

MONITORING FOR ENVIRONMENTAL CHANGE
THE EARTHWATCH EUROPE S'ALBUFERA PROJECT

A summary report of the sixth season's work, 1994

at S'Albufera Natural Park, Mallorca

by

NICK RIDDIFORD

(Principal Investigator, Project S'Albufera)

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CONTENTS

	Page
Report of sixth season's work	
1. Introduction	3
2. Project S'Albufera Fieldwork in 1994	4
3. Fields of Research	6
4. Additional Studies	11
5. Progress and Future Planning	11
6. Acknowledgements	12
Appendix 1	
List of Participants	14
Appendix 2	
1994 Fields of Research	17
Appendix 3	
1995 Programme Details	20
Appendix 4	
List of Publications	22
Annex 1	
A brief study of the growth of Phragmites (by Alan Radermacher)	26
Annex 2	
Bryophytes in the Parc Natural de S'Albufera (by R. C. Stern)	35
Annex 3	
Monitoring water quality at S'Albufera (by Nick Riddiford)	42
Annex 4	
Making Biodiversity Data Accessible (by Jeremy Harrison)	43
Annex 5	
S'Albufera as an International Model Biodiversity Site (by Nick Riddiford, Terry Wells & Sara Hawkswell)	46

	Page
Annex 6	
Biodiversity - Channelling Field Data into use in action (by Max Nicholson)	49
Annex 7	
Project S'Albufera data management system (by Sara Hawkswell and Nick Riddiford)	53
Annex 8	
Assessment of the functions and values of natural ecosystems and protected areas: a case study of the Parc Natural de S'Albufera , Mallorca (by ir. J. H. van Alst,)	55
Annex 9	
Mediterranean Wildlife - Team IV S'Albufera 1994 (by Michelle Chapman)	57
Annex 10	
Albufera - A personal overview, 1992-1994 (by Alan Radermacher)	64
Annex 11	
A study of roosting birds at the Parc Natural de S'Albufera , autumn 1994 (by Chris Donnelly & Nick Riddiford)	67
Annex 12	
Water level recording in the Gran Canal (by Sara Hawkswell)	
Annex 13	
Habitat mapping (by Sara Hawkswell)	

MONITORING FOR ENVIRONMENTAL CHANGE THE EARTHWATCH EUROPE S'ALBUFERA PROJECT

1. INTRODUCTION

This report summarises the sixth year of fieldwork for Earthwatch Europe's Project S'Albufera, carried out at S'Albufera Natural Park, Mallorca by teams of ecologists and volunteer fieldworkers. Fieldwork involved Earthwatch and Balearic volunteers assisting and working alongside specialist scientists for periods of two weeks at a time. In 1994, there were two spring teams and one in the autumn. Outwith the designated Earthwatch Europe sponsored fieldwork periods, a number of monitoring tasks were carried out by resident Mallorcan volunteers and Park staff.

Details of the establishment of the Project and choice of site were given in the first season's report (Newbould & Riddiford 1990) and its first five years' progress in Newbould & Riddiford (1990), Riddiford & Newbould (1991), Riddiford (1991), Riddiford & Perring (1992), Riddiford (1993) and Riddiford & Wells (1994). The objectives of the Project were

- (a) To assemble full & detailed ecological data, including climate, hydrology, soils, pollution, past & present land uses & cultural influences and reconstruction of past conditions to reach an understanding of composition, functioning and dynamics of major ecosystem types.
- (b) To provide standardised comparative data for evidence of local, regional & global change, to be reconciled with aerial photography & space sensory data and to be re-recorded at intervals of time; to provide a model for other global monitoring stations.
- (c) To afford material for application in further research & reserve management at S'Albufera and in general conservation practice.
- (d) To provide resources for comprehensive interpretive programmes & dissemination in all appropriate forms.
- (e) To serve as a focus for education of residents & visitors of all age-groups & levels and to help in creating environmental awareness & commitment.

Spring fieldwork in 1994 was undertaken by a team of 6 scientists and 5 volunteers from 27th March to 10th April and a further team of 4 scientists and 5 volunteers from 30th April to 14th May. A

two-week period of fieldwork in the autumn, from 22nd October to 5th November, was led by 4 scientists assisted by 4 volunteers. The teams were, as usual, international in composition. The Project attracted 5 volunteers from the United Kingdom, 3 from the United States, one from the Netherlands and one from Ireland. We were also delighted to receive our first two volunteers from the Czech Republic, their attendance helped by the British Airways Assisting Conservation (BAAC) programme. Local interest was again demonstrated by the participation of two Mallorca volunteers. Scientists were mainly British, but our policy of stimulating national interest and participation was boosted by the attendance of Maria Zas from Santiago del Compostela (Peninsular Spain) as botanist to the autumn team.

The co-operative nature of the Project was again marked by the involvement of a number of visiting scientists. We benefited particularly from the support of, participation by or advice from: several members of the Universitat de les Illes Balears (UIB) and the Institut d'Estudis Avançats de les Illes Balears (CSIC); the mentor of Project S'Albufera, Max Nicholson; the founder members of the Associació Balear d'Estudis Internacionals en Medi Ambient (ABEIMA); participating scientists; members of the Park's staff; and the Park's director, Sr. Joan Mayol. The overall responsibility for planning and supervision, however, remained with the Project's Principal Investigators, who were Nick Riddiford and Terry Wells. Details of all participants are given in Appendix 1.

2. PROJECT S'ALBUFERA FIELDWORK IN 1994

Fieldwork research in 1994 comprised further development and application of the long-term monitoring programme, including the study of the processes at work in the ecosystem. The opportunity was also taken to improve systems for recording the Park's biodiversity and to continue to expand our baseline knowledge particularly in areas where information was lacking or insufficient.

Long-term monitoring work continuing in 1994 included regular transects to monitor butterfly numbers and distribution in relation to habitat; and transects to monitor bird population dynamics. Work also continued to describe the vegetation communities and structure of the bird and butterfly transects. The now annual census of flowering Marsh Orchids *Orchis (laxiflora) palustris* was repeated in May. Co-ordinate mapping of the *Euphorbia terracina* population of Turo de ses Eres was repeated as part of our monitoring programme of the impact of grazing by horses and other mammals on the vegetation of the fossil dunes. Monitoring was also undertaken of frog *Rana*

ridibunda distribution and activities; and of sea level fluctuations at the seaward end of the Gran Canal.

Study of the processes at work in the ecosystem comprised further work in a number of areas and the introduction of new lines of research. We continued to investigate the impact of moth larvae on the marshland plant *Phragmites australis*, particularly aspects of species identity, phenology and life cycles, their role in diversifying the reedbed structure in terms of weakening and damaging stems, and the role of these larvae as potential prey items for the resident Reed Bunting *Emberiza schoeniclus witherbyi*. Further work was done to record habitat choice and time budgets of Coot *Fulica atra* and preliminary investigations done into applying these studies to other species, particularly the Reed Bunting. Further studies of aquatic invertebrate communities were undertaken and further research conducted into the spatial and temporal distribution of small mammals. A survey of the distribution and habitat requirements of *Arisarum vulgare* and *Arum italicum*, begun in 1993, was continued; as was research in spring into the body condition of migrant and breeding resident birds, to monitor the impact of Park habitats on the bird fauna. This theme was expanded in autumn with the introduction of a new focus of research, roost studies. This comprised testing and developing methodologies for investigating population sizes, roost locations, impact on the vegetation and behaviour (including interactions with raptors and other bird species) of roosting Starlings *Sturnus vulgaris*, White Wagtails *Motacilla alba*, Reed Buntings *Emberiza schoeniclus*, Corn Buntings *Miliaria calandra*, herons and egrets (*Ardeidae*). Methodologies developed and tested as a preliminary to investigating other new areas of research included a survey of aphid infestation of reedbed plants, behavioural activities of the Speckled Wood butterfly *Pararge aegeria* and the identification and role of pollinators of the mimic orchids in the genus *Ophrys*.

The large amount of data collected in the first five years has led to an extensive knowledge of the Park's biodiversity, and this was recognised in 1994 by the World Conservation Monitoring Centre (WCMC) who accepted S'Albufera as a World Model Biodiversity Site. Work done in 1994 in relation to this model included the transfer of new and archive data to specially prepared data sheets, the generation of up-to-date habitat maps, relating records to a standard grid based on the UTM system, full inventories of on-site photographic and specimen reference material and further program development for standardised data processing and storage.

Further efforts were made to fill gaps in and expand our baseline knowledge. Much of this work was linked to the development of a comprehensive biodiversity model. New species of flowering plants

continued to be discovered and additions made to the reference Herbarium. Moth trapping in spring and autumn once more contributed new species to the already impressive and useful reference collection of Lepidoptera; and specimens or field records were collected of a range of other invertebrates, including members of the insect orders: grasshoppers and crickets (Orthoptera), mantids and cockroaches (Dictyoptera), earwigs (Dermaptera), lacewings (Neuroptera), beetles (Coleoptera) and hoverflies (Diptera Syrphidae). One major gap, only partially filled by a small, incomplete collection in autumn 1993, was of the Park's bryophytes. This encouraged two further surveys, conducted by specialists, resulting in much fuller and more detailed information of distribution, habitat and management requirements for this often neglected group.

Interpretation of the Park is being achieved very successfully by the Park directorate and staff. However, Project S'Albufera has a commitment to assisting in this important work. Major contributions in this field were once again made by Dinah McLennan and Jo Newbould through the preparation of botanical interpretation material, including Dr McLennan's very attractive thematic illustrations of major Park habitats designed to be produced as posters.

3. FIELDS OF RESEARCH

The following is a summary, by category, of research studies by Earthwatch Europe's Project S'Albufera in 1994 (and see Appendix 2 for more details).

Marshes

Further investigation was made in spring into the ecological relationship between amounts of infestation by internal stem-feeding larvae, their impact on the major marshland plant *Phragmites australis*, and predation of these larvae by Reed Buntings *Emberiza schoeniclus*. The results of 1994 work are presented in Annex 1 of this report.

For further details of research into infestation of *Phragmites australis* by internal stem-feeding larvae at S'Albufera, see Annexes 1 and 2 in Riddiford (1993) and Annexes 1 and 2 in Riddiford & Wells (1994). For other studies of S'Albufera marshes ecology see also Wood (1989, 1991), Riddiford & Newbould (1991) and Riddiford & Perring (1992).

Dunes

Fossil dunes . Further monitoring was done in spring to assess the impact of grazing by horses on the dune vegetation at Turo de Ses Eres, with particular reference to the distribution and development of the *Euphorbia terracina* population, a potential shade species apparently unpalatable to grazing animals. For details of methods used in this study, see Annex 3 in Riddiford & Wells (1994).

For further details of dune studies, see also Wood (1991), Riddiford & Newbould (1991), Riddiford & Perring (1992) and Riddiford (1993).

Flora and Vegetation

- a) Species populations . Orchid population studies in 1994 comprised further monitoring of the distribution and population size of the marshland orchid *Orchis (laxiflora) palustris* . A survey was also conducted to compare the distribution and habitat requirements of *Arisarum vulgare* and *Arum italicum* . This survey led to the discovery of a third species, *Arum pictum* , not previously recorded in the Park. It was in deep shade just inside the Park's southern border.
- b) Total list . More work was done to add to the list of known species of flowering plants within the park and to provide additions to the Park herbarium.
- c) Applied orchid studies . A pilot study was launched in April 1994 into the viability of using volunteers and the methodology needed to investigate the role of invertebrates in the pollinisation of invertebrate-mimic flowers of the orchid genus *Ophrys* .
- d) Habitat mapping . Work was done in spring and autumn to produce current habitat maps of the Park, adopting the CORINE classification system and NCC Phase 1 Survey methodology. Habitat maps are a key element in our biodiversity studies, assisting in drawing relationships between animal and plant distributions. The habitat mapping work is described in Annex 13 of this report.
- e) Bryophytes . Following a small moss collection in autumn 1993, knowledge of the Park's bryophytes was greatly increased by further studies in winter 1993-94 and November 1994. The November work was of particular significance because it comprised a survey which sampled most of the Park's range of habitats and made a first assessment of the management strategies necessary for the conservation of this often neglected floral group. A Bryophyte

Herbarium reference collection of S'Albufera species is now available within the Park, and will be added to substantially in 1995. The results of the two studies are presented in Rosselló (1994) and Annex 2 of this report. Details of the autumn 1993 study are given in Annex 4 of Riddiford & Wells (1994).

For further details of botanical studies see also Wood (1991), Newbould & Riddiford (1990), Riddiford & Newbould (1991), Riddiford & Perring (1992) and Riddiford (1993).

Invertebrates

a) Butterfly transects . Two transects designed to monitor butterfly habitat preferences and population variations, the first established in 1989 and the second in 1991 and both repeated annually thereafter, were conducted regularly by all spring and autumn fieldwork groups. For further details of butterfly transects, including methodologies, see Riddiford & Perring (1992).

b) Invertebrate database . Records obtained in 1994 were once again predominantly of Lepidoptera, caught at night using standard insect light traps. This resulted in a further series of species being added to the on-site reference collection. Identifications and preparations of moth (Lepidoptera) specimens were undertaken by British moth authority, Barry Goater. Other insect identifications were provided by lacewing (Neuroptera) specialist, Colin Plant. The range of species studied was expanded in 1994 to include members of the insect orders Orthoptera, Dermaptera and Dictyoptera. Specimens from these orders have been added to the growing insect reference collection at S'Albufera. Identifications were undertaken by a British specialist in these groups, Chris Haes. We again received help and advice from members of the Balearic Invertebrate Group, based at the University of the Balearic Islands in Palma, particularly for beetles (Coleoptera). A computer database record was made of all invertebrate, and other fauna and flora records. For further details of moth studies, see Riddiford (1993) and Riddiford & Wells (1994).

c) Freshwater invertebrate studies . Further monitoring was conducted in spring to ascertain the distribution and populations of freshwater invertebrates in relation to water types and habitats. Details of previous work are given in Riddiford (1993) and Riddiford & Wells (1994).

d) Butterfly activities . A pilot study was launched in April 1994 to develop a methodology for investigating the behaviour, territoriality, habitat and vegetation preferences of S'Albufera

butterflies, beginning with the Speckled Wood *Pararge aegeria* .

For further details of invertebrate studies see Newbould & Riddiford (1990), Riddiford & Newbould (1991), Riddiford & Perring (1992) and Riddiford (1993).

e) Aphid studies . In an extension of our studies of invertebrate, bird and reedbed plant inter-relationships, a methodology was developed and tested in May 1994 which aimed to investigate, through random sampling, levels of aphid infestation of reedbed plants, particularly on the leaves of *Phragmites australis* and *Cladium mariscus* .

Vertebrates

a) Birds . Data were again obtained of temporal and longer-term fluctuations of breeding and migrant birds. The technique employed comprised two well established bird transects, conducted annually since 1989 and 1990 respectively. Both were repeated in 1994 during the spring and autumn fieldwork periods. To assist analysis of habitat use, a description was completed of the vegetation communities and structure of bird transect 1, using the Domin scale. For details of the bird transect methodology see Riddiford & Perring (1992).

The cancellation of the second spring team and the subsequent absence of Project personnel led to the suspension of a second population monitoring technique, a constant effort ringing study (CES). Some ringing work was, however, done to collect further data on the body condition of birds using S'Albufera. This ringing, conducted at a site developed in autumn 1993 at the north-east corner of Es Colombar, proved equally successful in spring in providing weight, adipose fat and muscle condition data for a good sample of birds.

Further study was conducted into the ecology and morphology of S'Albufera Reed Buntings and their role as predators of the moth larvae of *Phragmites* stems. However, progress has been slow because observations of Reed Bunting feeding behaviour are proving both difficult and time-consuming. This study would benefit from specialist research at post-graduate level.

Further data were collected in spring 1994 of the habitat choice and time budgets of Coots *Fulica atra* . Details of the 1993 study are given in Annex 10 of Riddiford & Wells (1994).

A new research theme was begun in October 1994, comprising a pilot study of roosting birds at S'Albufera. Information was sought regarding population sizes, distribution, habitat choice

and behaviour of roosting birds and their interactions with predators. The aim was to assess which aspects were of most relevance to our ecosystem studies, to develop specific methodologies for each element of study and to test the feasibility of using volunteer help to collect the data.

b) Mammals . Rob Strachan continued his investigation into the utilisation of habitats, populations and inter-specific relationships for three species of mouse at S'Albufera. He also collected basic bat information, including identification and use of suitable day-time sites; and conducted preliminary investigations into the feasibility of using bat detectors to obtain a measure of bat abundance. Further data were again collected for a range of other species.

Results of the mouse study are given in Annex 12 of Riddiford & Wells (1994).

c) Frogs . Further data were collected in autumn of the distribution and activity patterns of the Marsh Frog *Rana perezi* . The frogs were unexpectedly vocal in November, including in areas not previously recorded. High water levels and warm weather may have combined to produce this result. Fresh water dilution of normally saline areas through flooding was the probable reason for the extended distribution into areas of known elevated salinity, such as Es Cibollar. Because of this unexpected situation, study of frog activity patterns was continued into the winter - thanks to local resident volunteer, Nicole Smith. For further details of frog studies, see Annex 13 of Riddiford & Wells (1994).

For further details of vertebrate studies see also Wood (1991), Newbould & Riddiford (1990), Riddiford & Newbould (1991), Riddiford & Perring (1992) and Riddiford (1993).

Hydrology

To ascertain to what extent short-term changes in sea level were due to atmospheric or climatic conditions, water level readings were taken at the main sluice and the Englishmen's Bridge. Readings were taken daily at regular intervals and synchronised times in spring and autumn. In addition, Park staff made weekly readings of water levels from stageboards throughout the marsh and, from the autumn, weekly measurements of water quality at strategic sample sites.

The sampling technique and equipment used to obtain water quality measurements are described in Annex 3 and a summary of the water level recording study in Annex 12 of this report.

Meteorology

Meteorological data were collected daily by Park staff.

Data Management and Biodiversity Studies

Progress was made on two fronts: species lists were up-dated and expanded as more faunal and floral records were obtained; and work was continued to increase the usefulness of the data bank, most notably by introducing a mapping grid of 1 kilometre squares based on the UTM system of co-ordinates and encouraging all participants to cross-reference all data to precise co-ordinates or squares.

The structure of the S'Albufera biodiversity list was described in Annex 14 of Riddiford & Wells (1994).

Interpretation and Education

An illustrated summary of Project S'Albufera work is now part of the impressive audio-visual display in the new S'Albufera Interpretation and Display Centre, opened in 1994. Dinah McLennan and Jo Newbould continued to work in the botanical field towards their goal of providing interpretation material. One of the water-colour representations of major habitats being prepared by Dinah, freshwater marsh, has already been produced as a poster, available from the Park's Information Centre shop; Jo and Dinah also did further fieldwork in preparation for a S'Albufera flower guide for Park visitors.

For further details of interpretative work, see Annex 16 and Annex 17 of Riddiford & Wells (1994).

4. ADDITIONAL STUDIES

Follow-up monitoring work was undertaken for the Project by local volunteers Bernat Bergas and Cristina Moy... who collected data on the parasitism of Phragmites stems by insect larvae in winter 1993-94, and Nicole Smith who obtained data on frog activity patterns in both winters, 1993-94 and 1994-95. Park staff continued to collect year-round data in a number of fields, most notably ornithological, meteorological, hydrological and in aspects of Park management. Joan Castany i Alvaro joined the

Project for three days in April, during which volunteers and the scientific team helped him test his methodology for the monitoring of Moustached Warbler *Acrocephalus melanopogon* populations in south-east Spain. A number of studies, particularly in the spheres of hydrology, limnology and entomology, were carried out by members of the UIB, Balearic Institute of Advanced Studies and Balearic Invertebrate Study Group. Park staff undertook monitoring of the Park's management throughout the year. The results of Park management monitoring in 1993 were presented in Perelló, Mayol & Capell... (1994). Other published results included the description of a newly discovered fly *Stiplon intermedius* n. sp. (Diptera Brachycera Hybotidae) just outside the Park boundary but within the S'Albufera catchment area (Raffone 1994), an historical account of colony nesting herons, egrets and cormorants at S'Albufera in the eighteenth century (Mayol 1994) and a study of the bryophytes of S'Albufera (Rosselló 1994).

5. PROGRESS AND FUTURE PLANNING

Earthwatch Europe continued to provide sponsorship through their volunteer scheme in 1994, but a severe lack of other funding led to the cancellation of one spring team and an enforced change to voluntary status for Principal Investigator, Nick Riddiford. Despite these setbacks, Project S'Albufera endeavoured to maintain a high level of activity. This was entirely due to the generous and unselfish support of all scientists involved. A full programme of fieldwork is again planned for 1995, though extra sources of major funding have still not been identified. Planning has become much more difficult in these circumstances and has only been possible at all because of the unstinting loyalty and assistance of the scientists and supporters who make up the Project S'Albufera scientific team.

The future may not be all bleak. One important development has been the support of Glaxo Holdings p.l.c., in association with Earthwatch Europe, which will allow the running of an extra fieldwork team, in August. Project work continues to stimulate participation by other bodies. Research planned in 1995 includes: wetland nutrient dynamics and wetland functioning by the Royal Holloway Institute for Environmental Research, University of London; the Parc Natural de S'Albufera as a case study in assessing the functions and values of natural ecosystems and protected areas by the Centre for Environment and Climate Studies, Wageningen Agricultural University; and analysis of the Park's water monitoring results by members of the UIB's Department of Limnology. In their spare time, Project scientists continue to develop a Biodiversity model based on data already

collected and the results from this are playing a key role in defining, and in some cases, redefining fieldwork programmes and goals. In relation to S'Albufera Biodiversity studies, the Project was represented by the Principal Investigators, Max Nicholson and an Earthwatch Europe staff member at a seminar on Biodiversity Modelling at the World Conservation Monitoring Centre (WCMC), Cambridge in April and, later in the year, Nick Riddiford contributed a piece on S'Albufera as a Biodiversity field model in action to the UK Department of the Environment's Manual for Biodiversity Assessment, currently in preparation. Details of the WCMC seminar, and the Project S'Albufera submission to that seminar are given in Annexes 5 and 6.

The Project has also joined forces with the International Waterfowl and Wetlands Research Bureau (IWRB) MedWet sub-project on Inventory and Monitoring. MedWet (short for Mediterranean Wetlands) has been working to formulate an inventory and monitoring programme which can be applied to wetlands throughout the Mediterranean. Project S'Albufera has been invited to carry out field tests of the methodology which has been developed - much of which corresponds with work already in progress.

Earthwatch Europe has agreed to maintain its support through the provision of volunteers and associated sponsorship. The Balearic International Environmental Research Association (ABEIMA) was legally constituted in the winter of 1993-94 and, it is hoped, will develop in partnership with Earthwatch Europe in the not too distant future. The Balearic Government has been kept fully informed of events and expressed their support for the development of ABEIMA in a press statement issued on 23rd May 1994.

The plea in the 1993 report (Riddiford & Wells 1994) "limited resources have not prevented the Project from achieving an enormous amount but the Project needs more support, in terms of substantial funding targeted at specific areas of detailed research and international scientific involvement, if it is to build successfully on innovative and solid beginnings", applies more strongly now than ever.

Details of the 1995 Project S'Albufera programme are given in Appendix 3.

6. ACKNOWLEDGEMENTS

Once again it is my pleasure to say thankyou to a host of people and organisations for their help with and support of the Project. I thus express my sincerest thanks to my loyal, enthusiastic and hard-working scientific team; an equally enthusiastic set of

volunteers; our very good friends, the Park staff; the organisations of Earthwatch, Earthwatch Europe and Earthwatch España, and their members and staff in Boston, Oxford and Madrid; sponsoring bodies, most particularly Glaxo Holdings p.l.c. and the British Airways Assisting Conservation programme; scientists from several departments of the University of the Balearic Islands; the Balearic Institute for Advanced Studies; the Balearic Invertebrate Study Group; the Natural History Society of the Balearic Islands; the University of Durham's Department of Biological Sciences; our many friends within the Balearic Islands, including Pat and Dennis Bishop, the Bonner family, the Friends of S'Albufera, Bernat Bergas, Cristina Moy... and Nicole Smith (for collecting additional field data for the Project) and many other individuals. We also gratefully acknowledge the input of individuals and groups supporting, undertaking or planning to undertake research on our behalf: Pere Tomàs Vives and MedWet (IWRB); Professor Ed Maltby of the Royal Holloway Institute for Environmental Research; and Dr Rudolf de Groot of the Centre for Environment and Climate Studies, Wageningen. I offer special thanks to Keith Bowey and Sara Hawkswell for directing fieldwork during the enforced absences of the nominated PIs, and Chris Donnelly, Sara Hawkswell and Mike Wood for acting as logistics co-ordinators. Richard Stickney also generously gave of his time to help out with logistics. Of utmost importance to the smooth running of the Project was the steadfast logistic and scientific support and guidance provided by the Park's technical assistant and liaison officer to the Project, Biel Perelló; and the persistent encouragement, interest and effort on our behalf by Conservation Director, Sr. Joan Mayol Serra. No participant will forget, either, the wonderful lunches provided by Park cook, Margalida Moranta. Finally, let it be said that the energy and development of this unusual and remarkable Project draws much from the energy and commitment of Project instigator, the remarkable Max Nicholson, 90 years young in 1994. Happy birthday, Max.

As stated in last year's report, we would not have been able to operate at all without the consent of the Estructures Agraries i Medi Natural section of the Balearic Conselleria d'Agricultura i Pesca. This department has offered far more than mere consent, their high level of co-operation doing much to smooth the way and operations of our research. For this we once again express our sincere thanks to its Director General, Sr. Fernando Garrido Pastor, the Head of Section, Sr. Mateo Castelló Mes, and the Conservation Director, Sr. Joan Mayol Serra.

I am sure that the above list is incomplete. Let me say then, to all who have helped, named or otherwise: many, many thanks. They include all participants in, and visitors to, the Project, detailed in Appendix 1 below.

□

APPENDIX 1 - List of Participants

Principal Investigators

Nick Riddiford (and Dr Terry Wells)

Scientific/Logistics Assistants

Chris Donnelly (Ecological studies, Team I & Team IV Logistics),
Sara Hawkswell (Biodiversity studies, Team III Logistics)

Parc Natural de S'Albufera Advisor to Project

Joan Mayol (Director of Balearic Natural Areas, Mallorca)

Parc Natural de S'Albufera Liaison Officer to Project

Biel Perelló (Conselleria d'Agricultura i Pesca, Estructures
Agraries i Medi Natural)

Cook

Margalida Moranta

Team 1 (27 March-10 April)

Scientists

Keith Bowey (ornithological studies; Acting PI), Rob Strachan
(small mammal studies), Edward Cross (Freshwater invertebrate
studies) Alan Radermacher (reedbed plant-insect interactions),
Christine Donnelly (logistics, first week), Michael Wood
(logistics, second week)

Volunteers

Mark Abbas (UK), Ruth Rosenthal (USA), Susan Steele (Ireland),
Petra Slangen (Netherlands), Xisca Marian Martí Llor (Mallorca)

Team 2 (13-27 April)

Cancelled - shortage of volunteers and funds

Team 3 (30 April-14 May)

Scientists

Nick Riddiford (PI), Sara Hawkswell (logistics - computerisation
of data), Dinah McLennan (botanical studies and illustrations),
Jo Newbould (botanical studies, herbarium)

Volunteers

Gill Barker, Gillian Bourn (UK), Josef Rusnok, Kveta Rusnok

(Czech Republic), Simón Solivellas Vanrell (Mallorca)

Team 4 (22 October-5 November)

Scientists

Nick Riddiford (PI), Sara Hawkswell (Acting PI, first week),
Maria Zas Arregui (Botanical studies), Rod C. Stern (Bryophyte
studies), Chris Donnelly (logistics)

Volunteers

Valerie Bolingbroke, Michelle Chapman (UK), Bobi Lyon, J Nick
Nielsen (USA)

Additional scientist and volunteer contributions

Winter 1993-94

Bergat Bergas, Cristina Moy...: (parasitism of Phragmites stems by
insect larvae)

Nicole Smith: (frog activity patterns)

March

University of Durham, M.Sc. Ecology field course

Winter 1994-95

Nicole Smith: (frog activity patterns)

Identification advisors in U. K.

Barry Goater (Lepidoptera: moths)

Pete Kirby (Heteroptera: bugs)

Colin Plant (Neuroptera: lacewings)

Chris Haes (Orthoptera/Dictyoptera/Dermaptera: crickets &
grasshoppers/mantids & cockroaches; earwigs)

Visitors to the Project

Max Nicholson (Earthwatch Europe)

Antoni Martínez Taberner, (Dept. Biologia, Univ. Illes Balears)

Pat & Dennis Bishop (Friends of S'Albufera)

Juan Carlos Muntaner Cerda (Treasurer, Friends of the Albufera)

Graham Hearl (Mallorca RSPB/GOB representative)

Joan Castany i Alvaro (Organiser, south-east Spanish Moustached
Warbler population studies)
Representatives of Friends of S'Albufera and the Grupo
Ornitologico Balears
Richard Stickney
Tim Crundwell

Staff, Parc Natural de S'Albufera

Joan Mayol i Serra - Director of Conservation
Gabriel J. Perelló i Coll - Technical Assistant
Llorenç Capell - Chief Warden (spring)
Francesc Lillo - Chief Warden (autumn)
Alexandre Forteza i Pons - Reception Centre
Pilar Lacalle Pons-Estel - Reception Centre
Pere Viçens i Siquier - Ornithologist
Jaume Gamundí Capo - Guard
Martí Solivelles - Guard
Manuel Coello Vazquez - Maintenance
Antoni Rayó Amengual - Maintenance (spring)
Domingo Jacinto - Maintenance (autumn)
M'Angels Ferragut Muñoz - Monitor
Antoni Verd Canellas - Monitor
Jeronia A. Bonnin Roca - Monitor
Margalida Moranta Pericas - Cook

APPENDIX 2 - 1994 Fields of Research

The following is a catalogue of information collected in 1994. This information, along with 1989-93 material, has been deposited at Earthwatch Europe's Oxford (UK) headquarters. A second set of the material is held at S'Albufera Natural Park. Details of published material are given in Appendix 4.

Category : Marshes
Title of Work Done :
Phragmites infection by caterpillars.
Catalogue Reference Number : 94/14

Category : Dunes
Title of Work Done :
The impact of grazing: distribution of *Euphorbia terracina* at
Turo de Ses Eres.
Catalogue Reference Number : 94/9

Category : Flora and Vegetation
Title of Work Done :
Vegetation mapping of the park.
Catalogue Reference Number : 94/11

Category : Flora and Vegetation
Title of Work Done :
The pollination of *Ophrys* orchids by invertebrates.
Catalogue Reference Number : 94/8

Category : Flora and Vegetation
Title of Work Done :
Orchis (*laxiflora*) *palustris* survey.
Catalogue Reference Number : 94/10

Category : Flora and Vegetation
Title of Work Done :
Arisarum / Arum distribution survey.
Catalogue Reference Number : 94/16

Category : Flora and Vegetation
Title of Work Done :
Bryophyte survey.
Catalogue Reference Number : 94/19

Category : Vertebrates
Title of Work Done :
Bird habitat choice and time budgets: Coot.
Catalogue Reference Number : 94/4

Category : Vertebrates
Title of Work Done :
Roosting birds.
Catalogue Reference Number : 94/17

Category : Vertebrates
Title of Work Done :
Vegetation description of bird transect 1.
Catalogue Reference Number : 94/2

Category : Vertebrates
Title of Work Done :
Bird population surveys: transects 1 and 2.
Catalogue Reference Number : 94/6

Category : Vertebrates
Title of Work Done :
Ringing studies: condition of migrant birds.
Catalogue Reference Number : 94/1

Category : Vertebrates
Title of Work Done :
Mammal studies: small mammal trapping.
Mammal studies: Mammal observations.
Catalogue Reference Number : RA00

Category : Vertebrates
Title of Work Done :
Marsh Frog studies: population, distribution and activity.
Catalogue Reference Number : 94/18

Category : Invertebrates
Title of Work Done :

Butterfly transects.
Catalogue Reference Number : 94/7

Category : Invertebrates
Title of Work Done :
Butterfly activities.
Catalogue Reference Number : 94/3

Category : Invertebrates
Title of Work Done :
Moth trapping.
Catalogue Reference Number : 94/5

Category : Invertebrates
Title of Work Done :
Invertebrate collection: moths, hoverflies and beetles.
S'Albufera moth list (up-dated).
Catalogue Reference Number : 94/12

Category : Invertebrates
Title of Work Done :
Hoverfly studies.
Catalogue Reference Number : RA70/01

Category : Invertebrates
Title of Work Done :
Aphid survey.
Catalogue Reference Number : 94/13

Category : Invertebrates
Title of Work Done :
Freshwater Invertebrate studies.
Catalogue Reference Number : 94/20

Category : Hydrology
Title of Work Done :
Water level readings.
Catalogue Reference Number : 94/15

Category : Meteorology
Title of Work Done :
Park meteorological data.
Catalogue Reference Number : RP00

Category : Data Management and Biodiversity Studies
Title of Work Done :
Faunal records - species lists.
Ca talogue Reference Number : 94/12

Category : Data Management and Biodiversity Studies

Title of Work Done :

Biodiversity data base (up-dated).

Ca talogue Reference Number : Computer Disk " Project S'Albufera
Biodiversity List "

APPENDIX 3 - 1995 programme details

Project Title

Monitoring for environmental change at S'Albufera, Mallorca.

Research Site

Parc Natural de S'Albufera , Mallorca, Spain.

Principal Investigators

Nick Riddiford and Dr Terry Wells

Team Dates in Field

TEAM I April 9-April 23, 1995

TEAM II April 27-May 10, 1995

TEAM III May 13-May 27, 1995

TEAM IV October 22-November 5, 1995

Team Composition: integrated teams of Scientists, Earthwatch

Volunteers and Mallorcan Students.

Fields of Research

Wetland Monitoring

1. Applying the methodology of the MedWet sub-project on Inventory and Monitoring as a field test (Nick Riddiford; Pere Tom s).
2. Habitat mapping (Nick Riddiford; Chris Donnelly).
3. Wetland nutrient dynamics and wetland functioning (Dr Christopher Baker, Royal Holloway Institute for Environmental Research).
4. Aquatic invertebrates and water quality (Michelle Chapman).

Botanical

1. Orchid population studies (Terry Wells).
2. Herbarium (Jo Newbould; Dinah McLennan).
3. Plant Illustrations/Preparation of botanical interpretation material (Dinah McLennan).
4. Distribution of *Euphorbia terracina* in areas of grazing (Jo Newbould).
5. Fungi (Sheila Wells).

Vertebrates

1. Bird population studies (Nick Riddiford) - transects, body condition of migrants.
2. Bird foraging studies (Mike Wood).
3. Mammal population studies (Rob Strachan: Wildlife Research Conservation Unit, University of Oxford).

Invertebrates

1. Entomology:

- a) insect reference collection (Riddiford; Barry Goater);
- b) studies of Diptera, Syrphidae (Riddiford);
- c) butterfly and dragonfly transects (Riddiford).

Computerisation of Data

1. Program development for standardised data processing and storage (Sarah Hawkswell; Riddiford).
2. Biodiversity studies (Riddiford; Hawkswell).

APPENDIX 4 - List of publications

Details of Project S'Albufera -generated publications are given below. Note that a single asterisk draws attention to publications which have appeared since the last Project S'Albufera report.

*A NON. 1994. Conclusiones de la Primera Reunió nacional sobre la Cel.la marbranca, *Anas angustirostris* . Buttletj del Parc

- Natural de s'Albufera de Mallorca 1: 79-80.
- AS SOCIACIO BALEAR D'AMICS DELS PARCS (ed.). 1990. Seguiment de l'avifauna del Parc, agost 1989-juliol 1990 . Palma.
- AS SOCIACIO BALEAR D'AMICS DELS PARCS (ed.). 1990. Parc Natural de S'Albufera de Mallorca: ornithological overview, August 1989-July 1990 . Palma.
- AS SOCIACIO BALEAR D'AMICS DELS PARCS (ed.). 1991. Seguiment de l'avifauna del Parc, agost 1990-juliol 1991 . Palma.
- AS SOCIACIO BALEAR D'AMICS DELS PARCS (ed.). 1992. Seguiment de l'avifauna del Parc, agost 1991-juliol 1992 . Palma.
- BA RRINGTON, R. 1993. Mediterranean secret. Country 94 (August 1993): 21.
- *B OWEY, K. 1995. Apparent female Moustached Warbler singing. British Birds 88: 113.
- *D IRECCIO GENERAL D'ESTRUCTURES AGRARIES I MEDI NATURAL. 1994. Butlletj del Parc Natural de s'Albufera de Mallorca 1. Govern Balear Consellerja d'Agricultura i Pesca, Palma.
- ES TEVE-RAVENTOS, F. & ENDERLE, M. 1992. *Psathyrella halophila* spec. nov., eine neue Art aus der Sektion Spintrigerae (Fr.) Konrad & Maublanc vom Meeresstrand der Insel Mallorca (Spanien). Zietschrift für Mykologie 58: 205-209.
- EQ UIP D'EDUCACIO AMBIENTAL. (ed.). 1993. Programacio Didactica: Coneguem el Parc Natural de S'Albufera . Conselleria d'Agricultura i Pesca, Serveis Forestals de Balears, Palma.
- *F ERRAGUT, M. A. 1994. L'estudi de papallones diurnes a s'Albufera. Butlletj del Parc Natural de s'Albufera de Mallorca 1: 49-50.
- FO X, R. J. P. 1992. Monitoring Environmental Change at S'Albufera Parc Natural: the role of aquatic invertebrates . M.Sc. in Conservation dissertation, University College London.
- FR ONTERA I SERRA, M. & FORTEZA I PONS, V. 1991. Seguiment dels efectes de la paustura al parc natural de S'Albufera de Mallorca, 1990. Documents tecnicos de Conservaci6 4. SEGONA, Palma de Mallorca.
- *G OATER, B. 1994. Lepidoptera (Heterocera) recorded al s'Albufera Natural Park in 1992-93. Butlletj del Parc Natural de s'Albufera de Mallorca 1: 55-60.
- GO NZALEZ, M. 1993. Applications of Landsat 5 TM for inventorying Mediterranean woodlands in Mallorca . M.Sc. in Environmental Remote Sensing dissertation, Centre for Remote Sensing and Mapping Science, University of Aberdeen.
- HA FNER, H. & HOFFMANN, L. 1990. The Albufera de Alcudia (Mallorca): an assessment of the importance of this wetland for colonially nesting Ardeidae . Station Biologique de la Tour du Valat cyclostyled report.
- HO WE, C. 1989. Albufera: Aspects of Hydrology, Vegetation, History and Management . M.Sc. in Conservation dissertation, University College London.
- JU RADO ESTEVEZ, J. 1992. The usefulness of Landsat TM data for

- vegetation discrimination in S'Albufera de Mallorca - a marsh .
M.Sc. in Environmental Remote Sensing dissertation, Centre for Remote Sensing and Mapping Science, University of Aberdeen.
- MA RCUS, A. 1992. Estimation of soil's surface physical properties using Landsat TM Data in "Es Pla de Sa Pobla-Muro" (Mallorca) .
M.Sc. in Environmental Remote Sensing dissertation, Centre for Remote Sensing and Mapping Science, University of Aberdeen.
- MA YOL, J. 1991. Plan d'us i gestio del Parc Natural de S'Albufera de Mallorca. Documents tecnicos de Conservaci6 3. SECONA, Palma de Mallorca.
- MA YOL, J. 1992. Plan for the use and management of the Natural Park of S'Albufera, Mallorca, 1990-94. Documents tecnicos de Conservaci6 3. SECONA, Palma de Mallorca [English version].
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- *M AYOL, J. 1994. La col6nia d'Ardeids i *Phalacrocorax* sp de s'Albufera de Mallorca en el s.XVIII. Butlletj del Parc Natural de s'Albufera de Mallorca 1: 47-48.
- Mc GOVERN, P. 1993. The use of Landsat Thematic Mapper Data for the detection of urban change in Mallorca (Bahja de Alcudia) .
M.Sc. in Environmental Remote Sensing dissertation, Centre for Remote Sensing and Mapping Science, University of Aberdeen.
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Earthwatch Europe cyclostyled report.
- NE WBOULD, P. 1990. The Albufera, Mallorca, as a Global Observatory. Jornades del Medi Ambient de les Balears 2: 173-174.
- NE WBOULD, P. 1991. *Phragmites* and *Cladium* on Albufera .
Manuscript.
- *N EWBOULD, P. 1994. Monitoring species performance of common dominant plant species. In *Large-scale Ecology and Conservation Biology* (eds: Edwards, P. J., May, R. & Webb, N. R.): 273-292. Blackwell, Oxford.
- NE WBOULD, P. J., RIDDIFORD, N. J. and GRACE, E. 1989. Consumption of *Phragmites australis* at S'Albufera, Mallorca. In *The Albufera as a Global Monitoring Station* (Newbould 1989).
- NE WBOULD, P. J. and RIDDIFORD, N. J. 1990. Monitoring for Global Change: The Earthwatch Europe S'Albufera Project . Earthwatch Europe, Oxford.
- NI CHOLSON, E. M. 1994. S'Albufera - a research framework for the study of Biodiversity. Earthwatch Corporate Environmental Responsibility Group Bull . 7: 11-13.
- *N ICHOLSON, E. M. & CRICK, H. Q. P. 1995. British ornithology and conservation: from past to future. *Ibis* 137 (suppl. 1): S8-S15.
- NI CHOLSON, E. M. & RIDDIFORD, N. 1993. Ecotourism in Mallorca .
Earthwatch Europe Report for the European Community Model of Sustainable Tourism. Earthwatch Europe, Oxford.

- NO BLET, J. F. 1992. Les chauves-souris du Parc Natural d'Albufera, Majorque, Iles des Baleares - Espagne . Report to Earthwatch Europe.
- PALMER, M. and VIVES, J. 1993. Carabidae i Tenebrionidae (Coleoptera) de s'Albufera de Mallorca: Dades preliminars. Boll. Soc. Hist. Nat. Balears 36: 65-76.
- *PARC DE S'ALBUFERA. 1994. Observacions d'oques *Anser anser* amb collar a s'Albufera. Butlletí del Parc Natural de s'Albufera de Mallorca 1: 81.
- *PERELLO, G. 1994. S'Albufera de Mallorca. Us públic d'un espai natural protegit. Butlletí del Parc Natural de s'Albufera de Mallorca 1: 71-77.
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- *PERELLO, G., MAYOL, J. & CAPELLA, L. 1994. Parc natural de S'Albufera. Memòria de gestió 1993 . Govern Balear Conselleria d'Agricultura i Pesca, Palma.
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- *RIDDIFORD, N. 1994. Earthwatch Europe's project S'Albufera, 1989-1993. Butlletí del Parc Natural de s'Albufera de Mallorca 1: 67-69.
- *RIDDIFORD, N. 1994. El mostel, una presa inusual per a l'arpella. Butlletí del Parc Natural de s'Albufera de Mallorca 1: 82-83.
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- *V ICENS, P. & MAYOL, J. 1994. Seguiment de l'avifauna del parc natural de s'Albufera. Agost 1992 - juliol 1993. Buttletj del Parc Natural de s'Albufera de Mallorca 1: 13-31.
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- *V ICENS I SIQUIER, P. & MAYOL, J. 1994. Intent d'hibridaciç de *Passer montanus* x *P. domesticus* . Buttletj del Parc Natural de s'Albufera de Mallorca 1: 81-82.
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Mallorca. Discussion Papers in Conservation No. 52. Ecology & Conservation Unit, University College London.

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□

ANNEX 1

A brief study of the growth of *Phragmites* by Alan Radermacher

Aim

To investigate the extent of infection of the reed *Phragmites australis* by various caterpillars. This is now the fourth investigation I have carried out (October 1992 and 1993; April 1993 and now April 1994). I have therefore been able to compare two consecutive years in autumn and spring of each year.

In October 1992 I assumed that all caterpillars found were *Archanara geminipuncta* in various stages of growth. This was not so. There were several species of large caterpillar (2.5 to 3.0 cm long) which included *Archanara* and a very different small species (0.7 to 1.0 cm long) which was by far the most frequent.

The overall aim has therefore remained basically the same but widened in outlook.

Method

The method of sampling in the field has remained the same throughout. What we have recorded from the stems back in the laboratory has changed a little and become more ordered and precise, though there is still much room for improvement of the data form.

Site 3 (east side of the fossil dune road) was not sampled this time.

Site 6/7 (round the mound) was not sampled quantitatively in the field but a qualitative sample was taken for analysis in the laboratory.

Results

The results obtained in April 1994 are given in Tables 1 and 2.

Table 1. Sample sizes of *Phragmites australis* stems, by category,

in April 1994

Site	Healthy	Infected	Dead	Young	Total
1	10	44	129	106	289
2	61	110	170	70	411
3	-	-	-	-	-
4	68	68	84	68	288
5	10	43	163	61	277
6/7	(Not sampled quantitatively in the field)				

Table 2. Proportions of infected mature, dead and young stems in April 1994

Site	% Infected of mature stems	% of all stems that were dead (excluding young)	% of young
1	24	70	37
2	44	68	17
3	-	-	-
4	30	38	23
5	20	75	22
6/7	(Not sampled quantitatively in the field)		

Comments on results

In my previous three reports I have commented under this heading on each site by number but on review I find that in practice this meant stating the results of our laboratory analysis with a few rather general observations.

This information can be given in table form so that it is more easily digested and any comparisons between sites or times of year can be seen more clearly.

To this end I will present the information in tabulated form at the end of the report together with similar tabulations drawn from my earlier three reports (Table 3). This should serve as a comprehensive review.

Conclusion

None of the small caterpillars were found because they had all pupated. Two thirds of those recorded were in pupal form while the others were "present" only as pupal cases. Last spring we found no larvae or pupae of this species at all. I commented in

my report that it seemed very unexpected. This spring our results did at least follow those of autumn and winter. They showed a very slow but steady development which would presumably be complete by early May. I cannot account for the lack of this species in spring 1993. It is possible our sampling technique missed the stems which had been infected but it is very unlikely that we would have missed them all as I did know the appearance of the stems and would have made sure the teams sampled them for analysis back in the laboratory.

The larger species were similar in their occurrence to the previous year. This, in comparison with the smaller species, means very variable in stage of development and less predictable from the outward appearance of the stem. Frass was present in nearly all stems with insect holes, which one would expect, but the position and size of the hole was variable and often a pupa or pupal case would be in the same internode as the frass - which contradicts the accepted view of the life cycle of *Archanara* in England where there are separate nodes for development and for pupation.

Discussion and review

In this section I shall try to review the findings of all four visits I have made. The locations of the sample sites are given in Figure 1 (also included in my first report of October 1992) and a sample of the data sheet which we used when slicing and examining the stems back in the laboratory in Figure 2.

I will start by reviewing the quantitative sampling in the field. I include a very diagrammatic representation of the four categories we used with brief annotations (Figure 3). The specimens were usually easily assigned if "Healthy" or "Young" though the latter of course grow steadily to become the former and are often very tall. If the "Young" become infected then presumably they pass via the "Infected" category to the "Dead" category and there were some problems of overlap here.

The sample we selected for laboratory analysis came from within each square metre we counted. They would always come from the "Infected" and "Dead" categories but our selection was a little subjective because we only wanted to carry back specimens which were likely to yield positive observations. We would therefore look for the characteristic features I have drawn in the diagram (Figure 3).

Figure 2 is a fair copy of an actual laboratory data sheet filled during my most recent visit. We probably should have made clear whether a sample number was categorised as "Infected" or "Dead"

though this could usually be deduced. For instance sample 1 was "Infected" because there was no external evidence of insect activity (except lateral branches) and there was a 0.75 cm pupa. Sample 2 was "Dead" because it had externally visible holes and internal frass at two levels (internode 2a and 2b).

Table 3 is a summary of results over the four sampling periods, two in spring and two in autumn. This certainly seems to be a much clearer and more meaningful way of presenting results but written comments are usually helpful to lead one through the figures even if the writer thinks they are all self explanatory.

Bird damage was observed in 15-25% of the samples which is a very significant proportion, especially considering that 40-60% of the samples selected were "Infected" and therefore expected to reveal the small caterpillar within and have no bird damage anyway. The percentages can therefore be doubled and this surely shows that what the reeds have to offer is worthwhile for the birds. The site of damage is always related to the position in which the caterpillar was. The bird probably determines the site by the entry hole but it was difficult to calculate the success rate. We might assume that bird damage in an internode which contained an entry hole but no exit hole had been successful but sometimes the entry hole itself is damaged and in other cases a second habitation occurs. In this latter case an exit hole might not mean that a bird attack would go unrewarded. An exit hole should of course indicate to an intelligent bird capable of cognitive learning (!) that it is too late - "the bird has flown" or in this case, "the moth".

The large caterpillars, as has been stated before, give a consistently variable picture. This seems like a contradiction but means there are always two or three species and that they are present as caterpillars (larvae), pupae or pupal cases in no predictable pattern. This is probably because the sample times have not coincided with the high season for development. We are therefore looking at odds and ends of the close season.

As can be seen from the table, "frass" was the most frequently recorded observation. It indicates habitation by a growing caterpillar but the trouble was we could not determine its age. It should have a small exit hole in the internode but not the large exit hole (7-9 mm) through which the adult moth passed. Sometimes pupal cases were embedded in frass which suggests the caterpillar remained in the same internode to pupate surrounded by its own faeces, which is not a very sensible thing to do. Also frass was often present at several levels in one stem. In two stems we found frass in five different internodes and this surely shows a very high level of demand for the reeds as a site of feeding, growth and development.

Now the small caterpillars: it is a pity to have to go on calling these "the small caterpillars" but we have not discovered what they hatch into despite their high frequency and extreme regularity of life cycle and infection site. The eggs must be laid early in the first year of the growth of the reed and the lack of any associated bird damage suggests they are not worth eating. The life cycle is incredibly slow as can be seen by following figures.

	Site 4			Sites 3,4,6/7		
	October	December	March	October	December	March
Caterpillar	9	20	0	53	44	0
Pupa	2	8	9	4	13	35
Pupal case	0	0	5	0	0	19

We are grateful to local volunteers for the December figures which make the progress of the cycle clear. Pupation is just beginning in October but by March over 60% are still pupae. It seems that the process does not stop for the winter but just progresses very slowly indeed.

What thoughts are there for future work in this area? With regard to the "small caterpillar" we need to find out what species it is and this of course means catching the emerging adult. We need to confirm that there is just one cycle each year and whether it is really as slow as my evidence suggests. When and how does infection occur? How does the young caterpillar site itself in precisely the same position each time and why is it that the auxin flow from the terminal shoot is affected so that lateral branches are caused to germinate? Although I have commented on it frequently in earlier reports it will be the most positive scientific memory of my work here.

With regard to the larger caterpillar species we know that one of them is *Archanara geminipuncta* but we do not know what the other two or three species are. We also do not know how many cycles there are per year though just one does seem reasonable. All these species are termed "large" because the caterpillars are 2.5 to 3.0 cm long. If all their life cycles are synchronous, which seems probable, then it may be that the food source provided may be really significant for the Reed Bunting *Emberiza schoeniclus*. I planned a possible field form for recording Reed Bunting activity but attempting to use it for several hours from the mound at Sa Roca was not encouraging probably because it was too early in the year. If such recordings can be made successfully then it may be possible to link this with the data on the Reed Bunting bill size. I have mentioned this in earlier reports but to find a link between the reeds, the caterpillars and the bill size of Mallorcan Reed Buntings would be tremendously

satisfying.

In final conclusion I do hope that one day a research student will be able to gain his doctorate by following up some of these ideas. Hopefully it will soon be possible to spend longer on site thanks to the new accommodation that Max Nicholson, Joan Mayol and others are working to achieve. It is only reasonable that the daily administration of the park should continue from the main building while research students and Earthwatch volunteers should base themselves close by but under another roof. I have thoroughly enjoyed working for Earthwatch at Albufera and hope something develops from my little study in the future.

Table 3. Summary of laboratory analysis for all four visits

	October 1992							October 1993						
Site	1	2	3	4	5	6/7	Total	1	2	3	4	5	6/7	Total
Samples taken:	30	30	8	36	35	30	169	29	31	21	13	35	24	153
Bird damage:	-	-	-	-	-	-	-	12	6	2	2	9	8	39
Large species:	1	0	0	0	2	1	4	1	4	0	0	1	0	6
Pupae:	0	0	0	0	0	1	1	2	4	0	0	0	1	7
Pupal cases:	2	0	0	0	0	5	0	0	0	0	0	0	0	0
Frass:	12	18	4	8	22	15	79	24	24	18	5	16	17	104

Small species:	9	4	4	21	0	6	44	3	8	13	9	10	10	53
Pupae	0	0	0	0	0	0	0	0	0	0	2	2	0	4

Pupal
cases: 0 0 0 0 0 0 0 0 0 0 0 0 0 0

	March-April 1993							March-April 1994						
Site	1	2	3	4	5	6/7	Total	1	2	3	4	5	6/7	Total
Samples taken:	14	12	22	-	50	-	98	23	25	-	32	26	18	124

Bird
damage: 0 2 0 - 11 - 13 3 2 - 1 6 7 19

Large
species: 0 2 0 - 5 - 7 0 1 - 0 0 0 1

Pupae: 0 0 2 - 0 - 2 0 0 - 0 1 2 3

Pupal
cases: 0 1 16 - 7 - 24 0 2 - 3 1 2 8

Frass: 5 6 17 - 31 - 59 9 8 - 16 19 10 62

Small
species: 0 0 0 - 0 - 0 0 0 - 0 0 0 0
Pupae: 0 0 0 - 0 - 0 10 9 - 9 3 4 35
Pupal
cases: 0 0 0 - 0 - 0 3 6 - 5 4 1 19

FIGURE 2 HERE - Page 33

FIGURE 3 HERE - Page 34

ANNEX 2

Bryophytes in the Parc Natural de S'Albufera by R. C. Stern

Introduction

The week of 1st to 7th November 1994 was spent recording bryophytes in the Parc . The bryophytes were mainly confined to a limited number of sites, but a few common species of acrocarpous mosses also occurred occasionally on and at the side of the many kilometres of tracks.

Details of Survey

For recording purposes, eleven sites were surveyed in some detail. These are shown on the map (Figure 1) and are as follows:

1. Between Pont de Ferro and Tower Hide. Mainly short sections of silty ground under trees, including *Ulmus* species, both living and dead with some epiphytes.
2. South side of Canal des Sol. Silty track with some limestone boulders.
3. By northern boundary of Es Murterar. Silty ground and stream bank.
4. North and south sides of Gran Canal from Pont de Sa Roca to east of Bishop 2 Hide. Silty ground under trees and shaded track with limestone boulders.
5. Pont des Anglesos. Stony ground from west of bridge to the sea.
6. Sa Roca. The vicinity of the Parc headquarters. Stony ground, tracks, concrete and stone walls, streams, trunks of *Populus alba* .
7. Three hundred to four hundred metres south of Pont des Anglesos. Sandy ground and *Pinus halepensis* woodland.
8. Ses Punes. Sandy fields and fossil dune with open *Pinus halepensis* woodland.
9. The coastal sand dunes of Es Comf. Open heathland and *Pinus halepensis* woodland.
10. Ca'n Picafort. Open heathland and *Pinus halepensis* woodland. Sandy and stony ground with some old limestone walls.
11. Near Son Sant Joan. Stream.

Results of Survey

Forty-seven species were recorded and are listed below. The most abundant acrocarpous mosses are *Barbula unguiculata*, *Barbula convoluta* (including the var. *commutata*) and *Bryum radiculosum* on tracks including limestone boulders, and on sandy ground: also *Tortella flavovirens* and *Pleurochaete squarrosa* on sandy ground. Pleurocarpous mosses are much less frequent as is to be expected at a low elevation in the Mediterranean, but *Rhynchostegiella tenella* is locally abundant on silty banks and old walls. Hepatics are generally scarce, and almost completely absent from the main part of the Parc.

The range of habitats is limited and the majority of the Parc, comprising reed beds, has no bryophytes. The tracks locally have a significant biomass of bryophytes, particularly where there are limestone boulders at the sides. In the wooded strips between a track and a canal, there is a greater diversity and richness of bryophytes. The sections between Tower Hide and Pont de Ferro are especially notable in this respect. Epiphytes are generally rare, apart from on a few old trees at Sa Roca. *Populus alba* has no bryophytes on it, although many trees have lichens. The *Ulmus* trees, however, in the section between Tower Hide and Pont de Ferro, have a few species of bryophyte epiphytes but no hepatics.

Most if not all of the species have been recorded previously in Mallorca. The list of Koppe (1965) includes all those found in the Parc in 1994 except for *Fissidens incurvus*, *Octodiceras fontanum*, *Zygodon conoideus* and *Dicranella howei*, and there may be taxonomic reasons for certain of these exceptions (e. g. *Dicranella howei* may have been recorded as *Dicranella varia*). There is an old record of *Octodiceras fontanum* at the Font de Son Sant Juan (Rosselló 1981), probably in the same location where it was found in 1994. The species listed by Rosselló (1994) and Riddiford and Wells (1994) were seen in 1994 except for *Pottia recta* (which may have been present in *Pottia* gatherings but could not be determined without capsules), *Didymodon tophaceus*, *Trichostomum crispulum*, *Brachythecium rutabulum* (which may have been mistaken in 1993 for *B. salebrosum* in the absence of capsules), *Cephaloziella baumgartneri* (a very small hepatic easily overlooked) and *Riccia fluitans* (which was searched for without success).

Conservation

The total of over 50 species recorded in 1993 and 1994 is relatively high for a Mediterranean lowland locality with limited habitat diversity. The general management of the Parc must be

regarded as beneficial for bryophytes. There are, however, two aspects which need to be considered.

The first is the importance of retaining trees by the canal, even the dead and diseased elms. The woodland habitat, although it is very limited in the main part of the Parc, is an important one for bryophytes (as well as for lichens), both for the moist conditions under the trees and for the epiphytes which grow on the trees themselves. The general lack of epiphytes is partly because of the relatively small size of most of the trees, as well as the unsuitability for epiphytes of *Populus alba* as the commonest tree, the generally dry climate and possibly some air pollution from the Es Murterar Power Station. It is therefore important that the trees are retained, in particular the elms, not all of which in any case appear to be affected by the disease.

The second aspect relates to water quality. The aquatic liverwort *Riccia fluitans* was recorded by Rosselló in 1981 (Rosselló 1994). It was noted by N. Riddiford in more than one site until about 1990 but could not be found in a search with him in 1994. It seems likely that this species has disappeared as a result of pollution of the water from agricultural chemicals used on the arable land near the Parc on the west side. The moss *Octodiceras fontanum* which was also recorded by J. Rosselló in 1981, was refound in 1994 in a search with N. Riddiford; however, this species is known to be pollution tolerant, unlike the *Riccia*. It is to be hoped, therefore, that measures will be taken to reduce the level of pollution, which has of course undesirable effects on other wildlife as well.

Finally, it should be noted that the southernmost part of the Parc is a location for the hepatic *Petalophyllum ralfsii*. This is an Annex II species in the European Habitats Directive as well as being listed in Appendix I of the Berne Convention as a species threatened because of the destruction of its habitat. At S'Albufera, it occurs on damp stony ground on the inland part of Es Comf (an area known to the project as "Ca'n Picafort woods").

Conclusion

Bearing in mind the unsuitability of much of the Parc, the bryoflora is by no means without interest. It should be monitored from time to time and there is more scope for further examination of the sites listed above as well as surveying of other sites. The author hopes himself to spend more days in the Parc in the next few years. He is grateful in particular to N. Riddiford for enabling this survey to be undertaken and for his support and

encouragement during the course of this work. He also acknowledges the assistance in recording given by some of the personnel involved in Project S'Albufera fieldwork in November 1994 - namely John ("Nick") Nielson, Maria Zas Arregui and Valerie Bolingbroke. At least one specimen of most of the species will be kept for reference in the herbarium at the Parc headquarters.

Nomenclature in the following list is based on Corley et al. (1981), Corley and Crundwell (1993) and Grolle (1983). The numbers 1-11 refer to the sites listed above. F indicates "fruiting" i. e. with capsules present at one or more of the sites. JAR and NR indicate the species has been listed by Rosselló (1994) and Riddiford and Wells (1994) respectively.

Mosses

- Fissidens incurvus* Starke ex Rohl. Silty ground under trees. 1,4. F.
- Fissidens viridulus* (Sw.) Wahlenb. Silty banks and limestone boulder. 1,3,8. F.
- Ocrotia fontanum* (B.Pyl.) Lindb. Attached to aquatic vascular plants in stream. 11. (JAR).
- Dicranella howei* Ren. & Card. Stony ground and limestone boulder. 2,4,8.
- Cheilothea chloropus* (Brid.) Lindb. Sandy ground. 7,8,10.
- Tortula marginata* (B. & S.) Spruce. Walls and boulders. 4,8. F.
- Tortula vahliana* (K.F.Schulz) Mont. Bank of ditch. 3.
- Tortula muralis* Hedw. Walls and boulders. 5,6. F.
- Alouina aloides* (K.F.Schulz) Kindb. Limestone boulders and stony ground. 4,5,8. F. (JAR).
- Pottia starckeana* (Hedw.) C.Müll. Stony ground. 4. F. (Pottias collected at other sites without or with immatures capsules were probably this species).
- Baerula unguiculata* Hedw. Limestone boulders, sandy and stony ground. 2,4,5,8,9,10. (NR).
- Baerula convoluta* Hedw. Sandy and stony ground. 4,5,6,8,9,10. (JAR; NR).
- var. *commutata* (Jur.) Husn. Same habitats as type. 4,6,8,9. (NR).
- Leptobarbula berica* (De Not.) Schimp. Stone by edge of track. 6.
- Psilocrossidium revolutum* (Brid.) Zander. Limestone wall and boulder. 4,8.
- Psilocrossidium hornschiianum* (K.F.Schultz) Zander. Stony ground. 5,9. (NR).
- Dicymodon luridus* Hornsch. ex Spreng. Stony ground and limestone boulders. 4,5,8.

Didymodon vinealis (Brid.) Zander. Limestone boulder and wall. 5,10.
Didymodon fallax (Hedw.) Zander. Sandy and stony ground. 5,,8,9. (NR).
Gymnostomum calcareum Nees & Hornsch. Stony ground and walls. 6,10. (NR).
Trichostomum brachydontium Bruch. Stony ground. 10.
Weissia longifolia Mitt. Limestone boulder. 4.
Pl eurochaete squarrosa (Brid.) Lindb. Sandy ground. 7,8,9,10. (JAR; NR).
To rtella flavovirens (Bruch) Broth. Sandy ground, limestone boulder and pine tree bark. 4,5,8,9,10. F. (JAR; NR).
Timmia barbuloidea (Brid.) M"nk. Sandy ground. 10. F. (NR).
Cinclidotus mucronatus (Brid.) Mach. Trunks of *Ulmus* . 1.
Fu naria hygrometrica Hedw. Stony ground, tracks, woodwork etc. 2,4,6. F. (JAR).
Br yum capillare Hedw. Sandy ground, tracks woodwork etc. 4,5,9,10. F.
Bryum torquescens B. & S. Silty bank. 1. (JAR).
Br yum caespiticium Hedw. Sandy and stony ground. 2,5,6,8,9. (NR).
Bryum bicolor Dicks. Stony ground. 2,6.
Br yum radiculosum Brid. Limestone boulders, sandy ground, stony tracks, wood etc. 1,2,4,5,6,8. (NR).
Zygodon rupestris Schimp. ex Lor. Trunk of *Ulmus* . 1. (JAR).
Zy godon conoideus (Dicks.) Hook. & Tayl. Bark of *Ulmus* , living and dead. 1.
Or thotrichum diaphanum Brid. Trunks of *Ulmus* and *Populus alba* . 1,6. F. (JAR).
Sc orpiurium circinatum (Brid.) Fleisch. & Loeske. Silty banks and bark of *Ulmus* , living and dead. 1. (JAR; NR).
Br achythecium salebrosum (Web. & Mohr) B., S. & G. Sandy ground and pine litter in *Pinus halepensis* woodland. 7,9,10. F. (JAR).
Rh ynchostegium megapolitanum (Web. & Mohr) B., S. & G. Sandy ground by tracks. 4. (JAR).
Eurhynchium speciosum (Brid.) Jur. Silty ground. 1.
Rh ynchostegiella tenella (Dicks.) Limpr. Silty banks, tree stumps and walls. 1,4,6,8. F. (JAR).
Rh ynchostegiella litorea (De Not.) Limpr. Silty bank and damp sandy ground. 1,10. F. (This taxon with slightly shorter leaves than *R. tenella* and a papillose seta seems to be a good species).
Hy pnium cupressiforme Hedw. Litter in *Pinus halepensis* woodland. 9,10.

Hepatics

Lunularia cruciata (L.) Lindb. Silty banks. 1.
Oxymitra paleacea Bisc. ex Lindenb. Damp stony ground. 10.
Riccia sorocarpa Bisch. Damp stony ground. 10.
Fossombronina species. Damp sandy and stony ground. 9,10.
 (probably *F. caespitiformis*, but cannot be determined in the
 absence of capsules). (JAR).
Petalophyllum ralfsii (Wils.) Nees et Gott. Damp stony ground.
 10.
Sottobyia nigrella (De Not.) Henriques. Damp stony ground. 10.
 (JAR).

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 65-66.

FIGURE 1 HERE - Page 41

ANNEX 3

Monitoring water quality at S'Albufera by Nick Riddiford

Thanks to the generosity of one of S'Albufera' greatest friends and benefactors, Pat Bishop, the Park is now in possession of some sophisticated equipment for the monitoring of water quality. The equipment consists of three Microprocessors: an Oximeter, which measures the oxygen content of the water; a Conductivity Meter, which measures the salinity of the water; and a pH meter. All three also measure the temperature of the water.

The equipment is small, light and portable. Samples can be taken quickly and simply, thus allowing a series of measurements to be

obtained from carefully selected sites throughout the Park in the space of a few hours.

Scientists from the University of the Balearic Islands' (UIB) Department of Limnology have tested and calibrated the equipment and say that it is extremely accurate.

Measurements will be made on a weekly basis from selected sites, the selection of which has been done by the Park staff after consultation with UIB and Project S'Albufera scientists. The results will be relayed immediately to the Mallorcan Water Authorities and the UIB's Department of Limnology, as well as being stored for reference at the Park.

The response of the University has been immediate. They have already indicated that three post-graduates will be allocated to analysing these results. There is also some money still available from Pat Bishop's gift and it is hoped, with the permission of Mr & Mrs Bishop, to fund a "Bishop studentship" from this money.

ANNEX 4

Making Biodiversity Data Accessible by Jeremy Harrison

[Editor's note : this paper comprises key elements of the advice notes circulated in preparation for "Making Biodiversity Data Accessible", a meeting held at the World Conservation Monitoring Centre (WCMC), Cambridge, on 26th April 1994].

All over the world, information on key sites is being compiled by scientists and managers for use in management planning and research programmes. However, the need for information on the status and distribution of biodiversity goes beyond individual sites. In order to achieve sound decision-making on the conservation and management of biodiversity it is essential that the expanding mass of relevant data is compiled in a comparative way.

A workshop on monitoring in protected areas was convened at the IV World Congress in National Parks and Protected Areas (Caracas, Venezuela, February 1992). The report from this workshop is attached, as is the congress recommendation on "Information, Research and Monitoring". Particularly relevant are the recommendations relating to protected area managers (section a) and the recommendations relating to international organizations (section d).

In particular, the World Parks Congress called on international organizations to promote the harmonization of information so as to facilitate its exchange among institutions and provide a global or regional context for national level activities and to promote improved communication and coordination among international institutions.

The proposed meeting aims to provide some impetus to this process by bringing together a number of the international organizations collecting information, together with individuals involved in collection and management of information at one site in Spain, which is both an internationally significant wetland and a protected area.

The international organizations involved would include at least the following:

- World Conservation Monitoring Centre
- BirdLife International
- International Waterfowl and Wetlands Research Bureau

and through individuals from these organizations, information requirements of a number of international conventions/programmes would also be covered, including:

- World Heritage Convention
- Ramsar (Wetlands) Convention
- EU Birds Directive
- EU Habitats Directive
- EU CORINE Programme
- UNESCO-MAB Biosphere Reserve Programme
- MedWet Project

The Parc Natural de S'Albufera in Mallorca, Spain, is a Ramsar site, and Special Protection Area under the EU Birds Directive. As a wetland of international importance, the area is also relevant to the CORINE programme, the Habitats Directive, and the MedWet Project. For the last five years, serious effort has been put into a programme of field research and monitoring at the site. The new Environmental Research Centre has now taken over Project S'Albufera under the auspices of the recently created Medi Ambient. This is managed as a partnership between various European universities (including that of the Balearic Isles), the Parc Natural de S'Albufera, and Earthwatch Europe (previously solely responsible for the project).

Proposed orientation of meeting

It is intended that this would be a technical meeting of those actually involved in a day-to-day way with the various projects and information management activities. The meeting would result in a number of recommendations for follow up which would probably then require more strategic decisions to be made by the international organizations concerned.

Participants list

Cristian Ruiz Altaba, Balearic Institute of Advanced Studies
Claire Appleby, World Conservation Monitoring Centre
Robert Barrington, Earthwatch Europe
Nick Davidson, Coastal Review Unit, JNCC
Graham Drucker, World Conservation Monitoring Centre
Harriet Gillett, World Conservation Monitoring Centre
Barrie Goldsmith, University College London
Melanie Heath, BirdLife International
Richard Luxmoore, World Conservation Monitoring Centre
Dorian Moss, ITE Monkswood
Max Nicholson, Earthwatch Europe
Peter Nowicki, European Centre for Nature Conservation/Eurosite
Nick Riddiford, Consultant to S'Albufera Research Project
Mark Roekaerts, Council of Europe Consultant
Paul Rose, International Waterfowl and Wetlands Research Bureau
Pere Tomas Vives, International Waterfowl and Wetlands Research Bureau
Terry Wells, ITE Monkswood

Draft Agenda

1. Introduction to the meeting.

To introduce participants to the context and purpose of the meeting.

2. Presentation on Project S'Albufera , and on the management and use of the information being collected.

Progress and plans at S'Albufera, covering research and monitoring activities, use of the information in management planning, information management, and spinoff activities arising from research and monitoring activities.

3. Review of the types of information required by international organizations.

Brief presentations would be made by participants, and appropriate documentation circulated to identify what is required and why. This should lead to a discussion of the similarities and differences between the requirements.

4. Discussion of opportunities for closer collaboration between international organizations to facilitate improvement in management and exchange at national and international levels.

This is a large subject, and could not be adequately covered in a single meeting. It is intended at this meeting that participants identify the key points requiring attention, in effect setting the agenda for future meetings.

5. Discussion on the opportunities for S'Albufera to function as a model and demonstration centre for the implementation of standard practices developed in collaboration with international organizations.

To cover what S'Albufera needs and expects in order to carry out this role, and what international organizations might expect of S'Albufera.

6. Identification of key follow-up action.

WCMC would provide a rapporteur, who would identify the key actions to be taken, and draft a report of the meeting.

ANNEX 5

S'Albufera as an International Model Biodiversity Site by Nick Riddiford, Terry Wells and Sara Hawkswell

[Editor's note : this paper was a Project S'Albufera written contribution to the WCMC meeting "Making Biodiversity Data Accessible" held on 26th April 1994].

International implications

A major feature of Project S'Albufera is the collection of data by combined teams of volunteers and scientists from a number of countries and, most importantly, the strong involvement, at all levels of local (Balearic) people and organisations (culminating in the establishment of a Balearic-based body, ABEIMA, to administer it). When areas of research are beyond the scope of the fieldwork teams, University departments have been invited to apply their specialist knowledge and resources (e. g. studies in remote sensing undertaken by the Centre for Remote Sensing and Mapping Science, Aberdeen; hydrological, freshwater invertebrate and Moustached Warbler feeding ecology studies by members of the University College London's Ecology and Conservation Unit). The volunteer element and the willingness of scientists to participate for the price of an air fare, provisioning and equipment needs makes an extremely cost-effective means of collecting the data; and local involvement is essential if the data are to be understood and applied. Cost and local input are likely to be important supplementary elements in any development of Biodiversity models.

Forward planning for a Biodiversity Model

We have identified the following as key elements in designing and implementing an internationally compatible biodiversity model.

1. Collect and use baseline data to identify biodiversity indicators for detailed long-term monitoring.
2. Identify abiotic factors whose impact is likely to alter or

change the biodiversity.

3. implement monitoring regimes incorporating the above factors.
4. establish databases to hold inventory and qualitative data on biodiversity, management information and physiological factors (such as climate etc.).
5. develop mechanisms to relate and evaluate relationships between the above, to underpin management and site protection measures.

Database implementation of Biodiversity Model

To implement the forward plan, a structured multi-relational database, compatible with other systems, is essential. We have identified RECORDER. It is a UK standard which can hold both inventory and qualitative data - small changes would enable this to be used elsewhere in the World. The system can be linked into GIS systems and related non-biological data sets.

The JNCC and Somerset Environmental Records Centre are both committed to developing an international version of RECORDER (linked to GIS) but need other partners to ensure that finances are available and expertise to progress the project.

The commitment is there, and the system would enhance enormously the handling and analysis of S'Albufera (and other international) data especially on a temporal and spatial basis.

Biodiversity at the Parc Natural de S'Albufera - Summary of current status

- i) Baseline data have been gathered into an inventory of species covering all vertebrates, vascular plants and a wide range of invertebrates (particularly insects) and lower plant groups.
- ii) all taxa in the inventory have been computerised (on DBase III+ files) in preparation for transfer to a new "customised" system.
- iii) quantitative data have been gathered for a range of biota (e. g. Euphorbia terracina, orchids, birds, several insect groups, freshwater invertebrates). This work is on-going and of an applied nature as part of the Project's monitoring programme.
- iv) quantitative data are being used to underpin the management

work (e. g. data on Moustached Warbler habitat requirements are now influencing revised management planning). Management activities are now being recorded by Park staff and the findings of Project studies are making a major contribution to the formulation of the next Park management plan, currently in preparation.

Implementing Biodiversity Information

An inventory is only the first step. At the simplest level, comparisons of site inventories at regular intervals will demonstrate changes in biodiversity and the extent to which the level of biodiversity has been maintained. More detailed knowledge is, however, needed to understand and propose mechanisms for maintaining the biodiversity. This is being tackled in a number of ways at S'Albufera including: targetting indicator species which are sensitive to environmental factors and/or are significant representatives of particular habitats or ecosystems; studies of the processes at work; interrelationships within each ecosystem; and abiotic influences and impacts on the study site and, importantly, its catchment area.

ANNEX 6

Biodiversity - Channelling Field Data into use in action by Max Nicholson

[Editor's note : this paper was prepared for presentation to the UK Department of the Environment's Biodiversity Steering Group].

1. Worldwide awakening to the indispensibility of biodiversity for the continuance of human as well as all other life on earth has been signalled by the agreements reached at UNCED and its associated meetings, and particularly the signature of the Convention on Biological Diversity by over 150 nations at Rio de Janeiro. Faced with the need to carry out these commitments, the many international and national agencies concerned have lost no time in reviewing the needs for co-ordination of practical action and the agencies and channels having responsibility for it. While much of the basic structure and methodology exists, a major gap is emerging between the general concepts to be applied and the concrete factual data about the components and functioning of biodiversity as it exists in all its complexity in the field.
2. Observations on nature have been accumulating since long before civilisation began, but they remain to be reviewed and structured in conformity with the needs of modern science and of the requirements for sustainable use and conservation of

the earth's resources. In particular:

- (a) traditional ways of observation and even systematic surveys remain dominated by imprecise and fragmentary procedures and recording practices, much of the resulting data being of inadequate quality and scope;
 - (b) in addition, observers and recorders are often unaware of the correct channels and methods for passing on site data in accessible and usable form to those who need it;
 - (c) those operating databases, information services, libraries, archives and other processing and co-ordinating facilities have insufficient knowledge and authority to insist on being supplied with the data they need in the form and with the completeness and regularity which modern users require. Users themselves are largely in the dark about the availability of information relevant to management and decision-making, and how to go about obtaining it;
 - (d) even when information is obtained and its relevance identified, lack of standardisation and comparability between different sources introduces much uncertainty and error in drawing conclusions, and treatment of this aspect is not effectively covered through existing channels. Appropriate methodologies and processes are nowhere plainly authoritative and comprehensive;
 - (e) staff and observers on protected areas have no documented training for such purposes, particularly relating to the end-use of the data they gather, and no one is responsible for helping them with this;
 - (f) while serving such needs is of growing importance to official, scientific and other users who must look particularly to custodians of protected areas to assist them, this is no part of the defined responsibilities of these officers, and is too expensive for them to perform properly without special extra funding.
3. At the UK level, action here is evidently a responsibility of the Department of Environment's newly established Biodiversity Action Plan Steering Group, appointed to "manage the improvement of scientific recording and information databases in order to monitor policies and programmes against the targets...". It may be hoped that this topic will be a subject of early and effective action by the Steering Group.

4. The problem has been the concern during the past five years of Project S'Albufera, operating over the past five years on this Natural Park site on the Bay of Alcudia with the help of the authorities in Mallorca and under the sponsorship of an Earthwatch Europe team supervised by Max Nicholson. This team is now handing over the Project to the new international partnership based in Palma entitled the Associació Balear d'Estudis Internacionals del Medi Ambient (ABEIMA), consisting of SECONA, the official agency concerned, the University of the Balearic Isles and other European, including British, universities, and Earthwatch Europe continuing to take part. ABEIMA has been given official recognition and support for this by the Parliament of the Balearic Isles as the autonomous regional government of this province of Spain.

5. At a meeting convened at Cambridge by the World Conservation Monitoring Centre (founded by the IUCN and other international leaders in this field) representatives of the main international bodies concerned agreed on the importance of filling the gap between international data processors and protected sites by, among other things, developing a series of demonstration models, of which S'Albufera would be one. Special reference was made to Resolution 12 of the IVth World Congress on National Parks and Protected Areas at Caracas, Venezuela in February 1992 on the importance of full information on key ecological elements, processes, interactions and stresses to be made accessible for protected areas. Among its detailed action recommendations was the strengthening of the World Conservation Monitoring Centre (WCMC) "as a scientific co-ordination and data analysis and dissemination agency" developing inventory research and monitoring, helping to secure funding, and encouraging development of standardised data management systems to ensure conformity with international scientific standards. The WCMC has confirmed its agreement with this Resolution and its readiness to act accordingly.

6. In pursuance of these resolutions experts of the Project S'Albufera considered how effectively to build on the mass of material assembled at S'Albufera a generally applicable working model for widespread use. They concluded that three steps were needed. Full evaluation of existing methodologies used within the park and an assessment of their suitability for either collecting inventory data or monitoring change. Identification of key indicators for predicting change within the park, and adaptation or development of appropriate methodologies. Development, expansion and implementation of data handling systems within the park, which should comply

with international standards, including work towards a GIS to relate species data, other environmental factors and management data. These steps would begin to develop an information acquisition and management model at site level compatible with national and international strategies for information exchange. Methodologies and their resource implications should be written in a prescriptive format usable at other sites.

7. On the basis of critical examination of extensive results obtained through systematic work by experienced scientists at S'Albufera aided by picked Earthwatch teams and by the Park staff and other valuable helpers from a number of countries, including the Balearics themselves a sufficient database has been assembled to enable problems of standardisation, practical methodology and co-ordination between disciplines to be tackled in an international perspective. Practicalities of on-site management and cost-effective working have been addressed with success. In the absence of such comprehensive experience over a number of seasons it is not possible to contribute satisfactorily to the development of internationally applicable models.
8. At the next stage the following are identified as key elements in designing an internationally compatible biodiversity model.
 - 8.1 Collect and use baseline data to identify biodiversity indicators for detailed long term monitoring.
 - 8.2 Identify abiotic factors whose impact is likely to alter or change the biodiversity.
 - 8.3 Implement monitoring regimes accordingly.
 - 8.4 Establish databases to hold inventory and qualitative data on biodiversity, management information and physiological factors such as climate.
 - 8.5 Develop mechanisms to relate and evaluate relationships between the above, to underpin management and site protection measures.

In implementing such a programme it is especially important to have the benefit, as at S'Albufera, of a working site Management Plan functioning under an adequate professional staff in full daily contact with events on the area.

9. Complex and important issues arise concerning the development of internationally compatible recording systems and methodologies. While much study is being devoted to these it would as yet be premature to discuss these issues, the agreed resolution of which is a key element in the task. A final plan for bridging the gap depends on detailed discussions between those representing the end users (including land managers, conservationists, protected area managers and information interest as well as researchers) and the field observers and monitors. It will be necessary to define the information requirements of all the end users, the potential contributions of the data processors and services and the capabilities for product supply of those working directly on the biodiversity raw material in the field. We are approaching a point where all these can be practically formulated and married together.

□

ANNEX 7

Project S'Albufera data management system by Sara Hawkswell and Nick Riddiford

Project S'Albufera has amassed a welter of data over the six years of operation and it would be easy to lose control of information if those data were not organised in a sensible, systematic manner. Each year's data is given an immediate reference number beginning with the year followed by a number, allocated chronologically (thus, for example 94/1, 94/2, and so on). This immediate referencing allows easy access and storage of on-going data sets, but for long-term storage, we have installed an archive which uses the accepted and widely used data management system introduced by the British Nature Conservancy Council. This system is set out in full in Site management plans for nature conservation - a working guide, BP edition, Appendix 4 (NCC 1987). The archive is kept at the Casa del Parc, S'Albufera de Mallorca. Additional archives, representing copies of the raw data, have been established at the Earthwatch Europe offices, Oxford, and at the home of Principal Investigator, Nick Riddiford. Project scientists, of course, also hold data sets for their own study and/or discipline.

The NCC data management system references currently employed and their headings in relation to the S'Albufera Casa del Parc archive are listed below.

RV00/01 References
RV00/02 General Correspondence
RV20 Aerial Photographs
RV30/01 Maps - Originals & Masters
RV30/02 Maps - Copies for Use

RV30/03 Compartment Maps & Recording Guidelines
RV50 Archived Physical Records

RP00 Climatological Data
RP10 Hydrological Data
RP10/01 Conductivity Data
RP40 Pedological Data

RH51/01 Visitor Surveys

MM20 Tools & Equipment

AP60/01 Annual Work Plans
AR20 Annual Reports

RF00 Vegetation Data, Including Herbarium
RF02/01 Vegetation Survey - to assess impact of Buffalo Grazing
RF02/02 Vegetation Surveys
RF03/01 Vegetation Data, Sand Dune Transect
RF03/02 Quadrat Surveys
RF20/01 Orchid Surveys/Data
RF20/02 Orchid Pollination Work
RF23/01 Vascular Plant Data - Biomass Productivity of Phragmites
and Cladium
RF23/02 Euphorbia terracina study
RF23/03 Vascular Plants - Phragmites /Caterpillar interaction
RF30 Bryophyte Data
RF60 Fungi

RA00 Mammals
RA00/01 Rabbit *Oryctogalus cuniculus* Survey
RA13/01 Constant Effort Banding Studies
RA13/02 Bird Body Condition Studies
RA14/01 Coot Survey
RA14/02 Bird Migration Transects
RA14/03 Purple Heron *Ardea purpurea* Survey
RA14/04 Moustached Warbler *Acrocephalus melanopogon* Study
RA14/05 Nightingale *Luscinia megarhynchos* and Great Reed Warbler
Acrocephalus arundinaceus Study
RA14/06 Breeding Bird Census
RA14/07 Bird Hide Counts
RA20 Herptiles - General
RA25/01 Frog *Rana (ridibunda) perezii* Survey
RA30 Collect Data, Fish
RA42/01 Butterfly Transects & Surveys
RA42/02 Moth Trap Data
RA50 Odonata
RA70/01 Collect Data, Diptera
RA82/01 Mollusc Survey by Quadrat
RA82/02 Gammarus Key

RA82/03 Pitfall Traps for Terrestrial Invertebrates

RM00 Marine Data

ANNEX 8

Assessment of the functions and values of natural ecosystems and protected areas: a case study of the Parc Natural de S'Albufera , Mallorca by ir. J. H. van Alst,

[Editor's note : this proposal, drawn up by ir. J. H. van Alst, of Wageningen Agricultural University's Centre for Environment and Climate Studies in 1994, was delayed a year by funding difficulties but will now go ahead in 1995 led by another of the Centre's research staff].

1. Background and problem statement

Although it is recognised that natural ecosystems and protected areas are of great importance to human society, their full value is often underestimated in practice. The integration of detailed information on the functions and socio-economic importance of natural ecosystems and protected areas in environmental planning, management and decision-making can help to overcome this problem. In recent years a so-called function evaluation method has been developed by which the required information can be provided in

a relatively quick and systematic manner (Bouma en van de Ploeg, 1975: "Functies van de natuur" en De Groot, 1992: "Functions of Nature").

The descriptions of the cases to which the system has already been applied are largely based on literature. Now it is proposed to apply the system to a protected area in which the management-authorities have to deal with real-time environmental problems. For this purpose the Parc Natural de S'Albufera has been chosen. In this coastal wetland and the only natural park on the island of Mallorca (Spain) surrounding activities like agriculture and tourism have considerable influence on the ecological functioning of the park. Therefore a need exists for detailed information on the park's role in the regional ecology and the links between the park's functions and values and the surrounding activities.

2. Aims

Within this research project three main aims can be distinguished:

1. To contribute to the development of a manual with guidelines for assessing the functions and socio-economic values of natural ecosystems and protected areas, based on the classification as described by De Groot in "Functions of Nature" and with emphasis on functions of which the determination of a monetary value is difficult.
2. To carry out a pilot study assessing the ecological importance and socio-economic values of several functions of the Parc Natural de S'Albufera .
3. To develop a proposal for a more detailed study of the most important functions and socio-economic values of the Parc Natural de S'Albufera which should include suggestions for the conservation, management and sustainable utilization of the park.

ANNEX 9

Mediterranean Wildlife - Team IV S'Albufera 1994 by Michelle Chapman

[Editor's note : I have included this article and the one which follows because they give a good overview of the project, yet in contrasting ways. The first was written from the volunteer perspective and the second from that of a member of the scientific team. Both were unsolicited!].

The first thing that struck me on arrival at the Parc Natural de S'Albufera was the dominance of the reeds. I knew that as a

wetland site these would be the principal vegetation, but I hadn't expected them to tower above me at 15 to 20 feet (c 4.5 to 6 m) in height instead of the usual 5 to 6 feet (c 1.5 to 1.8 m) that I'd seen in England. Almost everywhere you go in S'Albufera, their sighing and whispering follows your every move. I learnt later that the height of the reeds (or *Phragmites*) has been linked to the amount of nitrate found in the water, the concentration varying according to the agricultural run-off entering the Parc 's ecosystem. I found this of particular interest as it tied in with my recently completed studies in Applied Hydrobiology at Cardiff University.

Why had I come to S'Albufera? I had been lucky enough to be awarded an Earthwatch Fellowship, sponsored by Glaxo Holdings p.l.c., to come and help in the study of this wonderful site. The briefing document had prepared me for the variety of work that would be available and I was keen to learn as much as I could. My fellow volunteers on Team IV were Valerie, a retired biology teacher also from England; Bobi (short for Roberta), a landscape architect from California; and Nick (instead of John), a truck driver from Oregon.

Our first full day was spent getting to know the Parc and each other a little better. In the morning we walked to the Tower Hide, almost in the middle of the Parc , in the company of Sara, Chris and Maria (three of the field staff). Our progress was slow as there were many interesting plants, grasshoppers, dragonflies, butterflies and birds to see along the way. We particularly noted the difference between two plant species, *Arisarum* and *Arum italicum* , as one of our tasks would be to complete mapping the distribution of them during our stay at S'Albufera. The Tower Hide is the only elevated hide and gives a wonderful overview of the main canal system as well as much of the Parc . From other viewpoints, it looks like a galleon riding upon a sea of reeds.

In the afternoon, we went to the dune area of the Parc , along part of a butterfly transect that leads to the seashore. Here we tried to determine the difference between the speckled wood *Pararge aegeria* and wall *Lasiommata megera* butterflies, two of the main species to be seen in the Parc . At first I was utterly confused, but soon even I could spot their subtle differences in colour and markings. We ended our day with a walk along the beach and soon we could see some of the pressures upon the Parc 's fragile ecosystem. Tourist development is right next door to the designated protected beach area and there was much evidence of dune erosion and litter as well as the intrusion of the hotel complexes nearby.

The next day was a training day. In the morning we walked to the sluice gates on the Gran Canal to take water level readings.

There are several boards with depth markings sited in different parts of the Parc where these levels can be taken. We were to take two sets of readings every day in two locations at 0900 hrs, 1200 hrs, 1500 hrs and 1800 hrs. The first pair of readings were upstream and downstream of the sluice gates, and the second pair were at either side of the Englishmen's Bridge at the entrance to the Parc. In addition we were to note which (if any) of the sluice gates were open at each location. Nick demonstrated his daredevil attitude by volunteering to clear the reeds in front of the downstream board so that we could take readings using our binoculars. The levels varied quite dramatically during our stay, as Mallorca had had the wettest October for 30 years. This meant that the levels were high at the start of our records and then reduced to more normal levels for the time of year towards the end of our time at S'Albufera. We made out a rota for the water level readings and I particularly enjoyed my cycle rides to Englishmen's Bridge when it was my turn.

In the afternoon, Sara introduced us to the mysteries of habitat mapping, one of the major tasks for our team. We used a modified version of the technique used in the U. K. [a Europe-wide system actually, Ed.] to classify major habitat types. The Parc had already been divided into 5 or 6 types by a previous team, our task was to provide a more detailed map of over 30 types such as dune scrub, heathland, standing water, running water, swamp, built up area etc. Many of the habitat types are characterised by certain assemblages of vegetation, such as Aleppo pine *Pinus halepensis*, gum mastic *Pistacia lentiscus*, juniper *Juniperus oxycedrus macrocarpa* and *Smilax* denoting dune scrub (as long as the pines were not too tall and dominant or if there is more than 40% heather, then the habitat types became coniferous woodland and heathland respectively). The art of determining grid references, taking compass bearings and estimating distances (luckily my pace is about one metre in length) also had to be mastered if we were to map successfully.

The Parc was divided into one-kilometre squares (over 30 in total) and we tackled the first one together to ensure that we were consistent in our approach and that any questions or problems could be answered quickly. Over the next few days we settled into a routine of walking or cycling round allocated squares (or "square bashing" as it was quickly renamed!) during most of the day, and writing up our results in the evening. Most of the time we worked in pairs and I had the pleasure of working with Maria, Valerie, Nick and Mike (another member of the field staff) on a number of occasions. During this exercise we also collected specimens of anything unusual which intrigued us or made notes of anything which could not be sampled. In this way, a number of our walks turned into fungus and plant forays - Valerie could always be relied upon to come back with a good assortment

of vegetation to identify. In this way we found at least another three new plant species to add to the Parc's inventory. I also had the honour of finding a particular species of beetle which Nick Riddiford (renamed Nick Nick by the team so that he would not be confused with the Nick the volunteer!), the Principal Investigator, was hoping to find in the Parc. I found it completely by accident, as I was picking some wild rosemary for a barbecue. I spotted a number of brightly striped red and green beetles brouching on the herb, took a sample and Nick confirmed later that this was indeed the beetle he had been looking for! [*Chrysolina americana* , determined by Miquel Palmer: Ed .]. Nick (the volunteer) proved to be inventive in finding locations for mapping. One of our problems was the lack of hills to get an overview of the area being mapped. Nick soon took to any available tall object - obelisks, trees, windmills, bird hides were all used in his efforts to map the Parc ! In fact Nick turned out to be the champion Parc mapper, often going out on his own to complete several squares or to check upon differences/queries thrown up during quality control (i. e. comparing the mapped boundaries of adjacent squares). One of the daily task lists said it all - "0930 hrs: Nick cycles off to complete mapping his 5,000 squares"! Nick was also our expert "bicycle repair man" making sure our bikes were kept in good enough shape during our stay.

Our other major task during our stay at S'Albufera was a roosting bird survey. At about 4.00 pm (1600 hrs) on about half our days we were sent to various parts of the park to observe the activities of certain species of bird - starlings *Sturnus vulgaris* , cattle egrets *Bubulcus ibis* , little egrets *Egretta garzetta* and white wagtails *Motacilla alba* . At each location we kept a timed diary of the activities of these birds - numbers, direction of flight, where they came down to rest (or roost if it was the last rest place observed) and predator/prey interactions (particularly between marsh harriers *Circus aeruginosus* and starlings - an exciting sight). We did not go to the same places every day - often the location was determined by our observations from the day before (to confirm a location for roosting seen in the distance previously) or from intelligence gathered from the Parc staff and other bird watchers we met. We were dispersed in twos and threes so that as much of the Parc could be covered each time. I particularly enjoyed partnering Bobi on these occasions as she was a very keen bird watcher and we got on together extremely well. On two occasions, we also got up very early in the morning (0530 hrs) to confirm that the birds had not moved from their final roosting places observed the night before. On one occasion, Maria, Valerie and I arrived at the waterworks observation point before dawn to confirm that 500 000 starlings were still there. At first there was total silence, then a whispering noise almost indistinguishable from that of the *Phragmites* , next a noise like rushing water rising to the voices

of the starlings in full cry - it was deafening. Needless to say we had found their roosting place!

From all the individual information gathered on the roosting birds activity, Chris produced a master diary together with a map showing incoming direction and numbers, final roosting areas and dispersal numbers and direction. The egret and starling activities were particularly well documented, the white wagtails not so well as on a number of occasions they did not show where our intelligence gathering had indicated they should be. They were also much harder to identify. Bobi and I had a particularly good session with them flying in from all directions and roosting around the Tower Hide, which provided some of the main data for this species.

Other activities during our stay included baseline data and monitoring activities. This included moth trapping together with bird and butterfly transect walks. Moth trapping involved setting out an ultra violet lamp beneath which was a funnel to take the attracted insects into a capture chamber below. The lamp was set out next to the Visitor Centre in the early evening and left overnight. In the morning we switched off the light and covered the trap with a cloth until after breakfast when we set out to discover the treasures within. On the first morning Nick Riddiford showed us what to do, carefully removing each moth from inside the trap and placing each type in containers for information. Repeat species were released straight away after being recorded on a data sheet. Nick made identification seem very easy and we had a long list of species after just half an hour. We were also introduced to the moth reference collection, a specimen of each moth found in the Parc is kept for comparison with later captures. The collection currently stands at over 250 species. Moths which Nick could not identify straight away were labelled for detailed investigation later; the rest of the moths were released after their identification. The next day, Bobi and I were asked to perform this task and soon realised that it was not as easy as Nick had made out! In an hour we had identified just 10 species and had a long line of unidentified ones. We found the reference collection an invaluable tool; I am sure we would still be identifying moths now without it! Nick was very encouraging about our progress and then proceeded to identify the remaining moths in about 10 minutes flat. From the three times that we set up the moth trap, we found at least 3 new species to add to the reference collection. The trap did not just attract moths, we also found some magnificent beetles. A great diving beetle *Hydrous piceus* was found one morning, clicking away angrily until I released it into a stream nearby. Another evening, Nick Riddiford found the other beetle species he had been hoping to find, a particularly distinctive type of stag beetle with a long horn protruding from its body [*Copris*

hispanus , determined by Miquel Palmer: Ed .].

The butterfly transects (two different ones) were walked on hot, sunny afternoons when the butterflies were most likely to be seen. Nick Riddiford, Valerie, Bobi and I had a very pleasant afternoon walking one of the transects from the heart of the Parc down to the seashore. This meant walking a prescribed eight kilometre route looking for species and numbers of butterflies within 5 metres either side and above the track. The walk is divided into a number of sections corresponding to different habitat types. In addition to recording butterfly numbers and species, the time taken to walk each section and the weather conditions were also noted as these factors may affect the numbers seen. We also recorded the species and numbers of dragonflies seen as they were on the wing in large numbers. Both dragonflies and butterflies are key indicator species for the Parc 's state of health.

The bird transects operated in a similar fashion to the butterfly transects only over slightly different routes; noting numbers and species within a 20 metre distance from the track; and starting out at dawn when the birds are at their most active. The Parc is particularly noted for its variety of bird species - resident, seasonal and migratory visitors, so all our bird studies were of major importance. Nick Riddiford, Bobi and I walked a particularly interesting transect one morning, as it has a section which was damaged by fire a number of years ago. Nick is investigating which species re-visit and recolonise this section and the time period involved. I was amazed to hear the difference between this section and those either side of it as they all appeared the same in terms of vegetation but the fire damaged section was almost silent in comparison with the variety of bird song heard elsewhere. Nick thinks that whilst the vegetation looks to have recovered, the associated invertebrate population has not yet, hence the continued lack of birds in this area. It was also a great privilege to be out with Nick on this occasion as birds are his passion. I had been struggling with my bird book to try and distinguish the different types of warbler found in the Parc . By the end of the walk, thanks to Nick's patient tuition I could happily identify three different types of warbler both by sight and from their calls, together with a host of other birds. Bobi and I became quite an effective partnership during the walk as she could identify birds better by sight and I quickly picked up identification using bird calls. I also saw no less than 4 Hoopoes *Upupa epops* on the walk, the bird I had been most hoping to see during my visit to S'Albufera. On another occasion we broke the record from most Robins *Erithacus rubecula* on a transect: 125, or nearly 20 for every kilometre walked.

Most of our days were long with lots to do. Between us we managed

to work from 0530 hrs to 0200 hrs the next day on most days. I fitted into the early bird category, maximising the amount of time spent in daylight. On the days when there was no early birdwatching, I would go out birdwatching anyway or on early morning walks and cycle rides to take photographs. Early mornings and the sunsets by the Gran Canal were my favourite times in the Parc , when I had it almost to myself. The light at these times was wonderful and my favourite spots were sitting on the bridge over the Gran Canal watching the Purple Gallinules *Porphyrio porphyrio* (one of Europe's rarest birds) or at Xisco Lillo bird hide at the northern edge of the Parc . We did have one day off though, and I elected to go with Sara, Chris and Nick (the volunteer) on a mystery tour of the island. The idea was that we would set off in the direction of Pollensa and just go to any place that looked interesting. Our vague itinerary decreed that this should include mountains, sea and some Spanish culture. We soon deviated from our route finding a small Hermitage perched 300 metres above Pollensa with wonderful views. The Hermitage was inhabited by nuns for over 600 years and is now open as a hostel and rest place for weary travellers. This was well off the tourist route and we all wished that we could stay the night as the place was so peaceful. The tariff for a night's stay was 700 pesetas (about æ3.50) or 500 pesetas "with handbag" - obviously something was lost in the translation! ["sleeping bag": Ed .].

We also visited Pollensa, a small medieval town also well off the tourist route. We entered the town during a thunderstorm and soon our navigation changed from turning left or right to turning upstream or downstream as the streets turned into rivers in the rain! We found a small tapas bar for lunch and once the rain had stopped we climbed the 365 steps to Calvari, a small chapel at the top of the town. At Easter this route is filled with pilgrims carrying replica full size crosses as a penance for their sins of the past year. Each step represents forgiveness for each day's sin. It was an exhausting enough climb to the top without a cross but worth it as the views back towards the Hermitage and over the mountains behind Pollensa were superb. Other highlights of our day included a visit to Cala St Vicente, a small seaside resort now closed for the season, and sunset on top of the mountains overlooking Cape Formentor.

All too soon it was time to leave S'Albufera, though we kept working right until the end. On my last morning's bird watching, I found another new beetle species for the Parc , the Devil's Coach Horse *Staphylinus olens* . This large beetle looks quite formidable and raises its abdomen like a scorpion when startled - a spectacular ending to my time at the Parc ! What did I get out of the experience? Many things. The habitat survey was an important technique to learn and it made me realise just how diverse a wetland area can be, not just reeds and water. This

also helped me to understand why there is such an abundance and diversity of life in these areas and their importance to conservation. I had an opportunity to learn with the experts and to learn far more than I ever could out of books. I also had the privilege to meet Max Nicholson and to share in his experiences in conservation over a period of nearly 60 years. I was able to contribute my own expertise to the project as well as being a volunteer, but I realise now that the way forward in ecology are these broad based studies where all the pieces of the jigsaw are fitted together, not just some of the components. I also had a personal challenge prior to joining the project as I had to learn to ride a bike - I now realise what I have been missing all these years!

Some of my lasting memories include: the hard work put in by Nick, Sara, Chris, Mike and Maria to ensure our total involvement in the work and that everything ran smoothly; bird calls everywhere, particularly from the coots *Fulica atra* and moorhens *Gallinula chloropus* hidden in the reeds; cormorants *Phalacrocorax carbo* hanging their wings to dry at Xisco Lillo hide; sunsets and quiet half hours of contemplation by the Gran Canal; singing at the top of my voice with Maria and Bobi whilst cycling on the way home from bird watching; Maria teaching me the proper way to make Spanish Tortilla; singing frogs at night; early morning cycle rides to capture the light on the Gran Canal and Englishmen's Bridge; and trying to get as much as possible out of every day. I hope I will return to S'Albufera soon.

ANNEX 10

Albufera - A personal overview, 1992-1994 by Alan Radermacher

I have visited Albufera once as a volunteer and three times as an assistant scientific investigator. I was told the site was the flag ship of Earthwatch Europe and that I should use my sponsorship to go there. After my first visit I observed the twelve volunteers closely and compiled a list of pros and cons for such a trip. After three further trips, admittedly to the same site, the reasons still hold good so I repeat them here.

Reasons for not going:

- (1) It is far more expensive than a holiday package trip to the same place.
- (2) There will be a minimum of sight-seeing visits.
- (3) There will not be a variety of restaurants to visit in the evening.
- (4) There will be a lack of freedom to do what you want.
- (5) You cannot choose the type of accommodation that would suit you.
- (6) You cannot choose the type of people you want to go with.
- (7) You can never be sure if the subject will be as interesting as you thought it would be.

Reasons for going.

- (1) Some may be retired and seeking something different before it is too late and have saved enough money to do so.
- (2) Some may be particularly enthused by the environment in its

- broadest sense and want a positive close-up view of it.
- (3) Some may be particularly enthused by the actual topic either professionally or as a hobby.
 - (4) Some, still youngish, have done the beach bit and are exhausted by sightseeing.
 - (5) Some, of any age, may like to be organised in a positive way.
 - (6) Some may wish to return to a learning situation having been deprived of this by a traditional job or bringing up a family.
 - (7) Some, of any age, may be enthused by the thought of working with experts. This is an opportunity to enter what may be seen as a rather remote world and observe the cutting edge of investigations.
 - (8) Some may be school teachers who need a fresh input into their jobs. Maybe they need new material to discuss and teach.
 - (9) For some there is a particular fascination for group spirit with a common aim, the forced companionship and the excitement of an unknown mix.

With regard to Albufera itself these arguments can be applied more specifically.

To quote the Oxford office "It is not a sexy project". That is to say it is not sited in a distant land with evocative animals peering down through a dripping canopy. The site is a flat homogenous marsh with endless reeds growing from semi-stagnant water that is mosquito ridden at certain times of year.

There is a great variety of projects and it is sometimes difficult to strike a balance between this variety and the need to become proficient at certain skills so that the Volunteer can feel involved and appreciate the ongoing nature of the investigation.

Some have considered that the living conditions are cramped and lack privacy permitting the spread of air-borne pathogens and night noises.

These points are however of no significance when one considers the overall interest and importance of the site.

There are many scientists from different disciplines and often from different walks of life. This is stimulating for the scientists as well as the Volunteers. Imagine the combination (Spring 1994) of a Norfolk farmer leading a freshwater invertebrate group consisting of a New York house wife, a Mallorcan barman and a school pupil from Manchester.

The variety of work is tremendous. It is possible to work on ten

different projects during the fortnight with several different scientists and to take over responsibility for some of these in the second week.

The physical nature of the site may not be dramatic but it has an atmosphere all of its own. Marsh Harriers *Circus aeruginosus* keep Reed Buntings *Emberiza schoeniclus* on the hop, semi-wild horses graze the swamps and a cacophony of frogs insures the nights are noisy.

Living may be congested but this increases the inter-lingual spirit of communication and laughter.

There can be few Earthwatch sites which involve so many scientists. This may seem an expensive luxury but nearly all the scientists pay for their travel. As a sponsored Volunteer even my train fare to Luton airport was paid for but now I am actually working for the project and I pay for it myself. The scientists pay their own way because they feel that the project is worthwhile. They also spend many hours writing up their reports because they feel that such reports may have long term significance. It is also very enjoyable partaking in original science and communicating with other scientists and Volunteers.

One important aspect of the Albufera project is that it depends on a good relationship with Spanish workers and conservationists. We must not be seen as foreigners who do their own thing and push off. Not all Spanish people shoot, eat and develop their environment. Local Volunteers are always in the groups. They are recruited by the excellent Biel Perelló who is the thoughtful and perceptive Assistant Director of the Park.

All the projects being carried out at Albufera by Earthwatch Volunteers depend tremendously on the administration of the senior investigator, Nick Riddiford. His all round environmental knowledge is impressive but just as important is his fluency in Spanish. This enables him to communicate not only with Park staff on a day to day basis but at a higher level with Spanish officials when the need arises. An awareness of the Spanish view is important for the success of our involvement in Mallorca and Nick plays a vital role here. For concrete evidence of the work one need look no further than the impressive 166 page report (Riddiford & Wells 1994). It includes the detailed write-up of 18 separate pieces of work, all carried out in 1993. It is all meticulously checked and put together by Nick. He called me one evening from Fair Isle to say that my *Phragmites* figures did not add up and wondered if there was some hidden significance. I have not seen many Earthwatch reports but I cannot believe that there are many as impressive as this.

Finally I must record the debt we all owe to Max Nicholson for realising the potential importance of the site and playing such an important part in helping to save it from the developers.

Reference

Riddiford, N. & Wells, T. 1994. Monitoring for Environmental change. The Earthwatch Europe S'Albufera Project. A summary report of the fifth season's work 1993 : 61-62.

ANNEX 11

A study of roosting birds at the Parc Natural de S'Albufera , autumn 1994 by Chris Donnelly and Nick Riddiford

Aims

The aim of this study was to establish the following:

1. Location of roost sites
2. Size of roosting population
3. Time of going to roost
4. Level of disturbance at roost by predators

A further, secondary, aim was to test the feasibility of using volunteer help to collect the data.

The key species (in relation to population size, obviousness and ease of identification) chosen for the study were Starlings *Sturnus vulgaris*, Herons and Egrets (*Ardeidae*), Swallows *Hirundo rustica* and White Wagtails *Motacilla alba*. Insufficient data were collected for Swallows and Herons and the study therefore concentrated on Starlings, Egrets and White Wagtails.

Methods

Observations were made of the following activities:

1. PRE-ROOST GATHERING

- Location of pre-roost gathering sites
- Number of birds gathering
- Time of gathering
- Direction of arriving birds
- Direction of birds leaving

2. ROOSTING

- Location of roost sites
- Number of birds roosting
- Time of entering roost
- Direction of arriving birds

3. POST-ROOSTING

- Time of leaving roost
- Numbers leaving roost
- Direction of birds leaving

4. OTHER

- Predator disturbance and interactions (pre-roost aerial, pre-roost ground, at roost) including species identification where possible
- Pre-roost aerial manoeuvres

Observation times

Observations were made over a period of days from 25/10/94 to 4/11/94. A selection of sites were covered each day for one to two hours leading up to dusk and, when possible, from just before dawn for one to two hours. Dusk was defined as the time when it was too dark to reasonably collect data on the target species, which was earlier on dull days but generally fell within the time

period 1800-1815 hrs. The first light of dawn was noted as 0620-0630 hrs. The locations from which observations were made are given in Table 1.

Observation points and key roost and gathering areas are depicted in Figure 1.

Table 1. Location of observation sites

No.	Code	Grid Reference	Name
1	SR	091054	Sa Roca Mound
2	WW	099033	Water Works Hide
3	TH	079053	Tower Hide
4	WL	092022 *	Windmill
5	MF	085028	Melon Field
6	PG	087032	Park Gate
7	FP	066045	Frog Pond
8	BG	088071	Buffalo Gate
9	XL	087067	Xisco Lillo Hide
10	QR	105016 *	Quarry

* Approximate locations

Results

Egrets

Two species, Little Egret *Egretta garzetta* and Cattle Egret *Bubulcus ibis* regularly gathered in one area - Tancat de Sa Roca. However, separate counts for each species were not always achieved. This was due to the poor light conditions, distance from birds, unclear views and insufficient identification skills of some observers. Thus counts for Little and Cattle Egrets were usually lumped.

Pre-roost gathering

Observations were made on eight evenings. Table 2 gives the earliest and latest egret arrival and departure times, the number recorded at those two times, and the total number of arrivals and departures recorded. On some evenings birds were already at the site when observation began, including the earliest observation at 1600 hrs. The last arrival was at 1804 hrs. The start of the gathering activity was not clear, partly because some birds frequently foraged there during the day - and indeed foraging, including by birds which had arrived at the time of pre-roost

gathering, continued right up to the time of departure. The earliest apparent time of departure for the roost was 1639 hrs, on 3/11, when 26 birds flew on a heading of 330° - a bearing which would take them towards the Xisco Lillo area. Figure 2 depicts the number of arrivals and departures in each direction (when direction was recorded). The majority of birds arrived from the south whereas departures were mainly on north-east and north headings. It was not possible to calculate the average time spent at the gathering site because of the wide range of arrival and departure times. Such information could only be obtained by the study of individuals, which was not done.

Roosting

Only one roost site was found - the lagoon in front of the Xisco Lillo hide. Observations until dark and before dawn the following day suggested that birds were roosting in fairly open situations, the birds being seen at first light in the small Tamarisk *Tamarix* trees surrounding the lagoon where they had taken up position the night before. The species roosting there comprised Little Egrets, Cattle Egrets and one Great White Egret *Egretta alba* - roosting alongside Cormorants *Phalacrocorax carbo* (one Cormorant count: 38). Table 3 gives the times of arrival, the number of birds at that time and the total number of arrivals seen. The roost site is observable from both the Xisco Lillo Hide and the Buffalo Gate. On both evenings birds were already at the roost when observation began. Records of birds entering the roost, observed from other observation points, are also given. Figure 3 depicts the number of arrivals from each direction. The majority were from the east but a considerable number also arrived from the west.

Post-roosting

Table 4 gives the times of departure from the roost, the number leaving at that time and the total number of departures seen. The maximum seen at any one time was 187 on 4/11. This was a morning count, but on that morning 39 birds remained at the roost when observation ended yet only 92 were recorded leaving. Full view of the site was obstructed by vegetation and light conditions were obviously not good. Though it is possible that the extra birds were still there, unseen, the most likely explanation for the discrepancy in numbers is that some departures were missed. Figure 3 depicts the number of departures in each direction, the majority heading south-west and west. Three birds were recorded arriving at Tancat de Sa Roca from the north-east on the morning of 29/10 but there were no certain records of birds flying there directly from the roost.

Other activities

Disturbance at the roost by predators was noted on at least three occasions, in the evening and on both mornings when observations were made, when Marsh Harriers *Circus aeruginosus* flew over the roost and birds were seen to fly up, circle and return to the roost. The birds reacted similarly on one occasion when gunshot was heard.

Species differences

Although exact numbers were not recorded, on both mornings the majority of birds at the roost were Cattle Egrets. On 4/11 the Little Egrets began to preen earlier than the Cattle Egrets and the last Little Egret left the roost at 0724 hrs while 39 Cattle Egrets remained until at least 0821 hrs. At Tancat de Sa Roca, when the species were counted separately, Cattle Egrets outnumbered Little Egrets on three evenings (20 to 5 on 26/10, 69 to 15 on 28/10, 69 to 9 on 29/10), but on a fourth evening (31/10) there were 21 Little and only 16 Cattle Egrets.

White Wagtails

Gathering

Only one clearly defined gathering site was recorded - the Water Works (La Depuradora), where gatherings of over 400 were recorded. However, a combined total for all evenings observed of 86 birds arriving near the Tower Hide, with most birds dropping into the reeds and 27 (in one evening) at the Buffalo Gate, again dropping into the reeds, sometimes near the Xisco Lillo hide lagoon, may also have represented pre-roost gatherings. There were a few records of birds dropping down alongside the Gran Canal in the Sa Roca area. Figure 4 is a summary of the number and direction of birds seen flying over the observation points. The numbers shown are the total sightings in each direction over a period of days and therefore do not represent the size of the population. Exact comparison between the sites is also not possible as some sites were observed more fully than others. All observations were made in the evening. The birds may not have flown directly over the observation point and therefore the diagram shows only the general direction of flight. Some of the records were difficult to assess as wagtails frequently changed their direction of flight and it was known that some passed an observation point more than once, including in opposing

directions. Two major patterns do emerge, however, based on observations from the Tower Hide and at Sa Roca, though they are conflicting. They comprise a strong north and north-east movement over the Tower Hide and a marked tendency to take a south-west or south-east heading at Sa Roca.

Figure 5 shows the pattern of activity at different times on a number of days. The figures represent the number of sightings of groups of 40 or more birds in flight. Observations began and ended at different times on each day and the earliest and latest records are therefore not necessarily representative. The period from 1700 hrs to 1800 hrs was usually covered, however, and the recorded peak at 1740 hrs is probably representative.

On 31/10 a flock of 16 flying at the Tower Hide at 1625 hrs was followed by no further records until 1728 hrs after which sightings were regular. There was a similar pattern at Frog Pond on 1/11, when a flock of 50 flying at 1627 hrs preceded by over an hour the next record, which was not until 1736 hrs. On 1/11 regular sightings at the Tower Hide began at 1659 hrs. The 500 birds recorded flying south-west at Sa Roca were seen at 1727 hrs and the 400 gathering at the Water Works was recorded at 1734 hrs. The earliest White Wagtail record at the Water Works was 1702 hrs.

Roosting

No clearly defined roost sites were located although birds dropping into the reeds, particularly near the Tower Hide, may have been arriving to roost. There was, however, one record here of birds leaving the reeds, a flock of 12 from alongside the Gran Canal. The earliest recorded arrival was 1722 hrs at the Tower Hide and 1725 hrs at the Buffalo Gate.

Post-roosting

No significant observations were made of this species at dawn.

Other activities

Twelve birds were recording "flying out of the way" of a Marsh Harrier but no other predator interactions were noted. However, a flock of 15 was recorded mobbing and pursuing a Ruff *Philomachus pugnax*. Birds were seen feeding as they gathered at the Water Works.

Starlings

Due to the large number of birds and a flight behaviour comprising groups constantly amalgamating and separating, circling in dense flocks and descending into the reeds temporarily, precise recording of numbers proved very difficult and some records were missed as observers were unable to watch the activity of a number of flocks at the same time.

Gathering

Large flocks of 7000 or more and smaller flocks of c 200 were recorded flying into the area of the park on a number of headings, but erratic flight patterns and constant changes of direction made their initial arrival headings very difficult to assess. Both large and small groups were seen to go down into the reeds only to rise up again and, usually, move on to a different site - often after some time spent flying over a large area of the park. On three occasions, 28/10, 29/10 and 3/11, a large number of birds, judged to be the majority, descended into the reeds for some time only to fly up again and move on to a final roosting site. The birds selected the same initial and the same final site on all three occasions.

Accurate estimates of the number of birds were not achieved on most evenings. This was due to the restrictions of observing from one point and the difficulties encountered in counting flocks which continually fragmented or amalgamated into dense groups. The general lack of experience shared by most volunteers was another contributory factor, though the presence of an experienced counter on the last few days produced more accurate counts. Table 5 gives the minimum number counted each evening.

The earliest recorded arrival in the park was 1610 hrs on 31/10 (100 birds flying south, seen from Sa Roca).

Roosting

Only one roost site was located - to the west of the Water Works. Figure 6 depicts its approximate location and the location of the "pre-roost" site recorded on each of the three evenings.

Table 6 gives the time of main arrival at the roost site in comparison with the first recorded arrival in the park and the "pre-roost" gathering on each of three days.

Post-roosting

Departure from the roost was only observed on one morning, from the Water Works. The first movement from the roost was recorded at 0653 hrs.

Other activities

No clear feeding activity was recorded although birds were recorded gathering in trees on farmland at the edge of the park.

There were 60 records of Marsh Harrier activity which directly involved Starlings. Most were while the birds were in flight, but Marsh Harriers were also observed flying low over Starlings in the reeds, causing them to take flight and re-group in flocks. There were also records of interactions with other species - one involving 2 Merlins *Falco columbarius*, two involving a Kestrel *Falco tinnunculus*, one involving a Peregrine *Falco peregrinus* and three involving unspecified falcons *Falco*. Starlings were observed "mobbing" the predator on numerous occasions. No actual predation was witnessed, either in the air or from the reeds, although as predator activity was frequently in failing light or distant from the observers, "kills" may have been overlooked. In the period approaching dusk, Marsh Harriers were invariably to be seen quartering the reedbeds of the park's southern and western sectors. Observations such as three Marsh Harriers seen from the Tower Hide flying towards the south shortly before the arrival of Starlings in that sector may have represented movement into that area by raptors drawn to the Starlings as a potential food source. Predator activity was also recorded as the Starlings left the roost in the morning, including on one occasion a total of 9 Marsh Harriers flying amongst them.

Discussion, conclusions and possible future investigation

Egrets

Only one roost site was found - at the Xisco Lillo hide lagoon. Though it was not possible to achieve synchronisation between counts from separate observation points, it seems probable that the birds departing to the north and north-east from the gathering site at Tancat de Sa Roca and those arriving at the Xisco Lillo hide area roost site were mainly the same, and that this roost site was used by the majority of birds observed during

the study. However, a number of birds was recorded flying in other directions just before dusk and further investigations could perhaps lead to the discovery of other roosting sites outside the park.

Only one gathering site was found, at Tancat de Sa Roca. However, a substantial number of birds arrived at the roost site from the west and this, along with several observations of birds flying east along the northern edge of the park towards the roost, could indicate the existence of other gathering sites. On the other hand, these records may have involved birds flying direct to roost from their foraging areas. Departure from the roost was mostly to the south-west or west, which may indicate that the most important foraging areas occurred in those directions. Few birds were seen at Tancat de Sa Roca during the dispersal period and only three were recorded as arriving from the direction of the roost.

The highest recorded number of roosting birds was 187 but, with less than perfect observation conditions pertaining, the roost population size may have been rather higher. Location of a better observation point for seeing arriving or departing birds is needed to achieve more comprehensive counts, although observations over several days, morning and evening, might also provide a more accurate picture of the population, particularly if this could be combined with a comparison of numbers seen at the gathering site and the roost site over a similar period.

The earliest time of entry to the roost was prior to 1608 hrs and the latest arrival time was 1825 hrs. Observations were, however, only made on two days and birds were already on site on both days. Earlier observations are needed although some birds may use the lagoon there during the day. The earliest apparent departure from the gathering site for the roost was 1639 hrs and the latest was 1922 hrs.

Marsh Harriers were seen to disturb the roosting birds on three occasions although no actual predation was seen.

White Wagtails

Specific observations are needed at particular sites, such as the Tower Hide, the Sa Roca Area and the Xisco Lillo hide area, to establish whether the birds are roosting there. Despite a series of apparently random and variable flight directions, comparatively large numbers were recorded flying north, north-east and east from the Tower Hide and south-east and south-west from Sa Roca. This may indicate more than one roost site, or possibly gathering site, located in those general

directions. The birds flying south from Sa Roca may have been heading for the Water Works but further investigation is needed to establish whether the birds seen from the Tower Hide were flying to a site in the north. Better information about the direction of dispersal from the Water Works could also be important.

The level of gathering activity seemed to be relatively high between 1715 hrs and 1800 hrs but more comprehensive and consistent study is needed to record a more accurate pattern. If the birds arriving at either the Tower Hide or the Buffalo Gate were arriving to roost, the earliest roosting time recorded was 1722 hrs. Latest roosting times were not established because activity generally seemed to continue after we had ceased observing in rapidly failing light.

Starlings

One roost site was recorded - in the area to the west of the Water Works. Due to the large numbers of birds it is unlikely that another major roost site was overlooked, although smaller groups may have roosted elsewhere. The windmill and quarry proved useful observation sites but more sites with a clear view would be useful.

The maximum number recorded was approximately 750,000 on 3/11. Although more accurate counting may only have taken place in the last few days, the numbers did seem to increase over the period of study.

Observations from a variety of viewpoints are needed to record the birds' first approaches to the park and thereby the start of gathering activity. The approximate time of main arrival at the roost was 1720-1740 hrs on the three days that comprehensive observations were made.

Due to the difficulty in counting and the fragmentary nature of the numerous flocks, a team of at least two volunteers supporting a skilled counter would be needed to obtain a relatively accurate picture.

Methodology, volunteers and further study

Volunteers can obtain valuable data, but the species should be easy to identify, and a comprehensive but easily completed record form is needed to ensure that the most essential information is recorded. For further study, observations by teams of volunteers

concentrating on one particular species is recommended.

Acknowledgements

We cannot finish this report without mentioning the energy and enthusiasm of 1994 Team IV. We especially thank Bobi, Michelle, Nick and Valerie, our hard-working volunteers, for dusk and dawn commitment in collecting the data; and pay particular tribute to Nick for his efforts to locate "ideal" observation points, covering enormous distances in the process, and to Bobi for tackling the task of collating and undertaking initial analysis of the data.

□