

MONITORING FOR ENVIRONMENTAL CHANGE
THE EARTHWATCH EUROPE S'ALBUFERA PROJECT
A summary report of the third season's work
at S'Albufera Natural Park, Mallorca

by

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and

DR FRANKLYN PERRING

(Principal Investigators, Project S'Albufera)

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(by Keith Bowey & Nick Riddiford)

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MONITORING FOR ENVIRONMENTAL CHANGE

THE EARTHWATCH EUROPE S'ALBUFERA PROJECT

1. INTRODUCTION

This report outlines the third season of fieldwork for Earthwatch Europe's Project S'Albufera, carried out at S'Albufera Natural Park, Mallorca by a team of ecologists and volunteer fieldworkers. The Project's aims were the same as in the first two years, but the means of achieving them changed slightly. Fieldwork again involved Earthwatch and Mallorcan volunteers assisting and working alongside specialist scientists. However, staff and students from the Ecology and Conservation Unit of University College London, who were instrumental in giving the Project its initial impetus, were no longer involved. Another departure was the introduction of a two-week fieldwork period in the autumn and the additional participation by scientists and resident Mallorcan volunteers in studies outwith the designated Earthwatch Europe sponsored fieldwork periods.

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 two years' progress in Newbould & Riddiford (1990) and Riddiford & Newbould (1991). 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.

In 1991 spring fieldwork comprised three periods of two weeks, each separated by two days reserved for review of information gathered and further planning. The first team comprised 3 supervising scientists and 4 volunteers. There were 8 scientists and 7 volunteers in the second, and 3 scientists and 1 volunteer in the third. The autumn team comprised 5 scientists and 5 volunteers. Team dates were 2nd-16th April, 19th April-3rd May, 6th-20th May and 14th-28th October. Participants were drawn from a number of countries, emphasising the international nature of the Project. Scientists were mainly British, but we were pleased to welcome two scientists, Dr Adam Kertesz and Dr Olga Morozova, from the Geographical Research Institute of the

Hungarian Academy of Sciences; and Dr Enrique Descals and Dr Antoni Martinez of the Universitat de les Illes Balears (UIB) were frequent day-visitors and advisors. Seven volunteers were from the United States, five from the United Kingdom, one each from Holland, Mexico and Canada and two from Mallorca (both students from the UIB). Two of the UK participants were sponsored by the Rockware Group Plc. The responsibility of overall planning and supervision was shared by Principal Investigators, Dr Franklyn Perring and Nick Riddiford. The studies also benefited from the expert advice and assistance of all participating scientists, in particular Professor Palmer Newbould, the Project's Principal Investigator in 1989-90, and the Park's director, Sr. Joan Mayol. Details of all participants are given in Appendix 1.

2. FIELDS OF RESEARCH

The following is a summary of research by Earthwatch Europe's Project S'Albufera in 1991. Fieldwork was organised into nine categories of research. Research included some repetition of surveys and studies initiated in 1989 or 1990, expansion into new areas within existing categories and a first study in one additional category, Geology/Geomorphology. These are described below (and see Appendix 2 for more details).

Aquatic Systems

Hydrobiological studies comprised a continuation of a study begun in 1989 relating the distribution of aquatic macrophytes and invertebrates to the pH and salinity values of the water by sampling these at a series of sites throughout the marsh. This study is considered integral to an overall understanding of S'Albufera's marsh system. See Riddiford &

Newbould (1991) for further descriptions of methodology and Wood (1991) for methodology and 1990 results.

Marshes

Studies were repeated of the botanical composition of permanent marshland quadrats, and of biomass and productivity of *Phragmites australis* and *Cladium mariscus*. Marshland quadrat methodology and 1990 results are given in Wood (1991). Results of the biomass and productivity of *Phragmites australis* and *Cladium mariscus* are presented in Annex 1 of this report.

Dunes

a) Coastal dunes . The problem of relocating and recording the sand dune transects was considered in May. In October dune transect 1 was recorded in great detail over the first 280 metres towards the shore from the Ca'n Picafort road, and its route clearly marked with posts.

b) Fossil dunes . In May the stabilised dune quadrats were revisited. Whilst the quadrats were not re-recorded advantage was taken at the later date (mid May rather than mid April of previous years) to check and, in some cases, change the identification of plants previously seen only in the vegetative state.

For further details of dune studies, including methodologies, see Wood (1991) and Riddiford & Newbould (1991).

Flora

a) Species populations . An important new study was established to monitor long-term recruitment and survival rates of orchids. The study was designed by Terry Wells, an orchid population specialist. Using techniques he had evolved in Britain, he located and mapped the exact position of all orchid

plants within three large quadrats. These were situated at two sites in the fossil dunes and at one particularly rich marshland site for *Orchis palustris*. Results of his study are presented in Annex 2 of this report.

b) Total list . Work continued to draw up a comprehensive list of known S'Albufera flowering plants and to add to the herbarium established in 1989. Many species were also illustrated by drawing and photography.

c) Fungi . A collection of fungi fruiting bodies was made in April 1991 by mycologist, Sheila Wells, to expand our knowledge of the species present at S'Albufera in spring. Results of her survey are presented in Annex 3 of this report. This is the first study of fungi undertaken by the Project and adds to information collected previously by S'Albufera warden, Xisco Lillo.

Invertebrates

a) Butterfly and dragonfly transects . The butterfly transect from the Torre to the northern part of the Es Comu sand dunes was repeated and dragonflies were recorded on the same transect. In 1991 we were able to extend the period for which data were obtained thanks to Mallorcan volunteer, M'Angels Ferragut, who continued the transect throughout the summer. Further data were collected from the transect in October. A second transect, from north to south through the Es Comu sand dunes, was established in spring 1991. Details of methodology are given in Annex 4 of this report.

b) Invertebrate database . The on-site reference collection of specimens was extended (though still mainly restricted to moths and hoverflies) and work was continued in establishing the identity of other insect species occurring at

S'Albufera. Work in 1991 to extend the database is described in Annex 5 of this report.

c) Hoverfly transect and survey . A hoverfly survey of the Park was done and a transect established in May 1991. Details of the transect methodology and the survey are given in Annex 6 of this report.

d) Molluscs . A detailed survey of molluscs at S'Albufera was undertaken in October by Dr Chris Paul of the University of Liverpool's Department of Earth Sciences. The results of his survey and recommendations for further monitoring studies for molluscs are presented in Annex 7 of this report.

Vertebrates

a) Birds . Two studies were used to obtain data for temporal and longer-term fluctuations of breeding and migrant birds. One technique comprised two bird transects begun in 1989-90. Both were repeated in spring 1991 and one continued throughout the summer thanks to Mallorcan volunteer, Carmen Chacon. The second technique, introduced in April 1991, was a constant effort ringing study. The study, using methodology evolved by the British Trust for Ornithology, comprised a fixed number and size of nets at fixed sites. The location of this study was among the reedbeds and pines of Ses Puntes, and the study was carried out from dawn to midday once in each ten day period. The study began during the first ten day period of April and, thanks to the participation of Edward Grey Institute student Jon King, was continued until August. The bird transect methodology is described in Annex 8 of this report.

In an attempt to assess the effects of the September 1990 fire, the locations of singing Moustached Warblers *Acrocephalus melanopogon* and Reed Buntings *Emberiza schoeniclus* were mapped in

April 1991 and a 1990 capture-recapture ringing study repeated. Unfortunately, the capture-recapture work was severely curtailed by poor weather, but mapping of singing birds indicated very few individuals singing in burnt areas, a marked decrease compared with 1990. Dawn to dusk observations of Purple Heron *Ardea purpurea* feeding movements from and to the Es Colombar breeding colony, conducted from the Torre once every ten days in April and May, was designed to assess use of feeding areas by that species subsequent to the fire. See Wood (1991) for details of the 1990 capture-recapture study.

A new study, introduced in April 1991 and designed to compare the use by birds of managed and unmanaged open areas, comprised daily counts of the maximum number of each species seen during a ten minute period within defined areas of grazing marsh from the hide at Sa Roca and in front of the Bishop and Watkinson hides, and a similar ten minute count once every ten days within a defined area of Es Cibollar from the white bridge.

Another new study, prompted by large assemblies of migrant Swallows *Hirundo rustica* during several spells of inclement weather, comprised the capture of a sample of Swallows to assess their body condition. Collection of data for weight, adipose fat and muscle condition demonstrated the capability or otherwise of individuals to sustain migratory readiness and the importance of S'Albufera as a fuelling site for migrants during inclement weather.

b) Mammals . Following subjective observations of a marked decrease in terrestrial mammal species after the flood and fire of autumn 1990, a mammal transect was established between the Pont dels Anglesos and the Casa del Parc in April 1991. A survey of mammals present in the Park was also conducted. Descriptions

of the 1991 mammal studies are given in Annex 9 of this report.

c) Reptiles and amphibians . The gecko/snake transect begun in 1990 was repeated in May 1991, with a particular aim to assess the effect on their populations of flooding in October 1990. Unfortunately it was not possible to compared results with spring 1990 as the 1991 transect was hampered by poor weather.

Meteorology

Meteorological data, collected daily by Park staff, were made available to the Project. The need for more sophisticated meteorological equipment, recommended by Riddiford & Newbould (1991), has prompted the Park directorate to make representations to the National Meteorological Office for the installation of a permanent weather station at S'Albufera.

Geology/Geomorphology

Hungarian scientist, Olga Morozova, took a series of soil samples from a wide range of non inundated sites within and adjacent to the Park. Her report is awaited.

History

Work was continued into historical aspects of S'Albufera, with particular reference to establishing a comprehensive bibliography of publications referring to the site, a comprehensive list of research carried out there, and of recent events affecting the ecology and development of the marsh (ranging from "natural phenomena" such as flood and fire to human management practices).

3. DATA PROCESSING AND COMPUTERISATION

Work was begun in October to develop programs for the storage on computer and processing of Project S'Albufera data.

The need to make data storage compatible with national and international systems has been recognised from the outset, so we were very pleased to receive the help of Sarah Hawkswell of the Royal Society for Nature Conservation (RSNC) in adapting the Biological Recorder package, newly developed for British nature reserves, to the S'Albufera situation. This development will be of benefit in providing us with a versatile and compatible data storage system; and of benefit to nature conservation bodies generally by stimulating the creation of an international version of the package.

4. PROGRESS AND FUTURE PLANNING

From the start Earthwatch Europe estimated that the first three years would mainly involve obtaining baseline data and the development of suitable methodology, leading in a second phase to the establishment of a definitive programme of studies. It was appropriate therefore in 1991 to take stock of progress towards fulfilment of these first phase objectives and to refine forward planning in the light of the first three years' work. To achieve this, a thorough review was undertaken. The result was the publication of the document *Project S'Albufera, a new model for environmental research* (Riddiford 1991). The document presented a comprehensive overview of all aspects of the Project. On the scientific side it set out research priorities, problems of regular monitoring, a summary of results for 1989-91, the programme for 1992-93 and beyond and relationships with other scientific bodies. The document also outlined the historical and scientific importance of S'Albufera, its context in local, regional and global terms, the creation of the Natural Park and its roles, and the logistics of running and sustaining the Project. A final part drew together aspects of Project

development including relations with sponsoring and supporting bodies, funding requirements, public relations and information, and publications.

The document clearly confronted problems which needed to be resolved for the Project to succeed. Main areas of concern were the need for adequate funding, the recruitment of suitably qualified scientists in each field of specialism, the involvement of local scientists and volunteers, the limitations of fieldwork restricted to only two or three months of the year, the urgent need to develop a computerised system for data storage and processing, and inadequate Park work facilities.

It is pleasing to report that many of these obstacles are being overcome. The most important single event in 1991 was the receipt of a substantial grant from the World Wide Fund for Nature. This enabled us to meet the travel expenses and equipment needs of an increased number of scientists, thus extending the scope of the Project and the fields of research. It also allowed us to extend our monitoring beyond the volunteer fieldwork periods by sending out scientists at other times of year. Another encouraging development was the steadily increasing interest and involvement shown by Balearic scientists and volunteers. Our contact with the Department of Biology of the Universitat de les Illes Balears led initially to the loan of equipment through a co-operation agreement between Earthwatch Europe and the UIB and, increasingly in 1991, to collaboration in terms of research. In addition two UIB students, one from the Department of Biology and one from the Department of Geography, undertook to continue monitoring tasks throughout the summer. This was not only a further positive sign of local involvement but also extended the period of fieldwork for two monitoring tasks. Park staff too were

keen supporters of our programme.

One major drawback to conditions of fieldwork at S'Albufera has been the lack of telephone and mains electricity. This made communications difficult and restricted immediate processing of data. The problem was resolved in autumn 1991 when mains electricity, telephone and fax were all installed. They came too late to be of much benefit to 1991 fieldwork, but we did take advantage of the new facilities to embark on developing a versatile and compatible data storage system. We were most fortunate in this respect to obtain the services of Sara Hawkswell of the RSNC who saw the opportunity of using Project S'Albufera to adapt a newly developed British package to the European context. In conjunction with Conservation Director for the Balearic Islands, Joan Mayol, the Project was also able to host a seminar on computerisation of biological data, organised by Sara, which attracted managers of natural areas and other participants from throughout Spain.

Excellent progress has been made in compiling inventories, particularly for vascular plants and vertebrate groups, but more work is planned to update and expand, while invertebrate inventories remain at an early stage and require more work. Collection of raw data has been accompanied increasingly by more detailed long-term studies. The populations of some groups are already being monitored and further baseline work will include development of methodology designed to monitor these groups for environmental change. One need which we have identified but have not yet achieved is the assembly and study of remote sensing images and aerial photographs. We need to know more, too, of the hydrology of S'Albufera. The setting up of a computerised data base is also recognised as paramount.

The 1992 programme has been designed to take into account all these needs. Students from the University of Aberdeen's Centre for Remote Sensing and Mapping Science will embark on two remote sensing studies in 1992, one regarding vegetation distribution and the other water quality. Useful initial hydrological studies were done in 1989-90 by members of the Ecology and Conservation Unit of University College London and we have approached this Unit to build on the foundations laid to provide us with a fuller knowledge of the hydrology of the marsh. Sara Hawkswell will continue program development for computerisation of data.

Other 1992 fields of research designed to improve and extend baseline data include further herbarium, mycological and invertebrate work; while Jean-Francois Noblet, a specialist of the Corsican bat fauna, has agreed to apply his expertise to the bats of S'Albufera. Ongoing botanical studies include Professor Newbould's research into the ecology of *Phragmites australis*, dune transects and orchid population studies. Bird population studies continue with transect and point counts, mapping of Moustached Warbler *Acrocephalus melanopogon* distribution, constant effort site ringing and studies of the body condition of migrants. A study of small mammals, based on trapping, is planned for the autumn. Transect counts of butterflies and dragonflies will continue, while other invertebrate studies include work on *Phragmites* damage by moth larvae and evolving suitable methodology for monitoring night lepidoptera. Dr Chris Paul hopes to further his mollusc distribution and monitoring studies in October.

The majority of these studies will take place during designated periods when three spring and one autumn teams of Earthwatch volunteers will again be present to assist and carry

out routine tasks. The nature of the Project, however, increasingly demands fieldwork at other times of the year, and in 1992 this will be achieved by both visiting and resident scientists. Ecologists from the Universitat de les Illes Balears are currently seeking funding to embark on parallel studies of the S'Albufera marsh system and have already planned one limnological study which will be of benefit to our work. The scale and difficulties of recording environmental change are great and can only be resolved long-term by integrating local scientists and fieldworkers within the Project. Thus, looking to the future, we consider the development of shared schemes with both the UIB and Park personnel as of high priority during the coming phase of fieldwork.

Details of the 1992 Project S'Albufera programme are given in Appendix 3.

5. ACKNOWLEDGEMENTS

In 1991, as in previous years, the Project received considerable help and support from a number of people and organisations. We are particularly grateful to the World Wide Fund for Nature for their generous grant. We also express our gratitude to all volunteers and scientists involved in the field work, to Earthwatch and Earthwatch Europe members and staff in Boston and Oxford for their financial and organisational help, and to Rockware Group Plc for sponsoring the secondment of staff from their management team. The Estructures Agraries i Medi Natural section of the Balearic Conselleria d'Agricultura i Pesca, continued to support us through the good offices of its Director General, Sr. Miguel Angel Borrás Llabrés, Sr. Mateo Castello Mes, and Conservation Director, Sr. Joan Mayol Serra.

The Parc Natural de S'Albufera staff were very helpful and particularly Park Technical Assistant, Gabriel (Biel) Perello, who acted as liaison officer to the Project. Mallorcan residents, Pat and Dennis Bishop, and the officials and members of the Friends of S'Albufera were also particularly helpful. Jon King of the Edward Grey Institute of Field Ornithology, researching into Fan-tailed Warblers *Cisticola juncidis*, and Pere Tomas Vives, a past volunteer and Park staff member, gave freely of their expertise and help when time allowed. The success of the Project was greatly enhanced by the quality efforts of our team of scientific supervisors and logistics co-ordinators. Chief logistics co-ordinator, Dr Dinah McLennan also contributed on the scientific side with some fine plant sketches some of which she has kindly provided to illustrate this report. To all these people, and to the many others whose names are listed in Appendix 1, we owe an enormous debt of gratitude.

APPENDIX 1 - List of Participants

Principal Investigators

Dr Franklyn Perring and Nick Riddiford

Scientific Assistants

Mrs Jo Newbould (Botanist), Dr Dinah MacLennan (Botanical illustrations, Logistics), Barbara McKelvey (Team III Logistics), Margaret Perring (Team IV Logistics)

Parc Natural de S'Albufera Liaison Officer to Project

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

Cooks

Margalida Moranta, Francisca Rayo, Margalida Serra

Team 1 (2nd-16th April)

Scientists

Nick Riddiford (PI), Jo Newbould (herbarium), Dinah McLennan
(botanical illustrations)

Volunteers

Tom Greene, Delta Greene (USA), Alastair Pike (UK), Carmen Chacon
Alhama (Mallorca)

Team 2 (19th April-3rd May)

Scientists

Nick Riddiford (PI), Keith Bowey (invertebrates & mammals),
Palmer Newbould (vegetation biomass studies), Jo Newbould
(herbarium), Dinah McLennan (botanical illustration), Terry Wells
(orchid studies), Sheila Wells (mycology), Olga Morozova (soil
science)

Volunteers

Irma Galuseca, Leslie McGuirk (USA), John Gielen (Holland), Livia
Soledad Szekely (Mexico), Sharon Bey (Canada), Pauline Tomkins
(UK), M'Angels Ferragut Munoz (Mallorca)

Team 3 (6th-20th May)

Scientists

Franklyn Perring (PI), Nick Riddiford (PI), Simon McKelvey
(invertebrate studies)

Volunteer

Sharon Thomas (USA)

Team 4 (14th-28th October)

Scientists

Franklyn Perring (PI), Chris Paul (mollusc distribution), Palmer Newbould (ecologist), Sarah Hawkswell (computerisation of data), Nick Riddiford (ornithology)

Volunteers

Edward Cross, Robert Gilhooly, Bernice Young (UK), Arline Hunt, Harold Pierson (USA)

Additional scientist and volunteer contributions

7th-28th February

Franklyn & Margaret Perring

14th-21st February

Palmer & Jo Newbould

April to August

Jon King (Edward Grey Institute of Field Ornithology, University of Oxford)

16th-20th May

Carlos Cazador de Pablos, Enrique Perez Alemany, Maria-Jose Pujol de Pinto, Angel Javier Gasso Cerda, Eva Maria Morales Domingues, Javier de Miguel Cunill, Rut Casanas Gavria, Joan Manuel Rayo Picon, Francesc Xavier Fullana Janet (School of Nature Conservation, Palma de Mallorca)

June-September

M'Angels Ferragut Munoz, Carmen Chacon Alhama

17th-24th July

Professor Palmer Newbould, Jo Newbould, Sharon Bey

Visitors to the Project

Joan Mayol (Director of Balearic Natural Areas, Mallorca)

Antoni Martinez Taberner, Enrique Descals, Jaume Estarellas
(Dept. Biologia, Univ. Illes Balears)

Pat & Dennis Bishop (Friends of S'Albufera)

Prof. Dr. Adam Kertesz (Head of Department, Geographical Research
Institute, Hungarian Academy of Sciences)

Max Nicholson, (Earthwatch Europe Trustee)

Josep Antoni Aguilo (Escola de Conservacio de la Naturalesa,
FODESMA)

Gabriel Bardi (FODESMA)

Bruce & Bonnie Bishop (Mallorca)

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

Graham Hearl (Mallorca RSPB/GOB representative)

Sarah Gillingham (University of Oxford)

Rob Magrath (Dept of Zoology, Univ of Oxford)

Representatives of Friends of S'Albufera and the Grupo
Ornitologico Balears

Staff, Parc Natural de S'Albufera (April 1991)

Joan Mayol - Director

Gabriel Perello- Technical Assistant

Andreu Muntaner - Chief Warden

Alexandre Forteza - Reception Centre

Pilar Lacalle - Reception Centre

Pere Vicens - Ornithologist

Jaume Gamundi - Guard

Vicens Lillo - Guard

Manolo Coello - Maintenance

Eddy Morro - Maintenance

Antoni Rayo - Maintenance

Xesca Crespi - Monitor

Carlota Viada - Monitor

Susanna Llobet - Monitor

APPENDIX 2 - 1991 Fields of Research

The following is a catalogue of information collected in 1991. This information, along with 1989-90 material, has been deposited at Earthwatch Europe's Oxford (UK) headquarters. A second set of the material has been established at S'Albufera Natural Park. Details of published material are given in Appendix 4.

Category : Aquatic Systems

Title of Work Done :

Net-sampling data at sample sites.

Catalogue Reference Number : 91/16

Category : Marshes

Title of Work Done :

Biomass and productivity of Phragmites and Cladium .

Catalogue Reference Number : 91/9

Category : Dunes

Title of Work Done :

Coastal dune transects.

Permanent quadrats on fossil dunes.

Catalogue Reference Number : 91/FHP

Category : Flora

Title of Work Done :

Herbarium.

Catalogue Reference Number : 91/6a

Category : Flora

Title of Work Done :

S'Albufera plant list.

Catalogue Reference Number : 91/6b

Category : Flora

Title of Work Done :

Orchid populations.

Catalogue Reference Number : 91/7

Category : Flora

Title of Work Done :

Fungi.

Catalogue Reference Number : 91/10

Category : Vertebrates

Title of Work Done :

Bird population surveys: Little Grebe, Coot, Mallard census.

Catalogue Reference Number : 91/1

Category : Vertebrates

Title of Work Done :

Bird population surveys: grazing marsh study.

Catalogue Reference Number : 91/2a

Category : Vertebrates

Title of Work Done :

Bird population surveys: transects 1 and 2.

Catalogue Reference Number : 91/2b

Category : Vertebrates

Title of Work Done :

Bird population surveys: Es Cibollar census.

Catalogue Reference Number : 91/2c

Category : Vertebrates

Title of Work Done :

Purple Heron feeding sites.

Catalogue Reference Number : 91/3

Category : Vertebrates

Title of Work Done :

Moustached Warbler population study.

Catalogue Reference Number : 91/4a

Category : Vertebrates

Title of Work Done :

Bird population surveys: Reed Bunting.

Catalogue Reference Number : 91/4b

Category : Vertebrates

Title of Work Done :

Bird population surveys: constant effort banding.

Catalogue Reference Number : 91/5a

Category : Vertebrates

Title of Work Done :

Condition of migrant Swallows.

Catalogue Reference Number : 91/5b

Category : Vertebrates

Title of Work Done :

Mammal studies.

Catalogue Reference Number : 91/11

Category : Vertebrates

Title of Work Done :

Gecko/snake transect.

Catalogue Reference Number : 91/13

Category : Vertebrates

Title of Work Done :

S'Albufera fish list from Barcelo & Mayol.

Catalogue Reference Number : 91/15

Category : Invertebrates

Title of Work Done :

Butterfly and dragonfly transects.

Catalogue Reference Number : 91/8

Category : Invertebrates

Title of Work Done :

Molluscs: collection, survey.

Catalogue Reference Number : 91/12

Category : Invertebrates

Title of Work Done :

Invertebrate collection: moths, hoverflies and beetles.

Catalogue Reference Number : 91/18a

Category : Invertebrates

Title of Work Done :

Invertebrate collection: list of collection.

S'Albufera moth list.

Catalogue Reference Number : 91/18b

Category : Invertebrates

Title of Work Done :

Invertebrate collection: Diptera, Ephydriidae list (paper).

Catalogue Reference Number : 91/18c

Category : Invertebrates

Title of Work Done :

Hoverfly studies.

Catalogue Reference Number : 91/19

Category : Meteorology

Title of Work Done :

Park meteorological data.

Catalogue Reference Number : 91/14

Category : Geology/Geomorphology

Title of Work Done :

Soil studies.

Catalogue Reference Number : 91/17

Category : History

Title of Work Done :

S'Albufera bibliography and historical records.

Catalogue Reference Number : 91/20

APPENDIX 3 - 1992 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 (Teams I-IV)

Dr Franklyn Perring (Team III)

Team Dates in Field

TEAM I April 13-April 27, 1992

TEAM II April 30-May 14, 1992

TEAM III May 17-May 31, 1992

TEAM IV October 17-October 31, 1992

Team Composition: integrated teams of Scientists, Earthwatch
Volunteers and Mallorcan Students.

Fields of Research

Botanical

1. Ecology of *Phragmites australis* (Palmer Newbould)
2. Dune transects (Franklyn Perring)
3. Herbarium (Jo Newbould; Perring; Dinah MacLennan)
4. Orchid population studies (Terry Wells)
5. Fungi (Sheila Wells)

Vertebrates

1. Bats (Jean-Francois Noblet)
2. Bird population studies (Nick Riddiford; Keith Bowey; Jon King) - transects, point counts, Moustached Warbler distribution, constant effort site ringing, body condition of migrants
3. Mammal population studies, including trapping (Bowey)

Remote Sensing

1. vegetation mapping & water quality (students of Centre for Remote Sensing and Mapping Science, University of Aberdeen, Scotland)

Hydrology

1. Hydrological studies (Ecology and Conservation Unit, University College London)

Invertebrates

1. Molluscs (Chris Paul)
2. Entomology
 - a) Phragmites damage by moth larvae (Barry Goater; Newbould)
 - b) insect reference collection (Goater)
 - c) monitoring methods for night lepidoptera (Goater)
 - d) butterfly and dragonfly transects (Riddiford)

Computerisation of Data

1. Program development for standardised data processing and storage (Sarah Hawkswell)

Project S'Albufera scientists, 1992

Team I 13-27 April

PI - Nick Riddiford

Jo Newbould & Dinah MacLennan - botany

Terry Wells - orchids

Sheila Wells - fungi

Team II 30 April-14 May

PI - Franklyn Perring

PI - Nick Riddiford

Sarah Hawkswell - data programming

Palmer Newbould - ecology of Phragmites

Team III 17-31 May

PI - Nick Riddiford

Barry Goater - lepidoptera

Jean-Francois Noblet - bats

Team IV 17-31 October

PI - Nick Riddiford

Jon King - ornithology

Keith Bowey - mammals

Chris Paul - molluscs

APPENDIX 4 - List of publications

Results from the first three seasons' work have contributed to the following publications. An asterisk draws attention to those which have appeared since the last Project

S'Albufera report.

*F RONTERA I SERRA, M. & FORTEZA I PONS, V. 1991. Seguiment dels efectes de la paustura al parc natural de S'Albufera de Mallorca, 1990. Documents tècnics de Conservació 4. SECONA, Palma de Mallorca.

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 . University College London M.Sc. in Conservation dissertation.

*M AYOL, J. 1991. Plan d'us i gestió del Parc Natural de S'Albufera de Mallorca. Documents tècnics de Conservació 3. SECONA, Palma de Mallorca.

*M AYOL, J. 1991. Parc Natural de S'Albufera de Mallorca: Ornithological overview, August 1989-July 1990 . Associació Balear d'Amics dels Parcs, Can Picafort.

NE WBOULD, P. 1989. The Albufera as a Global Monitoring Station . 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.

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.

- *P ERELLO, B. 1991. Seguiment de l'avifauna del Parc, agost 1990-juliol 1991 . Associacio Balear d'Amics dels Parcs, Can Picafort.
- *R IDDIFORD, N. 1991. Project S'Albufera: A new model for environmental research . Earthwatch Europe, Oxford.
- *R IDDIFORD, N. 1991. A small influx of the Long-tailed Blue *Lampides boeticus* at S'Albufera Natural Park, Mallorca. Bull. Amat. Ent. Soc . 50: 164.
- RI DDIFORD, N. & NEWBOULD, P. 1991. Monitoring for Environmental Change : The Earthwatch Europe S'Albufera Project - a summary report of the second season's work 1990 . Earthwatch Europe, Oxford.
- WO OD, B. (ed.). 1989. A monitoring programme for S'Albufera, Mallorca. Discussion Papers in Conservation No. 52. Ecology & Conservation Unit, University College London.
- *W OOD, B. (ed.). 1991. Further studies towards a monitoring programme for S'Albufera de Mallorca. Discussion Papers in Conservation No. 55. Ecology & Conservation Unit, University College London.

ANNEX 1

Biomass and productivity of *Phragmites australis* and *Cladium mariscus* on the Albufera of Mallorca by Palmer Newbould.

ANNEX 2
Monitoring orchids at S'Albufera, Mallorca by Terry Wells

ANNEX 3
Preliminary report on the macrofungi of S'Albufera by Sheila
Wells

ANNEX 4

S'Albufera butterfly and dragonfly transect methodology by Nick Riddiford & Keith Bowey

Two transects have been established, transect 1 in 1989 and transect 2 in 1991. The instructions for each are as follows.

Aims & Methodology: during a period of steady walking, count and record all individuals of all butterfly and dragonfly species seen. For individuals flying directly until lost from view, the direction of flight should be noted with an arrow.

The preferred time and weather for transect walks is

early afternoon in calm, warm sunny conditions in winter, spring and autumn, and mid morning (i.e. before the period of maximum day temperatures) in calm conditions in summer. Recommended number of visits: at least one per week in preferred conditions. In all cases, the transect number, names of observers, details of weather conditions and start and finish times should be recorded on the standard form (Butterfly Census data sheet - see Form 1).

Transect 1

The transect is divided into nine sections. Counts should be recorded separately for each section (see Butterfly Census data sheet).

Description of Transect 1 (& see Figure 1):

Transect directions (see Figure 1 for section divisions):

Section 1 : start point is the base of the tower hide (point A on map). Head east along the dirt road to the intersection (B).

Section 2 : from B , continue straight east along the dirt footpath (i.e. do not cross the bridge over Gran Canal here) until the first right (C).

Section 3 : at C , turn right and head south across the Gran Canal at the cement sluice and across the wooden footbridge. You meet the main entrance road at point D (with the Information Centre on your right).

Section 4 : at D , turn left on to the main entrance road, heading east to the bend in the road (E).

Section 5 : at E , turn right and head south along dirt road. Pass through point F (wooden gate - usually open).

Section 6 : Continue along track from F to G (end of wooded section).

Section 7 : From G , continue on same track until the intersection.

Turn left and head east along an overgrown dirt road, through point H (end of field on left).

Section 8 is from point H to the end of the track where it meets the paved public road (point I).

Section 9 : Cross the road and continue to head east for 50 m, then turn right on to obvious sand track in dunes and follow the track as it meanders mainly southward. The track eventually leads to a tall cement obelisk. This is Point J , where the transect ends.

Transect 2

The transect is divided into six sections. Counts should be recorded separately for each section (see Butterfly Census data sheet). Discrete blue arrows painted on the tops of low wooden marker posts beside the track indicate the direction of the transect at all intersections and other decision points.

Description of Transect 2 (& see Figure 2):

Section 1 : from Alcludia Pins car park (start at the blue arrow point on post at edge of pine wood) continue along track through the wood, following the blue arrow points at junctions.

Section 2 begins where the pine wood gives way to open scrub and continues on the main track through the scrub. Blue arrow markers again indicate the route at all decision points. The section ends where the scrub gives way again to mature woodland.

Section 3 : continue along main track through the wood as far as the gate. Immediately after gate, walk into and across the picnic area at an oblique angle. Exit on the far side where a blue arrow on a low post indicates the direction for section 4.

Section 4 starts at the beginning of the area of open scrub outside the picnic area and continues along the main track which winds through this scrub. Follow the main track which at one

point tends towards the public road before turning sharply back in the direction of the seaward dunes. Section 4 ends 10 m further on where a narrow strip of pines crosses the track.

Section 5 : continue on the main track as it leads through low dune scrub. The section ends at a crossroads marked by 4-5 low wooden posts sunk into the ground of the left hand track.

Section 6 : take the left hand track (i.e. turn left 90°) and walk along it towards the sea. The section, and transect, ends at the point where the dunes and dune vegetation give way to unvegetated beach. This point is clearly demarcated by an almost vertical foredune bank.

ANNEX 5

S'Albufera moth survey, 1991 by Simon McKelvey

After some trapping in 1990 using a battery powered Heath trap, a more powerful Robinson mercury vapour trap was used between 8th and 17th May 1991. The trap was run from a portable generator 150 m east of the Sa Roca centre. Poor weather conditions restricted trapping to only ten nights, with cold wind and rain occurring on half of these. Large moths were identified using Skinner (1984) and were either photographed or retained in a reference collection at the Sa Roca centre.

Twenty-four species were recorded in the two week period. They are listed in Table 1. A record was also kept of the numbers of each species caught on each night of trapping.

As a result of poor weather throughout the second half of April and much of the period of 8th-17th May 1991, fewer moths were on the wing than in the previous year. Further evidence of

this were the small number of moths seen in car headlights during driving at night and the presence of emaciated Nightjars *Caprimulgus europaeus* on the island.

The restrictions posed by the short time period and inclement weather limited the growth of the reference collection. However, the efforts made in May prompted S'Albufera park staff to continue trapping during the summer and autumn of 1991 and a Mallorcan volunteer has kindly agreed to curate the collection. Mallorcan involvement is much welcomed and will ensure the establishment of a more comprehensive and useful reference base.

Reference

SKINNER, B. 1984. Colour Identification Guide to Moths of the British Isles . Viking, London.
Table 1. Macrolepidoptera identified from the Sa Roca trap, 1991

<i>Scopula emutaria</i>	Rosy Wave
<i>Idaea sylvestraria</i>	Dotted Border Wave
<i>Orthonama vittata</i>	Oblique Carpet
<i>Orthonama obstipata</i>	The Gem
<i>Menophra abruptaria</i>	Waved Umber
<i>Hyles euphorbiae</i>	Spurge Hawk
<i>Hyles lineata</i>	Striped Hawk
<i>Hippotion celerio</i>	Silver Striped Hawk
<i>Cerura vinula</i>	Puss Moth
<i>Pelosia obtusa</i>	Small Dotted Footman
<i>Agrotis exclamationis</i>	Heart and Dart
<i>Agrotis ipsilon</i>	Dark Sword Grass
<i>Ochropleura plecta</i>	Flame Shoulder
<i>Noctua pronuba</i>	Large Yellow Underwing
<i>Lacanobia oleracea</i>	Bright-line Brown-eye
<i>Orthosia stabilis</i>	Common Quaker
<i>Mythimna vitellina</i>	The Delicate

Mythimna pallens	Common Wainscot
Mythimna favicolor	Matthew's Wainscot
Mythimna unipuncta	White Speck
Mythimna obsoleta	Obscure Wainscot
Archanara sparganii	Webb's Wainscot
Autographa gamma	Silver Y
Tyta luctuosa	Four-spotted

ANNEX 6

S'Albufera hoverfly transect and survey by Simon McKelvey

During my visit in May 1990, syrphids were noticeably absent. For instance *Episyrphus balteatus* was only recorded twice in fourteen days. In May 1991, however, it was immediately obvious that far more syrphids were on the wing, including large numbers of *E. balteatus*. This species is well known for its migratory behaviour during years of "over-population". In order to monitor variations in abundance of this species, I devised an easily repeatable transect. A description of the transect, taken from the instruction sheet for transect participants, follows:

The transect is carried out by at least two observers. It starts at the bridge by the Watkinson Hide (see Figure 1) and follows the wooded path to the Cami de Sa Senyora. It then follows the Cami de Sa Senyora to the Tower Hide. During the transect there should be a minimum of one observer recording each side of the track. Visual records of *E. balteatus* must be kept along along the entire length of the transect to give a single

score. Other species of hoverfly should be collected for later identification.

Extra parameters which should be recorded at the start are time, temperature, estimated wind speed and direction and cloud cover. The same parameters should be recorded again at the finish plus any additional weather details (e.g. precipitation, change in cloud cover or wind during the transect). The date and names of observers should also be recorded.

If the transect route is disturbed by passing pedestrians or vehicles, a pause of one to two minutes should be made to allow the hoverflies to settle or resume station.

The transect should not be attempted on cold, wet or very windy days, nor early or late in the day as those conditions depress hoverfly activity.

The location of the transect is given in Figure 1.

In addition to the *Episyrphus balteatus* transect a number of areas were surveyed for syrphidae. Surveying was by netting, "yellow trapping" and sweep netting. Yellow trapping (wet traps painted yellow, a colour which attracts several dipterid groups) proved less productive than the other two methods.

Specimens collected were stored in a reference collection based at Sa Roca. All identifications were made using Stubbs & Falk (1983). However, due to the presence of additional species to those covered by the key, the identity of some should be considered only provisional. Trapping was carried out between 5th and 18th May. Table 1 lists the 17 species recorded and briefly summarises their status at S'Albufera.

The Mallorcan syrphid fauna is larger and more varied than my 1990 visit appeared to demonstrate. Further work is desirable to establish the importance of migration on syrphid

numbers at S'Albufera.

Progress has been made with establishing a reference collection. Mallorcan volunteers have agreed to assist in curation and further collection during summer/autumn 1991 and links are being established with invertebrate scientists at the University of the Balearic Islands and at the natural history museum at Soller which is due to open in 1992.

Reference

STUBBS, A.E. & FALK, S.J. 1983. British Hoverflies . BENHS, London.

Table 1. S'Albufera Syrphid list, 1991

SPECIES	STATUS & NOTES
Melanotoma mellinum	one poor specimen
Melanostoma scalare	very numerous
Chrysotoxum species	keys at arcuatum but must involve one or more non British species
Episyrphus balteatus	very numerous
Meliscaeva auricollis	very numerous
Metasyrphus corollae	three specimens; seemed to be emergence late in second week of visit
Metasyrphus luniger	one male
Sphaerophoria scripta	numerous
Sphaerophoria rueppellii	one specimen
Eristalinus aeneus	one specimen; several seen but not captured were of this group
Eristalinus sepulchralis	two specimens
Eristalus arbustorum	very numerous; face entirely covered in pale dusting
Eristalus tenax	two specimens at the end of the period of study; possibly the start of an emergence
Helophilus trivittatus	several of this large spectacular species observed
Myathropa florea	one specimen
Parahelophilus versicolor	two specimens
Syritta pipiens	quite numerous; specimens examined did not have the femoral spine of S. flaviventris , a Mediterranean member of this genus

ANNEX 7

Molluscs at S'Albufera Natural Park by C.R.C. Paul

ANNEX 8

S'Albufera bird transects by Nick Riddiford

Two bird transects, one of 6.3 km and one of 6 km, were established along clearly marked tracks and paths in 1989. Each route is walked steadily but unhurriedly over a 2 hour period in early morning, and all birds counted to a distance of 25 m either side of the track.

The transects were chosen to sample representative habitats and were considered suitable to volunteers of ornithological ability. The transect technique has the potential to give a measure of seasonal and long-term changes in numbers for birds using the Park; including migrants, breeding and non breeding residents and, if done throughout the year, winter visitors. Transect counts are recorded on a standard data sheet (see Form 1) on which is also recorded the transect number, names of observers, details of weather conditions and start and finish times. Recommended frequency for each transect is at least once in each ten day period.

The transect instructions are as follows:

Transect 1

Aims and Methodology: during a 2 hour period of steady walking at the beginning of the day (recommended start time 30 minutes after daybreak), to 1) count all individuals of all species seen or heard within 25 m either side of track; 2) separately to count

all individuals of hirundines and all non passerine species (including flying birds) beyond 25 m; and 3) all birds on the lagoon at Sa Roca and the flooded grazing marsh immediately west of Turo de Ses Eres. In sections A and B, counts should also be made of species singing on the bank of the far side of Gran Canal (e.g. Nightingale, warblers and Reed Bunting).

Description: total distance approximately 6.3 km, divided into five sections (see Figure 1).

Section A : start at the Pont de Santa Margalida. To reach the Pont (bridge) from the Park information centre, walk east along a wide track. On the left is a disused aqueduct heavily overgrown with bushes, brambles and Phragmites . On the right mostly tall Phragmites screen the grazing area (Sa Roca) for endemic cattle and horses. On reaching the bridge turn left crossing over a small canal - this is the start point.

From start: take the narrow track behind the bench. This is wooded, mostly with elms and brambles, and Phragmites growing at the edge of the canals on either side of the track. Follow the track until reaching the sleuce, walk out halfway checking the Gran Canal in both directions. Return to the track and continue west until reaching the arched stone bridge. About 0.7 km.

Section B : turn right and cross the Gran Canal over an arched stone bridge. Check the canal in both directions. After crossing the canal turn left and walk west along a wide track (Cami de Sa Senyora) to the Tower Hide. Vegetation along the track is mostly elms, brambles and Phragmites . The Gran Canal is on the left (check the islands) and the Canal de Sa Senyora on the right. The far banks of both canals are bordered with extensive reed beds. On reaching the Tower Hide ascend and view the marsh, Gran Canal and Canal Loco. Make only one count from Tower Hide, leaving the

hide as soon as that count is complete. From the hide retrace your steps, crossing back over the bridge to the junction of A and B. Make no counts on the return journey from the hide to the junction because this repeats parts of the transect already walked. [Counts of species not recorded on the walk to the hide may be recorded on the return, but must be noted separately]. About 1 km each way.

Section C : After crossing the bridge, start counting as you head straight on southwards, immediately crossing another small canal. Follow the track for about 400 m, cross the arched wooden bridge, turn right and follow the track (Cami den Pujol) for about 1.6 km. The track has the Canal den Pujol on its right and a small overgrown canal on its left. Beyond these are extensive reedbeds of *Cladium* and *Phragmites*, Es Ras on the left and Es Rotlos on the right. The end of the section is a "T" junction. About 2 km.

Section D : turn left at the T junction and follow the track (Cami den Pep) eastwards to the next T junction. Es Ras is on the left and Canal den Pep on the right, at first screened with tall *Phragmites*, but then open to view; at the same point Es Ras is also open to view. 0.8 km.

Section E : turn left at the T junction and follow the track (Cami de Ses Punes) which passes through small pine wood. There is an overgrown aqueduct on the left bordered mainly with reedbeds (Es Ras). On the right after the pine wood of Ses Punes there are reeds leading to a more open area of grazing marsh immediately west of Turo de Ses Eres and finally saltmarsh. A chain across the Cami de Ses Punes at its northern end marks the end of the transect. About 1.8 km.

Transect 2

Aims and Methodology: during a 2 hour period of steady walking at the beginning of the day (recommended start time 30 minutes after daybreak), to 1) count all individuals of all species seen or heard within 25 m either side of track, 2) separately to count all individuals of hirundines and all non passerine species (including flying birds) beyond 25 m; and 3) all birds on the Salinas.

Transect description: total distance approximately 6 km, divided into four sections (see Figure 2).

Section A : start at the crossroads at the southern end of Ses Puntas. Take the track heading east with Canal de Pep on the right and a meadow on the left. Pass a few pine trees then past extensive reedbeds of *Phragmites* and *Cladium* on both sides of the track. On reaching the main road keep to the path on the right for about 100 m before crossing the road. About 1 km.

Section B : after crossing the road, follow the major track into the woodland for about 200 m. Ignore the first fork to the right, but turn right at the next junction on to the wide main track. This main track initially runs through an open dune area with low bushes and shrubs, then into a pine wood with some understorey. After the pines the track runs through open scrub before leading to the road. See detailed map (Figure 3) for exact route. About 2 km.

Section C : cross the main road again to the Salinas, then follow the path at the side of the road northwards, viewing the various lagoons of the Salinas from obvious vantage points marked by "pull-ins" from the road. The Salinas are disused salt-pans fringed with a small area of scrub and pine trees on the road side and on the far side by a relatively extensive *Phragmites*

reedbed. Continue heading north on the narrow path alongside the road until reaching a wide track to the left (giving vehicle access to sand quarries) marked Cantera de Arenas. Follow this track until the "T" junction. View saltpans on the left. About 1.8 km.

Section D : at the T junction turn right, taking the track which leads into the working sand quarry. There is arable land on the left and reedbeds on the right. Ignore the track curving left into the quarry, carrying straight on (right fork) north to skirt the park with reedbeds on your right and large mounds of rough ground on the left. Continue to follow the track as it turns sharp left into a small pine wood. Here the track turns sharp left and after a few hundred metres sharp right through a small farm (the finca of Ca N'Eixut). Follow the track through the finca until reaching the gate to the park and the crossroads at transect start point A. This marks the end of the transect. About 1.2 km.

Mammal survey

The mammal survey was made in preparation for more detailed studies at a later date and was carried out in between other scientific studies. Three Longworth mammal traps were set at various sites near to the Sa Roca centre, and volunteers were encouraged to record their observations, including date, location and species, of all mammals seen. The following information was gathered.

Algerian Mouse *Mus spretus* . One caught in a Longworth trap set among the Park buildings on 22nd April 1991. It had a much warmer tone to the pelage than *Mus musculus* , being almost gingery brown. The flanks were pale yellowy brown and the underparts unmarked off-white. The ears were large. It was very acrobatic and when running held its tail upright. A series of measurements was obtained and photographs taken.

House Mouse *Mus musculus* . One was caught in a Longworth trap set inside a Park building on the night of 22nd/23rd April 1991. It was a typical grey individual with dirty greyish white underparts. It was larger than the *M. spretus* and ran with its tail trailing.

Pipistrelle *Pipistrellus pipistrellus* . One recently dead individual, found on the road at the edge of the Park, was identified on measurement (forearm 2 mm) and ear/face characteristics. The specimen was eviscerated and set for future reference.

Rattus species. The remains of a rat, possibly Brown Rat *Rattus norvegicus* was found near the Park buildings on the morning of 1st May 1991. The tail length was 21.5 cm. The teeth have been retained for future reference.

Mammal transect

We obtained a strong impression of considerably fewer mammals in spring 1991 compared with similar periods in 1989-90, perhaps as a result of the effects of the fire and flood of autumn 1990. We had no means of obtaining a measure of population levels prior to 1990, but to monitor current and subsequent mammal abundance we devised a mammal transect along 1.8 km of drivable track between the Park entrance at the Pont dels Anglesos and the Casa del Parc at Sa Roca. Observers were asked to record the date, time of transect, whether night or day, the form of transport (most transects were done by car), the direction taken (in or out of the Park), number and species observed (including all nil observations), the location of species observed and the name of the observer or observers.

Form 1. Butterfly Census data sheet

Figure 1. S'Albufera butterfly and dragonfly transect 1

Figure 2. S'Albufera butterfly and dragonfly transect 2

Figure 1. S'Albufera hoverfly transect

Form 1. Earthwatch Project S'Albufera Bird Transect schedule

Figure 1. S'Albufera bird transect 1

Figure 2. S'Albufera bird transect 2

Figure 3. Detailed map of section B, S'Albufera bird transect 2

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