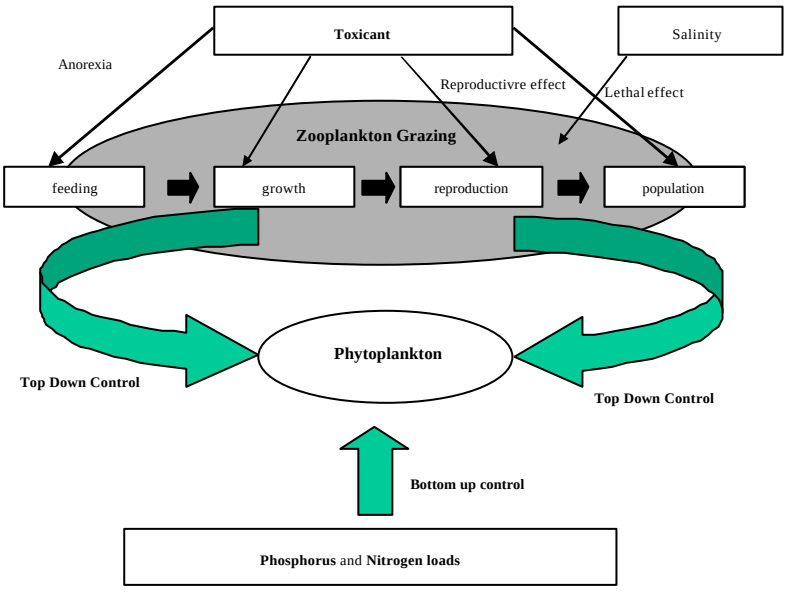

Figure 1.

The results of the zooplankton sampling are presented in table 2 and 3. *Pleuroxus globosus* and *Peracantha truncata* found at the frog pond are new species for the Albufera biodiversity list.

Table 2: An overview of found zooplankton taxa in the summer 2000 at a selection of baseline monitoring sites (Martinez-Taberner, 1988; Veraart, 2000)

Locations --> (in **bold** locations were zooplankton was measured) **Taxa**	**C2N1(A)/C12N1(a)/frog**	C12N1(B) (temporary)	**Ses Salines (temporary)**	EPHA (temporary)	C2N3 (C.Sol,Sa Roca)	C4N3 (C. Sa Siurana)	C3N3 (Gran Canal, Sa R	**C1N4 (Farm Margalida)**	Es Ras (temporary)	Pond Can Picaford	EPON (Estany du Ponts)	Biodiversity status
Daphnia magna		**X**		**X**	**X**	**X**	**X**		**X**	**X**	**X**	**Common species in world**
Daphnia longispina		X		X	X	X	X		X	X	X	Common species in the world
Daphnia pulex pulex		X		X	X	X	X		X	X	X	**Common species in the world**
Daphnia mediterrana		X		X	X	X	X		X	X	X	Tolerates higher salinities than 3.5 g/l (env. Tolerance Cladocera Western Europe)
Moina salinas		X	**D**	X	X	X	X		X	X	X	Tolerates higher salinities than 3.5 g/l (env. Tolerance Cladocera Western Europe)
Ceriodaphnia laticaudata		X		X	X	X	X		X	X	X	
Simocephalus sp.		X		X	X	X	X	**R**	X	X	X	
Alonella sp.	**R**	X		X	X	X	X		X	X	X	Measured also in 1987 by Jordi de Manuel in Font de Son San Juan (see Martinez&Mayol, 1995)
Pleuroxus globosus	**P**	X		X	X	X	X		X	X	X	Pleuroxus laevis was measured also in 1987 by Jordi de Manuel in Font de Son San Juan (see Martinez&Mayol, 1995)
Peracantha truncata	**P**	X		X	X	X	X		X	X	X	**New to the Albufera,**
Copepoda sp.(1) (Calanoida)		X	**P**	X	X	X	X		X	X	X	
Copepoda sp. (1) (Cyclopoida)	**D**	X		X	X	X	X		X	X	X	

R= Rare (only some individuals), P= present, D =Dominant (conc >300 ind l^{-1}), X= not sampled

Ses Salines

The sampling site was divided into a small ditch and an old saltpan, which were connected to each other. The water level in ditch and saltpan were approximately 50 and 20 cm respectively. In Figure 2 the vegetation cover at the sampling site is described. The first saltpan was turbid and algae like *Spirogyra* sp. and *Enteromorpha* sp. were present (sample 2). The second and third saltpan as well as the ditch were covered with dense beds of *Lamprothamnium papulosum* and *Ruppia maritima* covered with periphyton. The fourth saltpan was without vegetation. The water within the second, third and fourth saltpan was clear. In contrary to April 1999, *Gambusia affinis* (mosquito fish) was absent in April 2000 and 2001. Samples 3 and 6 were lost because they broke during the cycle ride back to the laboratory.

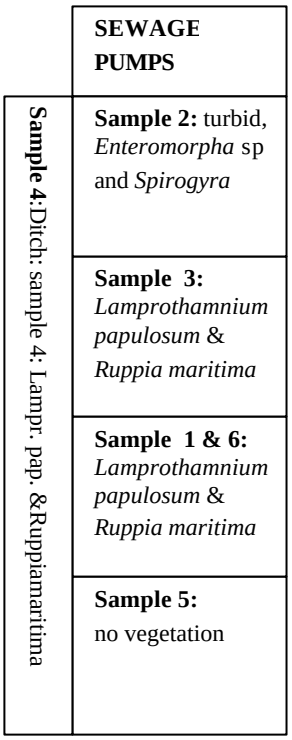

Figure 2 (right): Description of vegetation structure and cover within the saltpans in April 2001.

Table 3: Estimated concentrations (individuals/litre) zooplankton taxa at Ses Salinas in the month April in 1999, 2000 and 2001

	year 1999 (n=2)	**year 2000** (n=6)	**year 2001** (n=4)
Copepoda	131±17	472±665	215±230
Cladocera	3,6 ±3.3	316±182	690±800
Ratio Clad/cop	**0,03**	**0,67**	**3,21**

The following differences can be observed if we compare the zooplankton samples at Ses Salines in April 1999,2000 and 2001:

- Both copepoda and cladocera concentrations were lower in 1999 compared to 2000 and 2001. An explanation could be the absence of *Gambusia affinis* (mosquito fish).
- In 1999 the filter feeder capacity of algal biomass was relatively low (low numbers of Cladocera) and relatively high in the summer of 2000 and 2001.
- In April 2001 the Cladocera were dominant in contrary to 1999 (copepods were dominant) and 2000 (no significant difference).

2.3 Aquatic vegetation

The aquatic vegetation community structure of the visited baseline sampling sites (table 4) did not much differ from the survey done in the summer of 1999 and 2000. Two different variations of *Chara vulgaris* were identified: var. *longibracteati* and var. *hispidula*. These variations were found at sampling location C1N4 (Margalida's farm).

Table 4: An overview of aquatic vegetation taxa found in summer 2000 at a selection of baseline monitoring sites (Martinez-Taberner, 1988; Veraart, 2000)

Locations --> **Taxa**	**C12N1(A) S. des Pollo**	**C12N1(B) (temporary)**	**Ses Salines (temporary)**	**EPHA (temporary)**	**C2N3 (C.Sol,Sa Roca)**	**C4N3 (C. Sa Siurana)**	**C3N3 (Gran Canal, Sa R**	**C1N4 (Farm Margalida)**	**Es Ras (temporary)**	**Pond Can Picaford**	**EPON (Estany du Ponts)**	Biodiversity status
Zannichellia spp (2)		X		X	X	X			X	X	X	Check NIOO
Ruppia maritima		X	D	X	X	X			X	X	X	Common
Ruppia sp. *(cirrhosa?)*		X		X	X	X			X	X	X	Check NIOO
Cymodocea nodosa		X		X	X	X			X	X	X	In 1999 identified in error as *Zostera marina*
Potamogeton pectinatus	P	X		X	X	X	D	P	X	X	X	Common
Potamogeton crispus	P	X		X	X	X			X	X	X	Common
Apium nodiflorum	P	X		X	X	X			X	X	X	
Nasturtium officinale	P	X		X	X	X			X	X	X	
Myriophyllum spicatum	P	X		X	X	X	P		X	X	X	Common
Ranunculus sceleratus		X		X	X	X			X	X	X	
Ranunculus trichophyllus		X		X	X	X	P		X	X	X	
Chara vulgaris		X		X	X	X		P **	X	X	X	Currently most common stonewort in the Albufera
Chara imperfecta		X		X	X	X			X	X	X	**New to the Albufera**
Lamprothamnium papulosum		X	D	X	X	X			X	X	X	Increasing distribution since 83-85, rare species for Europe, salinisation indicator
Nitella sp.		X		X	X	X		P	X	X	X	**New to the Albufera**
Spirogyra spp.	P	X	P	X	X	X			X	X	X	Eutrophication indicator (N)
Cladophora sp.		X		X	X	X	P		X	X	X	Eutrophication indicator (pers.com. Santamaria)
Rhodopyceae sp.		X		X	X	X			X	X	X	
Chaetomorpha sp.	P	X		X	X	X			X	X	X	Salinisation indicator
Enteromorpha sp.		X	P	X	X	X			X	X	X	Eutrophication indicator (N)

R= Rare (only some individuals), P= present, D =Dominant (coverage >75%), X= not sampled ** In 2001 two different variations of *Chara vulgaris* were identified: var. *longibracteati* and var. *hispidula*

3. Discussion of the results

3.1 Objective A: Charophyte abundance and diversity

Abundance:
It was not possible to visit all the baseline locations due to breeding birds and time restrictions. As a result it was not possible to make a complete inventory of the charophyte community in the Albufera.

Diversity:
Two new variations of *Chara vulgaris* were identified: var. *longibracteati* and var. *hispidula*. These variations were found at sampling location C1N4 (Margalida's farm).

3.2 Objective B: long-term monitoring of the aquatic vegetation

The aquatic vegetation community structure of the visited baseline sampling sites (table 4) did not differ greatly from the survey done in the summer of 1999 and 2000.

However, although the state of the aquatic vegetation does not seem to change fast as a result of anthropogenic pressures within the Albufera one should consider that the resilience of the ecosystem becomes undermined to the point that even the slightest disturbance can make it collapse (Scheffer, 2001).

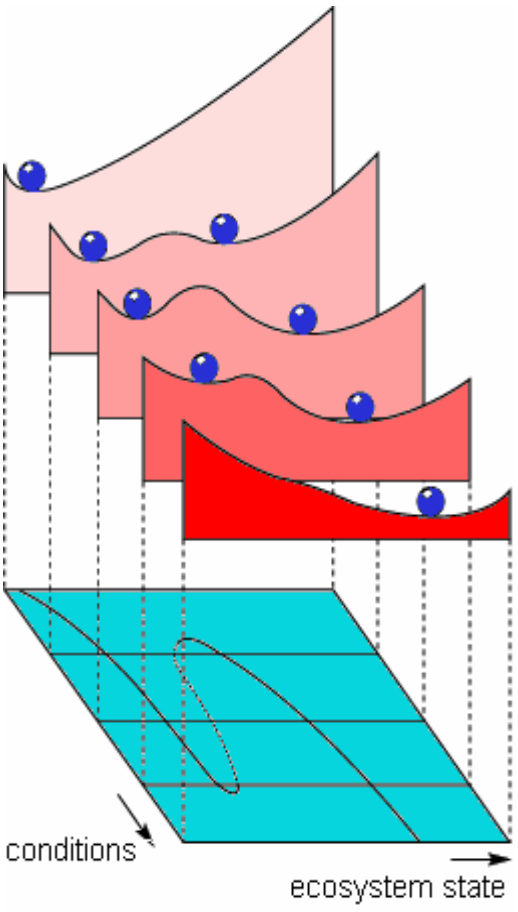

Figure 3, A stability landscape of ecosystems (source Scheffer, 1998)

Stressed ecosystems, given the right nudge, are capable of slipping rapidly from a seemingly steady state to something entirely different (Scheffer *et al.*, 2001). Gradual changes in vulnerability accumulate and eventually you get a shock to the system – a flood or a drought – and, boom, you're over into another regime.

The implications of lost ecosystem resilience, are "profound" in light of current resource management. Moreover, while subtle change over long periods of time undermines ecosystem resilience, it "implies a lack of early warning signals." And since a single event – a flood or a drought – can cause an ecosystem to shift from one state to another, "the role of gradual environmental change might be disputed".

3.3 Objective C: Zooplankton sampling

Observed differences within the zooplankton community in April 1999, 2000 and 2001 at Ses Salines:

- Both copepoda and cladocera concentrations were lower in 1999 compared to 2000 and 2001. An explanation could be the absence of *Gambusia affinis* (mosquito fish).
- In 1999 the filter feeder capacity of algal biomass was relatively low (low numbers of Cladocera) and relatively high in the summer of 2000 and 2001.
- In April 2001 the Cladocera were dominant in contrary to 1999 (when copepods were dominant) and 2000 (no significant difference).

Several explanations could be formulated for the observed differences:

1) The higher concentration of zooplankton (both cladocera and copepoda) in 2000 and 2001 could be explained by the absence of *Gambusia affinis* in 2000 and 2001 within the salt pans. As a result of **reduced grazing pressure** the concentrations were probably higher.
2) However, it is also possible that the saprobic and eutrophic degree of the water was higher in 2000 and 2001. As a result more food (algae) is available for the zooplankton community. The eutrophic degree withn the saltpans is a function of the load of sewage leakage from the pumping station, the volume of the saltpan (load / volume = concentration nutrients and organic material) and the temperature (rate of processes, like decomposition and assimilation). The **climate conditions** (precipitation & evaporation) determine the volume of the saltpans. In other words the differences within the zooplankton communities could also be explained by the climate conditions: maybe the winters and springs of 2000 and 2001 were relatively warm and dry compared to the winter and spring of 1999. The monthly measured water temperature at the saltpans by the park staff could clarify a lot of these assumptions as well as the meteorological data from park management.
3) Another possibility could be that **sewage leakage** has increased since 1999.

In April 2001 the Cladocera were dominant in contrary to 1999 (when copepods were dominant) and 2000 (no significant difference). In May 1999 the Copepoda community also collapsed and the Cladocera community became dominant (Veraart, 2000). Probably the saltpans warmed up faster in 2000 and 2001, which might explain why cladocera taxa were dominant earlier within the season. Also other scientists demonstrated recently that the climate driven changes in water temperature have a major impact on the ecosystem: In warmer years the chances of having clear water in spring are higher. This water clarity is caused by zooplankton that filter the water (Scheffer *et al.*, 2001).

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Human and Management Impact studies

Impacts and problems: why should damage to seagrass beds in Alcudia Bay be a concern to the Parc? by Nick Riddiford

[*Editor's note*: the following paper, originally prepared as an advice note, takes on new relevance with the dumping of sand in 2002 on Ca'n Picafort beach. The effects of that action are not known but are unlikely to be favourable to an ecosystem already severely threatened by a series of impacts in Alcudia Bay, Mallorca and the Mediterranean.]

There are a number of issues which impact on the biodiversity and ecological integrity of s'Albufera habitats. Tourism, intensive agriculture and a coal-fired power station on the northern perimeter of the Parc are just three. This brings, or has the potential to bring, a series of problems for maintaining biodiversity and ecological functioning and/or for Parc management. There is some overlap in effects. For instance, all three use water and release chemicals which impact on hydrology and water quality within the Parc. Tourism and other human activities also contribute directly to practical management problems ranging from the day-to-day (such as noise, car parking, weight of numbers, pressure on facilities, litter, etc.) to the longer-term (such as sand dune erosion, destruction of sensitive biotopes such as the pioneer vegetation and fore-dune vegetation communities on the upper beach); as well as indirectly through inappropriate activities in the sea and on the shore - e.g. boat destruction of the very important *Posidonia* sea grass beds in the bay, local council policies to clean beaches mechanically (which straightens the profile of the beach making the dunes more vulnerable to winter storms), and policies of open access, parking and picnic areas within coastal areas of the Parc.

This paper focuses on just one issue, the ***Posidonia oceanica* seagrass beds**. This plant and its habitat do not occur in the Parc. However Alcudia Bay, immediately offshore, supports one of the most best examples of this habitat remaining in Mallorcan waters. Apart from the general concern that environmentalists have for conserving habitats and biodiversity, why should impacts on the *Posidonia* beds be an issue for the Parc and the wider Mallorcan community?

Posidonia oceanica seagrass beds

Why are *Posidonia* beds so important?

1. They promote diversity through provision of habitat, feeding and breeding grounds for a diverse array of fauna. They constitute one of the most important submarine ecosystems, providing a refuge for many vertebrate and invertebrate species.
2. They provide important nursery areas for fish, including commercial species.
3. They act as sediment traps. They retain and recycle sand.
4. They are home to the invertebrate animals which create the "raw materials" for the famous Balearic beaches.
5. They act as breakwaters offering natural shoreline protection.

In addition, *Posidonia*:

- Is endemic to the Mediterranean
- Forms large underwater meadows
- Maintains water clarity

Posidonia, like other seagrasses, is an important primary source for Mallorcan beaches. It contributes a substantial fraction of the particles as well as acting as a particle sink. Seagrass meadows rank amongst the most productive communities on Earth. Moreover, seagrass leaves

support large biomasses of epiphytes, which can also generate particles. Hence, seagrass canopies are sources of particles. Not only do they support the epiphytes and other seabed occupants which create the sand of the future, but the meadow also acts as a trap for sand lost from the beaches on bathers' bodies or during winter gales. Otherwise, a large proportion of that "beach" sand would be carried into deeper water where it is lost for good from the beach formation process.

Posidonia beds also act as a brake, dissipating wave energy and reducing the power of the sea as it reaches the land. Even when dead, *Posidonia* continues to contribute to sediment stability and coastal defences. Large banks of debris thrown up on the beaches in winter are composed almost entirely of leaves and other dead material cast from these perennial plants. This plant litter retains sand and acts as a further buffer against heavy seas reaching the dunes. On the other hand, mechanical cleaning of the beach removes this buffer and flattens the profile of the beach. Arrival of heavy seas as far as the dunes is then inevitable during onshore winter gales.

Posidonia is a long-lived, slow-growing species. This makes it very vulnerable to impacts and change. It is endemic to the Mediterranean and has been declared a priority habitat under the European Habitats Directive. Nevertheless, *Posidonia oceanica* meadows are a declining ecosystem. Impacts are considered to be mainly a) reductions in light, b) changes in sediment patterns (often associated with hydrodynamic changes). Increased nutrient availability (eutrophication) often has resulted in reduced light availability for seagrasses by stimulating growth of phytoplanktonic and periphytic alga. Decreasing water transparency in the NW Mediterranean has important consequences not just for the *Posidonia* but for the ecosystem. The transparency of the water controls the maximum depth in which seagrass meadows can develop. The depth limit of *Posidonia oceanica* may have been reduced by 4 m in recent years.

It is not just the phytoplankton which clouds the water. The activities of bathers have an impact, as does boating activity and inappropriate piers and jetties built into the bay – which disturb inshore currents and change sediment deposition and erosion patterns. Fast-growing algae, their growth enhanced by nutrient rich water, compete with and smother the *Posidonia*. Removal of the fish guild (e.g. through overfishing) disrupts the ecosystem balance because it removes the grazers who play an important role in removing epiphytes.

Alcudia Bay is not within the Parc Natural de s'Albufera. Nevertheless, the nutrient rich water which enters s'Albufera from agricultural land finishes up in the sea. This in turn impacts on the *Posidonia* beds, which then impacts on the role of *Posidonia* in sustaining the natural and physical processes which maintain the beach. Disruption to inshore currents, sand accretion and dissipation of wave strength during storms puts pressure on the coastal dunes - which are in the Parc and are of international importance for a number of reasons. Therefore, long-term management planning for the Parc needs to address the issue of impacts on this, and other, key habitats outside the Parc.

Local authorities should also be addressing the issue. Damage and, potentially loss, of the seagrass meadows could have enormous long-term socio-economic consequences. The long-term well being of the beaches depends on a healthy *Posidonia* ecosystem. There are plenty of examples from other sites (e.g. Pollensa Bay) that the alternative, bringing in sand from elsewhere and dumping it on the beach, is both environmentally damaging and expensive. Short-term measures may generate short-term popularity, but do not take into account the environmental consequences nor the enormous costs of repeating the same solution over and over again as sand is washed away from a beach no longer buffered against winter gales. Not only is the beach at risk. The dunes are a wide buffer against invasion by the sea, but are in retreat and cannot sustain constant erosion long-term. The dunes are the only barrier between the sea and the towns and agricultural land of the catchment. The event may be distant, but breaching of a weakened, retreating dune system could occur, with disastrous economic and humanitarian ramifications. This may be a long way ahead, but protection

of the internationally important *Posidonia* beds, as part of a wide-ranging and integrated long-term approach to management of the coastal and marine ecosystem, is needed now to avoid high financial costs and extensive environmental loss in the future.

Because of its importance to shallow water and coastal ecosystems in Mallorca, a considerable amount of *Posidonia* studies have been conducted recently. Useful reference sources are:

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Biodiversity studies

Additional records of Bryophytes in the Parc Natural de S'Albufera de Mallorca by R.C. Stern

Introduction

A further visit to the Parc Natural de S'Albufera de Mallorca was made on 8th-12th March 2002. This was a follow-up of previous visits in 1994 and 1996 (Stern 1997 and 1998).

Details of Survey

The main purpose was to look for new localities for hepatics and possibly for species which had not previously been recorded in the Parc. It was hoped that conditions at the end of the winter might favour the growth of these bryophytes, particularly in the areas of Es Comú and the Ca'n Picafort Woods (Es Comú Baix).

A careful examination was made of nine of the thirteen sites, listed in the reports of the previous visits (Stern 1997 and 1998). No new sites were visited; almost all of the Parc outside the thirteen sites comprises reed beds, which are unsuitable for bryophytes. The sites surveyed were nos. 1,3,4,6,8,9,10,11and 13.

Results of Survey

The wooded areas of Es Comú and the Ca'n Picafort Woods had suffered in a severe storm in November 2001, when large numbers of pine trees had been blown down. Some clearance had been done but a considerable part of the wooded area was virtually inaccessible because of blown trees; some of these included shaded hollows and walls which could have been of interest for liverworts. Where access was possible, several moss species were recorded but almost no liverworts.

Altogether 23 moss species were recorded in new localities, and these included 6 species which had not been seen in the Parc by the author during the two previous visits. No new liverworts were collected but one species (*Fossombronia caespitiformis*) was seen in a new locality. Three other species (*Lunularia cruciata*, *Southbya nigrella* and *Cephaloziella baumgartneri*) were refound in the sites where they had been recorded previously.

The additional species (**in bold**) and new sites for species previously recorded are as follows:

MOSSES

Cheilothela chloropus (Brid.) Broth. 9.	Sandy ground
Dicranella howeii Renaud & Cardot 1.	Sandy ground
Weissia longifolia Mitt. 10	Limestone rock
****Gymnostomum viridulum* Brid. 6,10.**	**Limestone rock & wall**
Gymnostomum calcareum Nees & Hornsch. 1.	Silty ground
****Tortella humilis* (Hedw.)Jenn. 9**	**Sandy ground**
Didymodon tophaceus (Brid.) Lisa 4.	Limestone boulder
Didymodon fallax (Hedw.) Zander 10.	Stony ground
Leptobarbula berica (De Not.) Schimp. 10.	Limestone wall
Barbula convoluta Hedw. 1.	Silty ground
Barbula unguiculata Hedw. 1	Silty ground
Pseudocrossidium revolutum (Brid.) Zander 10.	Limestone wall
****Pottia recta* (With.) Mitt. 1**	**Silty ground**
Pottia starckeana (Hedw.) (Müll.Hal.) 9	Sandy ground
****Pottia davalliana* (Sm.) C.E.O. Jensen 3**	**Bare silty ground**
****Pottia intermedia* (Turner) Fürnr. 3,13**	**Bare silty ground**
Tortula marginata (Bruch&Schimp.) Spruce 13	Stony ground
Tortula vahliana (Schultz.) Mont. 13	Stony ground

***Grimmia orbicularis* Wilson 10**	**Limestone wall**
Funaria hygrometrica Hedw. 9	Sandy ground
Bryum radiculosum Brid. 9	Sandy ground
Zygodon rupestris Lorentz 4	Silt-covered tree root
Scorpiurium circinatum (Brid.) M. Fleisch.&Loeske 4.	Sandy ground
Rhynchostegiella tenella (Dicks.) Limpr. 10	Limestone wall

(*NB: The species listed in bold are new to the Parc)

LIVERWORT

Fossombronia caespitiformis De Not. ex Rabenh. 4	Limestone boulder

Discussion and conclusion

Although the main purpose of the survey was only partly successful, in that no new liverworts were found and liverworts in the Es Comú and Ca'n Picafort Woods areas were not refound, the addition of six new mosses to the total bryoflora of the Parc was a useful result of the visit. In addition, a number of new sites were found for species which had been recorded previously.

A check-list of all the bryophytes recorded by the author in the three visits in 1994, 1996 and 2002 is given in the Appendix. There have been some recent taxonomic changes so the nomenclature has been updated accordingly. There has been some doubt about the correct identity of two species recorded during the 1994 visit (*Zygodon conoideus* and *Brachythecium salebrosum*) and these are therefore excluded from the check-list.

N. Riddiford accompanied the author and assisted with recording on some days, and thanks are again due to him for his continued help and encouragement.

Specimens of most of the species found during the three visits have been deposited in the Parc's herbarium.

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Appendix

Check-list of bryophytes recorded by R.C. Stern in the Parc Natural de S'Albufera de Mallorca 1994-2002. The sequence and nomenclature for mosses follow Casas, Brugués & Cros (2001), and for liverworts follow Grolle & Long (2000).

The numbers refer to the sites listed in previous reports (Stern 1997 and 1998).

MOSSES

Cheilothela chloropus (Brid.) Broth. 7,8,10.
Dicranella howeii Renaud & Cardot 1,2,4,8.
Fissidens viridulus (Sw.) Wahlenb. 1,3,6,8.
Fissidens incurvus Röhl 1,4.
Octodiceras fontanum (Bach Pyl.) Lindb. 11.

Weissia longifolia Mitt 4,10.
Weissia brachycarpa (Nees & Hornsch.) Jur. 10
Gymnostomum viridulum Brid. 6.10
Gymnostomum calcareum Nees & Hornsch. 1,6,10.
Trichostomum brachydontium Bruch 10.
Timmiella barbuloides (Brid.) Mönk. 6.10.
Pleurochaete squarrosa (Brid.) Lindb. 7,8,9,10.
Tortella flavovirens (Bruch) Broth. 4,5,6,8,9,10,12.
Tortella humilis (Hedw.)Jenn.,9.
Didymodon tophaceus (Brid.) Lisa 4,6.
Didymodon fallax (Hedw.) Zander 5,8,9,10.
Didymodon luridus Hornsch.4,5,8.
Didymodon vinealis (Brid.) Zander 5,10.
Leptobarbula berica (De Not.) Schimp. 6,10,12.
Barbula convoluta Hedw. 1,4,6,8,9,12,13.
Barbula unguiculata Hedw. 1,2,4,5,8,9,10,13.
Pseudocrossidium hornschuchianum (Schultz) Zander 5,9.
Pseudocrossidium revolutum (Brid.) Zander 4,8,10.
Aloina aloides (Schultz) Kindb. 4,5,8.
Pottia recta (With.) Mitt 1.
Pottia starckeana (Hedw.) (Müll.Hal.) 4,9.
Pottia davalliana (Sm.) C.E.O. Jensen 3.
Pottia intermedia (Turner) Fürnr. 3,13.
Tortula marginata (Bruch & Schimp.) Spruce 4,6,8,13.
Tortula muralis Hedw. 5,6,13.
Tortula vahliana (Schultz.) Mont. 3,13.
Cinclidotus mucronatus (Brid.) Guim. 1.
Grimmia orbicularis Wilson 10.
Funaria hygrometrica Hedw. 2,4,6,9,13.
Bryum bicolor Dicks. 2,6.
Bryum radiculosum Brid. 1,2,4,5,6,8,9,12,13.
Bryum donianum Grev. 6,10.
Bryum torquescens De Not. 1.
Bryum capillare Hedw. 4,5,9,10.
Bryum caespiticium Hedw. 2,5,6,8,9,13.
Zygodon rupestris Lorentz 1,4.
Orthotrichum diaphanum Brid. 1,6.
Scorpiurium circinatum (Brid.) M.Fleisch. & Loeske 1,4,6.
Rhynchostegium megapolitanum (F.Weber & D.Mohr) Schimp. 1,4,7,9,10.
Rhynchostegiella tenella (Dicks.) Limpr. 1,4,6,8,10.
Rhynchostegiella litorea (De Not.) Limpr. 1,10.
Eurhynchium speciosum (Brid.) Jur. 1.
Scleropodium touretii (Brid.) L.F.Koch 10.
Hypnum cupressiforme Hedw. 9,10.

LIVERWORTS

Lunularia cruciata (L.) Lindb. 1.
Oxymitra incrassata (Brot.) Sérgio & Sim-Sim 10.
Riccia sorocarpa Bisch. 10.
Fossombronia caespitiformis De Not. ex Rabenh 4,9.
Petalophyllum ralfsii (Wils.) Nees & Gottsche 10.
Southbya nigrella (De Not.) Henriques 6,9,10.
Cephaloziella baumgartneri Schiffn. 6,12.

Ecological and Monitoring studies

Diversity and Foraging Behaviour in the Hymenoptera of S'Albufera by Leanne Mason, Jo Phillips, Dan Nussey and Daniel Morrish

[*Editor's note*: This article reports on a study undertaken by students of the University of York's Masters Research in Ecology and Environmental Management course]

Introduction

The diversity of Hymenoptera in S'Albufera was studied by collecting specimens that visited three different types of plants: rosemary (*Rosmarinus*), asphodels (*Asphedelus*) and euphorbia (*Euphorbia*). Observations made at timed intervals were used to assess differences in the frequency with which different Hymenoptera species visit the three plant types.

1. Diversity

On 21 March 2001, specimens from various rosemary plants at Es Comú, S'Albufera, were collected using sweep nets. Further specimens were taken on 22 March 2002, from Asphodels at Camí des Senyals and from *Euphorbia* species found on the banks of the Gran Canal north-east of Sa Roca. Specimens were killed using Insect Killing Fluid and then pinned and set.

The specimens collected during this study will be passed to Dr Peter Mayhew (Department of Biology, University of York) for identification. Various specimens will be kept at S'Albufera to form part of the Hymenoptera collection.

2. Behaviour

Eight plants were selected for study, two asphodels, two euphorbias and four rosemary plants. The euphorbia and asphodel plants were in S'Albufera near Sa Roca. All four rosemary plants were at Es Comú, two in woodland and two in open ground. A small section of each plant was selected for observation. Estimates were made of the number of flowers in the section and the proportion of the plant the section represented. Each plant section was observed for 20 minutes and the type of Hymenoptera (and other insects) that visited the plant during this period was recorded. Observations took place on 23 March 2002, with four twenty-minute observation periods during the morning and four during the afternoon.

Results

The plant species differed in the diversity and abundance of Hymenopteran species they attracted. When considering the entire plant, *Asphodelus* was by far the most frequently visited. *Rosmarinus* was visited the least frequently per plant, and rosemary plants in open areas were more frequently visited than plants in wooded areas (See Table 1).

Table 1. Average number of visits by insects per flower on the entire plant per hour, for each of the investigated species and cover types.

Species & Cover	Average No of Visits Per Flower on entire Plant per hour
Rosmarinus Wooded	0,011
Rosmarinus Open	0,028
Asphodelus	1,359
Euphorbia	0,044

The species of hymenoptera observed varied across the plant species. On R*osmarinus* we recorded predominantly honey bees and small unidentified species of bee, but sand bees *Campsoscolia* were also observed. *Asphodelus* was visited by large numbers of large bees as well as *Polistes* wasps and small bee species. *Euphorbia* flowers were visited predominantly by non-hymenopteran species, although *Polistes* wasps and other smaller wasp species were observed (See Figure 1). Endemic sand bees were only observed feeding on *Rosmarinus* in wooded dune areas.

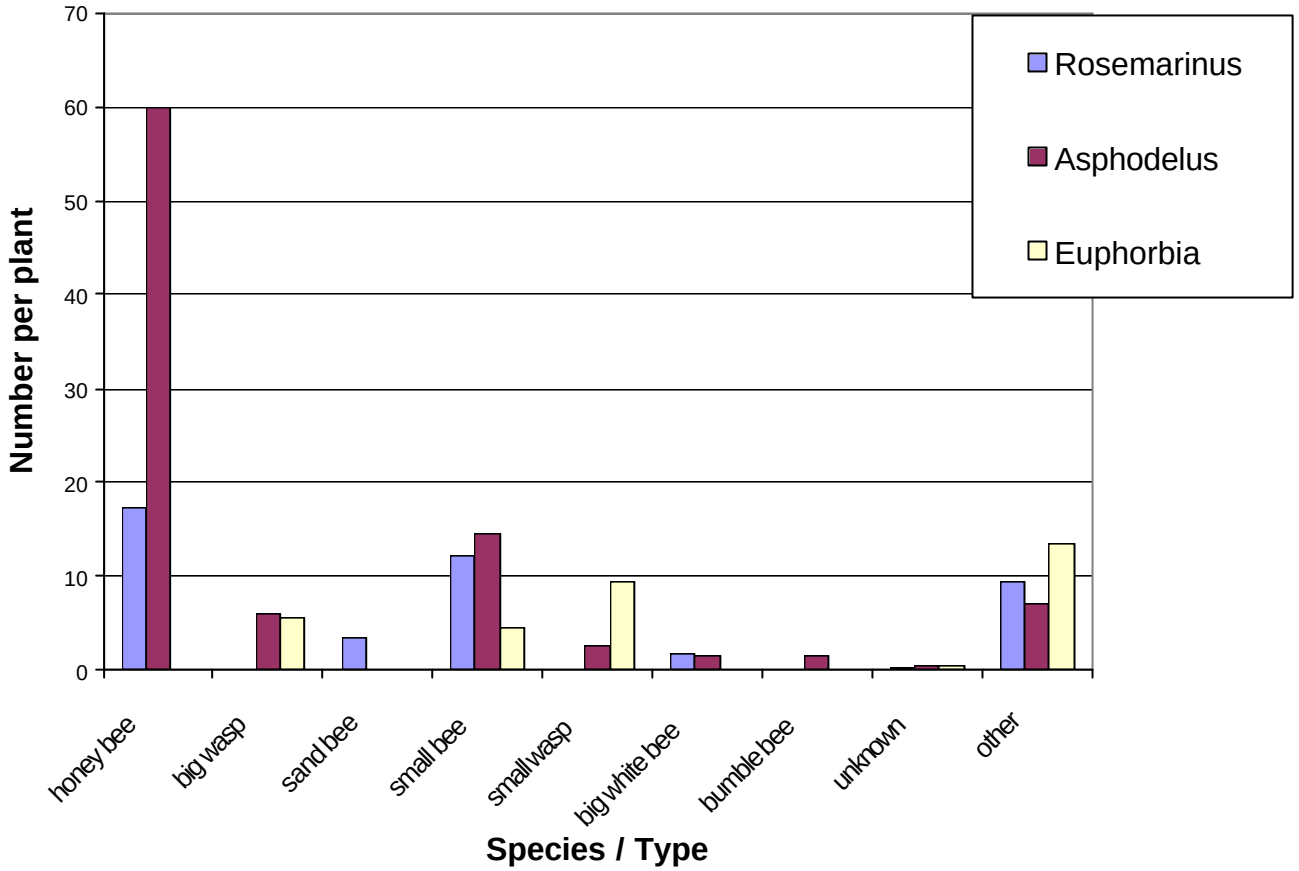


Figure 1. Number of each species or type visiting each plant species over all observation sessions.

Conclusions

There is clear variation in the hymenopteran species involved in pollination of these three plant species. This could have important consequences should management or conservation of these species be required. In addition, the endemic sand bee was observed around and on *Rosmarinus* plants, and its relationship with this plant species may be an important focus for future studies. Specifically, the difference between visitation patterns in open and wooded dune areas may be of interest.

Ecological and Monitoring studies

Herons and Egrets in S´Albufera by Iain Hartley, Augustus Asamoah, Felix Eigenbrod, Gareth Fisher and Andrew Marshall

[*Editor's note*: This article reports on a study undertaken by students of the University of York's Masters Research in Ecology and Environmental Management course]

Aim:

To investigate the heron and egret population of the S´Albufera Natural Park, gaining an estimate of the populations of each species using the park, and an insight into the movements of the birds in and out of S'Albufera Natural Park.

Method:

Morning and evening point samples were used to observe the movements of all heron and egret species between 21/03/2002 – 24/03/2002. Morning samples were carried out between 6.15am (0615 h) and 7.05am, and evening samples were conducted between 6.00pm and 7.30pm (approximately). Evening sessions tended to end when the light level became too low to reliably identify birds.

A number of locations were used, including sites within the interior and on the edges of the park. For the first two samples the number of locations used was four, which subsequently became six as a greater number of observers, and a better impression of where best to monitor the birds became available. The locations were:

1: The mound observation point.
2: The tower hide.
3: The roost.
4: The West gate, alternative site used a single time.
5: The North gate, near the power station.
6: The Southern edge, alternative site used a single time.

Each sample used between one and three observers at each location. All herons or egrets were identified and the numbers recorded, along with the time observed and the direction being flown. Flock size and composition was also recorded.

Results:

General notes

The commonest species noted during the study was cattle egret *Bubulcus ibis*, followed by little egret *Egretta garzetta.* The numbers of these species leaving the roost were approximately 300 and 100 birds respectively. Night herons *Nycticorax nycticorax* were observed in reasonable numbers early in the morning and late in the evening. Around 50 birds were consistently seen leaving the roost on all three evenings. Grey herons *Ardea cinerea* were observed in small numbers. Very few purple herons *Ardea purpurea* or great white egrets *Egretta alba* seemed to be flying at dawn or dusk. Spoonbill *Platalea leucorodia*, greater flamingo *Phoenicopterus ruber* and sacred ibis *Theskiornis aethiopicus* were also recorded but in very small numbers. Therefore the main three species studied were cattle egret, little egret and night heron.

Number of birds feeding outside the park

Despite the large park circumference, observers situated around the park boundary noted a large number of birds entering the park in the evening. Almost 100 cattle egrets were observed entering the park from various directions on 21st March. A further 90 and 70 cattle egrets were noted entering the park on the next two nights. Much lower numbers of little egrets were noted entering the park. A total of only three birds definitely identified as this species were noted entering the park over the three nights. Marginally more little egrets (10, 17 and 13) were seen leaving the park in morning surveys.

Morning observations were less useful for determining how many cattle egrets were leaving the park each day. Only 54, 13 and 15 cattle egrets and 20 and 17 unidentifiable small egrets were observed leaving the park in the morning. These figures are lower than those seen re-entering the park in the evening. Therefore it is likely that many birds continued to exit the park at times later than our morning surveys.

In addition, 16 night herons were observed entering the park from the north during morning observations on 23rd March. Observations made at the roost revealed a minimum of 53 night herons roosting in the park. Therefore nearly one third of the S'Albufera night herons had left the park on 23rd. Limited observations were made on other days, therefore it is uncertain whether this is a common occurrance.

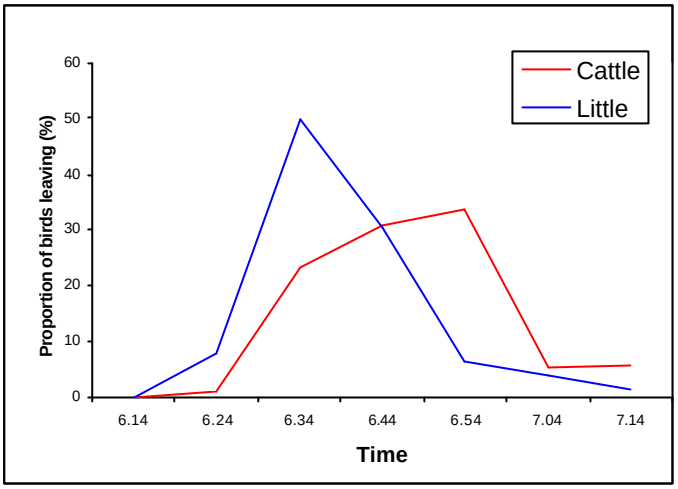
In sum, a large proportion of the herons and egrets roosting in the park appear to be feeding elsewhere during the day.

Direction in which birds leave the roost

- Little egrets and cattle egrets tend to follow the course of the Gran Canal to the west and south west exiting the roost, and to the east and north east on their evening return. Some little egrets also headed north from the roost in the morning.
- Night herons tend to fly along the course of the canal in the morning and evening, with some also heading north west in the evening.

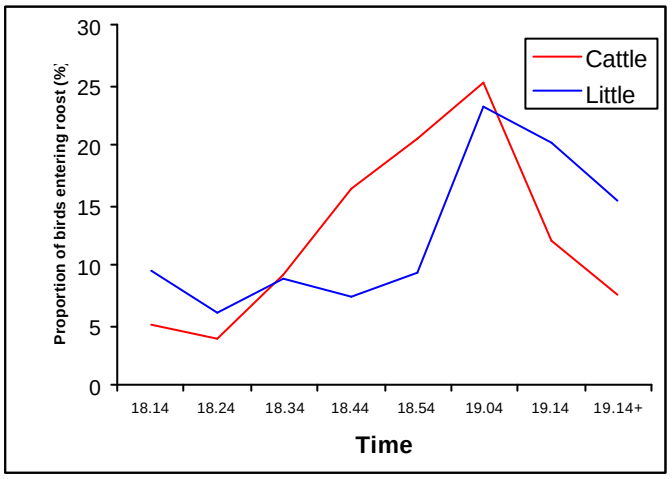
Peak periods activity at roost site

By recording the times of departure (am) and arrival (pm) of egrets at the roost, we were able to calculate peak activity times. The peak period of little egret activity in the morning seemed to occur before that of cattle egret. In general cattle egrets left the roost in high numbers between 6.35am (0635 h) and 7am, whereas the majority of the little egret activity was complete by 6.45am. A much higher proportion of the little egret movement occurred between 6.35am and 6.45am.



Graph showing the proportion of birds leaving between in different 10 minute time periods during the morning count. The tail off of little egret movement can clearly be seen to occur before the peak of cattle egret movement.

The peak time for returning cattle egret was consistently betweeen 6.30pm (0630 h) and 7.10pm, and especially high between 6.50pm and 7.00pm, when an average of 90 birds were recorded each day. Little egret peak activity if anything occurred slightly later than that of cattle egret.



Recommendations for further study/repeat analysis

Should the study be carried out again in the future then a large degree of organisation will be required. Time, direction, species and number of birds must be recorded within an hour of dawn or dusk at as many sites as possible. If the key objective is to ascertain how many birds are leaving/entering the park then more observers must be deployed to the edge of the park. Data should be collated and summarised each day to prevent confusion and statistical and graphical analysis carried out. Our tentative conclusion that the majority of egrets roosting in Albufera feed outside the park requires further investigation. This conclusion seems likely to hold true for cattle egret but is much less cetain for little egret.

Ecological and Monitoring studies

Odonata (dragonflies and damselflies) at the Parc Natural de S'Albufera – project proposal

by Mayumi Sato, Master of Research in Ecology and Environmental Management, University of York

Introduction

Dragonflies and damselflies (Odonata) are one of the groups of insects, which are known to be indicators for assessing the aquatic environment (Brown 1991). Studies on Odonata have been conducted in the Parc Natural de S'Albufera since 1989 and 17 species reported, including the rare species *Selysiothemis nigra*. Two other damselflies were reported previously but have not been confirmed yet. Although studies have shown the high species richness in S'Albufera, little is known about distribution, abundance and habitat preference of these species, especially in June and July since no survey has been conducted during this period. Extending the work undertaken by TAIB Project S'Albufera will provide valuable information about Odonata and the quality of the ecosystem in the area.

The aim of this study is to answer some of these questions, primarily with a view to extending knowledge of distribution and abundance of Odonata species in relation to habitat quality.

Aims

This project has three main objectives:

1) To reassess Odonata species diversity in the park.
2) To investigate distribution and abundance of each immature and adult Odonata species in the park.
3) To determine preferred habitat types of adults and immatures for each species. Additionally, to determine if adult habitat selection changes for: a) hunting; b) breeding (including setting up territories before breeding and seeking mates); c) laying eggs.
4) To investigate the suitability of Odonata as indicators of environmental quality.

Methodology

Sampling site:

Sampling sites will be chosen to cover as many different habitats and water sources as possible. The sites will include a number of the Park's standard water quality sampling sites.

Point count:

For adults, the total number of species and total number of individuals observed for each species, will be recorded at each sampling site within a 10-m^2 quadrat, during 30-min observation periods. In addition, behaviour of individuals will be categorized into a) hunting, b) breeding, c) laying eggs and d) other. Observations will be repeated 20 times for each quadrat. Specimens will be collected using a sweep net when their identification is required. The total number of species and total number of individuals will be counted at each 10-m^2 quadrat for immatures. Sampling will be conducted using the standard sweep net technique of 10 under water motions from one side to the other and back.

Line transect:
The total number of species and total number of individuals observed for each species, will be recorded along each transect. Behaviour of individuals will also be observed and categorized into a) hunting, b) breeding, c) laying eggs and d) other.

Habitat Types:
Habitat types will also be recorded for each of 10-m^2 quadrats. Habitat types include several variables, and each variable will be measured for each site based on categories or unit provided below.

Habitat Variables for Each Site	Categories or Unit for Each Variable
1. Water-body	1. Main canal; 2. Secondary canal; 3. Lagoon
2. Water depth	meter
3. Water flow	1. Running water; 2. Standing water
4. Reeds	Percentage of cover
5. Reed density	1. Open; 2. Not open
6. Reed height	1. High; 2. Medium; 3. Low
7. Shade	Percentage of cover (at fixed time)
8. Aquatic macrophytes	Percentage of cover
9. Water pH	-
10. Water oxygen concentration	Percentage
11. Water conductivity	ms/cm
12. Water salinity	g/l

Potential contribution of study to park management planning

1) Elucidation of ecological requirements of individual species as a guide to future park management for Odonata diversity.
2) Evaluation of the value of Odonata as bio-indicators for water quality
3) Clarification of current status of species of conservation concern, e.g. *Salysiothemis nigra*.

Ecological and Monitoring studies

Distribution of the Purple Gallinule (*Porphyrio porphyrio*) population in S'Albufera Natural Park, Mallorca by Monika Böhm, Sarah Gwillym, Mairead Maclean and Mayumi Sato

[*Editor's note*: This article reports on a study undertaken by students of the University of York's Masters Research in Ecology and Environmental Management course]

Aim

To ascertain the distribution of Purple Gallinules *Porphyrio porphyrio* throughout S'Albufera Natural Park, and to identify a possible relationship between *Phragmites* habitat characteristics and Gallinule occurrence.

Methods

Eight transects covering the park were determined, following the main tracks within the park and along the periphery where possible. The transects covered a variety of wetland habitats of various reed height and density as well as different grazing regimes. Transects walks were carried out at 0730 hours and 1730 h over a three-day period from 22nd – 24th March 2002 (exception: on day one, the evening transects were walked at 1700 h; this was changed to 1730 h afterwards to increase the chance of gallinule sightings and decrease disturbance by tourists. On day three, the evening transect was omitted).

At any one time, between four to eight transects were walked simultaneously, depending on volunteer availability. Where gallinules were sighted or heard, the distance of the bird from the path was estimated and placed in one of two categories: within or beyond 25 metres. The bird´s location was recorded on a map, and a brief description of its location was also given. *Phragmites* height at the gallinule sites was recorded to allow assessment of some basic habitat characteristics. This was estimated using three categories: low (less than 1 m high), medium (1-4 m high) and high (more than 4 m).

Each transect walk was followed by one to three point counts, the number of which depended on the transect in question. Approximate GPS positions for the point counting sites are given in Table 1. On day one, each point count lasted 10 minutes. However, the duration was increased to 15 minutes on days two and three in order to increase the chance of gallinule sightings. Again, all gallinules seen or heard were recorded and *Phragmites* height and density was estimated. *Phragmites* density was classified as low if water could be seen within the *Phragmites* bed, and as high if no water could be seen. Furthermore, gallinule behaviour such as foraging, aggression, feeding young etc. was recorded.

To obtain supplementary data, other participants on the York field course were asked to record any casual gallinule sightings in the park during the gallinule study period. Thes observations were plotted separately.

Results

On Day 1, four transects were walked in the morning (transects 1, 2, 3 & 4) with nine gallinules sighted or heard. Transects 5, 6, 7 & 8 were walked in the evening and with only one sighting. On Day two, 17 gallinules were heard or seen in the morning (walking seven transects), while 29 birds on eight transects were recorded in the evening (after changing the start time to 1700 hours). Eight transects were walked again in the morning of Day three and 22 birds were recorded.

There appeared to be no apparent trend for reed height in association with gallinule presence during transect walks. Gallinules were mostly recorded in medium or high vegetation, or a mix of the two. However, gallinules were also found in short reed. The point counts suggested that gallinules were most likely to be associated with medium or high rather than short *Phragmites*, but there appears to be no difference between high and medium reeds.

Table 1. Description of Transect walks and point counts

Transect no.	Transect name	Point Counts: location (rough GPS)		
		1	**2**	**3**
1	Cami des Senyols	N 39º48.115' E 003º06.182'	N 39º06.182' E 003º06.123'	N 39º48.474' E 003º06.109'
2	Pont de Sa Roca to Observation Tower	Observation Tower	Pont de Sa Roca	-
3	Observation Tower to gate	N 39º47.721' E 003º04.683'	-	-
4	Cami de Ses Puntes	N 39º47.150' E 003º06.918'	N 39º 47.567' E 003º06.754	-
5	Cami d'en Pujol	N 39º47.149' E 003º06.376'	Mound	-
6	Pont de Sa Roca to Main Gate	N 39º47.884' E 003º06.660'	Small bridge at Visitor Centre	-
7	Cami des Forcadet	N 39º47.323' E 003º04.645'	N 39º47.309' E 003º04.654'	-
8	Section between Cami d'en Molinas and Cami d'en Pep	N 39º46.896 E 003º06.449'	N 39º46.919' E 003º06.917'	-

Phragmites density was generally difficult to assess due to long distance sightings of gallinules which made the categorization of reedbed density somewhat difficult. From the limited data we obtained, no difference could be seen between low and high reedbed density and the occurrence of gallinules.

No pairs of Gallinules were sighted on transects 1, 5 and 6 compared to one pair sighted on transect 8 and two pairs sighted on transects 2, 3, 4 and 7. Furthermore a pair of Gallinules was sighted from the mound 50 m due East while another pair was sighted opposite the Watkinson hide from transect 1, although these were not during the transect walks.

Our mapped results showed an equal spread of gallinules along the canal des Sol to Pont de Ferro. This was a very different result to the findings of a Purple Gallinule survey carried out by Nick Owens and Pere Vicens in October 1995 which demonstrated a very clustered population around Sa Siurana and Canal des Sol. We also recorded more Gallinules at the end of Camí de Ses Puntes towards Ses Puntes and at the Ca' n Etxut location. This may be attributed to the fact that competition among a growing number of Purple Gallinules is forcing some of them to seek new territory closer to the park´s boundary. Only a few Gallinules appear to have colonized the Canal d´en Pujol.

Discussion and Conclusion

Though our data gives a general idea about the spread of Purple Gallinules throughout the park, a more accurate estimate would have to include a survey of the extensive *Phragmites* beds which are not easily accessible on foot. Although this present study did not reveal any significant relationships between reed height and density and the occurrence of Purple Gallinules, this can not be conclusively rejected as an important factor determining Gallinule distribution due to the possible inconsistencies amongst observers. Furthermore, future work could be done on estimating the Gallinule population size in the park by using computer packages such as DENSITY which infers real population size from transect data.

Park Management

Observations of the condition of trees at s'Albufera 1989-2002 by Nick Riddiford

[*Editor's note*: This article was originally written following a request on behalf of the Balearic Conselleria de Medi Ambient for information on the theme as part of their preparations for establishing a recovery plan for riverine vegetation at the Parc. The article was submitted for that purpose in July 2002.]

The trees

Elm *Ulmus*

In 1989 the riverine woodland of *Ulmus* still contained considerable numbers of tall trees, including a number which were still relatively healthy. Nevertheless, there was plenty of evidence of Dutch Elm disease (*grafiosis*). Since then, we have witnessed the grafiosis gradually killing the majority of trees. At the same time, dense suckering from the roots has led to considerable regrowth so that by 2002 a continuous band of large shrub/small tree sized elms up to 3 m tall lined the Camí d'Enmig. Trees lining the track to the Bishop hides survived longer than those along Camí d'Enmig, and some taller trees continue to produce leaves – though grafiosis generally affects some or many of the branches.

White Poplar *Populus alba*

Our attention was drawn to apparent problems with the *Populus alba* by Parc warden Xisco Lillo in 1995. The problem comprised early withering and die back of leaves on outer branches of certain trees. The problem rapidly accelerated to affect a large proportion of trees. In certain areas, the problem was intense – and in particular at the western end of Camí d'Enmig where large, mature trees were all dead.

The problem appeared to affect larger trees in particular, but in recent years more and more juvenile trees were affected. One area that remained largely free of the problem was amongst the trees at Sa Roca immediately behind the Casa del Parc.

Tamarisk *Tamarix*

Apart from a few planted trees at Sa Roca, and scattered plants elsewhere in the marsh, *Tamarix* was mainly restricted to a couple of groves in the northern corner of Es Colombar and the other side of Camí des Senyals on the western edge of Es Cibollar. In the last few years, there has been a notable expansion of Tamarisk plants – including a substantial colonisation of the Tancat de Sa Roca (on the bank opposing the CIM hide). Very small plants were beginning to appear in more open reedbeds, e.g. in Es Colombar where a small (1 m) Tamarisk was found growing in 50 cm deep water.

TAIB studies

The best known study was an investigation of the *Populus alba* condition by Myslibor Chalupa and Nick Riddiford in 1996 (Chalupa & Riddiford, 1997). No further intensive studies have been undertaken, but several experts participating in TAIB project work have been asked for their opinion on the problems and events impacting on these tree species.

The experts were Dr David Agassiz, President of the European Lepidopterological Society and world expert on moths; Rod Stern, British Bryological Society conservation officer and former forestry officer; Dr Brian Eversham, former head of the British Biodiversity Records Centre and now Director of a Wildlife Trust.

Opinions on:

Ulmus

We were informed that specialists from Madrid claimed that the form of grafiosis affecting the Albufera elms was of a non virulent form. The TAIB experts all considered that the form of disease observed at s'Albufera was consistent with the situation in areas of disease within the UK. The regrowth from suckers was typical. Currently the bark (cortex) of the young elms is thin. It is only when it becomes thicker and separates slightly from the core of the trunk that the coleopterans acting as carriers for the fungus disease which leads to the grafiosis are attracted to the tree. Their preferred habitat is underneath the cortex on the surface of the trunk itself.

Only future observation will determine whether further attacks occur when the young trees reach a sufficient age and trunk development to make them vulnerable to coleopteran attacks. Rod Stern considered that, in his experience, further attacks are likely to occur once the elms reach that stage in their development.

Incidentally, though we all refer to the elms as *Ulmus minor*, several botanists (including Dr Llorenç Saez) consider that the majority of the elms at s'Albufera are Dutch Elm *Ulmus x hollandica* – which is very susceptible to Dutch Elm disease (grafiosis), to the extent aht it gives the disease its common name.

Populus alba

The approach of Chalupa & Riddiford (1997) was to eliminate potential causes for the *Populus alba* dieback in order to narrow down the possibilities to one or two factors. We felt that we eliminated several factors leaving one or more of the following as the most likely cause: salt intrusion affecting the roots, air pollution directly via the leaf stomata or indirectly through precipitation of the pollution into the soil and then absorption via the roots.

Spanish specialists, however, identified *Sesia apiformis* as the reason for the dieback. We considered that we had eliminated this possibility by cutting down some trees and investigating insect damage. We cut the trunks into sections in order to observe whether tunnelling had occurred at different levels of the trunk; we also investigate the bole of the trunk (i.e. its base) for tunnelling and/or insect damage. I was thus very surprised to learn that *Sesia* was considered the reason.

I asked Drs Agassiz and Eversham for their opinions on this finding. Each was asked independently - so their views were not influenced by each other. Nevertheless, they all gave a similar opinion. Dr Agassiz investigated the bole of trunks in November 2001. He agreed that there were plenty of signs of *Sesia* borings. However, he felt that a strong population was unlikely to be contributing to the death of trees. His experience elsewhere is that *Sesia* populations fluctuate and any large increase is usually balanced out very quickly by increased predation and parasite mortality which reduces the population to a lower level again. Thus, *Sesia* on its own is not capable of doing prolonged, severe damage to the trees.

Brian Eversham (late April 2002) made his own investigations, and discovered several anomalies. Firstly, he found trees in poor condition where one had several *Sesia* borings and another alongside none. Secondly, there were plenty of young trees in poor condition which were too small to be attacked by *Sesia*. In his experience *Sesia* only did lasting damage to trees which were already weakened by another factor. He felt that this was the case at s'Albufera, with *Sesia* attack being a secondary issue to the main (unknown) factor affecting the trees. As far as he was concerned there was without question another factor involved. He suggested that investigation of salt content at root level would be worthwhile.

Rod Stern (March 2002) did not comment on the *Sesia* attacks of damage but considered that salt intrusion affecting the roots was the most likely reason for the dieback. He deduced this from the fact that trees near the Casa del Parc had remained healthy.

Tamarix

Tamarisk is an opportunist tree which is perfectly happy to colonise strongly brackish areas. Rod Stern considered that it current expansion may be related to increasingly saline conditions in the areas it was colonising.

Future actions

Ulmus

In a report into the bryophytes of s'Albufera, Rod Stern recommended that the riverine woodland, particularly alongside the Camí d'Enmig, should not be removed because it created a damp micro habitat which supported several moss species not found elsewhere in the Parc. His recommendation included leaving dead, and fallen, trees.

An important biodiversity is also supported by the regrowth small trees (e.g. strong colonies of the holly blue butterfly *Celastrina argiolus*) and even the dead and dying trees alongside the track to the Bishop hides. These support good lichen communities for instance (including species which do not occur on the more acid bark of *Pinus*) and in the autumn the roots and bases of trunks are a substrate for fungi.

It may be that the death of virtually all large elm trees, and the absence of elm trees elsewhere in the district, will be enough to interrupt the life cycle of the beetles which perpetuate the disease – in which case the regrowth may yet grow into mature trees. If, however, after a number of years the problem returns, we may have to accept that the ecological role of elm in future will be as a shrub or small tree with a short "life" span before being replaced by new growth from the roots.

Our recommendation for elm is to leave the young growth and monitor its progress towards maturity; and to leave as much of the mature woodland, including dead trees, as possible. The only factor which should force a removal is when the particular tree is considered to be a threat to human safety. Other factors, such as criticism from visitors about "bad management" should be countered by information about Dutch elm disease, its effects and the biodiversity and conservation reasons for leaving dead wood. This can be achieved in the form of leaflets, explanatory boards in the information, and inclusion within the education programme.

Populus alba

If the problem is truly one of sub surface water quality or air quality, then the problem can only be addressed by solving the root problem. In the first case this can only be achieved by the introduction of integrated management policies at a district (Comarca) level for such issues as water usage. In the case of air pollution, measures to combat ozone from cars on specific days of summer, or rigorous monitoring/compensatory measures of the power station at Es Murterar, may be required.

The species supports a range of insect species (larvae of several Lepidopteran species for instance) which do not occur on other plants, and one moss *Orthotricum diaphanum* is confined in the Parc to *Populus alba* along with the equally threatened *Ulmus*. In addition, species of parasitic wasp which emerged from lepidopteran larvae taken from *Populus alba* appear to include one or more species which are new to science. Every effort should be made to conserve as many *Populus alba* as possible. If this tree is lost, a lot of other species will be lost too and this would result in a severe loss of biodiversity for the Parc. As with the elm, if public perception is negative because of the number of dying trees, a programme of education and information needs to be put in place explaining the pressures of impacts from human activities in the surrounding area and the importance of the trees for biodiversity.

Tamarix

The spread of the Tamarisk in the wetland areas should be monitored closely. At the moment, its spread is probably a positive development but if it colonises many areas aggressively it could become a problem in the future.

The introduction of *Tamarix* species alongside tracks, however, may be of value in increasing the proportion of "healthy looking" trees – thus improving visitor perceptions as they enter the Parc. Provided they are *Tamarix* species already occurring in Mallorca, they are also very good from a biodiversity point of view. For instance, Dr Martin Ebejer (TAIB Diptera specialist, University of Malta) has indicated that Tamarisk is one of the best trees in the Mediterranean for fly diversity.

Reference

Chalupa, M. and Riddiford, N. 1997. Studies of *Populus alba*. *Earthwatch Europe Project S'Albufera rep* 8 (1996): 59-68.

Footnote: After this article was written, a note appeared in the "Conservation News" section of ***British Wildlife*** which may have a bearing on the situation at s'Albufera in relation to *Populus alba*, as well as demonstrating that the problem may be more widespread and affecting a wider range of trees. The note was as follows:

"A regular monitoring programme on forest defoliation in Europe has been going on since 1989. In 2001, 22% of trees studied showed more than 25% leaf or needle loss (a tree is regarded as 'damaged' when defoliation exceeds 25%)..... The extent to which defoliation can be directly attributed to air pollution or other factors is not known. The latest report, however, includes, for the first time, a comparison of the fallout of various pollutants for 230 intensively monitored plots. The results show that critical loads for nitrogen are being exceeded at 92% of plots, and that at 58% of plots nitrogen input is potentially endangering the plant diversity of the ground flora. At 33% of the investigated plots, the critical loads for acidity in relation to tree roots are being exceeded. Full details of the report, The condition of forests in Europe 2002, executive report (published jointly by UNECE and the European Union), can be viewed at www.icp-forests.org/RepEx.htm'. Source: *British Wildlife* 14: 146.

Park Management

Introduced species at S'Albufera by Nick Riddiford

[*Editor's note*: This article was originally written in response to information sought by the IUCN Mediterranean Group, French committee regarding introduced and invasive species on Mediterranean islands. The article was submitted to the committee in September 2002.]

The Parc

The Parc Natural de s'Albufera in Mallorca was the first ever designated conservation area in the Balearic Islands. It is renowned for its birds, but also has a host of other internationally important species including invertebrates and plants (including endemics).

The site is home to a number of introduced (alien) species.

The freshwater crayfish *Procambarus clarcki* has been a long time inhabitant of the marshes. Colonisation derived from a failed attempt to farm this species on the borders of s'Albufera. There is no concrete evidence of its impact on the indigenous wildlife, but the serious decline of the small fish *Gasterosteus aculeatus* has been attributed to this crayfish. S'Albufera is the only known Balearic site for *Gasterosteus aculeatus* which is now listed as a threatened species (Mayol, J., Grau, A., Riera, F. & Oliver, J. 2000. *Llista Vermella dels Peixos de les Balears*. Documents Tècnics de conservació, II època, núm. 7, Conselleria de Medi Ambient & Conselleria d'Agricultura i Pesca, Govern de les Illes Balears).

Another long-term alien inhabitant is the mosquito-fish *Gambusia holbrooki.* Introduced in the 1930s to combat mosquitoes, it is now super abundant in s'Albufera. This species has been put forward as a candidate in the decline and apparent local extinction of *Bufo viridis balearicus*. Mayol *et al*. 2000 (full citation above) call for information to be gathered on the subject. The same document points out that habitat change, dessication and predation by *Procambarus clarcki* could equally be factors in the loss of the *Bufo.* I understand that there are pockets of strong *Bufo viridis balearicus* numbers in sites (often temporal) where the *Gambusia* does not occur or cannot survive. There is no direct evidence of its impact on other elements of the ecosystem. However, in a small controlled experiment, undertaken in 1999 by Jeroen Veraart of the Aquatic Ecology and Water Management Group, Wageningen University, mosquito-fish were divided into two size classes and each class supplied with zooplankton, freshwater and terrestrial invertebrates. The small mosquito-fish fed mostly on zooplankton whereas the larger individuals fed on the freshwater and terrestrial invertebrates.

A more recent arrival at s'Albufera is the Florida Terrapin *Trachemys scripta elegans.* This is a popular pet in Mallorca, as any visit to a pet shop will testify, and it is thought that all occurrences derive from intentional releases of captive individuals. Those found in s'Albufera are without exception large, suggesting they have outgrown their domestic living facilities. S'Albufera has a strong European Pond Terrapin *Emys orbicularis* population. In the mid 1990s a colony of 30+ nests was found in soft sand in an isolated part of the Parc, and counts along canals can reach 12 or more along a one kilometre stretch. Genetic studies, conducted in the mid 1990s, showed that s'Albufera terrapins themselves were introductions, but with no Iberian genetic influences. They are a mixed genetic population derived from Tyrrhenian, central and eastern European source material. Introduction by the Romans is implicated.

Unfortunately, the large Florida terrapins are aggressive and overpowering. Observations suggest that they both oust males and try to mate with female *Emys*. The Parc staff have not yet found a

way of catching them, and often have to resort to discrete removal by shooting. The problem has become considerably worse in the last couple of years. From one occasionally, sightings are becoming more frequent and small groups have been seen together.

Two plant species, *Carpobrotus edulis* and *Carpobrotus acinaciformis*, are not a problem in the wetland but in the coastal dunes rapidly overwhelm and out-compete the more sensitive indigenous dune plants. The Parc staff and the Balearic "Friends of the Parc" organisation have regular campaigns to eradicate these two species from the coastal dunes. Unfortunately, hotels encroach to the very edge of the Parc's coastal strip at both ends, and the two *Carpobrotus* species are enthusiastically planted wherever there is open sand soil.

Other exotic plants, mostly South African in origin, are occasionally found in the sand dunes, including *Arctotheca calendula*, *Gazania rigens* and *Aptenia cordifolia*.

Cotula coronopifolia occurs within the wetland, but is restricted to one site and never seems to spread.

The latest exotic to arrive in s'Albufera is the Geranium Bronze butterfly *Cacyreus marshallii*. This is a South African butterfly which is rapidly colonising Europe. I know of records from Spain, France, Belgium and Britain. It was first detected in Mallorca, and probably spread from there. The larvae live on plants of the *Geranium* family. *Pelargonium* species are the backbone of a strong horticultural business in Mallorca, and the butterfly was probably introduced accidentally (as eggs or small larvae) on plants imported for that trade. The problem with this species (as with a lot of exotic animals and plants, e.g. *Eucalyptus*) is the absence of the normal ecological community associated with it. If the species arrived as eggs, then it would almost certainly not have brought with it the usual range of parasites and diseases which would otherwise keep the population in check. This may account for its exponential increase in European numbers and distribution. Currently, the species is only a minor (but growing) problem for plant growers. However, if it moves from garden *Pelargonium* flowers to wild *Geranium* it could have a major impact on this diverse and widespread group.

Problems for the future

Several bird species, no doubt escaped from captivity, have taken up residence or at least occur regularly at s'Albufera, whilst others are recorded on an occasional basis. They range from the huge (yellow-billed stork *Mycteris ibis*), to the inconspicuous (female weaver birds *Ploceus*). They are normally no more than a curiosity. However, three species should give greater cause for concern. Two of these are parakeets, the monk parakeet *Myopsitta monachus* and the ring-necked parakeet *Psittacula krameri*. The former remains a rare visitor to the parc (though it breeds at Puerto Pollensa, less than 20 minutes flying time away). The ring-necked parakeet has become much more frequent and vigorous defence of a tree hole has been recorded. The ring-necked parakeet is suddenly drawing attention to itself in Mallorca as numbers climb and begin to attack certain cultivated crops. It and the monk parakeet are both hole-nesters. It is a reasonable prediction that, if numbers continue to increase, competition for nest sites will become intense. Parakeets are aggressive and use their vicious beaks to great effect in defending nest sites. Their main competitors for nest holes in Mallorca are the scops owl *Otus scops* and hoopoe *Upupa epops*. Both are abundant, familiar and much loved species in Mallorca. However, neither species is capable of competing against the powerful beak of a parakeet and there is every likelihood that both species will suffer severe declines if the current parakeet population increases continue. Actions to control the parakeets have not been forthcoming, mainly because of adverse public reaction to measures against such attractive species. Now that the agriculturalists are complaining the likelihood of action is greater, but it may already be too late to implement an effective control programme.

The other species which should perhaps give cause for concern is the weaver *Astrilda astrild*. A small group bred successfully at the western boundary of the parc in 2000. The group kept tightly to this small area, where they could have been captured and removed with relative ease. Though the population is difficult to estimate, encounters with individuals by 2002 were occurring throughout the marsh. There is plenty of suitable reedbed habitat for this species and the population has every chance now to increase dramatically. What effect this will have on the ecosystem or other members of the reedbed community is completely unknown. The weavers may fill an empty niche. However, many examples exist of the negative impact of introductions on local fauna and flora and the colonisation of this species must be seen as a potential threat to s'Albufera and elements of its reedbed ecosystem.

Mallorca, outside s'Albufera

The classic, and oft quoted, example for Mallorca of the negative impact of introductions is the case of the ferreret *Alytes muletensis*, a distinctive midwife toad unique to Mallorca. It was known from the archaeological record in Mallorca and Menorca but only discovered as still extant just over 20 years ago when some individuals were found in very isolated mountain pools of extremely difficult access.

These virtually inaccessible mountain pools are the last refuge for a species which was formerly much more widespread. Its disappearance from so much of Mallorca (and completely from Menorca) more or less coincided with human colonisation of the islands. The viperine snake *Natrix maura*, the frog *Rana perezi*, the cat and the weasel, all species introduced by Man, are known to be predators of the ferreret. The snake is particularly implicated with its agility and predilection for water. Only far from domestic habitation and in impenetrable terrain has the ferreret been able to survive.

In the marine zone there are plenty of examples of introduced species, some of which are known or thought to impact negatively on native species and habitats. They include species carried by boats (e.g. the coral *Oculina patagonica*, the ascidian *Ecteinascidia turbinata*, the red alga *Asparagopsis armata*), fugitives from aquaria (particularly the alga *Caulerpa taxifolia*) or introduced by aquiculturalists (the oyster *Crassotrea gigas*).

Past impacts

When reviewing any impact of introduced species it should not be overlooked that all terrestrial mammal species, with the probable exception of the bats, were brought to Mallorca by man – and the same applies to a few other vertebrates, plus numerous plants and, probably, considerable numbers of invertebrates too.

Mallorca is still rich in endemic species, particularly plants and invertebrates, but many of these, like the ferreret, have been driven into the mountains and other inaccessible refuge sites. Many of the species associated with Man remain within landscapes largely shaped by Man, and thus their negative impact on indigenous biota is limited to man-made habitats. One particular problem for endemic plants is the ravages of goats which wander semi-wild throughout the mountains. Vertical cliff faces, precipices, crevices and caves are the only remaining sites where plant species vulnerable to grazing by goats continue to survive.

Spain

The best known case in Spain, of course, is the American ruddy duck *Oxyura jamaicensis* and the impact of its recent arrival on the globally endangered white-headed duck *Oxyura leucocephala*.

World wide

Gambusia may not be a proven problem in the Mediterannean but it is in Hawaii. Predation by these fish and by introduced invertebrates has been identified as the cause of serious declines in the populations of several damselflies (source: Polhemus, D.A. in the Spring 2001 issue of the Xerces Society's *Wings* magazine). *Megalagrion* is now confined to a single site in suburban Honolulu. The threatened *Megalagrion* species seems to be dependent on sites where exotic fish species are absent. Introduced species such as *Ischnura ramburii* seem to be able to survive alongside the predatory fish by virtue of defensive behaviours. The native species are more vulnerable because they have not been under evolutionary pressure to develop such behaviour. (source: Hawaiian damselflies at risk. Invertebrate Conservation News No 38, June 2002, page 10-12; and see www.bishopmuseum.org/research/natsci/ento)

Footnotes:

1. The biggest problem with assessing the impact of long established introduced species, both at s'Albufera and more generally, is the lack of information about the status of the ecosystem and its indigenous biota prior to the introductions. Thus it is impossible to fully evaluate their impact, or what has been lost.
2. There are also two inter-related management problems. The first is that actions to control or eliminate introduced species tend not to take place until a problem is perceived – and by then it is either too late or prohibitively expensive for effective action to take place. The other is that, because introduced species are perceived as usurpers rather than bonafide members of the ecosystem, there is no great interest in studying them or their impacts on the ecosystem, again until it is perceived that there is a problem.
3. Another fish has joined the list of introduced species at s'Albufera. Carp *Cyprinus carpio*, of various subspecies, were first noted in 2001. The first observations were from the Pont de Sa Roca, in the Torrent de Muro. By the autumn of 2002 the species was widespread and easy to see in the Gran Canal, including individuals exceeding 70 cm in length; most exceeded 30 cm. The impact of this new introduction to the ecosystem is not known but a programme of eradication has begun as a precautionary measure. However, current methods are not keeping pace with population increases. More effective methods are urgently required. The origin of these fish is unknown but assumed to be the result of recent surreptious introductions.
4. The IUCN recognises invasive species as the second most important cause of biodiversity loss after habitat destruction.

Summary report: herbivore feeding preferences – what do management "tools" eat? by Martin Helicar, Ian Morton, Alex Thompson and Ben Collen

[*Editor's note*: This article summarises a study undertaken by students of the University of York's Masters Research in Ecology and Environmental Management course]

Introduction and Aims

Cattle, horse and buffalo were introduced to the park in order to create and maintain habitat that would encourage wading bird species, maximise plant diversity and increase visibility of the marsh. *Phragmites australis*, being the dominant reed species, was the focus of our study. Did the animals brought in to graze the park preferentially browse this plant species? Given limited time resources a simple observational study was employed to answer this question.

Methods

The three herbivore species (cattle, horses, buffalo) were observed remotely for one hour periods and their behaviour recorded. Animals were randomly chosen from the herd, and every two minutes the feeding activity of the target animals allocated to a category. After each timed session, the principal plant species in each habitat were identified. Data were collected on 22nd and 24th March 2002, taken during time periods 1000-1100 h and 1500-1600 h.

Results

Buffalo showed a preference for *Phragmites australis* and the turf mix. Cattle also selected *P. australis*, whereas horses spent the largest proportion of their time feeding on the turf mix.

This is a short summary; a more detailed report will be prepared as a poster presentation.

Park Management

Monitoring grazing activity and its impact on biodiversity: invertebrate diversity, using Orthoptera as bio-indicators by Florent Prunier

[*Editor's note*: this article describes the rationale and methodology for a new study introduced in 2002]

Introduction

P.N. S'Albufera (Mallorca, Spain) is an important Mediterranean wetland. The wetland has been transformed, through time and human actions, from a lagoon wetland (*albufera*) to a landscape dominated by emergent vegetation. It now constitutes one of Europe's largest reed *Phragmites australis* and sedge *Cladium mariscus* beds, fringed by substantial areas of salt marsh, coastal and inland (fossil) dunes.

In order to diversify and restore former habitats, measures have been implemented to open one part of the reedbed. Zones of open water and marshy grassland have been created in order to provide favourable habitat for migrant and wintering birds (particularly waders and other waterfowl) and for breeding ducks, Purple gallinule *Porphyrio porphyrio*, etc. Maintenance of these open habitats is achieved by grazing animals (Mallorcan and other breeds of cattle, Buffalo, Camargue horses).

The effects of domestic livestock on biodiversity is now under study. To evaluate the positive effects of maintaining open lands for birds, we need to know much more about the ecology of target bird species (in particular, how do they use the habitat?), plant communities (which species are present? How does the community change in time with grazing?) and invertebrates (is pastoralism favourable for invertebrate biodiversity? can we use invertebrates as bio-indicators?). To monitor the effect of grazers on invertebrates, I propose to study the community of grasshoppers and bush-crickets (Order: Insecta; Class: Orthoptera; Sub-classes: Caelifera & Ensifera).

Various authors (see Tatin 1998) consider Orthoptera to be good bio-indicators of modifications to field habitats. They are very sensitive to changes in the structure and composition of the vegetation. For this reason, they have been used to study specifically the influence of pastoralism on diversity by several authors (Gueguen 1995, Olmo Vidal & Llimona 2000, Louveaux *et al*. 1996) and in various Nature Reserves: for example the Réserve Naturelle du Plateau du Vercors, R.N. de Prats de Mollo.

Orthoptera also make ideal subjects for study because:

- They are representative of a substantial guild of invertebrate species which also depend on vegetation structures and the humidity gradient (spiders, various beetle families, molluscs, etc.). Thus, Orthoptera monitoring can provide information on habitat quality which is relevant for a wide and diverse range of invertebrates.

- The relatively large size of many Orthoptera and their tendency to occur in high density, especially in open habitats, means that they represent a good food source, both in abundance and biomass, for predators - including insectivorous birds, small mammals, carnivorous bush crickets and other insects - as well as for parasites.

- Some species have special patrimonial values.

Objectives

Principal objective:
- Design and launch a monitoring programme using Orthoptera as bio-indicators for the impact of grazing on biodiversity.

Secondary objectives:
- Extend knowledge of Orthopteran diversity at S'Albufera.
- Verify and extend the Parc's Orthoptera reference collection.

Methodology

Abundance of Orthoptera
The main objective of the study is to measure the abundance of Orthoptera in the field using a standardised repeatable methodology which will allow for assessment of annual and seasonal fluctuations, and of locality and habitat variations in the Orthopteran fauna.

Two approaches are possible:

- **Linear Abundance Index (Voisin, 1986)**

An observer records all individuals on a linear transect (length:10 m; width: 1m) with a rope knotted each 10 meters. Five samples are a minimum number for each station.

- **Area Abundance Index [Biocénomètre (Tatin, 1998)]**

An observer records all specimens within a $1m^2$ quadrat. The minimum number of samples per station will be determined by field trial.

Vegetation
The structure and diversity of the vegetation in each sample will be required. A protocol needs to be designed which measures this.

Climatic factors
As climatic factors influence Orthoptera activity independently of grazing stock activity, the following parameters need to be measured during the sampling:

- sun (expressed as a percentage)
- temperature and humidity in the vegetation (thermohygrometer)
- atmospheric pressure (meteorological station).

Annual temperature and precipitation measurements will also be required (meteorological station).

Other points
The past history of grazing, including species, number and times of year, should be collected for each study site. Data should also be collected on the number, timing and species composition of grazing stock (preferably on a daily basis) in experimental fields and control sites.

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Programme development: training

Designing a monitoring programme by Nick Riddiford

[*Editor's note*: this article derives from a presentation given as part of the MedWetCoast wetland managers course in October 2002, based on a series of examples applying to s'Albufera. The design follows the format proposed in the *MedWet Guide to Monitoring Mediterranean Wetlands*, edited by Pere Tomas, 1996.]

ISSUE OR PROBLEM

GENERAL ISSUE/PROBLEM

1 Water Quality.
2 Human Impacts.
3 Park Management.

SPECIFIC ISSUE /PROBLEM

1 a) Nitrates from Agricultural land (affect Park biodiversity).
b) Phosphate from waste water (tourism development).
c) Increased salinisation (overuse of water).

2 a) Tourism related erosion and damage to coastal dunes.
b) Lack of public awareness.

3 a) Managing for biodiversity.
b) Managing public use.

SET THE OBJECTIVES

1 a) Monitor water quality to assess nitrate loads entering Park.
b) Monitor water quality to assess phosphate discharges into Park.
c) *Three Objectives*:
ci) Monitor conductivity at sample sites throughout the Park;
cii) Monitor water levels to evaluate the effects of water abstraction;
ciii) Monitor aquatic invertebrates as bio-indicators of water quality.

2 a) Monitor profile of beach and fore-dunes to establish erosion rates.
b) Develop Education programme.

3 a) *Three Objectives:*
ai) Create biodiversity reference (collection, lists, etc);
aii) Monitor population changes of key indicator groups;
aiii) Study the relationship between plants and animals in key habitats.

b) *Two Objectives:*
bi) Monitor visitors;
bii) Reduce negative effects of visitors.

DETERMINE THE HYPOTHESIS

1 a) Nitrogen levels in the water should not exceed the maximum concentration in the last 5 years (40µg/1) for any sample and mean nitrogen concentrations should not exceed half that level.
b) Phosphate levels should not exceed the seasonal mean for the last 5 years (4µg/1).
ci) Conductivity at any one site and season should not exceed the baseline set in the 1980s.
cii) Mean water levels should not fall below the lowest mean over the last 5 years.
ciii) The bio-indicators of appropriate water quality for each sample site should continue to be present.

2 a) The beach width should not decline from the present baseline; the dune edge should not retreat fromits present baseline position.
b) The proportion of schools visiting the Park should continue to increase on an annual basis (until 100%).

3 ai) No hypothesis = baseline.
aii) The number recorded of key species does not fall significantly below the mean level recorded in the pilot study.
aiii) No hypothesis = applied study.

bi) The number of visitors should not fall below the lowest annual total recorded in the last 5 years.
bii) Indicator species/groups for human impact should begin to recover after management measures implemented.

METHODS & VARIABLES

1 a) & b) Collect water samples from sites used for water quality monitoring.
ci) On-site measurements of conductivity (plus pH, oxygen content and temperature of water).
cii) Record water levels from a series of stageboards.
ciii) Collect invertebrate samples from water quality sample sites, using standardised sweep net sampling: identify and count samples.

2 a) Use Theodolite to measure beach profiles; establish fixed reference points in dunes; take fixed bearings from reference points to re-locate points exactly, support with photos and GPS.
b) Establish Education team; plan programme; obtain materials. Daily visits by schools; adults, Saturday morning.

3 ai) Collect plants; establish herbarium. Collect key insect groups; prepare mounted specimens. Support with photographic reference.
aii) Set up transects (bird, butterflies, dragonflies, orthoptera), netting programme (birds), fixed traps : KEEP ALL VA RIABLES TO A MINIMUM. Use repeatable standardised method.
aiii) Use standardised methods (fixed number of nets, along a defined transect line for birds; quadrats every 2m along a 150m transect for vegetation).

bi) Collect information systematically from people calling at reception centre (including nationality, means of reaching the Park).
bii) Use quadrats for vegetation, fixed transects for vertebrates and invertebrates. Put up advisory notices and signs for visitors.

FEASIBILITY/COST EFFECTIVENESS

1 a) & b) Costly. Requires laboratory analysis. Samples can be collected by Park. Accessibility to sites difficult.
ci) & cii) Simple techniques. Two staff days per month.
ciii) Cheap for equipment but labour intensive. Needs knowledge of invertebrate identification.

2 a) Labour intensive. Methodology relatively straightforward but expensive equipment needed.
b) Requires trained personnel and full support of Educational as well as Environmental Agencies. Relatively high level of organisational back-up needed.

3 ai) Relatively cheap to set up and maintain. Initial outlay mainly on storage materials. Preparation and curation of collections can be taught easily. Identification expertise required.
aii) Cheap to set up and maintain. Staff can be trained to do it. Some initial outlay on equipment (binoculars, quadrats, nets, etc).
aiii) Cheap on equipment, but labour intensive. Methodology straightforward but work hard and "unglamorous".

bi) Part of normal staff activities. Essential monitoring activity.
bii) Cost of signs and restoration work (fences, etc). Methodology simple to follow.

PILOT STUDY

1 a) and b) Based on 1st collections which tested:
1) accessibility,
2) established current nitrogen and phosphate levels (for baseline),
3) creation of suitable database,
4) feasibility of transfer of samples to laboratory.

Pilot study also used as a staff training period.

ci) and cii) Equipment and procedures tested in 1994. Calibration of equipment by University of Balearic technicians. Staff trained.
civ) Carried out in 1991/92 by Ed Cross. Sample sites later changed, analytical elements improved to standardise with water quality studies.

2 a) Pilot study conducted in April 2002. Improvement of methodology after consultation with scientists from Universities of Vigo & Balearics. More improvements may follow after more consultation.
b) Pilot study in 1989 with local schools. Quickly expanded to all Mallorca. Teachers invited to evaluate early programme (this is on-going).

3 ai) Early specimens taken before taxonomy specialists found for identification. System improved (identifications & storage/display) once experts found.
aii) Various pilot studies done. Five years' data required for most cases before data considered sufficiently reliable for interpretation purposes and for setting hypotheses.
aiii) Study developed using already standardised methodologies (developed in the Camargue, France) so pilot study concentrated more on accessibility and identifying "best" sites.

bi) No pilot study done, but results and methodologies constantly under review and being improved.
bii) Several actions were undertaken, some of which have not been continued due to success or failure (e.g. lack of man power).

SAMPLING

1 a), b), ci) and cii) Acceptable intervals for sampling determined by pilot study. Sample sites determined by location (canal junctions, points of entry from farmland, etc) and by need to compare with sites sampled (for a PhD) in the 1980s. Sampling done once per month.

cii) Sample sites as above. Intervals relate to the four seasons. Sampling technique follows (international) standard methodology. Sampling 4 times per annum.

2 a) Sample sites determined by:
1) need to space samples out at regular intervals along beach;
2) sample sites previously selected by University of Balearics scientists;
3) need for minimum 10 profiles.
[NB. Currently still at pilot study stage; final sample sites and number to be determined]. Sampling 4 times per annum: spring, summer autumn, winter.]

b) Not applicable.

3 ai) Sufficient samples for identification of species and to demonstrate the range of variation. On-going programme.

aii) Wherever possible, 3 replicates for each habitat. A lower number may not be statistically valid [but give sufficient information to guide management measures for biodiversity conservation]. Frequency once every 10 days at appropriate seasons.

aiii) Sampling is the minimum needed statistically to assess structural evolution and ecological functioning of the habitat: once per annum vegetation, 4 times per annum for birds, once per month for water levels and salinity, once every 3-5 years for invertebrates as food for birds.

bi) Recording visitors at the reception centre is a form of sampling. More information is needed to understand the ratio of reception centre visitors to total Park visitors.

bii) Monitoring impact of management measures to reduce visitor impact, using plants or animals as indicators: twice per annum, plants; daily, birds; at regular intervals for other indicators.

SAMPLE ANALYSIS

1 a), b), ci) and cii) Data stored on Park computer (Excel) and at the University/Government Laboratory. Statistical analysis done by Balearic Government Department of Environment (Conselleria de Medi Ambient) scientists.

ciii) Data stored on Park computer and with scientist in charge (Juana Garau).

ciii) For each sample site and survey a water quality score is determined and an average score per taxon (AST) calculated. Chemical data (1a, b), c) above) analysed using Analytical Variance (ANOVA) and biological/chemical data comparison using Principal Componants Analysis (PCA).

2 a) Data stored on Park computer, University of Vigo & University of Balearics.
Raw data on Excel. Locations eventually marked using GIS. Analysis will eventually be conducted in conjunction with other studies being conducted in the dunes and bay – including University of Balearics' coastal processes team. Sand grain samples taken for analysis.

b) Not applicable.

3 ai) Not applicable (cross-reference list on TAIB/Park computers).

aii) Data stored on Park and TAIB computers. Statistical analysis conducted using standard methods by individual scientists responsible for the studies. Expert statistical advice given by Dr. Calvin Dytham of the University of York (published author of "Statistics for Biologists").

aiii) as 3 aii).

bi) Simple analysis based on annual figures. Data stored at Park. Data also used by Government and University of Balearics in wider "indicator" studies of the impact of tourism & sustainability of resources in Balearic Islands.

bii) as 3 aii) above.

REPORTING

1 a), b), ci) and cii) Data statistically analysed and reported in the Park's annual report with conclusions and recommendations for management action and further monitoring.

ciii) Data statistically analysed and reported annually in TAIB's annual report and/or the "Bulletin of the Natural Parks", with conclusions and recommendations for management action and further monitoring. POLLUTION INCIDENTS AND OTHER MAJOR EVENTS ARE REPORTED VERBALLY DIRECTLY AND IMMEDIATELY TO THE PARC DIRECTORATE.

2 a) as 1 ciii).

b) Annual evaluation report published by the Park, written by the Education team after consultation with other staff, teachers, etc. Report twice per annum to Park Management Committee. Constant evaluation process in place, including regular meetings with teachers and NGOs, etc.

3 ai) Biodiversity Catalogue (2500 spp of 52 plant/animal groups) about to be published. Regular updates planned for TAIB annual report and Park Bulletins.

aii) as 1ciii) above.

aiii) as 1ciii) above. Results also sent to Tour du Valat Biological Station in France, who publish a summary in their annual report.

bi) Figures summarised and reported in the Park's annual report and quarterly bulletins.

bii) as 1ciii) above.

TAIB has a policy of keeping the Park informed on a regular basis of work done, work planned & interim results. TAIB scientists are frequently asked for data, results or opinions on numerous issues. TAIB policy is to make these freely available and to report back quickly.

Note:

Designing a monitoring programme is an integrated overview of the monitoring work element of the MedWedCoast training course at the Parc Natural de s'Albufera, Mallorca, in October 2002. For further information, the programme has been broken down into its constituent parts in the pages which follow:

Table 1a/b: Monitoring for water quality: nitrates and phosphates.

General problem	a) Water quality in the upper part of the Park is threatened by nitrate runoff from intensive agricultural land immediately west of the Park. b) Water quality in the south of the Park is threatened by organic material and phosphates discharged from tourist developments.
Specific problem	a) Nitrate concentrations threaten eutrophication of water in the Park. b) Though a water purification plant exists south of the Park and treated water from it is discharged away from the aquifer, illegal untreated discharges may still occur.
Objective	a) Monitor water quality to assess nitrate loads entering Park. b) Monitor water quality to assess phosphate discharges into Park.
Hypothesis	a) Nitrogen concentrations at Park sample sites should not exceed 40 µg/l for any sample and mean nitrogen concentrations should not exceed half that level. b) Phosphate levels at Park sample sites should not exceed 4 µg/l for any sample.
Methods & variables	Collect water samples from sites used for water quality monitoring.
Feasibility/cost effectiveness	Expensive. Requires laboratory analysis and chemists' time and expertise. Only possible by cooperation with UIB (Depts. of Limnology, Vegetal Physiology, Analytical Chemistry). Access to sites difficult.
Pilot study	Test accessibility. Regular collections from key sample sites throughout the year to establish a baseline. Create database. Test speed of transfer, samples to laboratory. Train staff.
Sampling	Sampling once per month (acceptable interval determined by pilot study). Sample sites same as used by Martinez (UIB PhD study) in 1980s. Collection of samples possible by Park staff after training but direct transfer of samples to laboratory essential.
Sample analysis	Data stored on Park computer (Excel) and at UIB/Govt. Lab. Statistical analysis done by Balearic Conselleria de Medi Ambient scientists.
Reporting	Data statistically analysed and reported annually in the Park's annual report with conclusions and recommendations for management action and further monitoring.

Table 1c: Monitoring for water quality: increased salinisation.

General problem	Water is being taken from the aquifer for agricultural and urban uses, in and beyond the catchment area.
Specific problem	Abstraction of water lowers water table and leads to increased salinisation.
Objective	i) Monitor water quality for salinity. ii) Monitor water levels to evaluate the effects of water abstraction. iii) Monitor aquatic invertebrate communities as indicators of water quality.
Hypothesis	i) Conductivity at any one site and season should not exceed the mean levels for conductivity during the 1980s baseline study at the same site and season. ii) Mean water levels should not fall below the lowest mean water level recorded in the last five years. iii) Key salinity tolerant or intolerant indicator species or assemblages should be absent/present from each sample site in relation to the appropriate (conservation management determined) water quality for the site.
Methods & variables	i) On-site measurements of conductivity (and pH, oxygen content and temperature of water). ii) Record water levels from stageboards. iii) Standardised sweep-net sampling, identification and counting of aquatic invertebrate fauna at water quality sites; results compared with water quality data.
Feasibility/cost effectiveness	i) Simple technique requiring two staff-days per month. ii) Feasible because of donation of portable electronic meters measuring the above parameters; requires four staff-days per month (also feasible at lower cost using simple conductivity meters). iii) Cheap for equipment but labour intensive. Only feasible because the Project has ample volunteer labour and water quality data are available from the water quality monitoring programme. Identification experts available, but little local reference material.
Pilot study	i) & ii) Equipment and procedures were tested under field conditions in 1994. Calibration of equipment done by University (UIB) technicians. Staff trained in use and maintenance of equipment. iii) Specialist expertise to establish a baseline reference and identification keys; sample sites changed, analytical elements improved following pilot study - to standardise with water quality studies.
Sampling	i) Staff trained during pilot study. Sampling done at sample sites selected as strategic (junctions of canals, points of water input into the Park, etc.) and, for comparative reasons, at the same locations as chosen for doctoral study into water quality and macrophytes in the 1980s (Martínez 1988).

	Samples collected once a month. ii) Once a month at regularly spaced intervals from stageboards positioned strategically throughout the Park. iii) Collections at each site at comparable seasons annually (once per season); macro-invertebrates identified, counted and released at the site of origin; some specimens of each species retained as reference and for specialist confirmation of identifications. Training of staff and development of straightforward replicable sampling techniques.
Sample analysis	i) & ii) Data stored on Park computer (Excel) and at UIB/Govt. Lab. Statistical analysis done by Balearic Conselleria de Medi Ambient scientists. iii) For each sample site and survey a water quality score is determined and an average score per taxon (ASPT) calculated. Chemical data analysed using Analysis of Variance (ANOVA) and biological/chemical data comparison using Principal Components Analysis (PCA). Data on Park computer and with scientist in charge (Juana Garau).
Reporting	i) & ii) Data statistically analysed and reported annually in the Park's annual report with conclusions and recommendations for management action and further monitoring. iii) Data statistically analysed and reported annually in TAIB Project's annual report and/or the Bulletin of the Natural Parks series, with conclusions and recommendations for management action and further monitoring. Pollution incidents and other major events reported verbally, directly to Park authorities to allow for immediate management action.

Table 2a: Monitoring human impacts: erosion and damage to coastal dunes.

General problem	Tourists from large tourist complexes adjacent to the Park create erosion of coastal dunes and damage to dune vegetation.
Specific problem	Tourists using the beach and dune systems for recreation create negative impacts, in particular through beach-head dune erosion.
Objective	Monitor profile of beach and fore-dunes to establish erosion rates.
Hypothesis	The beach width should not decline from the present baseline; the dune edge should not retreat from its present baseline position.
Methods & variables	Use theodolite to measure beach profiles; establish fixed reference points in dunes; take fixed bearings from reference points to re-locate points exactly; support with photos and GPS.
Feasibility/cost effectiveness	Labour intensive. Methodology straightforward but expensive equipment needed.
Pilot study	Pilot study conducted in April 2002. Improvement of methodology after consultation with scientists from Universities of Vigo and the Balearic Islands. More improvements anticipated after further consultation.
Sampling	Sample sites determined by: Need to space samples out at regular intervals along beach; need to use sample sites previously selected by UIB scientists; need for minimum 10 profiles. [Currently at developmental/pilot study stage, so final sample sites and number still to be determined]
Sample analysis	Data stored on Park computer and at Universities of Vigo and Balearic Islands (UIB). Locations eventually marked using GIS. Analysis will be conducted in conjunction with other studies being conducted in the dunes and bay – including UIB's coastal processes team. Sand grains taken to Vigo for analysis.
Reporting	Data statistically analysed and reported annually in TAIB Project's annual report and/or the Bulletin of the Natural Parks series, with conclusions and recommendations for management action and further monitoring. Major events reported verbally, directly to Park authorities to allow for immediate management action.

Table 2b: Monitoring human impacts: lack of public awareness.

General problem	Unsustainable human activities within the Park catchment area and in the Balearic Islands have negative effects on conservation measures at the Park and more widely.
Specific problem	Lack of access by local people and visitors to quality information about sustainable activities and biodiversity conservation in the Park and in the Balearic Islands.
Objective	Develop Education programme for schools; extend to adults through pilot programme on Saturday mornings.
Hypothesis	The proportion of schools visiting the Park should continue to increase on an annual basis (until 100%).
Methods & variables	Establish Education team; plan programme; obtain materials. Daily visits by schools. Adults, Saturday mornings.
Feasibility/cost effectiveness	Requires trained personnel and full support of Educational as well as Environmental Agencies. Relatively high level of organisational back-up needed. Long-term benefits highly cost-effective, though in economic terms difficult to measure.
Pilot study	Pilot study conducted in 1989 with local schools. Quickly expanded to all Mallorca. Teachers invited to evaluate early programme (this is on-going). Pilot study to extend programme to local people and organisations, tourists and other visitors begun in 2002.
Sampling	Not applicable.
[Sample] analysis	Constant evaluation process in place, including regular meetings with teachers and NGOs, etc. Children are encouraged to report back their visits through writing, art-work and other feedback mechanisms.
Reporting	Annual evaluation report published by Park, compiled by the Education team after consultation with other staff, teachers, etc. Report twice per annum to Park Management Committee.

Table 3a: Park management: managing for biodiversity.

General problem	Without the implementation of appropriate conservation measures, local, regional and global impacts could lead to ecological change and damage the Park's rich biodiversity and ecosystems.
Specific problem	The planning and implementation of conservation management measures which conserve the Park's internationally important plants and animals requires good knowledge of the Park's biodiversity and ecosystems.
Objective	a) Create biodiversity reference. b) Monitor population changes of key indicator groups. c) Study the relationship between plants and animals in key habitats.
Hypothesis	a) No hypothesis (=baseline). b) The number recorded of key species does not fall significantly below the mean level recorded in the pilot study (based on an index established during the five-year baseline period). c) No hypothesis (=applied study to understand aspects of ecosystem functioning).
Methods & variables	a) Collect plants; establish herbarium. Collect key insect groups; prepare mounted specimens. Support with photographic reference. b) Set up transects (birds, butterflies, dragonflies, orthoptera), netting programme (birds), fixed traps. Use repeatable standardised method and **keep all variables to a minimum**. c) Use standardised methods (fixed number of nets along a transect line for birds; quadrats every 2 m along a 150 m transect for Phragmites and other vegetation; sweep-netting, bird regurgitations and droppings for invertebrates). Collect water level/conductivity data at each site.
Feasibility/cost effectiveness	a) Relatively cheap to maintain. Initial outlay mainly on storage materials. Preparation and curation of collections can be taught easily. Identification expertise required. b) Cheap to set and maintain. Staff can be trained to do it. Some initial outlay on equipment (binoculars, quadrats, nets, etc.). c) Cheap on equipment, but labour intensive. Methodology straightforward but work hard and unglamorous.
Pilot study	a) Early specimens taken before taxonomy specialists found for identification. System improved (identifications, storage and display) once experts found. b) Various pilot studies done. Five years' data required for most cases before data considered sufficiently reliable for interpretation purposes and for setting hypotheses. c) Study developed using stardised methodologies (developed in the Camargue, France) so pilot study concentrated more on accessibility and indentifying "best" sites.

Sampling	a) Sufficient samples for identification of species and to demonstrate the range of variation. b) Wherever feasible, three replicates for each habitat. A lower number may not be statistically valid [though they may give sufficient information to guide management measures for biodiversity conservation]. c) Sampling is the minimum needed statistically to assess structural evolution and ecological functioning of the habitat.: once per annum for vegetation, four times per annum for birds, once per moth for water levels and salinity, once every 3-5 years for invertebrates as food for birds.
Sample analysis	a) Not applicable (a cross-reference list of taxa in collections is held on the TAIB and Park computers). b) Data stored on Park and TAIB computers. Statistical analysis conducted using standard methods by individual scientists responsible for the studies. Expert statistical advice available from Dr Calvin Dytham, biological statistician from the University of York. c) As b), but data also used by Tour du Valat Biological Station, France, scientists as part of an integrated international Mediterranean reedbed study.
Reporting	a) Biodiversity Catalogue (2500 species of 52 plant/animal groups) is in press (publishers: Balearic Government Conselleria de Medi Ambient). Regular updates planned for TAIB annual report and Parks Bulletins. b) Data statistically analysed and reported annually in TAIB Project's annual report and/or the Bulletin of the Natural Parks series, with conclusions and recommendations for management action and further monitoring. Incidents and sudden, major changes reported verbally, directly to Park authorities to allow for immediate management action. c) As b). Results also incorporated into Tour du Valat Biological Station summary of the entire project, published in their annual report.

Table 3b: Park management: managing public use.

General problem	Access to the site is encouraged but has a potential negative impact on the Park and its biodiversity.
Specific problem	a) The Park authorities and Balearic Government require the Park to be seen as an asset for local people and accessible and user friendly for visitors of all nationalities. b) Inappropriate use of the Park causes disturbance to birds, damage to vegetation and ecosystems, and reduces the quality of the visit for others.
Objective	a) Monitor visitors. b) Reduce negative effects of visitors through management.
Hypothesis	a) The number of visitors should not fall below the lowest annual total recorded in the last 5 years. b) Indicator species/groups for human impact should begin to recover after management measures implemented.
Methods & variables	a) Collect information from people calling at reception centre (including nationality, means of reaching the Park). Daily. b) Devise visitor plan to eliminate inappropriate activities and buffer or screen sensitive areas against human intrusion. Put up advisory notices and signs. Improve facilities and guidance material for visitors. Measure recovery of indicator groups through quadrats for vegetation, fixed transects for vertebrates and invertebrates.
Feasibility/cost effectiveness	a) Part of normal staff activities. Essential monitoring activity. b) Cost of signs, facilities (hides, screens, etc.) restoration materials (fences, etc.). Methodology simple to follow.
Pilot study	a) No pilot study done, but results and methodologies constantly under review and being improved. b) Several actions were undertaken some of which have not been continued due to immediate success, or to failure (e.g. lack of man power).
Sampling	a) Recording visitors at the reception centre is a form of sampling. More information is needed to understand the ratio of reception centre visitors to total Park visitors. b) Monitoring impact of management measures to reduce visitor impact, using plants or animals as indicators: twice per annum, plants; daily, birds; at regular intervals for other indicators.
Sample analysis	a) Simple analysis based on annual figures. Data stored at Park. Data also used by Government and UIB in wider “indicator” studies of the impact of tourism and sustainability of resources in Balearic Islands. b) Data stored on Park and TAIB computers. Statistical analysis conducted using standard methods by individual scientists responsible for the studies. Expert statistical advice available from Dr Calvin Dytham, University of York.

Reporting	a) Figures summarised and reported in the Park's annual report and quarterly bulletins. b) Data statistically analysed and reported annually in TAIB Project's annual report and/or the Bulletin of the Natural Parks series, with conclusions and recommendations for management action and further monitoring. Major impacts and events reported verbally, directly to Park authorities to allow for immediate management action.

Programme development: training

TAIB educational learning activity for participants: *Oral presentation with computer support*
by Florent Prunier

[*Editor's note*: this article describes and evaluates an active learning activity piloted in October 2002 as part of the MedWetCoast wetland managers course]

Presentation: aims

- *Plan*
  - Aim : to develop a theme or idea related to biology conservation supported by actual (real) examples (i.e. not a catalogue);
  - A few hours' work over a 7 to 10 day period;
  - Computer-assisted oral presentation;
  - A short evaluation of presentation by group.

- *Organisational advantages*
  - Flexible for putting into practice;
  - Numerous subjects available;
  - Exceptionally photogenic site;
  - Many intermediaries can help and answer questions;
  - Promotes a learning task during spare time.

- *Advantages for the participants*
  - Active TAIB approach: participants responsible for their own personal project;
  - Encourages participants to reflect on the fieldwork in which they have been involved;
  - Interpretation approach;
  - Use of digital camera, and Power point;
  - Consideration of a conservation theme;
  - Exercise in oral English and in public presentation;
  - Exercise in analysis;
  - Promotes working in a group: group integration, exchanges;
  - Gives a greater motivation and source of interest in the project (allows participants to base their project on actual project experience and observations).

- *Advantages for TAIB*
  - Enrichment of TAIB's photo and multimedia resource;
  - Communicates new ideas about the project;
  - Bank of presentations explaining the activities of TAIB.

Preparation guidance: choice of subject

TAIB fieldwork periods often comprise 2 two-week teams. Recommendation: Leave carte blanche to the first team. Direct the choice of subject for the second.

Evaluation of the Autumn 2002 presentations

Table 1: Evaluation of the presentations

TAIB	Group	Title	Positive points (presentation day)	Main difficulties (F.P. point of view)
Autumn 2002	Inma (ESP) Fede (ESP) Eshan (EGY)	"The training in nature conservation: the case of Project S'Albufera"	-Good structure - The subject developed in few illustrations, accompanied by personal points of view. - Gives recommendations. - Good oral presentation. - Enjoyable; good photos.	- Last moment work: late formation of the working group. - Difficulties met in structuring the plan of the presentation. - Some photos out of context.
Autumn 2002	Mohamed (EGY) Fayed (EGY)	"S'Albufera de Mallorca – Parc Natural: monitoring for biodiversity and environmental change"	- Could be the basis for an internet site/document to present TAIB project. - Interactive. - Hard work. - Enjoyable; Good photos.	- It is a catalogue: does not really develop a subject.

With respect to the very short time allowance for this activity (a few hours over a 7-10 day period):

- the final result cannot be formally perfect;
- the advantages of the exercise far outweigh the inevitable imperfections of the result.

Major difficulties for the organizer

- to clarify the general idea of the presentation: not give a catalogue but develop an idea about nature conservation.
- to give sufficient time to the groups: it is difficult to allocate a fixed time for the group to work on their project.

These difficulties can be resolved by a major organization of the activity (I did not manage to constitute a working group during the preparation period as planned). Main improvements for subsequent years: a sheet of instructions, a provisional timetable, allocation of a fixed time for the working group.

Florent Prunier (*TAIB Ecologist*) November 2002

TAIB
The Albufera International Biodiversity Group

TAIB Project S'Albufera: A Mediterranean model for the study of biodiversity and environmental change

The Albufera International Biodiversity Group Annual Report 2002

PART IV

TAIB Research and Training Programme for 2003

Fieldwork timetable for 2003

The fieldwork timetable for 2003 is as follows:

TAIB Team 1: ***30th March to 12th April***

TAIB Team 2: ***13th to 27th April***

Biodiversity Training Course: ***1st to 15th May***

TAIB Team 3: ***5th to 19th October***

The Biodiversity Training Course comprises 18 students from the Masters Research Degree in Ecology and Environmental Management, University of York, led by Nick Riddiford (Principal Investigator, TAIB) and Calvin Dytham (University of York).

TAIB Teams 2 and 3 have been designated wetland manager courses as part of the MedWetCoast training programme, and in collaboration with the Atelier Technique des Espaces Naturels.

Details of the two spring TAIB teams and a summary of the scientific research programme for spring 2003 follow:

Fieldwork in Spring 2003

Teams

Team 1: 30th March to 12th April

Scientists
Nick Riddiford (Principal Investigator, TAIB)
Pere Vicens (Naturalist, P.N. de s'Albufera), Park scientific collaborator
Ingirid Eunson (TAIB Logistics)
Juana Garau (TAIB Aquatic Biologist)
Angela Medina (TAIB butterfly transects; lepidoptera studies)
Jeroen Veraart (Climate Change and Biosphere Research Centre, Wageningen)
Laura Royo (TAIB Coastal Studies/University of Vigo; coastal processes)
Maria Cantallops Alba (TAIB Coastal Studies/University of Balearic Islands; coastal processes)
Florent Prunier (TAIB Entomologist)
Paul Lupton (TAIB Entomologist)
Angelo Gross (TAIB Entomologist)

Volunteers
Balearic/Peninsular volunteers (4, to be announced)
Katherine Boor (UK)

Team 2: 13th to 27th April

Scientists
Nick Riddiford (Principal Investigator, TAIB)
Pere Vicens (Naturalist, P.N. de s'Albufera), Park scientific collaborator
Inma Murillo (TAIB logistics)
Chris Donnelly (TAIB Biodiversity & Programme Development)
Henry Stanier (British Dragonfly Bio Museum & Reserve, Northampton; odonata ecology)
Brian Eversham (Conservation Director; Beds, Cambs, Northants & Peterborough Wildlife Trust)
Tony Serjeant (TAIB spider studies)
Pam Hill (TAIB Mollusc studies)
Angela Medina (TAIB butterfly transects; lepidoptera studies)

Volunteers
Balearic/Peninsular volunteers (2, to be announced)
MedWetCoast wetland managers/environmental planners/biologists (to be announced)

Fields of research

1. Human and management impact studies

1.1 Aquatic invertebrate communities in relation to water quality (Juana Garau).
1.2 Monitoring of aquatic vegetation and zooplankton in s'Albufera Natural Park (Jeroen Veraart).
1.3 Vegetation re-colonisation after fire, Es Comú (Nick Riddiford).
1.4 Coastal processes and erosion of the foredunes of Es Comú (Maria Cantallops, Laura Royo).

2. Biodiversity studies

2.1 Herbarium development and curation (Laura Royo).
2.2 Development and curation of the Albufera invertebrate collection (Nick Riddiford).
2.3 Hymenoptera and Diptera survey and reference collection (Paul Lupton).
2.4 Coleoptera survey and reference collection (Brian Eversham, Henry Stanier, Florent Prunier).
2.5 Extension of the aquatic invertebrate reference collection (Juana Garau, Henry Stanier).
2.6 Arachnid studies - spiders (Tony Serjeant).
2.7 Isopod studies – woodlice (Angelo Gross).
2.8 Biodiversity catalogue – extension (Nick Riddiford, Paul Lupton).

3. Ecological and monitoring studies

3.1 Bird population studies – transects (Nick Riddiford).
3.2 Habitat utilisation and local movements of birds (Pere Vicens)
3.3 Butterfly and dragonfly population studies – transects (Angela Medina, Chris Donnelly).
3.4 Ecology, phenology and habitats of Odonata (Henry Stanier).
3.5 Carabid beetles and their habitats (Brian Eversham)
3.6 Survey of mollusc distribution and habitats (Pam Hill).
3.7 Habitat descriptions and communities (Chris Donnelly).
3.8 Systematic light trapping for moths (Nick Riddiford, Florent Prunier).

4. Park management

4.1 Bittern population studies (Pere Vicens).
4.2 Marsh orchid *Orchis palustris* census (Pam Hill).
4.3 Public use and management issues at s'Albufera (Juan Salvador Aguilar).

5. Programme development

5.1 Biodiversity and conservation management studies: forward planning (Chris Donnelly).
5.2 Statistics and analysis: application for field monitoring (Florent Prunier).

6. Interpretation and education

6.1 Environmental education at s'Albufera and in Mallorca (Mari-Angels Ferragut).
6.2 Participatory project development (Florent Prunier & Chris Donnelly).
6.3 International volunteer biodiversity training (Nick Riddiford & the TAIB team).

7. International initiatives and collaborations

7.1 International volunteer biodiversity training (see 6.2).

Scientific Research Programme, Spring 2003

Human and management impact studies

Title: Aquatic invertebrate communities in relation to water quality.
Main objective: to use aquatic invertebrate communities as water quality indicators.
Secondary objective: to develop a replicable methodology which can be adopted in other wetlands throughout the Mediterranean basin.
Led by: Juana Garau.
Nature of work: systematic sampling of invertebrates using standard sweep-net methodology at representative sites throughout the Park also sampled systematically throughout the year for water quality.
Fieldwork period: Team 1.
Note: a cost-effective technique for guiding management of wetland sites.

Title: Monitoring of aquatic vegetation and zooplankton in s'Albufera Natural Park.
Objective: to test and develop methodologies which use bio-indicators to assess the anthropogenic impacts on aquatic biodiversity and water quality in s'Albufera Natural Park.
Led by: Jeroen Veraart (Climate Change and Biosphere Research Centre, Wageningen, Holland).
Nature of work: sampling of aquatic vegetation and zooplankton at a selection of baseline monitoring sites to identify the diversity and abundance of the community structure in relation to water quality.
Fieldwork period: Teams 1 and 2.
Note: a cost-effective technique for guiding management of wetland sites.
Note: this study comprises a continuation of monitoring work begun by Jeroen in 1999.

Title: Vegetation re-colonisation after fire, Es Comú.
Objective: to observe the natural recovery of vegetation in order to understand the long-term implications of the impact of fire on the coastal dune ecosystem.
Led by: Nick Riddiford.
Nature of work: census of plant species, vegetation cover and proportions of bare ground using a series of 1 x 1 m quadrats positioned randomly (paired random numbers) within a 70 x 50 m zone of uniform vegetation type in an area of coastal dunes burnt out in 1994.
Fieldwork period: Teams 1 and 2.
Note: an annual study begun in 1995.

Title: Coastal processes and erosion of the foredunes of Es Comú.
Objective: to collect further baseline and monitoring data for the condition of the beach and foredunes along the Parc foreshore of Es Comú.
Led by: Laura Royo, Maria Cantallops.
Nature of work: measuring dune and beach profiles; setting up reference points; photographic monitoring; recording pioneer vegetation.
Fieldwork period: Team 1.
Note: the impetus for this study comes from three events: 1) recent efforts implemented by the Balearic Government Conselleria de Medi Ambient to recuperate the coastal dunes of Es Comú; 2) the hurricane of November 2001 which did such damage to the coastal fringe; 3) the dumping of imported sand on a tourist beach adjacent to the Parc, as a response to the hurricane. The long-term implications of the last action on inshore currents and the coastal fringe are unknown.

Biodiversity studies

Title: Herbarium development and curation.
Objective: to maintain as complete a reference as possible in pressed material and photographs of the plants of s'Albufera, to be held at the Park as a permanent resource to assist Park staff and other scientists working in the Park.
Led by: Laura Royo.
Nature of work: changing papers in press; labelling and setting new species for press; adding prepared species to herbarium; general curating procedures to maintain herbarium.
Fieldwork period: Teams 1 and 2.
Note: begun in 1989.

Título: Development and curation of the Albufera invertebrate collection.
Objective: to maintain as complete a reference as possible in specimen material and photographs of the invertebrates of s'Albufera, to be held at the Park as a permanent resource to assist Park staff and other scientists working in the Park.
Led by: Nick Riddiford, Henry Stanier, Brian Eversham, Florent Prunier, Paul Lupton.
Nature of work: preparing, identifying and labelling specimens; curating, maintaining and reorganising collections; cross-referencing material to database.
Fieldwork period: Teams 1 and 2.
Note: an international collaboration with the Natural History Museum, London.

Title: Hymenoptera and Diptera survey and reference collection.
Objective: to increase our baseline knowledge of two poorly known but important elements of s'Albufera's biodiversity.
Led by: Paul Lupton.
Nature of work: collecting, preparing specimens for on site and later identification; investigating ecological relationships (e.g. habitat preferences; flight periods: Hymenoptera and plants); introduction to and training on new capture and monitoring techniques; use of Malaise (interception) trap to sample different habitats.
Fieldwork period: Teams 1 and 2.
Note: The Hymenoptera part of this study builds on preliminary work undertaken by Paul Lupton in 1996 and 1997. The Diptera part is based on the pioneer work done in spring 2001 by Dr Martin Ebejer, an expert from Malta who specialises in flies of the Mediterranean islands, and responds to his recommendations.

Title: Coleoptera survey and reference collection.
Objective: to increase our baseline knowledge of various coleoptera groups, an incompletely known but important element of s'Albufera's biodiversity.
Led by: Brian Eversham, Henry Stanier, Florent Prunier.
Nature of work: baseline survey work; collecting, preparing specimens for later, expert identification; relating specimens to plant pabulum and/or habitat; introduction of trapping techniques.
Fieldwork period: Teams 1 and 2.
Note: This work builds on a baseline study begun in spring 2002.

Title: Extension of the aquatic invertebrate reference collection.
Objective: to obtain a comprehensive collection of reference material in support of the aquatic invertebrate and water quality study.
Led by: Juana Garau, Henry Stanier.
Nature of work: curate and catalogue current material; obtain new material through collecting at targeted sites; preparing specimens; seeking specialist opinions for contentious identifications.

Fieldwork period: Teams 1 and 2.
Note: Progress has already been made towards establishing a full working reference but more material is needed. The study is leading towards the pioneering of new techniques and knowledge for the identification of difficult larval stages.

Title: Arachnid studies - spiders.
Objective: to increase our baseline knowledge of the diversity and distribution of Park spiders, another poorly known but important element of s'Albufera's biodiversity.
Led by: Tony Serjeant.
Nature of work: collecting, preparing specimens for later, expert identification; relating specimens to plant pabulum and/or habitat.
Fieldwork period: Team 2.
Note: in collaboration with Guillem Pons of the Balearic Invertebrate Study Group. This is a continuation of a study begun in 2000 during which Tony collected reference material representing 19 families, 45 of which have currently been identified to species.

Title: Isopod studies - woodlice.
Objective: to establish a baseline knowledge for this widespread but little known group in the Park.
Led by: Angelo Gross.
Nature of work: collecting, identifying specimens and/or preparing them for later, expert identification; relating species to habitats and distribution.
Fieldwork period: Team 1.
Note: this is a new study taking advantage of Angelo's knowledge and interest in the group.

Title: Biodiversity catalogue – extension.
Objective: with the publication of the Biodiversity Catalogue in January 2003, the objective is the extend this baseline by gathering information which can advise and guide biodiversity conservation in the Park.
Led by: Nick Riddiford, Paul Lupton.
Nature of work: to improve the catalogue (currently standing at over 2600 species of 52 faunal and flora groups) by targeting gaps in our knowledge, verifying unconfirmed records and investigating the current status of species known from s'Albufera. This will be done by targeted survey and collecting; literature searches.
Fieldwork period: Teams 1 and 2.
Note: Ecological information which guides conservation planning for notable species is now a priority target.

Ecological and monitoring studies

Title: Bird population studies - transects.
Objective: to monitor bird population fluctuations as a measure of local environmental change (e.g. in habitat quality or type) or more generally (e.g. in response to climate change).
Led by: Nick Riddiford.
Nature of work: two permanent transects, each of just over 7 km and sampling all major Park habitats, both divided into sections reflecting habitat types: counts of all birds seen and heard within 25 metres of the transect line.
Fieldwork period: Teams 1 and 2.
Note: annual study, begun in 1990.

Title: Habitat utilisation and local movements of birds.

Objective: to investigate habitat use and mobility of birds within the Parc.
Led by: Pere Vicens.
Nature of work: mist-netting for the capture and ringing of birds using 50 m lines of nets in adjacent reedbed sites to detect breeding phenology, local movements, population displacements and habitat selection.
Fieldwork period: Teams 1 and 2.
Note: This is a new study, building on reedbed bird investigations by Ditta Gregus (Masters study) in summer 2002.

Title: Butterfly and dragonfly population studies - transects.
Objective: to monitor butterfly and dragonfly fluctuations in a range of habitats as a measure of local environmental change (e.g. in habitat quality or type) or more generally (e.g. in response to climate change).
Led by: Angela Medina, Chris Donnelly.
Nature of work: two permanent transects, one of 2 km in the coastal dunes and a longer one of 7 km sampling all major Park habitats, both divided into sections reflecting habitat or habitat structure types: counts of all butterflies and dragonflies within 5 metres of the observers.
Fieldwork period: Teams 1 and 2.
Note: annual study, begun in 1991. The value of this study has been enhanced by a new collaboration with the mainland, begun in 2001 when the transects became part of a Catalunya wide butterfly monitoring scheme.

Title: Ecology, phenology and habitats of Odonata.
Objective: to extend our knowledge of the ecology, phenology and habitats of s'Albufera Odonata.
Led by: Henry Stanier.
Nature of work: a combination of sampling, netting and observations will be used to extend knowledge of the Odonata species present, as adults and as larvae. Particular emphasis will be placed on catching larvae to establish species identifications, distribution, phenology and habitat requirements; and on finding exuviae of emerging adults. One important aim of the study will be to extend and improve the current collection of labelled material, particularly on larvae, for future reference purposes.
Fieldwork period: Team 2.
Note: This study builds on information gathered by Henry in November 2001 and April 2002.

Title: Carabid beetles and their habitats.
Objective: to extend our knowledge of ecological associations and habitats of s'Albufera Carabid beetles.
Led by: Brian Eversham, Florent Prinier.
Nature of work: Employing a wide range of methods and techniques to gather as much material as possible relating to carabid beetles and their habitats. A range of techniques will be employed and "important" habitats targeted.
Fieldwork period: Teams 1 and 2.
Note: Brian Eversham is a well-known British entomologist with a particular interest in ground beetles. This study will continue to extend our baseline knowledge of Carabid beetles (supplied by Miquel Palmer and Guillem Pons) and is an important extension of our Coleopteran studies.

Title: Survey of mollusc distribution and habitats.
Objective: to repeat the surveys undertaken in 1991-92 and to extend our knowledge of the ecology and habitats of s'Albufera molluscs.
Led by: Pam Hill.

Nature of work: molluscs will be found and mapped mainly through searching and litter sampling. Identifications will be checked against the Parc reference collection. Any new material will be added.
Fieldwork period: Team 2.
Note: Pamela Hill is an ecologist with a particular interest in molluscs. This study builds on her work in spring 2002 and the extensive baseline work done by Professor Chris Paul of the University of Liverpool in 1991-92.

Title: Habitat descriptions and communities.
Objective: to provide baseline data on physical and vegetative structure and species presence for selected habitat types within the Park in order to improve our knowledge of ecosystem functioning at s'Albufera.
Led by: Chris Donnelly.
Nature of work: recording physical structure, vegetation structure, specific niches in randomly selected one-metre blocks within specific habitats; recording, collecting, sorting and identifying invertebrates and lower plants and relating them to niches within the sampled habitats; field observations of vertebrates in relation to habitat utilisation.
Fieldwork period: Team 2.
Note: this study has been designed to support the biodiversity programme and uses a habitat rather than a species specific approach; data will be used to aid assessments of the biodiversity of each habitat and the major impacts on the habitat that are affecting its biodiversity.

Title: Systematic light trapping for moths.
Objective: to survey, monitor and catalogue moth populations and their fluctuations, including in response to climate change.
Led by: Nick Riddiford.
Nature of work: setting up (evening) and emptying (morning) moth trap using mercury vapour ultra-violet lamp; identifying, counting and releasing or collecting captures.
Fieldwork period: Teams 1 and 2.
Notes: the systematic light trapping for moths is an annual study, begun in 1991. It will be interesting to see whether the abundance of moths in late 2002 is carried over into spring 2003.

Park management

Title: Bittern population studies.
Objective: to make a qualitative assessment of the impact of fire and drought on the Albufera Bittern *Botaurus stellaris* population.
Led by: Pere Vicens.
Nature of work: survey of calling Bitterns in the Park, using teams of scientists and volunteers positioned at strategic locations for one hour immediately before dawn.
Fieldwork period: Teams 1 and 2.
Notes: This will be the fourth year of a survey using a methodology introduced by Glen Tyler (RSPB) in spring 2000. Calling Bitterns declined alarmingly in 2001, probably due to short-term habitat change brought about by the November 2000 fire and low water levels after prolonged dry conditions. There was the suggestion of a recovery beginning in 2002 (minimum 2 territories). Will it continue in 2003? The survey is the best means of monitoring population levels and distribution of this very secretive and internationally important reedbed bird species.

Title: Marsh orchid *Orchis palustris* census.

Objective: to conduct an annual census of the numbers and distribution of flowering *Orchis palustris,* and relate it to Park management and in particular the intensity and timing of grazing by domestic animals.
Led by: Pam Hill.
Nature of work: a complete census of *Orchis palustris* based on flowering plants at all known sites within and adjacent to the Park.
Fieldwork period: Team 2.
Notes: A long-term study, begun in 1993. We are beginning to understand the ecology of the species. Grazing favours the species because it needs relatively open marsh, but it is very sensitive to grazing from January or February through until flowering. The best results are obtained if the flowering zones are grazed from about June until the end of January, then left ungrazed. A good example of the impact of grazing regimes is the marsh alongside camí des Polls. In 1997 grazing animals were removed in February, leading to a count of 1690 flowering *Orchis palustris* in late April-early May. In 1998 the animals were not removed and only 35 *Orchis* flowered. The change in grazing management resulted in a 98% decrease in flowering plants between years (numbers in other areas remained relatively constant). Very few *Orchis palustris* were recorded in flower in 2000 and just 320 in 2001. The grazing management at camí des Polls has now been adjusted to take into account *Orchis palustris* needs. This produced immediate results with the total number of flowering plants doubling to 645. Further gains are anticipated in 2003.

Title: Public use and management issues at s'Albufera.
Objective: to introduce and put into context the various issues and constraints which shape and determine management design and practice at s'Albufera de Mallorca.
Presented by: Juan Salvador Aguilar.
Nature of work: Presentation by the Parc Director, Juan Salvador Aguilar about the Parc, staff responsibilites, public use, scientific investigations and the many issues and constraints which impact on the Parc and influence the design and implementation of management.
Note: This is a very important introduction, because it gives a management team viewpoint of s'Albufera and puts all the fieldwork carried out during the two weeks into Parc management perspective.

Programme Development

Title: Biodiversity and conservation management studies: forward planning.
Objective: to prepare an internationally compatible biodiversity programme structure which links the various studies of the project and sets clear aims and targets for participants and users of the results.
Led by: Chris Donnelly.
Nature of work: Demonstration of structure and format; brain-storming sessions on improvements and streamlining of programme; setting timetables and priorities.
Fieldwork period: Team 2.

Title: Statistics and analysis: application for field monitoring.
Objective: to introduce straightforward statistical techniques which demonstrate how the various studies of the project can be analysed and the results used for conservation management purposes.
Led by: Florent Prunier.
Nature of work: statistical demonstration workshop using actual examples and data from monitoring studies being carried out by the project.

Fieldwork period: Teams 1 and 2.
Note: this is a new addition to the programme, and responds to feedback from participants.

Interpretation and education

Title: Environmental education at s'Albufera and in Mallorca.
Objective: to demonstrate the environmental education programme in place at s'Albufera and other natural areas in Mallorca.
Led by: Mari-Angels Ferragut.
Nature of work: presentation and seminar on the Mallorcan environmental education. programme; joining members of the education team working with school groups in the field.
Notes: All schoolchildren get to visit a natural area at least once under guidance from the environmental education team as part of the official Mallorcan school curriculum. *Joining the school groups is not obligatory for participants, but is an optional extra for those particularly interested in environmental education programmes.*

Title: Participatory project development.
Objective: to encourage volunteers to develop and undertake small monitoring projects for themselves.
Led by: Florent Prunier, Chris Donnelly and the TAIB team.
Nature of work: Volunteer participation in the design and implementation of small group monitoring studies and activities; production of a short, illustrated synthesis of the results.
Fieldwork period: Teams 1 and 2.
Notes: With a little guidance, local people and other volunteers can become a powerful force in collecting simple information that staff and scientists may not have time to collect. In addition, it is a method of imparting learning through participation, and instilling a sense of "contributing" and "ownership" amongst those involved in such projects.

Title: International volunteer biodiversity training.
Objective: to provide training in the study of biodiversity and biodiversity conservation for Balearic, Peninsular and foreign biologists, geographers, environmentalists and enthusiasts for the natural world.
Led by: Nick Riddiford and the TAIB team.
Fieldwork period: Teams 1 and 2.
Nature of work: volunteer participation in individual studies described above; plus the opportunity to work alongside experienced scientists and experts; and to participate in seminars and presentations on biodiversity and conservation field research.
Notes: The project has hosted and trained volunteers from over 20 countries and 5 continents since the beginning in 1989. Many have gone on to important positions in the World of conservation and the environment.

International initiatives and collaborations

Title: International volunteer biodiversity training.
Notes: Described in Interpretation and education above, but equally applicable here.