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PROCEEDINGS OF THE UNEP-MAP RAC/SPA SYMPOSIUM,

CONSERVATION OF MARINE AND COASTAL BIRDS IN THE MEDITERRANEAN

Editors: Pierre Yésou, Joe Sultana, John Walmsley, Hichem Azafzaf

PROCEEDINGS OF THE UNEP-MAP - RAC/SPA SYMPOSIUM, HAMMAMET - TUNISIA - 20 TO 22 FEBRUARY 2015

CONSERVATION OF MARINE AND COASTAL BIRDS IN THE MEDITERRANEAN

UNEP MAP RAC/SPA جمعية أحباء الطيور Association "Les Amis des Oiseaux" Conservatoire du littoral TOUR DU VALAT

جمعية أحباء الطيـــــور
Association "Les Amis des Oiseaux"

ASSOCIATION "LES AMIS DES OISEAUX"

Association "Les Amis des Oiseaux » (AAO) is a Tunisian NGO working for the study, monitoring and protection of bird populations in Tunisia. AAO carries out conservation programmes for sedentary and migratory birds and their habitats through relevant projects and activities (information, awareness raising, advocacy, monitoring, capacity building, etc.).
Founded in 1975, AAO has actively integrated national, regional and international networks and programmes aiming at the conservation of birds and their key sites. Thus, it is the official partner of BirdLife International in Tunisia, a member of IUCN and a founding member of the MedWaterbirds, MedWet North Africa, RANDET and TunWet networks.

Conservatoire du littoral

CONSERVATOIRE DU LITTORAL

The French Coastal Agency (Conservatoire du littoral) is a public entity aimed at purchasing coastal territories in order to improve their preservation. This organization has cooperation activities focused on the Mediterranean since 20 years and coordinate the Mediterranean Small Initiative since 2005 to promote and support management actions on micro-insular territories. Seabird species are one of its main preoccupations, therefore conservation actions to marine avifauna has been carried out in the framework of the "Albatross" project to improve knowledge and struggle against threats affecting seabirds and their habitats. Another objective of the PIM initiative is structuring seabird conservationists network, and pooling monitoring and ringing data of seabird species.

TOUR DU VALAT
STATION BIOLOGIQUE

TOUR DU VALAT

The Tour du Valat, located in the heart of the Camargue in southern France, was founded in 1954 by Luc Hoffmann. It develops today programmes of research into the functioning of wetlands, and tests out management methods and puts them into practice on the estate. Results are communicated by means of training, partnerships and the implementation of innovative projects. The Tour du Valat is involved at the scale of the Mediterranean Basin, in collaboration with
•local stakeholders
•universities and NGOs, and public research bodies
•governmental and international organisations
Its mission:
To halt and reverse the destruction and degradation of Mediterranean wetlands and their natural resources, and promote their wise use.
The Station's programmes are managed by multidisciplinary teams.

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THE EDITORS

Pierre Yésou is working for Office National de la Chasse et de la Faune Sauvage (ONCFS), a public body within the Ministry in charge for the Environment in France. He acts as an international expert on marine and coastal birds for this Ministry. He is a regular participant at the conferences organized by Medmaravis, and is well versed in the Mediterranean seabird scene.

Joe Sultana is an ornithologist who has been an active member of MOS (now BirdLife Malta) since its inception in 1962. He has been a Council Member of Medmaravis since its inception in Alghero in 1986 and served as Chairman of the Council (1995- 2011). Also served as Chairman of the ICBP European Section (1985-1992), World Council Member of BirdLife International (1994-99), and as a consultant of RAC/SPA and the European Diploma of the Council of Europe.

John G. Walmsley worked as an Avian Ecologist at the Tour du Valat Biological Station studying marine and coastal seabirds during the past 40 years. Has maintained a close relationship with MEDMARAVIS as project manager in the Mediterranean region and representative at international meetings and conferences, and has organized and edited several Symposia Proceedings.

Hichem Azafzaf is a keen ornithologist, serving as Chairman of the Association « Les Amis des Oiseaux » (AAO), BirdLife Partner in Tunisia. He was the North-African regional representative on the AEWA Technical Committee up to 2015 when he served also as the Committee's Vice-Chairman. As an international coastal and waterbirds expert, he was one of the authors of the Atlas of Libyan waterbirds. He has been involved with Medmaravis since the first symposium in Tunisia, and now he is this Association's General Secretary.

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&

Medmaravis

2016

CONTENTS

WELCOME ADDRESS BY
RAC/SPA

In 1995, the Contracting Parties of the Barcelona Convention adopted a new Protocol concerning the Specially Protected Areas and Biological Diversity in the Mediterranean (SPA/BD Protocol). The second Annex of this Protocol lists the endangered or threatened species found in the Mediterranean. An "Action Plan for the conservation of bird species listed in Annex II of the SPA/BD Protocol on Specially Protected Areas and Biological Diversity" was written for these pelagic and coastal bird species and adopted by the thirteenth Meeting of the Barcelone Contracting Parties (Catania, 2003).

The first Symposium on the Conservation of coastal and marine bird species of Annex II (SPA/BD Protocol), under the Mediterranean Action Plan and the Barcelona Convention, took place in Vilanova I la Geltru (Spain) in November 2005 and was co-organized with Medmaravis and SEO/BirdLife. One of the main recommendations proposed the addition of 10 new bird species to the list of endangered and threatened species in Annex II of the SPA/BD Protocol, which was later adopted by the 16th Ordinary Meeting of the Contracting Parties to the Convention in November 2009 in Marrakech (Morocco).

It is appropriate, ten years after the Vilanova event, to have a closer look on the status of marine and coastal birds. Now is the time to identify the gaps in our knowledge of these birds' populations; assess the effect of new regulations, conventions and research tools; and call for a closer cooperation among all the countries that adopted the 25 bird species list of Annex II of the SPA/BD Protocol.

The Regional Activity Centre for Specially Protected Areas (RAC/SPA) is organizing the 2nd Symposium on the Conservation of Marine and Coastal Birds in the Mediterranean in Hammamet (Tunisia) on 20-22nd February 2015, in partnership with "Les Amis des Oiseaux" (AAO, BirdLife Partner in Tunisia), MEDMARAVIS, and two French organizations: the Tour du Valat Biological Station and the Conservatoire du Littoral.

The main objective of the second Symposium is to review the current knowledge of the 25 bird taxa included in the SPA/BD Protocol and to discuss the most recent results of research and conservation work on these species. Particular interest will be paid to conservation issues, the current projects implemented in the Mediterranean, and innovative proposals to limit the threats impacting these species' populations. This symposium is an opportunity for Mediterranean ornithologists to exchange information and share experience and to give to MEDMARAVIS members the opportunity to get together again since Alghero, 2011.

Khalil ATTIA,
Director of RAC/SPA

UNEP MAP RAC/SPA

WELCOME ADDRESS BY
Association “Les Amis des Oiseaux”

Twenty years after the 4th Mediterranean Symposium of marine birds, held in this same city, in Hammamet, in October 1995, and 10 years after the First Symposium on the Mediterranean Action Plan for the Conservation of marine and coastal birds in Vilanova (Spain) in November 2005, we are gathered here, ornithologists, biologists and managers representing several countries around the Mediterranean, for an update of our knowledge of Mediterranean marine and coastal birds listed in Appendix II of SPA/BD Protocol of the Barcelona Convention.

No doubt, progress was made over the past decade, in monitoring populations and in the knowledge of their migration routes, roosting or feeding areas. However, much remains to be done for the conservation of these species and this is why we are all gathered here today to discuss the issues and to exchange studies and experiences that trace the best pathways to conservation. The Association « *Les Amis des Oiseaux* » (AAO), BirdLife in Tunisia, has been committed for the conservation of birds and nature since 1975 and is therefore one of the oldest environmental NGOs in Tunisia. In 1998, through a rigorous application of international criteria, AAO has identified 46 Important Bird Areas; 38 of these are wetlands hosting wintering and breeding populations of several species which are dealt with in this meeting. Two are archipelagos; La Galite, famous for its colony of Eleanora’s Falcons *Falco eleonorae*, and Zembra, renowned for its large breeding colony of Scopoli’s Shearwaters *Calonectris diomedea*. Furthemore, AAO has been implementing a monitoring programme of waterbirds since 2002 and has recently published the first identification guide in Arabic for migratory waterbirds in Northern Africa, which was distributed free of charge to professional and amateur observers of birds in the countries of North Africa.

Today, together with our partners, the Regional Activity Centre for Specially Protected Areas (RAC/SPA), MEDMARAVIS, the Tour du Valat and the Conservatoire du Littoral, we participate in the organization of this important meeting and we reiterate our commitment to the conservation of marine and coastal birds in the Mediterranean. We hope to find solutions to the existing conservation issues and come out of this meeting with realistic recommendations applicable at national, regional and international levels.

Hichem AZAFZAF
Chairman of the Association “ Les Amis des Oiseaux ”
BirdLife Partner in Tunisia

جمعية أحباء الطيـــور
Association "Les Amis des Oiseaux"

BirdLife INTERNATIONAL

WELCOME ADDRESS BY
Tour du Valat

The prerequisite for a sound and sustainable management of Nature is a good, regularly updated and shared knowledge on the status of habitats and populations, the pressures affecting them and their trends. A number of coastal and marine birds in the Mediterranean are threatened, as stated in the SPA/BD Protocol of the Barcelona Convention, and it is our common responsibility to join forces, to share our knowledge in order to ensure that the best decisions are taken to ensure the conservation of these species at stake.

The Tour du Valat has been involved in wetlands and waterbirds conservation since the 1950's. More recently, Tour du Valat has started participating in programmes to improve waterbird monitoring in the Mediterranean Region through support to the International Waterbird Census. The main objective of this programme is to improve the spatial coverage and overall quality of waterbird monitoring in this region. In order to strengthen national networks of observers and increase their capacities, the "Mediterranean Waterbirds" network was created in 2012, to bring together different partners involved in the monitoring and conservation of waterbirds and wetlands in the Mediterranean Region.

Up to now this network has focussed on partnerships with North African countries but further development in the North and East of the Basin is clearly the next step, so as to get a pan-Mediterranean vision of the evolution of these populations and to take the appropriate management decision at this coherent scale.

In this framework, the Tour du Valat is glad to support the organization of the 2nd Symposium on the Mediterranean Action Plan for the Conservation of marine and coastal birds, in collaboration with our partners, the Association « *Les Amis des Oiseaux* », the Regional Activity Centre for Specially Protected Areas (RAC/SPA), the Conservatoire du Littoral and MEDMARAVIS.

By sharing data and knowledge on the marine and coastal birds and thus strengthening a Mediterranean network for their study and monitoring, this 2nd symposium will contribute to their conservation and the conservation of their habitats in the Mediterranean basin.

Jean JALBERT
Directeur Général
Tour du Valat

TOUR DU VALAT
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Oiseaux d'eau Méditerranée

WELCOME ADDRESS BY MEDMARAVIS

It is a great pleasure to welcome you here at Hammamet for this 2nd Seabird symposium jointly organized with RAC-SPA, MEDMARAVIS and Association "Les Amis des Oiseaux" and under the auspices of the French Conservatoire du Littoral and Tour du Valat Biological Station. It is also our 14th MEDMARAVIS symposium dedicated to Mediterranean seabirds and our 2nd one organized in this hospitable city of Hammamet.

In order to be able to look forward and identify our priorities for seabird conservation during the next decade, it may be of interest to recall briefly the co-operation of MEDMARAVIS with the Mediterranean Action Plan. During a joint meeting of MAP and the Permanent Committee of the Bern Convention at Montpellier in 1999, some marine biologists were invited by the Barcelona Convention Secretariat to establish a list of threatened marine and infra-littoral species in the Mediterranean Region. This list included some plant species such as *Posidonia oceanica*, various species of invertebrates, reptiles such as *Caretta caretta*, as well as *Trionyx triunguis*, various fish species, and mammals including cetaceans and the iconic Monk Seal. However, seabirds were overlooked during that meeting and it was towards the end that MEDMARAVIS representatives managed to persuade participants to add 15 seabird species to the list. It took a couple of years to have the Annex 2 list ratified since some delegations were opposing the inclusion of seabird species since they happen to breed on land. Finally in November 2003 Annex 2, including the first list of seabirds, was ratified in Catania by the 13th Conference of Contracting Parties to the Barcelona Convention.

Recently, MEDMARAVIS proposed to add a further 10 species of seabirds or coastal birds during the first joint meeting with RAC-SPA at Vilanova y la Geltru, Spain, in 2005. Having established a list of 25 rare and threatened seabirds or coastal bird species ratified by the Barcelona Convention, now is the time to identify which priority actions should be taken to obtain an efficient long term conservation policy for these seabirds and their habitats. Where are the most threatened sites for these protected seabirds? Which priority actions should be taken? Where do we go from here? We need to seek the right answers for these questions.

Some coastal habitats, such as the Tunisian and North Adriatic tidal mudflats, or the non-tidal coasts of Spain, Sicily and Cyrenaica, which are particularly important for the vulnerable Kentish Plover *Charadrius alexandrinus*, need an increase in conservation efforts. Man-modified coastal wetlands, such as the salines, need far-reaching management plans and an extensive use of mitigation measures whenever a new development is proposed. The wealth of estuaries, not just the major deltas of the Ebro, Evros/Meriç, Nile (with the most important, but severely threatened, Lake Burullus), Po, Rhône and Seyhan, but also those of rivers Neretva, Buna/Drin, Habifa in the Marmara Sea, Hayran, Gediz, Menderes and Moulouya, should not be forgotten. The latter functions as a stop-over site for waders and a roosting area for Audouin's Gull *Larus audouini* breeding in the nearby Chafarinas islands. Despite hosting colonies of threatened species (such as Dalmatian Pelican *Pelecanus crispus*), no effective management plans exist for most of these sites.

We need to be aware of the fact that most of our coastal habitats remain threatened because of lack of proper conservation management. Over the last 40 years a large network of protected areas has been created. Yet, most of them happen to be protected only on paper. Problems have not been solved neither at national level nor at a transnational level (Ramsar, Bern, Bonn, Barcelona, Birds and Habitats Directives). Problems could be better dealt with by the local component, and on the administrative level of municipal organizations. The setting up of a Mediterranean Coastal Ecology Information Centre for Local Authorities would be helpful in this regard.

At the 10th Meeting of the Convention of Biological Diversity (COP 10) held in Japan in 2010, several so called Aichi Targets have been adopted. Target 11 reads as follows: "By 2020, at least 17% of terrestrial and inland waters and 10% of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effective and equitable management, through ecologically well connected systems of protected areas, and through other effective area-based conservation measures."

I honestly hope that this Aichi Target will elicit further action so that by 2020 at least 10% of our coasts and marine areas are effectively protected in the Mediterranean to the benefit of seabirds and their habitats, to the benefit of biodiversity in general and to the benefit of our civilization at large.

Xaver Monbailliu
Founding Member MEDMARAVIS

WELCOME ADDRESS BY
Conservatoire du littoral – Small Island Initiative

The French Coastal Agency ('Conservatoire du Littoral') is a public entity that has been developing an important international cooperation for more than 20 years, with specific interest on the Mediterranean coastal areas. We are very pleased to participate again as partners in an international seabird symposium, particularly in Tunisia, where some of our more motivated partners are working. We have been coordinating the "Albatross project", a Mediterranean programme specifically focused on seabird conservation within the wider Mediterranean Small Island Initiative (PIM), for about 10 years. Why did we choose to work on seabirds? Because they are closely linked with islands; and because they are emblematic, and flagship species. Therefore when we are protecting them, we have to protect their habitat and also all the other species interacting with them. Ornithologists were among the first experts involved in PIM. They have played a key active role and have been strongly involved in improving our knowledge on insular territories and ecosystems. Consequently the "Albatross project" was born. During the first workshop in Marseille in 2009, we started to build up a common action plan permitting to implement the following actions in cooperation with our local partners:

- Writing monographs; compiling all the monitoring data available for the target species at Regional scale and outlining conclusions about their state of conservation; and later producing Fact Sheets (a lighter document with the same objectives) presenting Last Updates;
- Carrying out field missions on insular territories targeting their seabird colonies, supporting actions such as monitoring Scopoli's and Yelkouan Shearwaters on Zembra (breeding and telemetry), as well as monitoring the Osprey population of Al Hoceima National Park in Morocco;
- Creating a database to gather ringing data on 4 different French protected islands hosting Shearwaters, with the object to extend it to other Mediterranean islands and species.

However, in the long term, the PIM Initiative is not aimed at supporting research programme focused only on a few species. Eventually we would promote the reinforcement of synergies with our premium partners such as RAC-SPA, MEDMARAVIS, NGO's like AAO in Tunisia and GREPOM in Morocco, so that the involvement and efforts of the 'Conservatoire du littoral' are gradually converted to operational activities. We are part of the organization of this symposium in Hammamet, because it is important that seabird conservationists sit around the table to decide how to work together during the next years. Considering the socio-economical context of the Mediterranean area, it is becoming more difficult to raise funds dedicated to this specific environment area. Therefore, we think that during this symposium and in the near future ornithologists should grasp the opportunity to build up an effective network of conservationists, and propose a common project to finance activities specifically focused on seabird research and conservation.

Fabrice BERNARD & Mathieu THÉVENET

Conservatoire du littoral

PIM

Alan Jonhson during the ringing session of young Flamingos in the Camargue, August 2013. Photo © Valérie Farine

A Tribute to Dr. Alan R. Johnson (1941-2014) by John G. Walmsley

Known to many as 'Mr Flamant', Alan R. Johnson was born in 1941 in Ruddington, Nottinghamshire, U.K. At an early age he became passionate about nature, in particular birds, visiting local birding sites and Gibralter Point. The turning point in Alan's life came when he visited the Camargue in southern France in 1960 and met Dr. Luc Hoffmann, Director of the Tour du Valat Biological Station who invited him to join the staff. Alan was fascinated by the movements of shorebirds that passed through the Camargue. He began a capture and ringing programme that showed that the Camargue is an important stopover site for thousands of shorebirds during the annual spring and autumn migrations. He devoted his next 45 years to the study of the Greater Flamingo *Phoenicopterus roseus* that became a 'flagship species' in the Mediterranean region, publishing numerous scientific articles and co-authoring many more. He organized a conservation and research project on Flamingos from 1965-2001, initiated a capture and ringing programme of hundreds of Flamingo chicks each year, and established an important data base on the movements, life histories and eventual breeding of marked birds. In December 1983 Alan successfully defended his thesis entitled "*Etho-écologie du Flamant rose* Phoenicopterus ruber roseus *en Camargue et dans l'Ouest-Paléarctique*". He organized 3 international workshops on Flamingos in Antequera, Spain, in 1989, Miami, USA, in 1998, and the Tour du Valat, Camargue, in 2002. Scientific director of two films on flamingos in 1989-90, Alan also produced a booklet 'Les flamants de Camargue' in 1992, and co-authored several books that included one with Frank Cézilly: *The Greater Flamingo* (Poyser 2007) and *Les Ailes Pourprés* with Arnaud Béchet (2008). Alan was also Chairman of the Flamingo Specialist Group (1974-2004) of Wetlands International-BirdLife International, and worked with the Species Survival Commission of IUCN as Editor of the Group' Newsletter. In October 2014 he was awarded a prize by the Flamingo Specialists Group in San Diego (California), in honour of his life-long commitment to the study and conservation of the species.

PART I

SPECIES OF PARTICULAR MEDITERRANEAN IMPORTANCE

Conservation of the critically endangered Balearic Shearwater *Puffinus mauretanicus*: an update

J.M. Arcos

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ABSTRACT

The Balearic Shearwater *Puffinus mauretanicus* is regarded as the most threatened seabird species in Europe. Increasing research in the last two decades provided insights on its biology and conservation concerns, particularly regarding the marine environment. However, monitoring effort at colonies remains very limited and conservation actions both on land and at sea are insufficient to reverse the serious decline of the species.
An overview of the recently updated European Action Plan of the species (2011) is presented, with updates from research and conservation action in the years afterwards. Low adult survival was the key driver of the current decline of the species, and therefore conservation action should prioritize those threats that increase adult mortality. Introduced predators in the colonies (particularly carnivores) and fishing bycatch at sea are the most serious threats identified.

INTRODUCTION

The Balearic Shearwater *Puffinus mauretanicus* was catalogued as Critically Endangered in 2004, following IUCN criteria (BirdLife International 2004). This way it became the most threatened bird species in Europe, and has maintained this doubtful privilege since then. The reason is, the small breeding population (formerly estimated at 2,000 pairs), endemic to the Balearic Islands in the western Mediterranean, is experiencing a sharp decline that may lead to its extinction in less than half a century (Oro *et al.* 2004).

This assessment took place short after the conclusion of an EU funded LIFE Project led by the Balearic Government and conducted in close collaboration with SEO/BirdLife (Ruiz & Martí 2004). This alarming situation led to the inclusion of this shearwater in several international lists and conventions (e.g. OSPAR, Barcelona Convention, ACAP), and prompted further research on the species, particularly at sea. However, conservation action has been quite limited. Moreover, monitoring has been rather low in the breeding colonies since then, precluding a sound assessment of the evolving trends of the species. An overview of the recently updated Action Plan of the species (Arcos 2011) is presented here, with updates from research and conservation action since then. Research and conservation priorities are then discussed.

BIOLOGY, POPULATION AND TRENDS

Taxonomic remarks

The taxonomic status of the Balearic Shearwater has been long debated. It is closely related to the Yelkouan Shearwater *P. yelkouan* and both taxa were considered as subspecies of the Manx Shearwater *P. puffinus* until the late 1980s. Its specific status was acknowledged in the late 1990s, based on paleontological, molecular, morphological, ecological and behavioural evidence (Sangster *et al*. 2002). Later, the discovery that birds in Menorca show mixed phonotypic and genotypic features of *yelkouan* and *mauretanicus* led to question again the specific recognition of *mauretanicus* (Yésou 2006). However, research so far suggests that *yelkouan* and *mauretanicus* are sibling species, which still keep a contact zone (Genovart *et al*. 2012).

Annual cycle

The Balearic Shearwater breeds exclusively in the Balearic Islands, Spain, from late February through early July. At this time of the year the species forages mainly off the Iberian Mediterranean shelf, and also makes use of some marine areas of the Balearic archipelago, the N African coast (Algeria and Morocco) and S France. After breeding, the bulk of the population leaves the Mediterranean and is distributed along the Atlantic coast of SW Europe and the northwest coast of Morocco. Birds return to the Mediterranean in early autumn, and concentrate mainly in the same areas frequented during the breeding period, though tending to show a more coastal behaviour and to form larger congregations. While this general cycle has been known for some time (Le Mao & Yésou 1993, Mouriño *et al*. 2003, Ruiz & Martí 2004), research in the last 10 years has greatly improved our knowledge concerning the detailed distribution patterns. This was addressed through boat-based transect surveys (e.g. Arcos & Oro 2002, Abelló *et al*. 2003, Louzao *et al*. 2006, Ramírez *et al*. 2008, Arcos *et al*. 2012a, Oppel *et al*. 2012), as well as with the aid of remote tracking devices (e.g. Ruiz & Martí 2004, Guilford *et al*. 2012, Louzao *et al*. 2012, Meier *et al*. 2015). Direct observations also contributed to refine this information, showing a northward shift in the summer-autumn distribution of shearwaters off western France and south-western Britain, presumably driven by environmental change (e.g. Yésou 2003, Wynn *et al*. 2007, Yésou *et al*. 2012, Jones *et al*. 2014), and more birds staying off western France in winter (e.g. Pianalto *et al*. 2013).

Population size and trends

Estimates for the population size in the last two decades ranged from about 2,000 to 4,500 breeding pairs, with the current official figure being 3,193 pairs (Ruiz & Martí 2004, Arcos 2011). However, recent research at sea (using two approaches, boat-based surveys and coastal counts at the Gibraltar Strait migration bottleneck) point to a global population of about 25,000 individuals, suggesting that the breeding population could be larger than previously assumed (Arcos *et al*. 2012b, Arroyo *et al*. 2014). Nevertheless, providing an accurate figure for the breeding population is difficult, as breeding sites are largely inaccessible and the count data often relies on indirect methods subject to strong biases. For this reason, population trends cannot be relied on counts, and would better be based on demographic data. According to such data, the species is suffering a sharp decline, first estimated at an annual rate of 7.4% (Oro *et al*. 2004). This sharp decline was recently confirmed, with similar rates, using a more powerful statistical approach (Tenant *et al*. 2014), and again incorporating new demographic information (M. Genovart pers. comm.). In all cases, adult survival was identified as the most sensitive parameter, with

values around 80%, when the expected survival rate for a Procellariiformes would be over 90%.

THREATS

The main threats for the Balearic Shearwater are those that directly affect adult survival, both in the breeding grounds and at sea. Predation by carnivores at the breeding colonies and fishing bycatch at sea have been identified as the two most serious ones.

Bycatch appears to be particularly relevant, and largely unattended. Indeed, there is increasing evidence of captures in different fishing gears, mostly demersal longlines but also purse-seines, trawlers and probably set nets (Louzao *et al.* 2011, ICES 2013, Oliveira *et al.* 2014). These captures are rather irregular, but can involve tens or even several hundreds of birds at a time, thus seriously affecting adult survival rates. Acute pollution (e.g. oil spills) also poses a potential and even more serious threat, as the highly gregarious behaviour of this shearwater at sea could result in the death of large numbers of birds in the hypothetical case of a major oil spill affecting an area of shearwater congregation. Harvesting for human consumption used to be an important threat in the past, influencing both survival and productivity, but this practice is illegal nowadays and practically eradicated.

Other threats affecting breeding performance or even (indirectly) adult survival are reduced food availability due to fisheries over-exploitation and/or human-induced environmental change, predation by rats, breeding habitat degradation, and oil and chemical pollution. Increasing research is necessary to assess the effect of these threats at the population level, as well as the impact of new potential threats, such as marine windfarms (which could cause adult mortality through collisions).

PRIORITY ACTION

Conservation action should focus on halting the negative trend of the Balearic Shearwater population. Priority action should therefore be centred on those threats causing significant adult mortality, primarily predation by introduced carnivores (cats *Felis catus*, genet *Genetta genetta*, pine marten *Martes martes*) in the colonies and fishing bycatch at sea. The problem of carnivores is concentrated in a few, though relevant colonies, with current efforts addressed to preclude access of carnivorous species to these colonies (particularly at Mola de Maó, in Menorca). Further efforts should be made to protect the colonies of Formentera, also affected by cat predation. Regarding the fisheries bycatch, the European Commission (2012) has elaborated an action plan which provides a framework to address the problem. However, the implementation of the plan is slow and no specific action has been taken so far.
As a secondary conservation measure, it is also important to direct our efforts at maintaining a sound environmental status of the current breeding colonies and important marine hotspots through effective site protection, the implementation of adequate management plans, including habitat restoration wherever appropriate. All the colonies of the Balearic Shearwater are officially protected, but management plans are lacking in many of them, and conservation action and monitoring is necessary. The marine environment is an ongoing process of extending the European network of protected areas (Natura 2000) to the open sea. In doing so it would contribute to the conservation of the species, once the sites are designated and management plans are implemented (Arcos *et al*., this volume).

To assess the efficacy of any conservation action, it is also essential to ensure monitoring of the species on land and at sea. Of particular relevance it would be wise to initiate an annual monitoring

scheme in a sufficient number of representative colonies, to assess the demographic parameters that would allow to assess with confidence the population trend of the species.

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Are there more Yelkouan Shearwaters *Puffinus yelkouan* than we thought?

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ABSTRACT

The Yelkouan Shearwater *Puffinus yelkouan* is one of the least known endemic species in the Mediterranean Basin. Its breeding behaviour may create difficulties when trying to make precise population estimates of breeding colonies. Land based count data from the Bosphorus reveal that remarkable numbers of Yelkouan Shearwaters are passing along the site just before the egg-laying period, at a time when breeders should be close to their breeding sites.

This means that the 90,000 birds counted in four hours in February 2015 should be mostly non-breeders. Continuous passage after these four hours of survey suggests the need to reconsider the global population estimates derived from breeding colonies, and gives rise to a discussion on how accurate these estimates are. Are there any other methods that can be applied to produce more precise estimates with land-based counts?

The aim of this paper is to emphasize the value of the Bosphorus in monitoring Yelkouan Shearwaters and a call for standardized land-based counts during the February passage of the species in order to support global population estimates.

INTRODUCTION

Population size is one of the most important factors when evaluating the conservation status and conservation priorities for certain species (IUCN 2012). However, in real world, it is difficult to measure not only the global population but also to census accurately discrete sub-populations of a given species. It is even more challenging when it comes to secretive species such as nocturnal seabirds (Croxall *et al*. 2012). The Yelkouan Shearwater *Puffinus yelkouan* is a species endemic to the Mediterranean Basin, including Black Sea. Its breeding distribution ranges from France to Bulgaria but its breeding status in many countries is not yet confirmed, especially in the southern and eastern Mediterranean including Turkey. In the Mediterranean Basin, only ten countries host a Yelkouan Shearwater colony in 40 known sites, and only 17 of the 40 locations have provided relatively high quality data for breeding population estimates (Bourgeois & Vidal 2008).

The Yelkouan Shearwater nests in burrows, holes and crevices on rocky offshore islands and islets. In most cases, these islands are remote and nest locations are difficult to access during censuses of breeding populations. The attendance at breeding colonies occurs only on dark

nights and the birds are also impacted by other factors (Bourgeois *et al*. 2008), that make precise population estimates of breeding colonies difficult. Other indirect methods such as raft counts are thus used to support population estimates. The global breeding population of the Yelkouan Shearwater is estimated at 15,300-30,500 pairs, which should correspond to 46,000-92,000 individuals (Derhé 2012).

Despite the useful geographic location and features of the Turkish Straits, researchers have only recently started to survey the passage of seabirds. Once the yearly pattern of Yelkouan Shearwater movements in the Bosphorus was obtained from the systematic counts between 2010 and 2014, we focused on the peak period of the species abundance in early February. This resulted in recording an unusually high number of birds. This paper aims to emphasize the importance of the Bosphorus in monitoring this species and in assessing its global population size, by long term monitoring with further systematic counts in the area.

STUDY AREA AND METHODS

Systematic land-based counts were performed at the Bosphorus, the strait connecting the Mediterranean Sea to the Black Sea. The Bosphorus is 30km long and the distance between the two banks at the narrowest point (Rumeli Hisarı & Anadolu Hisari) is approximately 700m. Despite the lack of previous scientific studies, the area is well known for Yelkouan Shearwater passage throughout the year (e.g. Nankinov 2001). From 2010 until 2014, shearwater counts were conducted twice a month from early morning until midday during four hour observation periods from Rumeli Hisari. The exact timing of the counts from start to finish varied by one and one and a half hours according to the season. Each daily census was divided into eight 30 minute counts and was conducted by two experienced members of the team assisted by trained volunteers.

Wide-angled 8×42 binoculars were used for counting the shearwaters and a telescope to spot the more distant flocks and the flight direction. Weather conditions during each 30 minute count were also taken into consideration. In 2014 complementary daily counts were conducted twice a month during the first week of February in order to catch the peak passage day. This February “coastal count marathon” was repeated in 2015.

RESULTS

The 121 systematic land-based counts conducted between 2010 and 2015 revealed a consistent peak passage period in the yearly pattern of movements (Sahin *et al*. 2012). In these peak periods, the total number of birds counted in 4 hours ranged from 29,553 to 91,245 individuals (Figure 1-A). The “coastal count marathon” during the first week of February each year showed that the numbers of shearwaters were higher on one of the days in both 2014 and 2015 (Figure 1-B). In these peak days the main direction of the movement was southwards to the Marmara Sea, i.e. birds moving from the Black Sea to the Agean Sea (Figure 1-C).

During these peak days, intense bird activity was observed before the start of the census, when the team was travelling along the Bosphorus to reach the observation point. Bird activity declined during the census, but after we stopped counting bird activity continued at more or less the same pace, indicating that our counts underestimated the true number of birds passing through the area.

DISCUSSION

Bosphorus shearwater counts have definitely a certain amount of bias. Potential bias from observer variation has not been quantified for this study, but at least two of the most experienced observers were always present during the counts in order to minimise the observer bias in peak days. The team members also made regular calibrated counts together when training volunteers and great care was taken that team members were constantly applying the same methodology when counting birds. Beside observer's variability, another potential source of bias is the detection probability of birds due to distance. However there is no limiting factor for spotting flocks due to the short distance between the banks in the Bosphorus (only 700m at our census site). For the same reason, we can ascertain that no significant reverse movement of birds was occurring in the opposite direction from census point; the birds' activity showed an almost strictly one-way flow on peak days.

This being acknowledged, observations made in the Bosphorus are an indication that a large proportion of the global population of Yelkouan Shearwater passes through the strait during early February. The results of these surveys must be interpreted as an underestimation of the global population size, since at this time of the year breeders should already be staying in the vicinity of the breeding colonies, at least as far as the main known colonies are concerned (Péron *et al*. 2013, Raine *et al*. 2013).

Moreover, the proportion of the global Mediteranean population that frequents the Black Sea after the breeding season is not well documented. Also there is no data on the breeding status of the Yelkouan Shearwater along the Black Sea coast of Turkey and this knowledge gap exists for the other countries around the Black Sea. All these gaps in our knowledge of the Yelkouan Shearwater make it highly challenging to conclude on what numbers counted in the Bosphorus are reflecting.

Moreover, counts conducted in the Bosphorus can be used to compare changes in numbers between years. However many factors are probably influencing the migration of Yelkouan Shearwater over the whole Mediterranean Basin, rendering it difficult to conclude any changes in population size by simply comparing the Bosphorus numbers in different years.

Land-based counts from narrow straits can nevertheless provide valuable insights into the population size for certain migratory seabird species (see Arroyo *et al*. 2014) and the Bosphorus counts can certainly contribute to the conservation effort in the Mediterranean Basin by questioning the population estimates from breeding locations and by providing not robust but comparable estimates. In order to better understand the situation of the Yelkouan Shearwater in the Mediterranean Basin, systematic counts in the Turkish straits during the peak period should be continued to support population estimates. With the increasing information about the migratory behaviour of the species, the Bosphorus counts may be even more valuable.

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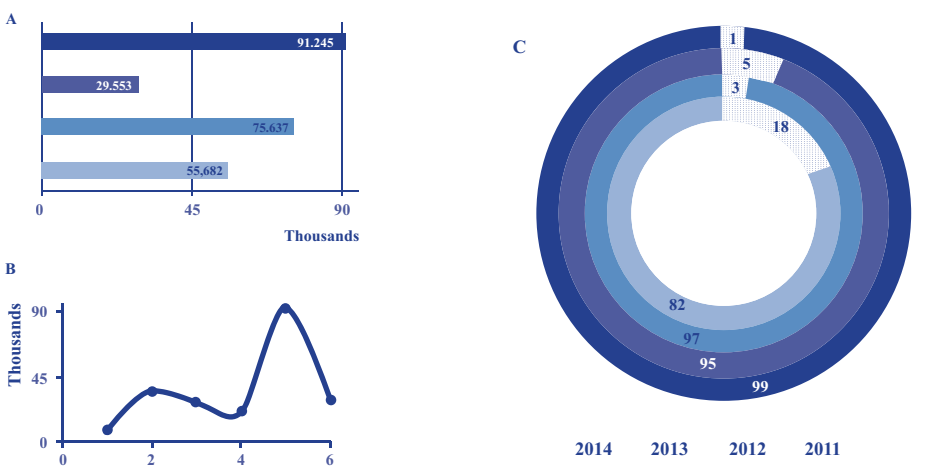

Figure 1. Counts of Yelkouan Shearwaters *Puffinus yelkouan* through the Bosphorus in February. A: Peak day numbers in each four years 2011 to 2014. B: Daily number of birds passing in a southerly direction in the first week of February 2014. C: Percentages of birds passing South (towards the Marmara Sea) and North (towards the Black Sea) in peak days. The smaller mid-grey areas centred on the top of the figure indicates northward movements.

Preliminary data on breeding populations of *Calonectris diomedea* and *Puffinus yelkouan* in the Marine SCI ITB040020 "Isola dei Cavoli, Serpentara, Punta Molentis, Campulongu" (Capo Carbonara Marine Protected Area, southeastern Sardinia)

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ABSTRACT

Reproductive parameters of Scopoli's Shearwater *Calonectris diomedea* and Yelkouan Shearwater *Puffinus yelkouan* obtained in 2013 in Marine SCI ITB040020 "Isola dei Cavoli, Serpentara, Punta Molentis, Campulongu", in Capo Carbonara Marine Protected Area, are presented. The study was carried out through nocturnal listening, mainly on moonless nights, and nests searching. Breeding of these species was verified in the two main islands Cavoli and Serpentara as well as in Variglione Sud, a rocky islet very close to Serpentara. A total of 157 holes were mapped, corresponding to at least 190 nests. Out of 99 nests certainly occupied in 2013, 33 were occupied by Scopoli's Shearwater and 54 nests by Yelkouan Shearwater; it was not possible to verify the species for the remaining 12 nests. The reproductive success was estimated between 0.21 and 0.64 young fledged per breeding pair for Scopoli's Shearwater and between 0.09 and 0.41 for the Yelkouan Shearwater, being probably lower in Serpentara than in Cavoli Island. The high density of black rat *Rattus rattus* is the main cause of reproductive failure in all sites.

INTRODUCTION

Shearwater species, including Scopoli's Shearwater *Calonectris diomedea* and Yelkouan Shearwater *Puffinus yelkouan*, are very sensitive to various threats on land and at sea, and a good knowledge of the local situations is therefore essential to ensure their conservation and management in the long term. The island system Cavoli and Serpentara, in southeastern Sardinia, is part of "Capo Carbonara" Marine Protected Area (MPA) that includes a SCI (ITB040020 Cavoli Island, Serpentara Island, Punta Molentis and Campulongu) and three SPAs (ITB043026 Serpentara Island, ITB043027 Cavoli Island and ITB043028 Capo Carbonara and Pond Notteri - Punta Molentis). Although the presence of both Scopoli's and Yelkouan Shearwaters was known (Mocci Demartis 1992, Schenk & Torre 1992, Zotier *et al.* 1992, Baccetti *et al*. 2009), knowledge on the size of breeding populations was completely

lacking. Moreover, the presence of black rat *Rattus rattus*, known from the whole island system (Baccetti *et al*. 2009), could strongly affect the breeding success and the long term conservation of both species's local populations. This study, carried out in 2013 as part of a monitoring programme of habitats and species of European concern with the Capo Carbonara MPA, aimed at estimating the breeding populations of both shearwater species, in order to assess how much the various terrestrial limiting factors affect their reproductive success and to develop management suggestions specifically targeted to the MPA.

STUDY AREA AND METHODS

Capo Carbonara MPA was established in 1998 and is managed by the Municipality of Villasimius. It is located on the south-eastern coast of Sardinia between Capo Boi and Punta Is Proceddus and it includes two islands (Cavoli: 43ha, and Serpentara: 30ha), several scattered rocky islets among which the main one is Variglione Sud south of Serpentara (3ha), and submerged reefs (Figure 1).

The study of Scopoli's and Yelkouan Shearwaters was carried out in April-October 2013 by the way of nocturnal counts of calling individuals (mainly on moonless nights) and ground nest searches facilitated by the fact that all the islets are small enough to allow a complete survey of suitable habitats. The search for nests was conducted by walking the entire accessible surface of the islands and checking the natural caves used by either species for nesting. Burrows with traces of occupation (e.g. smell, bird droppings, eggshells, footprints) were counted and inspected, if necessary, with an inspection camera. Each cavity was geo-referenced with GPS and marked with a permanent marker. The minimum number of nests included in each cavity was also registered. Almost all nests were checked at least twice during the breeding season; a subsample received multiple visits.

The estimated value of the breeding success (S = fledged young / pair)

Figure 1. Study area in Capo Carbonara MPA (Cavoli Isle, Serpentara Isle and Variglione Sud (mentioned as South on the map).

likely fell in the range calculated by the following equations:
method 1: S = Jci / Pi where: Jci = number of young which certainly fledged and Pi = number of pairs.
method 2 = S = Jci / (Jci + FCI) where FCI = number of verified failures (failure).
method 3 = S = Ji / (Ji + Fi) where Ji = number of nests in which reproductive success was verified or suspected, and Fi = number of nests in which failure was verified or suspected.

RESULTS

Breeding of both species was confirmed on Cavoli and Serpentara Islands; only breeding of Scopoli's Shearwater has been ascertained on Variglione Sud (Table 1). In total, 157 cavities were mapped corresponding to 190 nests, of which 99 (52.1%) were certainly occupied during the 2013 breeding season: 33 by Scopoli's Shearwater and 54 by Yelkouan Shearwater, 12 uncertain. The other 91 nests were mostly devoid of traces of recent occupation and are likely "historical" nests which might be potentially used again in case of a population increase following management actions.

Out of 33 Scopoli's Shearwater nests (Table 2), 7 had a breeding positive outcome, 10 probably positive, 4 negative, 11 probably negative and 1 was not evaluated. The cumulative reproductive success for Cavoli Isle, Serpentara Isle and Variglione Sud is in the range of the three values obtained with the methods described above: method 1 = 7/33 = 0.21 young / pair, method 2 = 7 / (7 + 4) = 7/11 = 0.64 young / pair, method 3 = (7 + 10) / (7 + 10 + 4 + 11) = 17/32 = 0.53 young per pair. Breeding losses can therefore be estimated between 36 and 79%.

Out of 54 Yelkouan Shearwater nests (Table 3), 5 had a positive breeding outcome, 13 probably positive, 17 negative, 9 probably negative and 10 were not evaluated. The cumulative reproductive success for Cavoli Isle and Serpentara Isle can similarly be estimated within the following values: method 1 = 5/54 = 0.09 young / pair; method 2 = 5 / (5 + 17) = 5/22 = 0.23 young / pair; method 3 = (5 + 13) / (5 + 13 + 17 + 9) = 18/44 = 0.41 young / pair. In this case too, losses appear to be very high, likely ranging between 59 and 91%.

The main detrimental element seems to be the regular presence of rats which seriously affect the reproductive success of both species. In fact, shearwater populations appear to be seriously threatened on Cavoli Isle, and their reproductive success is likely to be zero on Serpentara Isle and on Variglione Sud islet: data on reproductive success, and the big number of old abandoned nests, both indicate that the populations are in great danger and declining, especially the Yelkouan Shearwater. This suggests that rodent eradication is a high priority action to be carried out in the entire insular and micro-insular system.

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Island	Number of cavities	Minimum number of nests	Scopoli's Sh.: occupied nest	Yelkouan Sh.: occupied nest	Uncertain species: occupied nest	Total number of occupied nests
	129	155	27	47	11	85
Cavoli Is.	21	27	5	7	0	12
Serpentara Is.	7	8	1	0	1	2
Variglione Sud	157	190	33	54	12	99

Table 1. Number of nests of Scopoli's Shearwater *Calonectris diomedea* and Yelkouan Shearwater *Puffinus yelkouan* in "Capo Carbonara" MPA in 2013.

Island	Occupied nests	Breeding outcome				
		positive	probably positive	negative	probably negative	not assessed
Cavoli Is.	27	7	6	2	11	1
Serpentara Is.	5	0	3	2	0	0
Variglione Sud	1	0	1	0	0	0
Total	33	7	10	4	11	1

Table 2. Breeding outcome of Scopoli's Shearwater *Calonectris diomedea* in "Capo Carbonara" MPA in 2013.

Island	Occupied nests	Breeding outcome				
		positive	probably positive	negative	probably negative	not assessed
Cavoli Is.	47	5	13	13	6	10
Serpentara Is.	7	0	0	4	3	0
Variglione Sud	0	0	0	0	0	0
Total	54	5	13	17	9	10

Table 3. Breeding outcome of Yelkouan Shearwater *Puffinus yelkouan* in "Capo Carbonara" MPA in 2013.

Scopoli's Shearwater *Calonectris diomedea* at Rachgoun Island, Algeria

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ABSTRACT

Rachgoun Island is one of the largest islands of Algeria with more than 26ha. It houses one of the largest colonies of Scopoli's Shearwater *Calonectris diomedea* in Algeria. Several visits to the island were organized in 2013, in order to study the reproduction and distribution of this species. The nests are holes in the ground with an average opening size of 26.9cm and a total mean length of 95.3cm. The egg is deposited on average at 67.3cm from the opening. Nests are placed at a mean distance of 26.1m from the sea and at an altitude of 20.9m. Egg measurements: 67mm x 46.3mm. The average volume and weight of the eggs are 68.6cm^3 and 62.2g respectively. The breeding success is rather high (0.6 young fledged per pair, n= 30 pairs) thanks to the absence of rats on the island.

INTRODUCTION

Scopoli's Shearwater *Calonectris diomedea* is one of the fifteen species concerned by the Mediterranean Action Plan for Birds which includes species of differing status, some globally endangered, some whose breeding area is concentrated on rocky Mediterranean islands, other found mostly in beaches and coastal lagoons (Ben Nakhla 2006). The largest number of breeding Scopoli's Shearwater is found in Tunisia with over 100,000 breeding pairs, with the National Park of Zembra sheltering the largest colony in the world (Renou 2011, Anselme *et al*. 2012, Defos du Rau *et al*. 2012, 2015). The species reproduction has been studied in Europe (Anselme *et al*. 2012) and in North Africa (Durand 2011, Renou 2011, Telailia *et al*. 2014, Taibi *et al*. 2014). The study of its reproduction enters in the scope of monitoring and knowledge of this species in Algeria, where data is rare. Scopoli's Shearwater nests in cliffs or in caves dug into the cliff. Thirty nests each containing one egg were the subject of the research reported here.

MATERIAL AND METHODS

Study area

The volcanic Rachgoun Island (35°19'N, 1°28'W) is located in the Mediterranean

Sea, 3km from the Rachgoun beach in the Beni Saf region in the northern part of Ain Temouchent, Algeria. The study area covers 26ha between Cape Acra and Cape Oulhassa (Taibi *et al*. 2014). The climate is typically Mediterranean, with a rainy season in winter and a dry summer. The low rainfall (300-500mm per year) is due to a shadow effect caused by the Moroccan Atlas and the Rift to the west and the Spanish continental masse to the northwest. Temperatures vary from 12.6-13.5°C in January and February to. 24.7-26.1°C in July and August. The absence of Black Rats (*Rattus rattus*) facilitates the birds' breeding success.

Nest survey

Scopoli's Shearwaters are nesting in cavities dug by the birds in the ground, sometimes under bushes. The nests under survey have been located in 2013 during bird censuses and observation of the birds' movements at dusk. Each burrow and nest has been measured (diameter of the opening, length of the tunnel, distance between the nest and the opening of the burrow) as well as their distance from the sea and their altitude. In June 2013, during the incubation stage, the brooding adult was carefully removed from the nest, then its egg was handled delicately to avoid abandonment by breeders. The large and small diameters of each egg were measured in the field using a two-decimal electronic caliper and their weight was registered using a three-decimal electronic scale. In order to calculate the reproductive success, the marked nests were monitored along the reproduction period until the last chick took flight.

RESULTS

The population of Scopoli's Shearwater at the Rachgoun Island is at least 150 breeding pairs. In 2013 the largest colony was observed at the south of the island near the small port: 50 nests, of which 10 were inaccessible and 22 were studied, the rest was abandoned. To the east below the lighthouse, we estimated the number of pairs at 30; the presence of the herbaceous saltwort *Solsola longifolia* making the access to the nests very difficult, we studied only 8 nests in this second area. More to the west a new colony of 20 pairs was discovered in 2014. The north coast of the island is rocky, so is not suitable for breeding Scopoli's Shearwaters.

The 50 nests of the southern colony were scattered over 6,600m², i.e. an average density of 1 nest per 132 m². The estimated 30 nests of the second colony occurred within a 4,000m² area, i.e. an estimated density of 1 pair per 133 m².

In the southern colony, the diameter of the burrow opening varied from 10 to 50cm, the total length of the burrow between 45 and 180cm, and the nests were positioned between 30 and 140cm of the opening, toward the rear end of the burrow. The distance of nests from the sea fluctuates from 5 to 50m and the height relative to sea level ranged from 10 to 35m. In the second colony, the diameter of the burrow opening was 15 to 43cm, burrow length 50 to 100cm, and the nests were at 30 to 70cm from the to the burrow opening. The distance from the sea varied between 20 and 60m and the altitude was 28 to 40m. On average, the diameter of the opening was 26.9cm, the length of burrow 95.3cm and nests position from the opening of the burrow 67.3cm. The average distance from the sea was 26.1m and the altitude 20.9m.

In the southern colony, the greatest length of eggs varied from 64.2 to 74.2mm and the greatest width from 42.3 to 49.3mm. Their volume varied from 57.3 to 84cm³ and their weight from 58.2 to 72.4 g. In the second colony the respective values were 55.9 to 70.9mm, 45.2 to 48.6mm, 59.8 to 79.3cm³, and 54.4 to 65.3g. On average

the eggs measured 67mm x 46.3mm and their volume and weight were 68.6cm^3 and 62.2g respectively.

At the end of season 18 young had fledged from the 30 monitored burrows, i.e. a breeding success of 0.6 young produced per breeding pair. This relatively high value is helped by the absence of rats, which are an significant predator of shearwater chicks. However, human frequentation at the most accessible places and predation by Montpellier Snake *Malpolon monspessulanus* are responsible for juvenile mortality.

CONCLUSION

Although the number of pairs of Scopoli's Shearwaters on Rachgoun Island is not very important compared to some other islands in the Mediterranean, the reproductive success is rather high: this illustrates the importance of keeping the seabird breeding islands free of such predators.

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Population estimates in Maltese pelagic breeding birds: numbers, trends and an appeal to assess these cautiously

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ABSTRACT

Mediterranean islands hosts four species of pelagic seabirds of which Scopoli`s Shearwater *Calonectris diomedea* is the most widespread, present from coastal Spain eastwards into the Aegean. The Balearic Shearwater *Puffinus mauretanicus* is confined to the Balearic Islands, while the main concentrations of the Yelkouan Shearwater *Puffinus yelkouan* and Storm-petrel *Hydrobates pelagicus melitensis* are essentially central Mediterranean. The Maltese Islands hold significant colonies of *C. diomedea*, *P. yelkouan* and *H. p. melitensis*.

Annual censuses of the breeding population of the three species have been carried out since 1983. Seabird censuses present some of the most demanding challenges of ornithological studies, and this is exceedingly so when attempts are made in counting the breeding population of underground nesting seabirds such as the shearwaters and storm-petrels. The majority of these species visit land only during the breeding season and do so under cover of darkness. They often nest in inaccessible places or nearly so. At certain times of the breeding year, the colonies are visited by numerous prospecting and non-breeding birds, greatly inflating the number of birds in the colony. Faced with all these variables, any figures presented from these censuses can only be considered, at best, as guesstimates. Without the necessary background knowledge of the biology and ecology of the species under study, in many cases, these censuses will result in greatly inflated figures as were recently reported for Malta, Lampedusa and possibly Zembra.. These overestimated figures will inevitably lead to both short and long term negative implications on any conservation efforts undertaken for these species.

INTRODUCTION

Seabird censuses present some of the most demanding challenges of ornithological studies, and this is exceedingly so when counting the breeding population of shearwaters and storm-petrels. The majority of these species visit land at night and only during the breeding season. They nest in sea caves, crevices in vertical cliff faces, and among boulder screes. Furthermore

the breeding colonies are visited by numerous prospecting and non-breeding birds at various times of the year. Also, one must take into consideration the low attendance by breeding birds during the incubating and chick rearing periods. Any figures presented from counts carried out in such difficult terrain can only be considered, at best, as guesstimates. Three species of pelagic seabirds, namely Scopoli's Shearwater *Calonectris diomedea*, Yelkouan Shearwater *Puffinus yelkouan* and European Storm-petrel *Hydrobates pelagicus* breed in the Maltese islands.

The most difficult species to count is the Storm-petrel, closely followed by the Yelkouan Shearwater. Mitchell and Newton (2004) stated that in the absence of any recognized method for surveying breeding European Storm-petrels, two previous censuses in Britain and Ireland – Operation Seafarer 1969-70 and Seabird Colony Register 1985-88 – had to largely guess the location of the colonies, let alone their size. During Seabird 2000 the authors also stated that obtaining estimates of breeding numbers of Storm-petrels has been virtually impossible. The same can apply to the Scopoli's and Yelkouan Shearwaters, the latter in particular, as it nests in narrow crevices in cliffs, is less vocal and does not form large rafts off the breeding colonies.

FIRST COUNTS IN MALTESE ISLANDS

Up to the 1930s, all the authors failed to provide estimates for the breeding populations of seabirds (Schembri 1843, Wright 1863, 1864 and Despott 1917). Prior to 1970 the only figures ever mentioned were two pairs of Storm-petrels on Filfla after a thorough search during the day in 1952 (Roberts 1954), and "over a thousand, possibly twice as many" shearwaters during a night visit to Filfla in 1949 (Traill 1949-50). In the 1970s the first estimates of breeding pairs were 10,000 Storm-petrels on Filfla, 1000 Scopoli`s Shearwaters at Ta' Ċenċ Cliffs (Gozo), and 250 Yelkouan Shearwaters at Rdum tal-Madonna (Sultana & Gauci 1970, Sultana *et al.* 1975). Regular monitoring of the seabird colonies was later carried out from 1983 to 2001 (Borg & Sultana 2002). The gradually increasing number in Yelkouan Shearwater breeding pairs noted in the years 1983-1993 (Figure 1) was not an actual increase of the breeding populations. This was the result of perfecting methodologies as well as the discovery of new nesting areas. In the following years (2001 to 2013) estimates of breeding birds showed a high degree of variability. Estimates of the breeding populations appeared in various publications such as Borg & Sultana (2004), Raine *et al*. (2009) and Sultana *et al*. (2011).

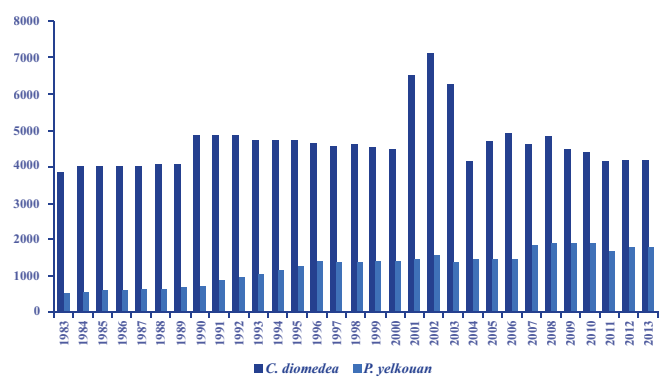

Figure 1. Breeding Estimated total breeding pairs of Yelkouan *Pufinus yelkouan* and Scopoli`s *Calonectris diomedea* Shearwaters in the Maltese Islands from 1983 to 2013.

METHODS FOR ESTIMATING NUMBERS

The methodologies used since 1983 to estimate the breeding populations of the 3 breeding species were:

a. Counting of flying and rafting birds in front of the breeding colonies in the pre-laying and again in the post-laying period;

b. Direct counts of birds arriving at the colonies (visual and audio);

c. Use of play-back;

d. Ringing and recapture of breeding and non-breeding adults and chicks at the colonies.

POPULATION ESTIMATES

It is imperative to highlight the difference between figures of a whole population and numbers of a breeding population. To date no figures for the whole Maltese populations of *C. diomedea, P. yelkouan* and *H. pelagicus* have ever been presented. Counts carried out over a thirty year period (from 1983 to 2013) have shown several trends and changes in breeding pairs' figures.

The highest estimate breeding population (1,890 pairs) of Yelkouan Shearwater was recorded in 2008, while the lowest estimate (495 pairs) was registered in 1983. The latter figure does not reflect the true numbers of breeding pairs, as not all the colonies had yet been discovered.

The average annual estimate for the thirty-year period was 1,238 breeding pairs for the whole archipelago. The annual average estimate of the breeding population of Scopoli`s Shearwater in the same period of years was of 4,875 pairs. The highest estimate of 7,100 pairs was registered in 2002, while the lowest estimate (3,980 pairs) was recorded in 2013. Storm-petrel numbers appear to have remained constant during the thirty year period; 5,000 to 8,000 breeding pairs.

FLUCTUATION IN NUMBERS

Changes in breeding population numbers occur either naturally or due to human interference. Factors which greatly influence breeding numbers are the availability of food, disturbance of birds at the breeding colonies and the loss or changes of breeding habitat. The increase in the breeding number recorded in the first few years resulted to newly discovered colonies, while fluctuating numbers since the 1990s were due to heavy disturbances at colonies. In some cases, this led to a total desertion of the accessible parts of colonies, some of which were re-occupied in later years (our unpublished data). Some common pitfalls noted in estimations of breeding populations of burrow-nesters include the wrong timing of a census, short-term studies, lumping together the relatively larger number of non-breeders with the actual breeding birds and relying only on counts of offshore birds.

Telemetry studies carried out in recent years have shown that large numbers seen offshore may easily be birds from colonies in other Mediterranean countries (Raine *et al.* 2012). Publishing unsubstantiated figures without proper studies and sound methodologies is nothing less than a disservice to ornithology.

CASE STUDIES

In recent years differing numbers of the breeding populations of Scopoli`s and Yelkouan Shearwaters have been presented. Fenech (2010) and Baldacchino & Azzopardi (2012) attempted to present a "critical and scientific" approach to the current status of the populations of both

species. These authors failed to address three fundamental points: (a) the issue of breeding and non-breeding populations, (b) timing of counts and (c) that counting birds off shore may include birds from other seabird colonies of other central Mediterranean countries. Furthermore, they appear to be totally unaware of the fluctuating population numbers concept common in pelagic seabirds as mentioned above, all this may be due to the fact that none of these authors ever carried out any field studies at Maltese seabird colonies. Without providing any alternative numbers or proposing any methodologies, they wrongly concluded that the Maltese breeding seabird populations are "heavily underestimated".

Corso *et al*. (2009) reported on a newly discovered colony of Yelkouan Shearwaters on the island of Lampedusa with an estimated breeding population of 2000-4000 breeding pairs. These figures were based on sporadic counts from headland of birds flying and rafting out at sea. The colony on Lampedusa was first reported by Moltoni (1973) and systematic searches and counts along the northern cliffs of Lampedusa from 2012 to 2014 revealed that the island supports an estimated total of 1,000 to 1,500 breeding pairs (Borg *et al*. 2014).

Defos du Rau *et al*. (2012, 2015) presented new and staggering figures for the Scopoli`s Shearwater breeding population on Zembra Island, Tunisia.

In 2010 shearwater nests were counted along 174 line-transects, following a distance-sampling methodology. This effort resulted in a new estimate of 141,780 breeding pairs on Zembra Island. This methodology alone will present incorrect figures and needs to be corroborated with other methodologies mentioned above. Also, an intense knowledge on the ecology and biology of the study subject is fundamental before executing any type of census work. With a background knowledge of the birds' behaviour, counts of incoming birds carried out on Zembra by one of us (JJB) in May 2013 resulted in an estimated breeding population of about 30,000 pairs, a figure relatively close to those of Gaultier (1981) and Isennmann *et al*. (2005). New figures presenting inaccurate data on breeding populations can result in negative conservation assessments of the species. In fact, IUCN has recently downgraded the conservation status of the Scopoli's Shearwater to a species of Least Concern due to the figures found in Defos du Rau *et al*. (2012).

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Effects of habitat features on the abundance of Greater Flamingo *Phoenicopterus roseus* wintering in the Gulf of Gabès, Tunisia

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ABSTRACT

The Gulf of Gabès, in south-eastern Tunisia, is one of the most important Mediterranean wintering areas for the Greater Flamingo *Phoenicopterus roseus*. However, information on the ecological factors shaping the distribution of this species in this wintering area is lacking. During the winter 2012-2013, we conducted repeated counts of Flamingos in fifty sites in the central part of Gulf of Gabès. Using capture-recapture-like approach, the collected data were used to investigate the relationships between habitat parameters and flamingo abundance, while taking in consideration factors affecting detection probability.

Our results show that the abundance of Flamingos was positively related to habitat features. We found that the abundance of this species increased in sectors characterized by large mudflats intersected by many tidal channels, an important cover of sea-grass, and high quantities of mud and organic materials in the sediment. Further investigations of habitat use are nonetheless needed to understand better the wintering ecology of this species in this particular wintering area, as well as for conservation.

INTRODUCTION

The Gulf of Gabès, in south-eastern Tunisia, is one of the most important Mediterranean wintering areas for the Greater Flamingo *Phoenicopterus roseus*. The wintering population in this area is c.22,750 birds, which represents 7 % of the total number of wintering waterbirds (Hamdi *et al.* 2008). The attractiveness of this area to Flamingos is mainly due to the diversity of wetlands and coastal habitats, including sandy beaches, extensive large mudflats and wadi estuaries (Van Dijk *et al.* 1986). Despite the importance of the Gulf of Gabès for wintering Flamingos in the Mediterranean region, information is lacking on the ecological factors shaping the abundance and distribution of this species in this area. The present work aims to understand the relevance of habitat quality and the intensity of human presence when calculating the abundance of Greater Flamingos.

METHODS

The study sites were localized in the central part of the Gulf of Gabès. Fifty plots confined between Kneïs islands (34°22'N, 10°15'E) to the north and Boughrara lagoon (33°41'N, 10°40'E) to

Figure 1. Map of the Gulf of Gabès showing the location of study plots.

the south, and separated from each other by 2.5km, were visited five times during the winter 2012-2013 (Fig. 1).

During each visit, the numbers of Greater Flamingos and human beings (fishermen and shellfishers) were noted. Variables used as descriptors of habitat were also recorded (i.e., tidal width, number of tidal channels, area covered by seagrass, mud content and organic matter of the sediment). Intertidal flat width, (i.e. the distance between low water and high water) was directly measured on the field during low tide. The number of tide channels was also directly counted on the field and then verified using aerial images. Seagrass cover (i.e. the percentage of intertidal area covered by seagrass) was estimated visually on the field, usually by the same observer (F. Hamza). With regard to sediment, twelve core samples were taken from each site. The collected sediment samples were carried to the laboratory for mud quantity and organic content determination.

Given that the original habitat and human variables were highly inter-correlated (see results), a Principal Component Analysis (PCA) was carried out to summarize them into a few independent factors providing composite measures of site characteristics.

The factors extracted from the PCA were then used as predictors when studying the factors affecting the abundance of Flamingo. Using capture-recapture-like approach we constructed four competitive models: (1) without covariates, (2) with PC1 as a covariate, (3) with PC2 and (4) with PC1 and PC2 as covariates. We used Akaike's Information Criterion (AIC) (Burnham & Anderson 2002) to compare and select candidate models constructed with additive combinations of habitat and human variables. Models with $\Delta AIC \leq 2$ were considered to have substantial support in the data. Because there was a model selection uncertainty, we used model averaging techniques for parameter estimation (Burnham & Anderson 2002). We considered predictors had an effect if the 95% confidence interval (CI) did not include zero.

RESULTS

The habitat and human variables measured in our studied sectors were highly correlated (correlation coefficient test: P < 0.05 in all pair correlations). A Principal Component Analysis summarized these variables into two independent factors (PC1 and PC2) whose eigenvalues exceeded 1 and that accounted together for 70% of the variance in the original data. PC1 was positively correlated with habitat variables: intertidal flat width (r = 0.90, P < 0.0001), tide channel number (r = 0.86, P < 0.0001), seagrass cover (r = 0.84, P < 0.0001), mud fraction of the sediment (r = 0.82, P < 0.0001), and organic content of the sediment (r = 0.47, P = 0.0006). High PC1 scores characterize large mudflats intersected by large numbers of tidal channels, with important covers of sea-grass and high amounts of mud and organic materials in the sediment. However, PC2 represents an axis of increasing human presence, as it was positively correlated with the average number of humans (r = 0.80, P < 0.0001) and the rate of site occupancy by humans (r = 0.84, P < 0.0001). According to the results of the capture-recapture-like approach, no model had a weight > 0.9 (Table 1).

The use of model averaging techniques revealed that the model including habitat features (PC1) as predictors had a positive effect on the abundance of Greater Flamingo. Model averaging showed that the 95% confidence interval of PC1 did not include zero (Table 2). This suggests that the abundance of flamingos increased in the sectors characterized by large mudflats crossed by large numbers of tidal channels, an important cover of sea-grass and high amounts of mud and organic materials in the sediment. Our results also show that human presence (fishermen and shell-fishers) did not appear to affect flamingos' abundance. Model averaging showed that the 95% confidence interval of PC2 include zero (Table 2).

Model	AIC	ΔAIC	W
λ (PC1)	231.46	0.00	0.55
λ (PC1+ PC2)	231.89	0.43	0.44
Constant	273.06	41.6	0.00
λ (PC2)	274.07	42.6	0.00

Table 1. Summary of model selection procedure for the estimated abundance of Greater Flamingos in the studied sites. AIC: Akaike's Information Criterion. ΔAIC : difference between the AIC score of the model and the best ranked model. W: Akaike model weight. λ : estimated mean plot abundance. PC1, principal component 1. PC2, principal component 2.

	β moyen	CI à 95 %
Intercept	0.7	0.28 ; 1.12
PC1	1.12	0.76 ; 1.48
PC2	0.08	-0.04 ; 0.20

Table 2. Model-averaged parameter estimate and 95% confidence intervals of all predictor variables for flamingo; variables for which 95% confidence intervals did not overlap zero are indicated in bold.

DISCUSSION

Our results show that the abundance of Greater Flamingo increased in the sectors characterized by large mudflats intersected by large numbers of tidal channels, an important covers of sea-grass, and high amounts of mud and organic materials in the sediment. The attractiveness of these sectors to Flamingos can be explained by the occurrence of tidal pools and tidal channels that retain a thin layer of water at low tide. In these tidal constantly immersed pools and channels, the sediment is muddy and hosts dense benthic invertebrate populations, providing favourable feeding sites for flamingos (Hamza *et al.* 2014). By contrast, sandy beaches are characterized by narrow and steeply inclined intertidal zones. In these habitats, only a limited intertidal area is available to use as feeding ground. Tidal pools and channels are absent and the sandy sediment does not host important invertebrate biomass (Hamza *et al.* 2014), which makes this habitat less attractive to flamingos.

With regard to the effects of human presence, our results show the lack of effect on the abundance of Greater Flamingo. This result is consistent with several previous studies (e.g. Yasué 2006, Hamza *et al.* 2014) which reported that in large areas human disturbance does not necessarily lead to a shift in the spatial distribution and abundance of waterbirds. At least two hypotheses can explain this result. First, people encountered in our study area were mainly traditional clam harvesters occurring in large mudflats. In these large mudflats, Flamingos can position themselves faraway from humans, which makes disturbance to be low. Second, it is possible that Flamingos became habituated with the presence of clam harvesters and did not perceive them as predators.

Overall, this study improves our understanding of the spatial variation of the abundance of Flamingo in the gulf of Gabès, one of the most important and poorly known wintering areas in the Mediterranean region. Further investigations of habitat use are nonetheless needed to understand better the wintering ecology of this species in this particular wintering area, as well as for conservation purposes.

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An update of the status of the two *Pelecanus* species in the Mediterranean-Black Sea region

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ABSTRACT

Within the Mediterranean-Black Sea flyway, the Dalmatian Pelican *Pelecanus crispus* population has been estimated at 2,154 –2,437 pairs in 2011-2012 and over 2600 pairs in 2014, while the Great White Pelican *Pelecanus onocrotalus* numbers were estimated at 4,702-5,175 pairs in 2011-2012. The first species is obviously increasing and the second appears to be rather stable over the long term. Information is given on population structure, both geographically and regarding the proportion of non-breeding birds. Their movements and interactions are discussed, particularly the dependence of Great White Pelicans on food provisioning during their migration stop over in Israel and the fact that small colonies of this species are socially attracted by larger breeding numbers of Dalmatian Pelican. Conservation challenges concern the management of breeding sites regarding the various causes of disturbance and their erosion through natural and man induced processes, and the standardisation of survey methodology.

INTRODUCTION

Catsadorakis *et al*. (2015) presented an overview of the conservation, management and population status of the two species of pelican which nest, migrate and/or winter in the Mediterranean-Black Sea flyway up to 2012: the Dalmatian Pelican *Pelecanus crispus* (hereafter DP), listed as "Vulnerable" in the global IUCN Red List but characterised as "Least Concern" in Europe (BirdLife International 2015), and the Great White Pelican *Pelecanus onocrotalus* (hereafter GWP) listed as "Least Concern" globally. The present paper offers an update of the status of these two species to the end of 2014 and places emphasis on the gaps in knowledge about pelicans as well as on the steps to be taken in order to improve capacity to cope with conservation challenges for the next twenty years.

STATUS OF BREEDING POPULATIONS

Dalmatian Pelican

In 2011-2012 the breeding population of DP in the Mediterranean-Black Sea region was 2,154 –2,437 pairs distributed in 16 colony sites (Catsadorakis *et al*. 2015). In 2014 there were well over 2,600 pairs in 16 colonies (Pelican Specialist Group, unpubl. data) in this region. However, the world population of DP cannot be accurately estimated because census coverage

in the countries of south-western and Central Asia and from Russia, is far from complete. Two new colonies have been established after 2011, both in Greece: at the Messolonghi lagoons (38°34.3'N, 21°44.8'E) and the Karla Reservoir (39°48.8'N, 22°82.8'E). After 2010 it has been possible to monitor annually almost all colonies except the Danube delta and possibly those in the Ukraine. A small number of colonies cannot be covered every year mostly due to lack of resources.

The evidence so far collected from ring readings between 1983 up to 2010 (Saveljic & Rubinic 2009, A. Crivelli pers. comm.) implies that in SE Europe and Turkey pelicans form a meta-population consisting of two distinct sub-populations. The first one occurs in four coastal wetlands along the Adriatic and Ionian coast (Skadar in Montenegro, Karavasta in Albania, Amvrakikos and Messolonghi in Greece). The second is made up mainly of the pelicans nesting in the other three colonies in Greece (Prespa, Kerkini, Karla), the Srebarna colony in Bulgaria and all the Turkish colonies. The two groups are separated by the geographical barrier of the Pindus mountain range (Greece) and so far there is only one case of a bird ringed in the western group that was observed in the eastern group (A. Crivelli pers. comm). The western colonies are all small in size (16-161 pairs). They are situated in wetlands intensively used by people for fishing, hunting and recreation and thus suffer heavily from disturbance. It seems that for the last 30 years, the Amvrakikos colony has acted as a source population. Unless systematically managed and protected these colonies are at various risks of extinction. The eastern group consists of larger and more stable colonies generally better protected and more secure, although they also face a number of serious threats. Lake Mikri Prespa population, which has seen an impressive ten-fold increase over the last 30 years mainly due to successful protection measures, has been the main source population.

Great White Pelican

In 2011-2012, the population of GWP in SE Europe and Turkey was estimated at 4,702-5,175 pairs (Catsadorakis *et al*. 2015). It was distributed in 5-6 colony sites and has remained more or less stable during the previous decade. For this species too, there is one or two colonies that cannot be monitored every year, so data from several years must be combined to have an estimate of the overall breeding numbers. This is exemplified in the Danube delta which due to its vast size and inaccessibility of colonies is practically difficult to be to carry out a census every year. In recent years the censused in the delta were carried out by aircraft. There is hope that this situation will improve and an annual census will soon become possible.

MIGRATION, MOVEMENTS, AND WINTERING RANGE

Dalmatian Pelican

DP are short-distance migrants in the region and it seems that the more south the location of the breeding places is, the less far they move to overwinter. No systematic analysis of DP wintering censuses and numbers has been done so far. Data for wintering DP come from the IWC censuses where pelicans are counted among other waterbirds. In some countries, e.g. Turkey, censuses were not carried out every year or wetlands were covered outside the time limits specified. In some cases though (in Turkey from 2012 to date) there have been specific censuses focusing exclusively on counting pelicans. All data from colour ring readings available so far have shown that DP breeding in

Greece overwinter in northern Greece and a varying proportion proceed to the wetlands of Turkey (A. Crivelli and O. Gül pers. comm.). It is not clear to what extent the choice of wintering wetlands is affected by a trade-off between prevailing air and water temperature and/or availability of food, or other reasons. Numbers of passing and wintering DP in Bulgaria and read rings imply that a large percentage of birds breeding in the Danube delta and Bulgaria move south and overwinter either to the Bulgarian coastal wetlands or other sites in Greece and Turkey (Catsadorakis *et al*. 2015). It is also known that there are practically no DP overwintering in wetlands of the Black Sea coast in Turkey, Georgia and Ukraine. Only 162 DP have been counted there during all counts in the period 1984-2010 (Kostiushyn *et al*. 2011). It is suspected that DP also move south, to Bulgaria, Turkey or Greece, but there is no hard evidence about it whatsoever. Even if a thorough analysis of wintering data has not been done yet, it can be estimated form the IWC counts that up to 6,000-6,500 individuals may have been present in winter in the countries of SE Europe and Turkey (Wetlands International database). However direct observations and a few telemetry data indicate that an unknown number of DP may also overwinter along the lower Danube (S. Bugariu pers. comm.).

Great White Pelican

In contrast to the DP, the GWP is a true long-distance migrant most likely overwintering in the Sudd wetlands of southern Sudan and in other wetlands along the Rift Valley in nearby countries (Crivelli *et al*. 1991, Izhaki *et al*. 2002). Although the absolute numbers of GWP migrating through Bulgaria (Bourgas), the Bosphorus and the Dardanelles, as well as Israel, are not clearly deduced from published data, and comparisons are not directly possible due to limitations of the censuses. All published comparable data show no major trend in numbers observed since the early 1980s. The numbers of migrating GWPs remain stable on average (Leshem & Yom-Tov 1998, Alon *et al*. 2004, Michev *et al*. 2011). Michev *et al*. (2011) mention that numbers of GWP counted at the Bosphorus are relatively low in comparison to numbers at Bourgas, and there are no data for the Dardanelles. From the data collected annually since 1981 by the Israel Nature and Parks Authority in the Hula Valley wetlands it has however become clear that up to 2007 migrant numbers peaked in November-October. After that year the peak shifted earlier to September-October, while the overall amount of time GWP spent in Israel also increased, thus intensifying the pressure on aquaculture there (Labinger & Hatzofe 2014). Although numbers of wintering GWP in Israel had started to increase notably in the 1980-90s, food provisioning by the authorities help the pelicans to restore their fuel load and recover physical condition before continuing their journey to Africa. This provisioning measure successfully led the numbers to drop to an average of 255 GWP overwintering in Israel in the last 5 years (Labinger & Hatzofe 2014).

ESTIMATES OF NON-BREEDER NUMBERS

We may have a more or less clear estimation of how many pairs breed at the several colony sites in the region, but data are still lacking about numbers of non-breeders, including floaters and/or prospectors present at the various colonies. Data on this issue started to be collected in Greece in 2013 and 2014 by organizing a Panhellenic Pelican Census during the breeding period (Alexandrou *et al*. 2014). In 2013 there were just over 514 non-breeding individuals in a total of 3,564 Dalmatian Pelicans present in Greece (14.4%, Alexandrou *et al*. 2014) and in 2014 there were 843 non breeders in a total of 4,043 DP present during the

breeding period (20.8%). This census is planned to be continued for Greece and an effort is made to launch a similar simultaneous spring census in all the countries hosting pelican colonies in SE Europe and Turkey in order to obtain an estimate of the ratio of non-breeders in the whole population. However, the task is formidable as it is known that there are many individuals, both mature and immature, that are met in several areas along the lower parts of the Danube (S. Bugariu pers. comm.), an area which is very large and difficult to be covered in a short time.

Similarly, there are no data on numbers of non-breeding Great White Pelicans. However the difference between the average autumn migration counts at Bourgas wetlands (20,946 individuals for 1979-2003, Michev *et al*. 2011) and the estimated total SE Europe population of 5,000 pairs, i.e. 10,000 individuals, imply among other plausible hypotheses that variable numbers of non-breeders in adult plumage may spend part of the breeding season in various wetlands of SE Europe (Izhaki *et al*. 2002).

INTERACTION IN THE TWO SPECIES

The two species of pelicans are frequently sympatric in Europe and will nest side by side on the same islands. This is something occurring at Lake Mikri Prespa, locally in the Danube delta and at some wetlands in Russia, Kazakhstan, Uzbekistan and Turkmenistan (Crivelli *et al*. 1994). Catsadorakis & Crivelli (2001) have shown that the breeding success of GWP increased with an increasing overall colony size of DP, because larger colonies have higher breeding success. A sufficient sub-colony size might be assured for GWP. The highly social GWP uses the congener species' higher numbers to increase security and social stimulation. Therefore at Lake Prespa GWP are strongly depending on the other species and will always establish their breeding units very close to already existing DP units that are at the stage of copulation and early incubation.

Using data from the colony of Prespa for the period 1985-2005, Doxa *et al*. (2012) have shown that milder and wetter winters at the main wintering and stop-over site lead to an advancement of the median laying dates of DP by 1.4 days per year. This shift was also associated with an increase in population size. Earlier breeding was associated with enhanced survival of juvenile DP. The GWP exhibited no advancement in its median laying date, but it significantly reduced the duration of its laying period by 1.7 days per year by advancing the latest laying date. From a conservation point of view this means that if weather conditions continue to favour earlier breeding for DP, there might be a mismatch with the phenology of its long-distance migrant sister species which seems to have a more fixed date of arrival at the breeding site.

If GWP remain unresponsive to warming trends on the breeding grounds and fail to advance their arrival date, they may ultimately arrive too late to benefit from breeding in heterospecific sub-colonies of optimal size. This may threaten the smaller colonies, such as that in Lake Mikri Prespa, to disappear. Another scenario would be that the species starts to overwinter closer to the breeding grounds, allowing birds to effectively adjust their departure and arrival dates for better timing in relation to conditions on the breeding grounds (Doxa *et al*. 2012).

CONSERVATION CHALLENGES

Despite the fact that all pelican breeding and wintering areas are under some status of protection, disturbance at colonies and direct persecution are

still frequent (Catsadorakis *et al*. 2015). Improved guarding, wiser planning and public awareness are needed to minimize and eventually stop all direct threats such as direct persecution, disturbance, and collisions with overhead wires and wind turbines. Emphasis must be aimed at small and vulnerable colonies. Action plans must be prepared and applied for both species in those countries where they do not exist. The European Action Plan for the DP also requires an update.

Although the issue of following standard methods in carrying out censuses breeding colonies has been repeatedly emphasized (e.g. Crivelli 1987, Crivelli *et al*. 1991), the matter still remains unresolved partly due to site-specific practical and logistical obstacles.

This applies to both conventional methods and the use of aerial manned or unmanned flights (UAVs/drones). Standard protocols must be prepared and promoted as much as possible. Unfortunately, the species' vulnerability decreases possibilities to carry out intensive studies as it is needed to minimise research disturbance, especially in very small and/or very dense colonies.

Annual data on breeding population sizes and breeding performance parameters, especially breeding success and wintering numbers, need to be compiled regularly

Sudden water level fluctuations at water bodies where pelicans nest, caused by natural phenomena or due to human interventions to the hydrological regime of the wetlands, lead to flooding and/or erosion of nesting islands.

Their frequency will be probably increased in the context of climate change. Building artificial nesting platforms for pelicans to cope with water level fluctuations should be decided only after very careful planning, especially including the setting up of target numbers. Solutions to issues of hydrology and pelicans should always be sought within an integrated ecosystem management approach.

A large-scale international collaboration is critical to explore the factors that are involved in the conflict between GWP and aquaculture in Israel and to produce useful data to inform management suggestions (Labinger & Hatzofe 2014).

The extent to which pelican demography, behaviour and population attributes will be directly or indirectly affected by climate change merits further research and attention.

Since various populations in meta-populations may exhibit opposite trends, fund raising for conservation of a vulnerable species which increases locally may be inhibited by the inability of potential donors to understand the interdependence of the populations and consider that the future of the species is ensured.

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Scale-dependent approaches applied to the conservation biogeography of a cosmopolitan raptor: the Osprey

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ABSTRACT

The Mediterranean Sea represents one of the most exploited marine environments, where intense commercial and touristic activities produce continuous disturbances that are affecting the biological diversity at different scales. In the Mediterranean region, the presence of Osprey *Pandion haliaetus* is limited to a few breeding nuclei and is jeopardised by habitat fragmentation and human threats, which call for specific management actions. However, to plan appropriate management and conservation measures at the right scale, a preliminary understanding of the proximate causes of geographical distribution, genetic divergence, population connectivity, migratory strategies and foraging ecology of animal populations is pivotal.

The results reported in this study have been the subject of a PhD thesis on this matter.

Being a cosmopolitan and migratory species, the Osprey provides a good opportunity to explore how behavioural adaptations evolved under different ecological conditions in different and widely spaced populations. According to this, a multi-scale integrated approach has been adopted for the Osprey.

Through an interdisciplinary framework made by molecular ecology, trophic ecology as assessed via stable isotopic analyses, spatial ecology through the use of novel biotelemetry tools, as well as population dynamics, fish censuses, and assessments of levels of human disturbance, I (a) investigated the genetic divergence between Osprey populations at global scale, (b) estimated population connectivity in the Western Palearctic (c) studied the migratory behaviour and winter ecology of Mediterranean Ospreys and compared it with northern European populations, in an evolutionary context, (d) evaluated the threats and the status of two local populations of the Mediterranean basin (Corsica and Morocco) to detect the adequate management measures to be adopted. Overall, this work has led to some important advances with respect to the conservation biogeography of Ospreys at different scales. In this paper, I present results of the genetic, ecology and behaviour of the species in relation to the scientific questions addressed.

GENETIC DIVERGENCE AND POPULATION CONNECTIVITY

The geographical pattern of mitochondrial DNA diversity in the Osprey was investigated to clarify its phylogeographic structure and to elucidate its taxonomic status. The Osprey appeared structured into four main genetic groups representing quasi non-overlapping geographical regions (Americas, Indo-Australasia, Europe-Africa and Asia). Each lineage showed slight internal genetic variability, although including birds from well-distant geographic areas. Contrary to the low within group variation, a larger number of nucleotide differences was recorded between the four clades.

At a global scale, the Osprey complex is composed of four different evolutionary significant units that should be treated as specific management units.

Genetic variability and population structure were studied using DNA microsatellite markers. Special emphasis was placed on the subspecies living in the Afro-Palearctic (*Pandion haliaetus haliaetus*). For comparative purposes, American subspecies (*P. h. carolinensis* and *P. h. ridgway*) and Indo-Australian subspecies (*P. h. cristatus*) were included in this analysis. Twenty DNA microsatellite loci were analysed across a total of 200 individuals. Ospreys from America and Australia were clearly separated from *P. h. haliaetus* suggesting a more ancient isolation which prevented recent gene flow across these groups. Within *P. h. haliaetus*, significant genetic differentiation was found between populations in northern and southern Europe, suggesting that the Afro-Palearctic group is structured into two interconnected entities (Mediterranean and continental Europe).

Our study brought essential genetic clarifications, highlighting implications for conservation strategies in identifying distinct lineages, across which birds should not be artificially moved in reintroduction schemes.

MIGRATORY STRATEGIES AND WINTER ECOLOGY

Migratory flexibility was studied between Osprey populations in the Western Palearctic. Fifty-four Ospreys from Scandinavian and Mediterranean populations were GPS-tracked across 70 migratory trips to investigate variation in migratory traits across a latitudinal divide and in relation to a broad set of ecological factors (e.g. geographical barriers, wind conditions, etc.). Scandinavian Ospreys performed homogeneous long-distance migrations (600km range), crossing the Strait of Gibraltar before reaching sub-Saharan wintering grounds in West Africa.

In contrast, Mediterranean Ospreys showed a heterogeneous migratory behaviour typical of partially migrating populations, with 46% of the individuals not migrating, 39% performing a long-distance migration, and 15% travelling short-distances. Higher levels of variability in the choice of migratory routes, timing and wintering grounds revealed higher plasticity in migratory behaviour in the Mediterranean region.

To infer wintering ecology of Mediterranean Ospreys, we relied on a dual and complementary approach, using both GPS tracking and multi stable isotope tracer approaches. Variability of carbon, nitrogen and sulphur stable isotope ratios ($\delta^{13}C$, $\delta^{15}N$ and $\delta^{34}S$, respectively) were examined from an experimental set of 18 Mediterranean adults to infer wintering ground locations and habitat types used during the inter-breeding period. Additionally, 12 adult Ospreys were fitted with GPS devices and tracked during migration and the wintering season. By combining the two techniques we evidenced a partial migratory population

with tagged individuals being both resident and migratory. Mediterranean Ospreys spent the winter at temperate latitudes and showed a high flexibility in habitat selection. They made use of marine bays, coastal lagoons/marshland and inland freshwater sites. Movements and home range areas were reduced during the season. Wintering grounds were largely spread over the coasts of different countries of the basin, rather than concentrated in one single area. Such behavioural flexibility in the choice of location and habitat type suggests the implementing of broad-scale approaches for the protection of important areas for Ospreys in winter. Harmonization of management protocols of wetland sites among countries in the Mediterranean basin is necessary to guarantee the right level of conservation of the Mediterranean Osprey populations.

STATUS AND THREATS OF MEDITERRANEAN OSPREY POPULATIONS

In the Mediterranean, sea-based tourism and related recreational activities increased rapidly, especially within marine protected areas (MPAs) hosting emblematic biodiversity. Local examples of conservation management approach for Osprey are presented here for two different sites of the Mediterranean basin, Corsica and Morocco.

In Corsica, Osprey breeding performance initially increased but then dropped for pairs nesting within the reserve of Scandola (MPA on the west coast) compared to those breeding elsewhere in the island. Recent Osprey breeding failures in the reserve are not caused by food scarcity, since 98 underwater transects conducted in 2012-2013 showed that fish consumed by Ospreys were more numerous inside the MPA. Furthermore, we performed focal observation at nests in 2013 and 2014, which revealed that the overall number of boat passages and of boat approaches at <250m from Osprey nests were significantly higher within the MPA than in the controlled area. Further observations at Osprey nests conducted in 2012-2014 demonstrated that boat traffic modified Osprey time-budgets significantly, by decreasing the number of prey items brought to the nest by males, and increasing time spent alarming and flying off the nest by females. Finally, corticosterone levels in chick feathers from Scandola were 3 times higher than in places with lower tourist flow in Corsica, the Balearic Islands and Italy. This strongly suggests high stress levels in chick within the Scandola MPA. Our overall assessment combining raptor demography and behavioural ecology, with fish and boat surveys clearly demonstrates the impact of the Scandola MPA on the Corsican Osprey population.

In the Al Hoceima National Park (PNAH, Morocco), the status of the population in 2012-2013 was reported and compared with data collected during the period 1983-1990. A reduction in number of nests and breeding pairs was observed and a 35.7% decrease in population size was recorded. In addition, we identified several threats to Osprey habitats (e.g. dynamite and poison fishing) that affected the Osprey breeding population in this area. In this situation , we stress the necessity for urgent measures to be adopted at the local scale for the protection of this vulnerable population in the light of a sound conservation strategy also at the Mediterranean level. These case studies stress the worldwide importance of rigorously implementing sustainable ecotourism.

CONCLUSION

Overall, this work has led to some important advances with respect to the conservation biogeography of Ospreys in the Western Mediterranean, in Western

Europe, as well as at an international level. Those insights are particularly valuable with respect to the effective management of this emblematic species.

Our results on sequences of mtDNA highlighted the presence of four distinct evolutive lineages in Ospreys, at a worldwide scale. Each Osprey lineage represents an Evolutionary Significant Unit and should hence be treated and managed separately from other populations from other lineages.

Thus, in the framework of reintroduction projects it is recommended that no translocations should be conducted using source populations belonging to another distinct lineage. On the basis of behavioural differences in migration and in the genetic structuration at nuclear loci, it is also recommended to pay attention to these aspects in the management of these populations. In particular I think that restoration of small populations, or the reconstitution of breeding nuclei, by means of reintroduction or restocking programmes should rely primarily on source populations sharing similar characteristics, which evolved under similar environmental constraints.

Indeed, reintroduction and reinforcement programmes would aim at restoring wild populations at sustainable levels with identical biological characteristics to the original population. In the case of Osprey, long-distance migratory populations with specific genetic information should not be primarily used to reconstruct populations in the Mediterranean region and Atlantic islands, where local populations show both differential genetic structuring and behaviour.

Inadequate human interventions may provoke modifications in these populations and produce changes which are not in synchrony with natural evolutionary processes, neither with the habitat matrix and related environmental constraints.

A sound conservation strategy should take into great consideration not only the ensuring of a rapid population recovery, but also the expression of migratory movements to maintain the integrity of native population.

Since the wintering grounds are largely spread over the coasts of the western parts of the Mediterranean basin (Italy, North Africa, France and Spain), rather than concentrated in one single area, a harmonization of the management protocols of these wetlands is required for different countries. Consequently, I recommend the implementation of an inter-national institution for Osprey conservation and/or the creation of a specific network or foundation, which will oversee the management actions and local protection aspects across countries.

More specifically the results gathered during this PhD can be used to implement management and conservation action at local scale. Considering the two specific cases in the Mediterranean, some practical considerations can be outlined. In Corsica, applied measures can be advised for the management of Scandola Natural Reserve and the conservation of its iconic species, the Osprey.

For instance it would be worth to regulate the daily boat traffic in terms of accesses and visits allowed per day. Big numbers and high density of ships at specific nesting sites should be avoided and strictly controlled to keep disturbance to Ospreys at a minimum limit. Boats should not be allowed to approach the coast in front of Osprey nests, but should rather respect a buffer zone of a minimum 300 m radius in order to avoid any disturbance to Ospreys and to allow the males fish efficiently. To delimit such areas, waypoint buoys could be placed at sea.

Such regulations could be adaptive and flexible every year, according to the Ospreys' active nest distribution; even

changing during the the season after a nest failure. In Morocco, repeated censuses revealed the vulnerability of this population restricted to a narrow stretch of coast which is heavily exploited and disturbed by human activities (e.g. exploitation of the coastal habitat and dynamite fishing activities). Wardening and adequate regulations for a better securing of this nucleus are urgently needed and should be implemented by the National Park, with the help of the national agency *Haut Commissariat aux Eaux et Forêts et à la Lutte Contre la Désertification* and NGOs.

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Conservation The Mogador Island colony of Eleonora´s Falcon *Falco eleonorae* Project: methods for a population assessment and study of breeding parameters

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ABSTRACT

Previous counts of Eleonora's Falcon *Falco eleonorae* in Morocco have been significantly underestimated both locally and nationally. The aim of this study was to provide a reliable method for estimating the size of the population breeding in Mogador islands, Morocco, using a distance-sampling approach.

The project also aimed at gathering data on the species' breeding ecology and reproductive success, investigating the relation between clutch size and pre-laying food availability, the effect of nest site and pair quality on productivity, and the effect of habitat and intraspecific competition on breeding success. Methods developed in the course of this project provide guidelines for reviewing the conservation status of Eleonora's Falcon in Morocco and helped to set an effective national conservation plan for future population monitoring.

INTRODUCTION

The Eleonora´s Falcon *Falco eleonorae* has been identified as rare and in need of conservation efforts in various international agreements, including the African Convention on Conservation and Natural Resources (1968), the Convention on the Conservation of European Wildlife and Natural Habitats (1979), the Convention on International Trade in Endangered Species of Wild Fauna and Flora (1973), the European Union Directive

on the Conservation of Wild Birds (79/409/EEC/1979), hence it constitutes a priority species for conservation throughout its distribution range.

The Eleonora's Falcon is a migratory species that covers more than 9,000km from the breeding grounds to its wintering areas which are mainly in Madagascar, on the way crossing the Sahara and much of the African continent (Delgado & Quilis 1990, Gschweng *et al*. 2008, Lopez-Lopez *et al*. 2009-2010, Lopez-Darias *et al*. 2010).

Its breeding area includes the Mediterranean region, the Atlantic coast of Morocco, and the Canary Islands (Cramp & Simmons 1980, Dimalexis *et al*. 2008, Mellone *et al*. 2012). The breeding season begins in July, which is much later than for other migratory falcons due to its adaptation to prey on migratory birds flying from Europe to Africa in late summer (e.g. Rguibi Idrissi *et al*. 2011). The global breeding population size of the Eleonora's Falcon has recently been updated to more than 13,500 pairs (Dimalexis *et al*. 2008). In Morocco two breeding sites are known (Sidi Moussa cliffs and the Essaouira/Mogador archipelago) where 100 breeding pairs were recorded in 1996, which was larger than the 1970-1980 estimates (Rguibi *et al*. 2011 & 2012).

Meanwhile the population had increased by 30 breeding pairs (35%) at Sidi Moussa cliffs but no change was observed in the archipelago of Essaouira, due perhaps to a shortage of suitable breeding sites (Rguibi *et al*. 2012). Overall, the population trend was positive over the last 40 years, but more substantially from the late 1996s onwards (Rguibi *et al*. 2012). Taking into account that Morocco plays a vital role in the conservation and long term survival of this species, the Project presented here aims at providing a reliable estimate of the current population size of Eleonora's Falcon in Morocco.

STUDY AREA

The archipelago of Essaouira (Mogador) consists of eight islets situated along the Moroccan Atlantic coast, *ca* 700km south of the Strait of Gibraltar (Figure 1): Dzira Lakbira (22.7ha, & 29m a.s.l.), Firaoun (2.1ha, 26m a.s.l.) has a of crater-like structure in the middle, Smia is a tower-shaped rock on the western side of Firaoun island, at 18m a.s.l. and Maqtoâ an isolated rock on the northern side of the main island, *ca* 7m a.s.l. There are three small rocky islets: Haha Hajratis (1ha, *ca* 11m a.s.l.), Hajrat Rbia (1ha, 10m a.s.l.) and Hatf Ghorrabo (13m a.s.l.).

THE ELEONORA'S FALCON PROJECT IN MOROCCO

One of the difficulties in the study of the population dynamics of this falcon is to determine the size of the population on the island of Mogador, a task that requires the application of a reliable methodology. Previous data (Table 1) are the results of visual observations and counts made during visits of one or two-days, nests counts were made however in 2012 (Rguibi Idrissi *et al*. 2012). This led to an important variation in the population estimates, in addition to the irregular gaps between counts and visits.

The Eleonora's Falcon Project is divided into two parts. First, actions were conducted in 2013-2014 in order to: (1) provide a reliable estimate of current population size of Eleonora's Falcon in Morocco according to a distance-sampling technique; (2) conduct an analysis of nesting-site preferences by means of GIS and DTMs methods in order to define an adequate spatial model including several topographic, climatic, anthropogenic and biotic variables; (3) describe the spatio-temporal variability and breeding parameters of Eleonora's Falcon on Mogador island; (4) describe

the reproductive performance in relation to the various factors; and (5) describe the influence of habitat characteristics, food resources, and intraspecific competition on clutch size and breeding success

In 2015-2016, a second step includes the following actions: (1) observations of chicks from hatching to fledging, including the analyses of the behavioural patterns and time budgets of chicks being fed by adults, using fixed cameras at the nest; (2) carry out an intensive ringing project of as many chicks as possible with metal and colour rings in order to study the eventual recruitment within the population in coming years; (3) GPS tagging of adult and juvenile Eleonora's Falcon's in collaboration with IFV, Germany; (4) study of genetic divergence and the degree of connectivity among populations; (5) the initiation of a stable isotopes analysis; and (6) radio-tracking of a limited number of adults and juveniles.

METHODOLOGY USED FOR POPULATION ESTIMATE

A suitable sampling method was designed by delimiting *ca* 20m-long count sectors on topographical maps throughout the whole Mogador islands except the steepest cliffs, producing 61 line-transects along which distance-sampling counts were conducted (Ronconi & Burger 2008). The distance-sampling approach postulates that the average density of objects is homogeneous whatever the distance to the observer while the theoretical probability of detection varies in function of the distance. In doing so, the population estimate of Eleonora's Falcon in the Mogador islands takes into consideration the detectability as a limiting factor when converting counts into densities, using a distance sampling software (Distance 5·0 under R software). Breeding population size can then be estimated as twice the maximum nest count, where this value exceeds the number of individual birds observed at any one time.

MOVEMENTS OF ELEONORA'S FALCONS DURING CHICK-REARING

Two adult Falcons (Figure 2) were caught by nets and equipped with satellite transmitters on 21 September 2011. Both individuals often visited the mainland up to 20km east of Essaouira, one of them making a long flight (200km) to a wetland south of Agadir. The maximum distance over the open sea was around 10km (Mellone *et al*. 2011).

NEST-SITE PREFERENCES STUDIED THROUGH DIGITAL TERRAIN MODELS

Our aim was to make a stereoscopic analysis of aerial photographs available in several different years, in order to cover all the Mogador islands with the DTM technique, and to use this model to determine the limiting factors affecting the Eleonora's Falcon population during the breeding season. For this we used ARC/INFO 7.1 algorithms (ESRI 1998).

FURTHER STEPS

While acknowledging the on-going improvement in the study of Eleonora's Falcon on the Mogador islands, we stress that further investigations of the local breeding ecology of the species, using appropriate quantitative approaches and statistical tools, are still needed to understand the dynamics of this poorly known population. Such investigations should help to set an effective national conservation plan for this species in Morocco.

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Years of census	Number
1958	200
1959	100
1966	168
1972	85
1980	420
2001-2002	678
2010	768
2011	816

Table1. Available estimates of Eleonora's Falcon *Falco eleonoare* population size (number of pairs) on the islands of Mogador.

Figure 1. Location of the study area.

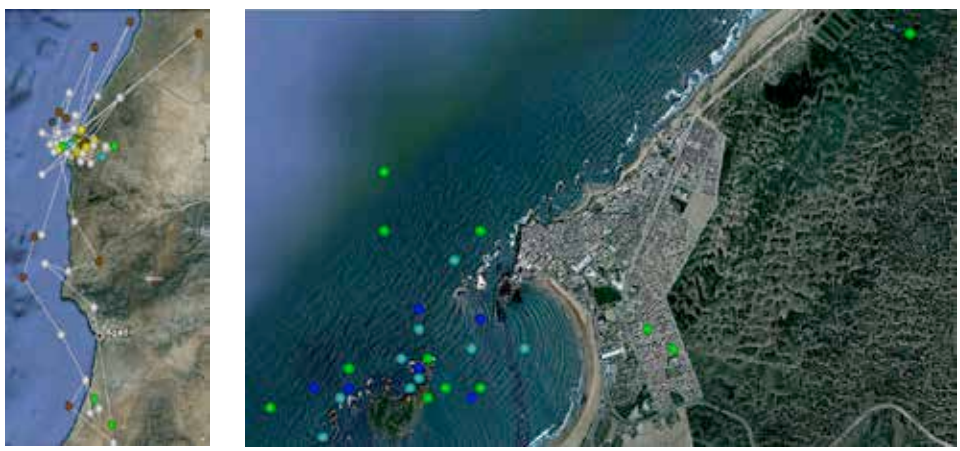

Figure 2. Routes of two adult Eleonora's Falcons *Falco eleonorae* equipped with satellite transmitters. Only the locations in green and blue are reliable (max. error 1km).

The Slender-billed Gull *Larus genei* breeding in Egypt in 2014

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ABSTRACT

The Slender-billed Gull *Larus genei* is a common passage and winter visitor through Egypt, with more than 12,000 birds counted in winter 2013–2014. The first record of a breeding colony of Slender-billed Gulls in Egypt was on Gezira Dib, El Malaha east of Port Said. In 1990, 5,688 nests were counted at the same place. In the summer of 1998 an estimated 1,000 pairs nested on El Qarn island. In 2014 a survey was conducted at El Malaha and at lake Qarun.

A total of 12,675 birds were counted in the two Egyptian colonies, representing more than 9 % of the current estimated breeding population of Black and Mediterranean Seas (140,000-205,000 in 1999-2000). The increasing numbers from 1999 to 2014 at El Qarn island probably reflect the efforts made by the Ministry of Agriculture and the Lake Qarun Protected Area during the breeding seasons at Lake Qarun; their cooperation has ensured the availability of food for breeders and their chicks. Conversely, 5,688 nests were counted at El Malaha in 1990 while in our survey only 1,350 nests were counted in 2014, illustrating a sharp population decline. Slender–billed Gulls in Egypt face disturbances during the breeding season, such as fishermen walking through the nesting area especially at El Qarn Island, and eggs and chicks being collected at El Malaha. Signs should be posted forbidding any human disturbance of the breeding areas. These two colonies merit protection from further development, and further study is needed at the colony in El Malaha in order to understand the reasons for the population decline.

INTRODUCTION

The Slender-billed Gull breeds widely at isolated, scattered localities, from Senegal and Mauritania through the Iberian Peninsula to the Mediterranean and Black Seas, east to Asia Minor, the Middle East, Kazakhstan, Afghanistan, Pakistan and northwest India. The birds winter around the Mediterranean Black and Caspian Seas, on the coast of the Arabian Peninsula, and south to the Horn of Africa. The number breeding around the Black and Mediterranean Seas was estimated at 140,000-205,000 in1999-2000 (Wetlands International 2012). In Egypt, the Slender-billed Gull is a common winter visitor. During the winter of 2013-2014, more than 12,000

individuals were counted around Lake Manzala, El Malaha, Port Fouadand Lake Burulus (unpublished data). Abdel Megid (1945) recorded the first breeding colony on Gezira Dib in El Malaha, east Port Said. In 1979, eggs were examined that had been taken from 200-400 nests in El Malaha (Meininger & Mullie 1981). El Malaha then was the only site where the species was breeding in Egypt.

In 1990, 5,688 nests were counted there (Meininger & Atta 1994). Slender-billed Gulls started breeding at lake Qarun in the early 1990's and in summer 1998 an estimated 1,000 pairs nested on El Qarn island (Baha El Din 1999). The main objective of my study was to relocate the breeding colonies after the development of the Port Said area, especially the construction of the new Suez Canal by-pass, and to compare the results with previous data.

METHODS AND STUDY AREAS

The study areas are located within two Governorates. The first colony is located in Port Said Governorate on scattered small sandy islands at El Malaha (31°13'N 32°19'E) a hypersaline lagoon in the north-western corner of the Sinai Peninsula. The western side of the lake is bordered by the new by-pass of the Suez Canal. The lake is connected with the Mediterranean Sea through a narrow canal; pipes are also connected to the Mediterranean Sea.

The lake is apparently variable in size, having a length of up to 13 km along the Suez Canal and up to 14 km along the Mediterranean Sea, giving a more or less triangular shape. El Malaha is shallow with a depth of only 50-70cm. (Meininger & Atta 1994). The second colony is in the El Fayoum Governorate on El Qarn island (29°28'N 30°40'E), which is about 2km in length and 75m wide. Lake Qarun is an enclosed basin about 40km in length and 5.7km mean width. The mean depth is estimated to be 4.2m with a maximum depth of 8m. The lake occupies the deepest part of the Fayoum depression, which is an isolated basin in the western desert about 100 km southwest of Cairo (Meininger & Atta 1994).

Most of the area was surveyed by car, then a small boat was used to visit the nesting sites. The weather was extremely hot, over 39ºC in July 2014. Visits to each colony were kept short: 5-10 min in duration depending on the size of the colony. Several short visits were made to El Malaha, the first on the 20 May 2013, a second visit on 20-22 of June in 2014 and our last visits were on 10 and 12 July 2014.

The El Qarn island colony was visited twice, the first visit on 12 May 2013, and again on 25 June 2014. Binoculars were used to identify the Slender-billed Gulls and counts were made using the total count method. Nest counts were also made, the counting unit being the apparently occupied nest.

The total number of nests at a given site is defined as the summed numbers of occupied and unoccupied nests that appear to have been used during the present breeding season (Bibby *et al*. 2007). Most behavioural observations were made using a telescope from the best vantage points available, as the rather muddy substrate prevented close access.

RESULTS

The main breeding habitat of Slender-billed Gulls in Egypt appears to be saline lakes (Lake Qarun in El Fayoum Governorate) and the coastal water stands of the Mediterranean Sea (laguna near Port Said).

At El Malaha the Slender-billed Gull has established a breeding colony on small scattered islets that are protected by a muddy substrate. On these islets 4,050 birds and 1,350 nests were counted on 28 July 2014. Breeders foraged at Lake Manzala to feed their chicks. I saw the first two fledged young on 28 July 2014, feeding with parents at the Port Fouad saline lagoons. By the end of August 2014, most of the 750 fledglings counted were feeding together with the adults at these saline lagoons.

Near Port Said 8,625 birds and 2,875 nests were counted on 25 June 2014 on El Qarn Island. The main colony consisted of 1,500 nests located on the rocky edge of the island. The typical nest is a deep scrape or shallow depression surrounded with algae and twigs or old nesting material from previous breeding seasons.

The nests are very close to each other, no more than 20 cm between each nest. Sixteen sub-colonies totaling 1,375 nests were scattered in front of the main colony on the sandy shore of the island. Each sub-colony varied between 24 and 240 nests and tended to be more widely spaced, with 50cm to 2m between nests. Parent birds were observed feeding young chicks with small *Tilapia sp.* and other small fish.

DISCUSSION

The total number of birds in the two Slender-billed Gull colonies at El Qarn island and at El Malaha was 12,675 individuals in 2014, which represents over 9 % of the currently estimated breeding birds for the Black and Mediterranean Seas, with 140,000-205,000 birds in 1999-2000 (Wetlands International 2012). In 1999 Sherif M. Baha El Din estimated that 1,000 pairs nested on El Qarn island, where we found 2,875 nests in 2014. The population increase is most likely due to the efforts of the Egyptian Ministry of Agriculture and the Lake Qarun Protected Area, specifically by banning fishing during the breeding season at Lake Qarun to ensure the availability of food for breeders and their chicks. In contrast, 5,688 nests were counted in 1990 at El Malaha (Meininger & Atta 1994), while in our survey only 1,350 nests were counted indicating a sharp decline. Further study is needed to understand the reasons for this decline.

These two colonies, especially the one at El Malaha, merit protection from further development within the breeding area and from other disturbances. In Egypt the Slender-billed Gull faces disturbance during the breeding season from fishermen walking through the area dragging nets. Signs should also be posted forbidding all human intrusion in the breeding areas throughout the entire breeding period (mating, nesting, and fledging periods) as established by this and other surveys. The elimination of disturbance and other threats such as fishermen walking through the colonies collecting eggs or chicks before they can fly should be prohibited.

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Nests of the Slender-billed Gull in Egypt, Photo Mohamed Habib.

Chick diet composition of Lesser Crested Tern *Sterna bengalensis emigrata* at their Mediterranean breeding sites in Libya

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ABSTRACT

The chick diet of the Mediterranean population of Lesser Crested Tern *Sterna bengalensis emigrata* was investigated in 2008-2010 and 2012 at three breeding sites on the Libyan coast, Gara Island, Julyanah islet and Al Ulbah Island, where over 2,400 pairs of Lesser Crested Tern breed every summer. The main objectives were to document prey species delivered to chicks, and the inter-site differences in diet structure in terms of prey species, diversity and biomass. Regurgitated prey samples with prey specimens left at colony sites are included in the present study. Samples were collected by hand during field visits to colonies (discarded prey specimens found on the ground) and during chick banding (when handled chicks regurgitate recent food).

A total of 422 diet samples belonging to 18 families of fish and one family of cephalopods were collected during the study period. Adult terns fed their chicks with different prey species at each site, indicating an adaptation in foraging yield at waters near the respective colony. Prey size increased with progress of chick growth indicating active selection of prey size with the increasing energetic requirements of growing chicks.

INTRODUCTION

Studying the diet of seabirds can provide a tool for assessing the type, size, mass and quality of prey available to them within their foraging areas during the breeding season (Dänhardt *et al*. 2011).

Diet composition is a major limiting factor in breeding productivity through its effect on growth and survival, as the energy and nutrients acquired are affected by the quality and quantity of food consumed which in turn affects growth rate (Wanless *et al*. 2005). Diet composition can also indicate the feeding regime of the parent bird as a generalist or specialist feeder (Nicholson 2002), and in turn how availability of prey population can impact the breeding success of a certain seabird species. Several factors can affect the diet composition of seabirds (Table 1).

Lesser Crested Terns of the subspecies *emigrata* are breeding only in Libya at

Factor	Reference
Seabird body morphology and mass	Hulsman 1988
Weather conditions	Shealer 2002
Prey distribution pattern and availability at foraging areas	Carty 2009
Differences in prey size	Hulsman1981, McLeay *et al.* 2009
Differences in energetic efficiency between parent and young birds	
Position of prey with respect to the water depth, correlated to prey size.	Dänhardt & Becker 2011

Table 1. Factors controlling diet composition in seabirds

three colonies, Gara, Elba (Meininger *et al*. 1994), and since a later date the colony in Jeliana lagoon, Benghazi (Hamza *et al*. 2007). This species uses two main feeding techniques: plunging at the water surface (i.e. the bird dives into the water but does not submerge completely); feeding by aerial diving, which take place when the bird dives and submerges completely, relying on momentum to reach and catch its prey (Ashmole & Ashmole 1967). The preferred food is epipelagic and nektonic fish species, with a smaller proportion of benthic species such as crustaceans and cephalopods (Cramp 1985, del Hoyo *et al*. 1996, Hulsman *et al*. 1989). As previous studies on feeding ecology and diet structure in Lesser Crested Terns are few, there is a need to update existing information and to document data from poorly studied populations (Horn *et al*. 2010) as most published information on this subject is restricted to the Australian populations (Hulsman 1977, 1981 and 1988, Hulsman *et al*. 1989, Nicholson 2002). Information regarding diet structure and foraging of the Mediterranean breeding population in Libya is scarce, limited to seven fish species reported during a short visit to breeding sites in summer 1993 at the Elba and Gara colonies (Meininger *et al*. 1994). No information was previously available on diet structure at the Jeliana breeding site (Benghazi) as it was discovered several years after Meininger's report.

METHODS

Chick diet samples were collected during 2008-2010 and 2012 from Gara, Elba and Jeliana colonies. Regurgitates were hand-picked from chicks aged 1-3 weeks during ringing operations. Regurgitates collection is the method of minimal intrusion to seabirds (Cooper & Klages 1995, Barrett *et al*. 2007), including terns (Nicholson 2002, Shealer 1998, Surman & Wooller 2003). Food discarded near nests was also collected and included in the data analyses. Diet samples were preserved in plastic bags and then kept in 70% alcohol, prior to identification at the Fish Biology laboratory of Tripoli University, and at the University of Omar Al-Mokhtar in the 2012 season. Whole prey items (fish) and partially digested fish/cephalopods (where length could still be estimated) were included in the analyses. Total length (mm) and weight (g) of regurgitated fish was measured when the specimen is intact; when the specimen is partially digested, total weight was

calculated using allometric equations for that species listed in fishbase.org (Froese & Pauly 2000).

RESULTS

A total of 422 diet samples belonging to 18 families of fish and one family of cephalopods were collected during the 2008-2010 and 2012 breeding seasons.

At Gara Island, nine species of fish and one cephalopod species (*Loligo sp.*) belonging to 10 families were collected from regurgitated food and adjacent nest discards. 13 fish species belonging to nine families were collected from the Elba Island colony, and 18 species of fish belonging to 13 families were collected at the Jeliana islet, most of them during the 2008 and 2012 seasons. Details of prey species at each breeding site is listed in Table 2.

	Family	Species	Gara	Elba	Jeliana
1	Atherinidae	*Atherina boyeri*			■
2	Belonidae	*Belone belone*		■	
3	Blenniidae	*Lipophrys trigloides*			■
		Salaria pavo			■
4	Carangidae	*Seriola dumerili*		■	
5	Centracanthidae	*Spicara smaris*	■		■
6	Cichlidae	*Tilpia zilli**			■
7	Clupeidae	*Sardinella aurita*	■	■	■
8	Coryphaenidae	*Coryphaena hippurus*		■	
9		*Lichia amia*			■
10	Engraulidae	*Engraulis encrasicholus*	■		■
11	Exocoetidae	*Cheilopogon heterurus*	■	■	
12	Hemiramphidae	*Hemiramphus far*	■	■	
13	Labridae	*Coris julis*			■
14	Loliginidae	*Loligo vulgaris***	■		
15	Pomacentridae	*Chromis chromis*	■	■	■
16	Scaridae	*Sparisoma cretense*	■	■	■
17	Scombridae	*Scomber scombrus*	■		■
18	Siganidae	*Siganus luridus*			■
		Siganus rivulatus			■
19	Sparidae	*Boops boops*	■	■	■
		Lithognathus mormyrus			■
		Sarpa salpa			■
		Diplodus vulgaris		■	■
		Diplodus sargus		■	
		Oblada melanura		■	
		Pagellus erythrinus		■	

Table 2. Taxa constituting the chick diet of Lesser Crested Tern *Sterna bengalensis emigrata* in Libya. * Freshwater/brackishwater fish species. ** Squid (Mollusca).

TOTAL PREY LENGTH AND PREY MASS DISTRIBUTION

The total length of collected fish specimens (whole and partially digested fish) ranged from 26.8-150 mm (mean = 77.34 ± 21.8) at Jeliana, 32-140 mm (mean = 77.7 ±25.1) at Elba and 33-109 mm (mean = 63.4 ± 20.0) at Gara. The percentage frequency distribution of fish length shows some variable trends between the sites (Figure 1). At Jeliana, most fish ranged from 50 to 100 mm while at Elba, about 25% of the fish sampled were in the 100-140 mm category, and at Gara about 70% of fish length was in the 40-70 mm category (Figure 3).

Total prey length in the samples represents either planktonic or juvenile fish stages, as these terns actively select prey that suit the maximum gape opening of both adult and young terns (Hulsman 1981). Terns fed on larger fish at the Jeliana and Elba colonies compared to the Gara colony. The pooled reconstituted mass for regurgitated fish at Jeliana ranged from 0.3-41.2g (mean = 6.1 ±5.9, n = 249), at Elba it ranged from 0.1-19 g (mean = 5.1 ±4.3, n = 70), while at Gara it ranged between 0.3-25.7g (mean = 3.3, ±2.6, n =103).

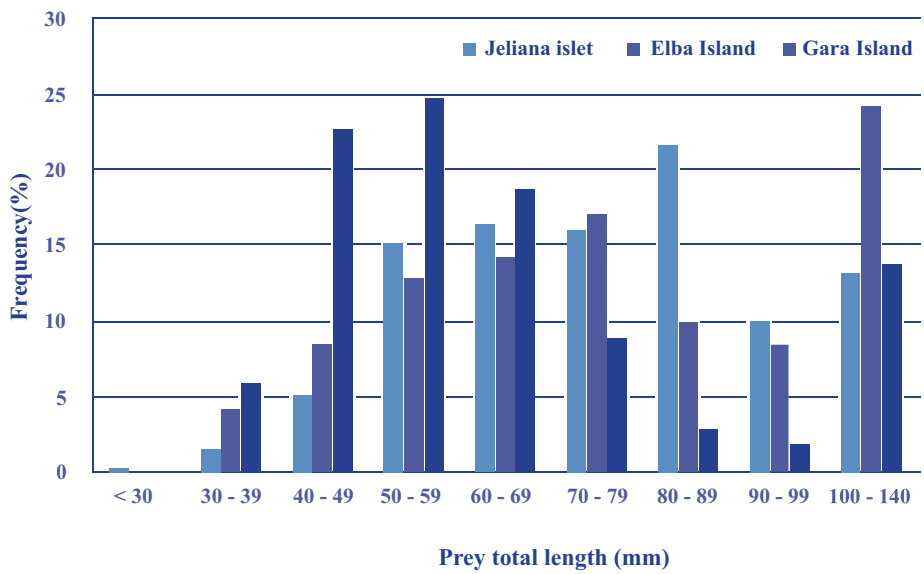

Figure 1. Percentage frequency distribution of total prey length (mm) collected from Lesser Crested Tern *Sterna bengalensis emigrata* chicks at the Gara, Jeliana and Elba colonies, Libya.

DISCUSSION

Ten fish species and one cephalopod from Gara, 12 fish species from Elba, and 18 fish species from Jeliana, were found to make up the diet of young Lesser Crested Terns at the three main breeding sites of the species in Libya. From the sample sizes collected, the majority of fish are either planktonic (larval) or the juveniles of demersal species. During this phase, many of these species tend to occupy the upper layer of the water column, searching for food (mainly zooplankton and phytoplankton) and use seagrass meadows of *Posidonia oceanica* as a shelter from predators. Meininger *et al*. (1994) mentioned four fish species in the diet of young Lesser Crested Tern at the Elba colony: bogue *Boops boops*, garfish *Belone belone*; Sand eel *Gymnammodytes cicerelus*; and a probable grey mullet (Mugilidae). No sand eel specimens were found in the Elba diet samples in the present study, which may indicate changes in structure of the local fish assemblage around this breeding site (alternatively, although one specimen of sand eel was recorded in Meininger's study, it may not be a preferred food for the terns in Libya). At Gara all the prey species mentioned by Meininger *et al*. (1994) were also found in our study. However, Meininger *et al*. did not mention either the Black-barred halfbeak *Hemiramphus far* nor the Mediterranean Flying fish *Cheilopogon heterurus* which might be explained by the later establishment of Black-barred halfbeak populations in Libya (first reported 14 years later by Shakman & Kinzelbach 2007) and possibly due to the low sampling effort for diet composition in the 1994 survey.

The highest number of prey species was found at Jeliana (19 species) possibly due to the large sample size (249 items) compared to the other two sites. However, Lesser Crested Terns from this colony appear to show a preference for foraging at inshore shallow water sites (there are many inshore bays and coastal lakes at Benghazi, incl. Ain Ziana lagoon and Benghazi Lake), a lower proportion being observed using deeper offshore waters. Taking into account the importance of these inshore sites as fish nurseries (and a former fish aquaculture site at the Ain Ziana lagoon) the adult terns have an easy and proximal area for provisioning their young.

In conclusion, Lesser Crested Terns have been found to catch a wide range of fish size, with more preference for certain species being both easier to locate and of higher energetic value, thus fulfilling the high food demand for the young, with an active selection of larger prey during the later provisioning period, as the gape of the chicks becomes more adapted for receiving larger food items. The results of this study can be used as baseline data on feeding aspects of the Lesser Crested Tern young at the Mediterranean breeding sites. It shows that although several prey species are consumed by the chicks and nestlings (and possibly other prey species are being utilized by the adult terns), only a few species are of greater importance in terms of occurrence and mass. Any change in population dynamics of these preferred few prey species, due to fisheries or changing oceanographic/ climatic conditions (e.g. sea surface temperature, circulation) over the foraging areas would have severe consequences on tern population dynamics (Wanless 2006).

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Observations of Saunders's Terns breeding at Ras Sudr, Egypt, in 2014

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CONTEXT

Breeding Saunders's Terns *Sternula saundersi* were discovered in 2012 in the region of the northern Red Sea, south of the town of Ras Sudr (Habib 2014).

Confirmation of the species identification was obtained during a visit to the breeding site by the Egyptian Ornithological Rarities Committee in July 2013.

We surveyed the area again from 7 June to 23 August 2014 in order to study the ecology of the birds and to produce recommendations for protecting the breeding and young rearing grounds, to be implemented by the Egyptian Environmental Affairs Agency (EEAA).

Here we report on local population size and productivity in 2014.

METHODS & STUDY AREA

Two colonies were located on a sand-bar on the Red Sea coast south of Ras Sudr (29°44.8' N 32°73 E), in the western part of South Sinai Governorate. The Sand-bar extends over 5km long and is 150m wide, with two large lagoons. The first colony was in the west part of the southern lagoon. It occupies a mostly sandy shore with halophytic vegetation and small stones originating from local resort development.

The second colony was located in the western part of the northern lagoon in an area totally covered with fine sand and small shells.

The colonies cannot be reached by car and the survey required a walk of 5km. Binoculars and a telescope were used to identify and count the birds and behavioural observations were made from vantage points that allowed us to observe the colonies from a reasonable distance, to prevent any disturbance. Visits were kept short, less than 20mn duration as recommended by Walsh *et al*. (1995) and were made from 7am to 3pm.

RESULTS

Forty pairs were counted in July 2014. On 23 August all the Saunders's Terns were roosting at the largest lagoon at the northern end of the sandbar: 130 individuals were counted, including both fledglings and adults still feeding their young; some fledglings were observed fishing with the adults.

From this survey we estimated that 50 fledglings had been produced in the 2014 breeding season.

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Nest of Saunders's Tern in Egypt, 2014, photo Mohamed Habib

Male Saunders's Tern carrying fish to female, Egypt 2014, photo Mohamed Habib

Pair of displaying Saunders's Tern, Egypt 2014, photo Mohamed Habib

The Common Shelduck *Tadorna tadorna*, an important coastal breeding species and bio-indicator of saline environments in the Mediterranean

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ABSTRACT

Early reports of breeding Common Shelduck *Tadorna tadorna* in the Mediterranean region date back to the 19th century, a period when Shelducks were persecuted throughout Europe for the fashion trade. Full protection for the species began in the 1930s in Germany and Denmark, in France in 1962. During the latter half of the 19th and in early 20th centuries the amalgamation of small artisanal salinas gave way to the modern industrial salinas of today. The Shelduck and the Flamingo *Phoenicopterus roseus* are just two of the many species that occur in the hyper-saline environments around the Mediterranean: coastal salinas, salt lakes, and river estuaries.

The attraction and increase of bird populations in salinas is due to the optimal conditions required for producing salt which lead to a biologically rich productivity of the invertebrate fauna, and close cooperation between the salt companies and ecologists. The present situation shows a population recovery and an extension of the breeding range in west Mediterranean countries that includes France, Italy, Spain, Portugal, and the North African countries of Morocco, Algeria and Tunisia.

INTRODUCTION

The distribution of the Common Shelduck *Tadorna tadorna* is chiefly Palearctic with a fragmented breeding range across a narrow latitudinal band from 30°S to 50°N, east through southern Europe, the Middle East, Central Asia, Mongolia and Northeast China. A good proportion of the maritime Northwest European population occurs around the coastline of the British Isles and in continental Europe along the northwest coasts of France, Belgium, Holland, northern Germany, Denmark, the Baltic Sea north to Estonia and Scandinavia. Early population estimates for Northwest Europe were 130,000 birds (Atkinson-Willes 1976). This population increased until the 1990s (Rüger *et al*. 1986, Rose 1995) and since then is estimated at 300,000 individuals (Scott & Rose 1996, Wetlands International 2015).

A second Shelduck population in the Black Sea and Mediterranean region has for many years been separated from the Northwest European population by the European continent and is now estimated at 120,000 birds (Wetlands International 2015). One of the principal aims of this paper is to draw attention to the Shelduck breeding and wintering populations in hyper-saline environment

in Mediterranean salinas, where the climate and high summer temperatures are ideal for the production of solar salt (halite). The annual production of salt in the Mediterranean is in the order of 7 million tonnes, France being the highest producer with over two million tonnes, followed by Turkey 1,6 million, Spain 1,4 million, Italy c.1 million, Tunisia 500 thousand tonnes, and Greece and Israel approx. 300 thousand tonnes (Sadoul *et al.* 1998).

THE MEDITERRANEAN SITUATION

Mediterranean salinas date back to pre-Roman times when coastal dwelling people first found salt crystals in shallow pools left by wind and wave action. Primitive salinas like the "Zweini Saltpans" on Gozo, Malta, are a typical example. Salt is still harvested in these shallow hand-made saltpans. On the northern Mediterranean coastline, what formerly were small family or communal salinas were bought and eventually amalgamated to form the large industrial salinas of over 1,000ha established during the 1850s-60s and early 20th Century. Today, salinas have increased right across the Mediterranean.

They are now considered an integral part of the Mediterranean landscape and recognised as wetlands of international importance where thriving bird and plant communities have adapted to the hyper-saline environment. The Greater Flamingo *Phoenicopterus roseus*, Kentish Plover *Charadrius alexandrinus*, Audouin's Gull *Larus audouinii,* Slender-billed Gull *Larus genei,* Mediterranean Gull *Larus melanocephalus,* Little Tern *Sternula albifrons,* Sandwich Tern *Sterna sandvicensis*, Lesser-crested Tern *Sterna bengalensis* and Gull-billed Tern *Sterna nilotica* form the main group of annual breeding species, while many thousands of shorebirds frequent salinas during the spring and autumn migrations. These coastal species are all listed in Annex II of the Protocol concerning Specially Protected Areas and Biological Diversity (Protocol SPA/BD) adopted by the contracting parties to the Barcelona Convention.

The Shelduck was known as a breeding species in the Mediterranean region in the mid-19th century (Crespon 1844), a period when Shelducks were being persecuted throughout Europe for the fashion trade.

Indirect protection began with the creation of nature reserves, such as the Réserve Nationale de Camargue (13,000ha) created in 1927 by the French Société Nationale de Protection de la Nature. Little was known about breeding or wintering Shelduck in Mediterranean France until 1955-56, when Lévêque (1957) produced the first estimate of 11 breeding pairs in the Réserve Nationale de Camargue and the two largest industrial salinas in Europe: Salin-de-Giraud (12,000ha) and Salin d'Aigues-Mortes (11,000ha). Shortly after protection measures were enforced in France (Anon. 1962), the Shelduck population in Mediterranean France began to recover and a study was initiated by the author in the 1970s.

MONITORING

The Shelduck is one of our most colourful duck species, easily recognised by its black and white or variegated plumage. For breeding and feeding the Shelduck shows a strong preference for saline habitats, especially coastal salinas, salt lakes, and river estuaries in the Mediterranean region. The Flamingo and the Shelduck occupy the same saline habitats and exploit a highly productive food source the Brine Shrimp *Artemia* and its eggs (cysts) abundant throughout the summer months. As a study species Shelduck populations are relatively easy to monitor in salinas. Observation

and monitoring form the basis of any population study. Systematic counts of the winter and summer populations made over a number of years can provide an insight into annual fluctuations, the moult migration and cold weather movements in winter, and help to identify any positive or negative trends of a population. Regular observations and monitoring are useful tools that can be applied to individual salinas, or on a much larger regional scale. Care should also be taken when collecting and presenting the data.

In Mediterranean salinas Shelducks nest on small islands and dykes covered with salt resistant plants such as *Salicornia, Sueda* and *Obione* that intertwine together and form a dense vegetation cover under which prospecting pairs of Shelduck force their way thus creating tunnels at the end of which the nest site is a shallow scrape where the female lays 10-12 cream coloured eggs. The incubation period is approximately 28-30 days and a strong pair bond is maintained throughout the breeding season. After hatching the 1-2 day old chicks are escorted by the adults to a nursery water rich in *Artemia* and other invertebrates where they will develop, and later form large crèches of over 100 chicks. In July the adults are eager to depart on the moult migration north to the German Wadden Sea where they moult their wing and tail feathers and are flightless for several weeks. The outward flight is northwards via the Rhône and Rhine rivers, the return journey back to the breeding grounds is more leisurely, the total distance covered being c.2,500km (Walmsley 1987a).

SHELDUCK DISTRIBUTION IN WINTER

Systematic counts of Shelduck in Mediterranean France were made each month during 15 years covering the autumn and winter period from September to March 1976-77 through to 1991-92 inclusive. This data set provided a better understanding of events, in particular the distribution and movements of the young birds (Sept.-Oct.) and the return of the adult population (Nov.-Feb.).

The March counts are an important indication of the potential breeding population each year. On a more global scale, cold northern winters and severely cold winters throughout Europe have a dramatic effect on Shelduck provoking massive movements of birds to milder climates. Shelduck are particularly sensitive to cold weather and are often among the first species to die when food sources become unavailable. In the Mediterranean, little or no autumn rainfall will also influence the numbers of Shelduck in salinas, thus forcing them to move to more permanent waterbodies.

BREEDING POPULATIONS AND MOVEMENTS

Breeding populations of Shelduck in the Mediterranean are closely associated to the distribution of salinas. Formerly the West and East Mediterranean populations were separated from each other before hunting restrictions were imposed in France in 1960s and in Italy in the 1970s. Today however, there is evidence to suggest that Shelduck belonging to the Black Sea population are now intermixing with West Mediterranean birds in winter, in the coastal wetlands of Manfredonia and southern Italy. The sudden increase of Shelduck in the Salina of Margherita di Savoia in the1990s (Serra *et al*. 1997) supported this theory. More recent information provided definite proof of Shelduck movements, with birds ringed in Italy and recovered in Hungary and the Crimea, and birds ringed in the northern Black Sea region during the breeding season and recovered in Italy.
There was also an exceptional recovery of a Shelduck ringed in Kazakhstan during the breeding season and recovered in

Sicily in winter (Spina & Volponi 2008). Add to this the news that up to 25,000 Shelduck are wintering in the Venice Lagoon (N. Baccetti pers. com.).

In Algeria a team from the University of Annaba estimated the numbers of Shelduck in the wetland complex of Oum El Bouaghi salt lakes, known also as the Constantinois, during the three winters 2002-03, 2003-04 and 2004-05 and reported as "exceptionally wet years".

Large concentrations of Shelducks were attracted to these flooded salt lakes with rich biological food sources such as the Fairy Shrimp *Branchinella spp.* and the Brine Shrimp *Artemia salina*. Unfortunately the Shelduck counts were made in only two of the 12 wetlands on the same day, with estimates of 23,000 on 18 Jan. 2003, 28,500 on 16 Dec. 2003, and 31,800 on 15 Dec. 2004 (Boulkhssaïm *et al*. 2006). Generally speaking waterfowl are highly mobile and will move to other wetlands when disturbed. In order to avoid counting the same birds twice, a single aerial survey covering the wetland complex of Oum El Bouaghi would have produced a more realistic estimate of Shelduck present at each wetland site and for the whole wetland complex. Scott & Rose (1996) made the following statement: "the large numbers of wintering *T. tadorna* in Algeria in recent years (up to 20,000) are more likely to be birds forced out of the Black Sea region by hard weather, than birds from hitherto unknown breeding areas in northwest Africa".

WHAT IS THE FUTURE FOR THE CONSERVATION OF SHELDUCK AND ITS HABITATS?

In view of the changing status of salt production in Europe, partly linked to the unstable salt markets and the increase of imported salt into Europe from countries like South America and Israel, many salinas are in danger of becoming inactive or abandoned completely. Mediterranean salinas are today considered as prime development sites for industrial and tourism developments. Others are being transformed for aquaculture where waterfowl and fish-eating species are unwanted, and only one or two abandoned salinas have so far been declared as nature reserves.

Salt companies should be made aware of the need to protect the existing salinas because they are the custodians of these important wetlands, and the flora and fauna in these unique saline environments. The Flamingo has become a 'flagship species' in the Mediterranean and every effort should be made to protect the breeding and feeding habitat of the Flamingo. The future conservation of salinas for the Shelduck is equally important today, because the Mediterranean is now an international crossroads for the West Mediterranean and Black Sea populations, and also for Shelduck from the Northwest European population during severely cold winters (Walmsley 1987b). An important point to remember is: *Salt production and Conservation are compatible.*

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“PART II”

REGIONAL AND NATIONAL STATEMENTS

Fifty years of seabird research and conservation in the Maltese Islands: are we getting there?

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ABSTRACT

Seabird research and conservation were initiated in Malta after the foundation of the Malta Ornithological Society (MOS, now BirdLife Malta) in 1962. At that time, the seabirds breeding in the Maltese Islands, namely Scopoli's Shearwater *Calonectris diomedea*, Yelkouan Shearwater *Puffinus yelkouan*, Mediterranean Storm-Petrel *Hydrobates pelagicus melitensis* and Yellow-legged Gull *Larus michahellis*, were not afforded any form of legal protection. Shooting excursions for Scopoli's Shearwater at sea was one of the pastimes of the shooting fraternity. The important breeding sites of seabirds, such as Filfla, Ta' Ċenċ, Fungus Rock and the south-western cliffs, which offer ideal habitat for them, were also not protected. Filfla was frequently used as a bombing target by the British forces. Furthermore the status and breeding biology of seabird species in the islands were practically unknown and no research on these species had been ever carried out. After the members of the newly-established MOS ringing scheme started visiting Filfla in 1968, mainly to assess and monitor the breeding seabirds' population and ring the birds, MOS lobbied persistently against the use of Filfla for bombing practices. In 1970 the Society published *Bird Studies on Filfla* to coincide with the first European Conservation Year and the practice was finally stopped. Eventually Filfla and Fungus Rock were declared strict nature reserves and Ta' Ċenċ was declared a bird sanctuary. Seabirds became legally protected in 1980. In 1969 the largest Yelkouan Shearwater colony was discovered at L-Irdum tal-Madonna on mainland Malta. Since then other colonies of both shearwaters and Storm-petrel were discovered and their breeding biology has been studied along the years. After Malta joined the EU, all the colonies have been included within the EU Natura 2000 Sites. Studies were intensified since 2006 with two EU LIFE projects. The aim of the first EU LIFE project (2006-2010) was to reverse the population decline of the Yelkouan Shearwater; the aim of the second project (2011-2015) was to identify Marine Important Bird Areas around the Maltese islands. In spite of what has been carried out so far we are not there yet. There are still many gaps to fill in the conservation and research of seabirds. Lack of proper law enforcement; human disturbance, infestation of rats and the dearth of human and financial resources are some of the prevailing problems.

INTRODUCTION

The Malta Ornithological Society (MOS,

BirdLife Malta since 1995) was founded in 1962. It was the first environmental NGO in Malta. Its aims have been mainly the conservation and study of birds and their habitats. Before 1960, ornithological field studies were virtually inexistent. No research on seabirds had ever been carried out. The status and distribution of Malta's seabirds and their colonies, and their breeding biology was practically unknown. Seabird research and conservation was initiated in Malta in the late 1960s by MOS.

SEABIRDS PROTECTION

Seabirds breeding in the Maltese Islands were not afforded any form of legal protection. Shooting for Scopoli's Shearwater at sea was one of the pastimes of some hunters. Along the years this species has been pushed by human interference to breed only at inaccessible sites. It could survive and breed in such a hostile environment mainly due to the inaccessibility of their nesting sites. BirdLife Malta campaigned unfailingly for the protection of shearwaters and finally they became legally protected in 1980. Protection of important breeding sites of seabirds, such as Filfla, was also lacking. Filfla was used as a bombing target by the British forces. Research on Filfla was initiated in 1968, mainly to assess and monitor the breeding seabirds' population and to ring Storm-petrels and Scopoli's Shearwaters. In 1970, the Society published an account of visits to Filfla and their findings (Sultana & Gauci 1970) to coincide with the first European Conservation Year. The publication highlighted the importance of the islet as a seabird colony. Finally the Maltese Government requested the British forces to stop the bombing practices. Eventually Filfla was declared a strict nature reserve and Ta' Ċenċ was declared a bird sanctuary.

More recently, compiling data on important bird areas in the Maltese Islands based on BirdLife International IBAs criteria was initiated when Malta was in the process of joining the EU. Eleven sites, ten of which host seabird colonies, were identified. When Malta joined the EU in 2004, Birdlife Malta published the "Important Bird Areas of EU importance in Malta" (Borg & Sultana 2004). The EU Birds and Habitats Directives oblige the member States to declare many of their IBAs and Special Protected Areas (SPAs) under the Natura 2000 scheme. Now over 20% of the Maltese Islands are covered by nature protection legislation of some form and all seabird colonies fall within the Natura 2000 sites. Table 1 shows the present status of seabird breeding populations in the Maltese Islands.

Species	Present status/breeding population
Scopoli's Shearwater *Calonectris diomedea*	*Ca.* 4500-5000 pairs; down from 7000 pairs in 2000-2004. Colonies scattered mainly along the south-western cliffs - the largest at Ta' Ċenċ, Gozo (ca. 1000 pairs).
Yelkouan Shearwater *Puffinus yelkouan*	*Ca.* 1700 pairs (10% of the global population) Scattered colonies along sea-cliffs - largest colony at L-Irdum tal-Madonna (*ca.* 500 pairs). Up to 1970 bred on Filfla. Recently rediscovered still breeding on St. Paul's Islands.
Mediterranean Storm-petrel *Hydrobates pelagicus melitensis*	5000-8000 pairs on Filfla (one of the largest known colony in the Mediterranean). Few pairs at 3 other sites discovered in recent years.
Yellow-legged Gull *Larus michahellis*	*Ca.* 250 pairs (mainly on Filfla - *ca.* 200 pairs).

Table 1. The present status of the four sea-bird species found breeding in Malta (updated from Sultana *et al.* 2011).

RINGING STORM-PETRELS

Way back in 1966, BirdLife Malta's ringing scheme was set with the help of the British Trust for Ornithology. Filfla was visited for the first time in 1968 to investigate which seabird were still breeding on the island. This was the prelude of a long-term ringing and monitoring process of the Mediterranean Storm-petrel *Hydrobates pelagicus melitensis* and *ca*. 28,000 adults were ringed up to year 2014, with about 5000 re-trapped at least once on the islet during subsequent visits; 26 birds have been recaptured more than 20 years after their ringing date. The oldest five birds were recaptured as follows: two after 25 years, one after 26 years and two after 27 years; and one must bear in mind that these birds were ringed as adults (updated from Sultana *et al.* 2011).

Ringing is a good scientific tool for recaptures of birds at a colony, to study their longevity and to monitor a population. However, when it comes to recoveries beyond their colonies, the results are always relatively poor; and when a recovery occurs, ringing and recovery dates appear as snapshots, leaving information on the bird's whereabouts in the time between the two events unknown. With a bit of swell it is almost impossible to land by boat on Filfla, and the island was mainly visited between May and September. Studying the breeding biology of this species is also very difficult due to the rugged terrain of the island. In fact it is impossible to locate the actual nesting sites in any significant number, so much so that the number of chicks ringed there is very low (65 pulli out of *ca*. 28,000 adult birds ringed).

The recovery rate of the ringed birds is also very low. Only 12 birds were recovered beyond our seas. It has been suggested that the Mediterranean Storm-petrels do not leave the Mediterranean (Hashmi & Fliege 1994), but two Filfla-ringed birds were recovered beyond the Mediterranean; one in the Netherlands during a very strong storm and the other was found dead on the French Atlantic coast. Movements between Mediterranean colonies highlight the fact that the gene-pool of the Mediterranean Storm-petrel may not be as low as it was previously believed by Massa & Sultana (1990–91). In fact one of the ringed birds was recovered at the colony on Marettimo Island while 4 Marettimo ringed birds were controlled on Filfla (Table 2).

Ring No.	Age	Date ringed	Ringing site	Date recovered	Recovery site
S4121	4	24.05.1986	Filfla	20.02.1990	Côte Sauvage, La Tremblade, France
S7347	4	15.06.1991	Filfla	14.07.1996	Marettimo Island, Sicily
2114213	4	10.07.1971	Filfla	15.09.1989	Ameland, Strand, Netherlands
KN03195	4	02.07.1994	Marettimo	02.07.1998	Filfla
K46821	1	16.07.1987	Marettimo	15.07.1989	Filfla
KN14489	1	19.07.2003	Marettimo	10.08.2009	Filfla
KN23938	1	23.08.2011	Marettimo	01.07.2012	Filfla

Table 2 . Selected recoveries and/or controls of Mediterranean Storm-petrels.

Two small colonies of Mediterranean Storm-petrel in Gozo, one at Ta' Ċenċ and the other at Għarb, have been discovered relatively recently. The one at Ta' Ċenċ was discovered during a survey of caves in 1994 (Borg & Sultana 1992-94). Interestingly the breeding of storm-petrels in one of the caves at Ta' Ċenċ was first mentioned by the Gozitan scholar Agius de Soldanis in a manuscript in 1746. He described the birds correctly without knowing what the species was. The rediscovery of the birds in the area proves the resilience and faithfulness of this small long-lived pelagic bird to its rat-free breeding colonies.

SCOPOLI'S SHEARWATERS STUDIES

In the late 1960s, Scopoli's Shearwater's colonies were located to ring adults and young in the few accessible sites at cliffs. Then a long-term study was initiated in 1983. A total of 155 accessible nests at 17 sites were monitored for several years to study the species' breeding biology (Cachia Zammit & Borg 1986-87). This was a first for Malta which disclosed several secrets in the fascinating life of the Scopoli's Shearwater – their breeding behaviour, their longevity, their site tenacity and mate fidelity, and their breeding success, amongst several other studies. It was found that its breeding success was relatively low, mainly due to direct human interference, although predation by rats, feral cats and hunting dogs also occurred to a lesser extent.

EU LIFE YELKOUAN SHEARWATER PROJECT

Encouraged by the success to discover that the Storm-petrel still existed on the islet of Filfla in 1968, and providentially in large numbers, areas on mainland Malta which appeared to offer a good habitat for nesting requirements of the species were visited. It was then that, instead of finding storm-petrels, the largest Yelkouan Shearwater colony was discovered at L-Irdum tal-Madonna in the northern part of the mainland. This was the prelude of regular monitoring of the site in preliminary studies, which helped to discover the species' annual breeding cycle, amongst other things, and to collect various data, particularly from recaptures of the ringed birds (Sultana *et al.* 2011). The data collected during several visits annually throughout a relatively long period of years monitoring the colony, facilitated the pre-requisites for the first four-year EU LIFE Yelkouan Shearwater Project to delve with further studies in the species behaviour and to help reverse its population decline caused principally by rat predation. This EU LIFE project, spear-headed by Birdlife Malta, and launched in 2007, was to be the largest conservation project of its kind in Malta. It set in motion an impressive list of measures both on land and at sea, each with specific targets, but with the overall aim to reverse the decline of Yelkouan Shearwaters in Malta, especially through the protection of L-iRdum tal-Madonna.

It provided a major breakthrough in the knowledge on the Yelkouan's feeding and wintering areas and other aspects of its breeding biology (Borg *et al*. 2010, Raine *et al*. 2011, 2012). The first challenge was the eradication of rats from the cliffs. Two years into the project, a marked decline in rodents resulted in more birds in the area and higher breeding success.

Another target was locating the shearwaters' main feeding areas for eventual designation as marine nature reserves. Birds were tagged with tracking devices, and areas of critical importance identified. Other tasks high on the Project agenda were the raising of public awareness, control of human disturbance, and a model management plan for the protection of such sites.

SCOPOLI'S SHEARWATERS TRACKING STUDIES

During the Yelkouan Shearwater project, opportunity was taken to carry out some tracking studies on foraging behaviour and post-fledging movements of Scopoli's Shearwater. In 2009, an adult breeding female was tagged at Għar Lapsi with a GPS data logger to track the bird's movements during the chick rearing stage. The tagged bird was retrieved nine days later when she came into the nest to feed the chick. The results from the data logger showed that the bird did not travel farther than just over 50km to the south of the island. This showed that more detailed work was needed to ascertain whether this was the overall pattern for this species. Initial studies have also been carried out regarding post-fledging movements, and in the same year three Scopoli's male chicks were fitted with satellite tags before they fledged. The signals from two of the birds were received up to 27 and 38 days respectively after fledging; one when it was still in Maltese waters and the other after reaching the western side of the Mediterranean**.** The third bird continued transmitting for 44 days. The data received by the satellite tag showed that the bird spent the first few weeks feeding off the northern coast of Tunisia and the Pelagian islands. In early November it headed west and on the 13th of November it sent a signal from the Straits of Gibraltar showing that it was moving out of the Mediterranean. Then it continued southwards, following the coast of Morocco and Mauritania towards Senegal where the signal was eventually lost (Raine *et al.* 2011).

SECOND FIVE-YEAR EU LIFE PROJECT

Since 2006 sea-bird studies has intensified and the second five-year EU LIFE project with the main aim to identify Marine Important Bird Areas around the Maltese islands was in its final year in 2015. The studies included boat-based observations, deployment of GPS loggers on a number of Yelkouan and Scopoli's shearwaters, and fixing tiny radio tags on Storm-petrels, a first for the Mediterranean (Metzger *et al.* 2015).

YELLOW-LEGGED GULLS PREDATION OF STORM-PETRELS

Since 1970 Storm-petrels on Filfla started facing a voracious predator. The Yellow-legged Gull is presently mainly confined to the islet of Filfla, where its population has also been monitored; counting adults and nests and checking the breeding success. Apart from ringing the young birds, the impact of Yellow-legged Gulls on Storm-petrels has been regularly assessed by checking the remains of birds taken by the gulls. 55% of the avian remains collected from regurgitations are in fact Storm-petrels. Around 160 Yellow-legged Gull pairs nest on Filfla, mainly on the plateau surface. However in the last years the number of pairs nesting in the boulder scree below the cliffs inside the Storm-petrel colony has increased, and significantly more Storm-petrel remains are being found close to the nests of gulls nesting in the boulder scree (Metzger *et al*. in prep.).

CONCLUSION

In research and conservation of seabirds, one can never reach the end of the tunnel. It is always an uphill struggle. Monitoring seabirds can never be concluded. In spite of many years of seabird research there are still large gaps in our knowledge. These gaps need to be filled if one has to successfully address the problems these birds are facing and ensure their future conservation. In spite of what has been carried out so far we are not there yet. Lack of proper law enforcement; human disturbance, infestation of rats and the

dearth of human and financial resources are some of the prevailing problems. Several questions may be answered by modern technology methods. But modern technology methods require substantial funds. Seabird studies also require human resources, expertise and dedication. A lot of actions still remain to be carried out:

- Filling gaps in our knowledge of their breeding ecology and behaviour throughout the year.
- Monitoring regularly their populations and their colonies.
- Identifying the important bird areas at sea, particularly their feeding areas.
- Eradicating rats from sites holding seabird colonies, and from areas which would otherwise provide suitable habitat for their nesting requirements.
- Controlling any predators when found to be doing most harm to the colonies.
- Providing artificial nesting sites at colonies to make up for the loss of natural nesting sites through erosion.
- Protecting colonies from any form of development and other harmful human activities.
- Investigating the negative impact of pollution.

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Status of Marine and coastal birds of Montenegro: species listed under Annex II of the Barcelona Convention Protocol on Specially Protected Areas and Biological Diversity in the Mediterranean

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INTRODUCTION

Montenegro has a surface area of 13,852km^2 and approximately 92km of coastline on the eastern shores of the Adriatic Sea. There are several important coastal wetlands namely Ulcinj Salina (15km^2), Skadar Lake (300-550 km^2), Tivat salt pans (Tivatska Salina, 1.5km^2) and Buljarica (2km^2) with a beach of 12km.

Lake Sasko (6 km^2) is situated inland and northeast of Ulcinj. The coastline of Montenegro is under great pressure from tourism during summer.

Katici is the only Marine Protected Area in Montenegro. Other localities are of particular importance for birds, such as the mouth of rivers Bojana and Sutorina. Several localities are important for coastal birds but are not yet protected by national legislation: Sutorina, Jaz, Buljarica, Ulcinj Salina, Ada Bojana and Velika plaza.

Only Tivatska Salina is protected as an ornithological reserve. Some of these areas are acknowledged as Important Bird Areas (IBAs) (Lakes Skadar, Sasko and Ulcinj Salina) or are listed as Montenegrin potential IBAs (Saveljić *et al*. 2007).

BIRD STATUS

Here we give the Montenegrin status of marine and coastal species listed in Annex II of the Barcelona Convention Protocol on Specially Protected Areas and Biological Diversity in the Mediterranean. Among the 25 species of concern in the Mediterranean Action Plan, 19 are regularly observed in Montenegro, including 8 breeding species. Unfortunately the Eleonora's Falcon *Falco eleonorae* has not been recorded breeding in Montenegro since 2009 (see Table 1).

In recent years important changes were noted in the population of the Dalmatian Pelican, Pygmy Cormorant and Greater Flamingo, thanks to the construction of nesting rafts and the partial implementation of the Pelican Action Plan (Saveljić 2004).

In the last 10 years breeding numbers of Dalmatian Pelican has risen from 7-8 pairs to 39-40 pairs in 2014 on Skadar Lake which is the only nesting site of this species in Montenegro. The population of Pygmy Cormorant has significantly increased on its breeding sites on Skadar

Species	Number of breeding pairs	Wintering population (Nb individuals)	Population trend / remarks
Scopoli's Shearwater *Calonectris diomedea*	n/a	unknown	unknown
Yelkouan Shearwater *Puffinus yelkouan*	n/a	unknown	unknown
Mediterranean Storm Petrel *Hydrobates pelagicus melitensis*	n/a	unknown	unknown
Mediterranean Shag *Phalacrocorax aristotelis desmarestii*	n/a	<10	unknown
Pygmy Cormorant *Microcarbo pygmeaus*	3500	<7000	increasing
White Pelican *Pelecanus onocrotalus*	n/a	<2	stable
Dalmatian Pelican *Pelecanus crispus*	28-39	<106	increasing
Greater Flamingo *Phoenicopterus roseus*	<350	<2500	increasing
Osprey *Pandion haliaetus*	n/a	-	stable
Eleonora's Falcon *Falco eleonorae*	-	-	last breeding 2009
Slender-billed Curlew *Numenius tenuirostris*	n/a	-	unknown
Audouin's Gull *Larus audouinii*	n/a	-	unknown
Sandwich Tern *Sterna sandvicensis*	n/a	<100	stable
Little Tern *Sternula albifrons*	90	--	stable
Caspian Tern *Sterna caspia*	n/a	-	stable
Slender-billed Gull *Larus genei*	-	-	last breeding 2004
Mediterranean Gull *Larus melanocephalus*	n/a	unknown	unknown
Kentish Plover *Charadrius alexandrinus*	40	-	stable
Pied Kingfisher *Ceryle rudis**	n/a	-	seen once (2001)

Table 1. Status of seabirds and coastal species in Montenegro, listed in Annex II of the Barcelona Convention Protocol (SPAs & Biodiversity). n/a: not applicable (After Saveljić 2004, 2005, 2006 and 2013, Saveljić & Rubinic 2005, Saveljić et al. 2007

Lake while the population on Paratuk Island on the Bojana River is stable at 220 pairs (Saveljić 2006). The most impressive change concerns the Greater Flamingo. Formerly the species was a rare visitor in very small numbers at the Ulcinj Salina (Saveljić 2004). Thanks to efforts of the Centre for the Protection and Research of Birds regarding the monitoring of illegal hunting, 350 pairs attempted to breed in 2013. Unfortunately during one night all eggs were stolen from the nests by one man. Recently mass tourism has increased markedly along the Montenegrin coastal zone, and some of the natural habitats are now being threatened by complete destruction, which eventually may have a serious effect on the future survival of many migratory birds at Ulcinj Salina, Lake Skadar and Buljarica. In Montenegro our knowledge of seabirds is sparse. There are few ornithologists and volunteers interested in birds, and in developing quality monitoring of seabirds, and in maintaining our rich biodiversity, which are major challenges in Montenegro. The State Authorities should be made aware of these increasing problems.

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Seabirds of the Balearic Islands: status and recent changes (1987-2014)

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ABSTRACT

The breeding seabirds in the Balearic Islands are the Mediterranean Storm-petrel *Hydrobates pelagicus melitensis*, the Balearic Shearwater *Puffinus mauretanicus,* the Scopoli's Shearwater *Calonectris diomedea*, the Mediterranean Shag *Phalacrocorax aristotelis desmarestii*, the Audouin's Gull *larus audouinii* and the Yellow-legged Gull *Larus michahellis*. Other species occur in winter or during migration, such as the Northern Gannet *Morus bassanus,* various skuas *Stercorarius sp.* and terns *Sterna sp.*, the Black-headed Gull *Larus ridibundus* and the Lesser Black-backed Gull *L. fuscus*. We present here some information on these species and the conservation factors that affect them. We also include data for two raptor species breeding along the Islands' coast-line: the Osprey *Pandion haliaetus* and the Eleonora's Falcon *Falco eleonorae*. Changes in their conservation status since the first Medmaravis Symposium (Mayol 1986) are summarized here.

Mediterranean Storm Petrel
Hydrobates pelagicus melitensis

Presently seventeen colonies are found mostly around Ibiza and Formentera. In 1987 only three colonies were known. Habitat choice by the species and the calcareous rocky nature of the Balearics make quantitative surveys impossible. The total population size is unknown, but it is at least over one thousand pairs. In recent decades, the intense dedication of one ringer, E. Ramos, resulted in ringing over 15,000 birds (using mist-nets and vocalization play-back outside the colonies) and some recoveries or controls in colonies of Benidorm, Murcia and the Costa Brava, as well as at Marettimo (Sicily) and in the NW of Morocco. A standardized procedure for monitoring the most important colony, the Espartar islet in Ibiza, has been recently adopted (Minguez *et al*. 2005). The species is stable or growing, mainly thanks to eradication of rats at favourable islets.

Balearic Shearwater
Puffinus mauretanicus

The Islands hold 25 colonies with a population of probably 3,200 breeding pairs, but the whole population is larger. Counts of 25,000 to 30,000 birds have been registered in winter and during migration in Gibraltar or Atlantic waters. Great efforts (Project Life-Puffinus, eradication of rats, protection of colonies, etc.) have been carried out to conserve the

species. Intensive scientific monitoring is carried out at some colonies, while an effective protection of colonies is planned at three sites: La Mola of Maó, Tagomago Island and Punta Prima (Formentera).

Scopoli's Shearwater
Calonectris diomedea

The Islands host at least 4,500-5,200 pairs. A limited demographic decrease is suggested, although available data are inconclusive. Some colonies are being monitored accurately and the information on the species' post-breeding movements has increased significantly. In winter, movements are quite spread out in the Atlantic Ocean, with birds undertaking several ocean-crossings. During the breeding season, many birds are continually moving to the Iberian mainland coast in order to feed on fish as well as on discards. The main local problem is the accidental capture in March and April by surface longline fishing.

Mediterranean Shag
Phalacrocorax aristotelis desmarestii

This species breeds along almost all the rocky coast of the Balearics, and the protection of the species and its main colonies has considerably improved their conservation status. The population increased from 1,450 pairs in 1983 to 2,000 pairs in the 2010s, with a particularly marked increase in Ibiza and Formentera (Álvarez & Velando 2007, Ramos *et al*. 2011). A conservation plan is properly implemented.

Audouin's Gull
Larus audouinii

A significant percentage of the western Mediterranean population is breeding in the Balearics: around 1,000 pairs, although numbers are fluctuating from year to year (Muntaner 2003). The conservation status evolved very positively. The species' dependence on trawling is obvious, as evidenced by the establishment of some small colonies next to some fishing ports, and the decrease in the breeding population at Cabrera national park in the years where trawling was prohibited. There is a correlation between the breeding population size and the volume of fish landed by fishermen.

Yellow-ledged Gull
Larus michahellis

The species increased dramatically in the 1980s but now it is stable or decreasing due to intensive culling efforts (more than 43,000 individuals were killed and 80,000 eggs sterilized between 1988 and 2004) and to an improved waste management (closure of landfills everywhere, except in Ibiza). A wide-ranging population census was carried out in 2015, resulting in 7,500 breeding pairs (half of the maximum number, counted in 2001). From 2003 to 2010, 2,041 birds have been marked with colour rings, revealing movements to the NW and NE (1,266 controls in S France, 915 in Catalonia, 168 in the Basque Country) as well as dispersive movements up to the Netherlands, Great Britain, Galicia and Portugal.

Osprey
Pandion haliaetus

This species is slowly and constantly improving its conservation status (Thibault *et al*. 1996, 2012, Triay & Siveri 2008). In 2014 there have been 23-25 breeding pairs, including the spontaneous re-colonization of Ibiza where breeding had ceased forty years ago (one young fledged in 2015). Protection of wetlands and the elimination of danger from electrocution are the most important factors explaining this favourable development. Radio-

monitoring has shown that the juveniles of the local population mainly move to Iberia and North Africa, with some individuals undertaking more distant dispersion flights.

Eleonora's Falcon
Falco eleonorae

The Eleonora's Falcon breeding population has increased from 500 pairs in 1976 to over 1,100 in recent years (Mayol 1996, Del Moral 2008, Mas & Muntaner 2015b), through the legal protection of all the colonies and the declaration as parks, nature reserves or ZEPAS (Special areas for the protection of birds). Some birds have been tagged with satellite transmitters, which have revealed that the autumn migration occurs through the Sahara, while the pre-breeding return varies from East Africa (mainly in adults) to some dispersal to the west of the continent in the case of immature birds.

THE EVOLUTION OF THE LIMITING FACTORS

Ten categories of threats to seabirds have been identified in the Balearics (Mayol 1986). Significant changes have occurred in the last 28 years. Some risk factors that were identified in 1986 no longer exist today, namely direct destruction, collection of eggs and chicks, military activities and destruction of nesting sites due to building development. Although such risk factors may still occur occasionally, they are no longer of demographical significance.

Other risk factors identified in 1986 however still persist (e.g. Mayol *et al*. 2000). A major threat to seabirds is accidental fishing by-catch. This factor can be detrimental around the Balearics for the Shag, which gets caught in fixed nets and shearwaters particularly during March and April, which get hooked by long-line fishing. The local fishing fleet is undergoing a marked recession, and there are various restrictions in the protected areas that partially benefit the birds. However, we now realize that during the breeding season both shearwater species and the Audouin's Gulls feed along the mainland coasts, where the risk of by-catch is larger. A priority in the next years would be to quantify their mortality and to eliminate this risk factor.

Introduced species (rats and carnivores) remain another serious threat. Since 1987, successful eradication actions have been carried out on eleven small islands, and there have been several projects to reduce the number of cats and genets near colonies. However, socio-economic changes have led to a proliferation of poorly controlled cats which can be a factor of increased mortality in certain colonies of Balearic Shearwater at least in Menorca and Formentera.

The limitation of trophic resources is likely to limit the population level and the productivity at colonies. The new European policy of limiting discards at sea is a factor to be considered, although the Balearic fisheries have benefited from a system of exceptions. Reducing the fishing fleet may also damage the commensal species, such as Audouin's Gull and the shearwaters.

Two risk factors identified in 1986 are presently of unknown significance. Pollution affecting birds has not been properly studied and continues to be a potential threat although there is no evidence at the present time that it is relevant for any species. There has been no relevant case of oil discharge at sea. However, the 'Prestige' accident in Galicia, which occurred a few weeks from the migration peak of the Balearic Shearwaters there, demonstrates the possibility of such risk even when occurring far away from the breeding area. Protocols and infrastructures for recovery

of oiled birds have been improved, but it is doubtful that the existing response capacity would be adequate in a critical situation.

CONCLUSION

Great attention has been devoted to birds by ornithologists and birdwatchers over the past three decades, with relevant yearly publications on status (GOB 1988-2015), many specific articles and notes as quoted above, and important surveys in protected areas such as the Cabrera national park (Pons 2000). This helped in taking efficient conservation measures.

Consequently the conservation status of seabirds in the Balearic Islands has improved for most species, or remained stable for the others. Reducing the Yellow-legged Gull breeding population should be considered positive for the conservation of the other species.

A successful network of parks and reserves has been created and consolidated, and most of the negative factors limiting bird populations have been corrected or better controlled. The conservation priorities for seabirds are the protection and management of certain areas (especially Tagomago Island), the total control of introduced species (rodents and carnivores) and addressing the problem of by-catch.

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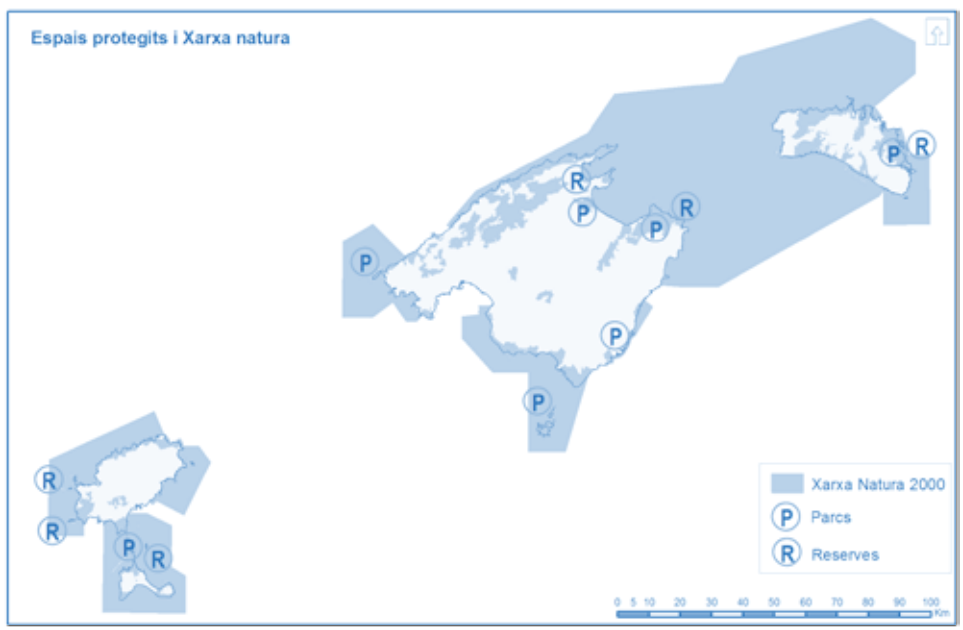

Figure 1. Protected areas for seabirds and coastal birds of prey in the Balearic Islands: N2000 network, parks and reserves.

Marine birds of the Aeolian Islands, South Tyrrhenian Sea: present status and conservation

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ABSTRACT

The Aeolian Archipelago form an area of considerable importance for bird conservation because it harbours the only nesting sites for three species (Yelkouan Shearwater *Puffinus yelkouan*, Mediterranean Storm Petrel *Hydrobates pelagicus melitensis* and Eleonora's Falcon *Falco eleonorae*) occurring in the wide basin of the Southern Tyrrhenian Sea. Furthermore, the Aeolian colonies of Eleonora's Falcon hold one fifth of the Italian population. From censuses carried out during a nine-year study (2005-2014), the breeding populations are estimated at c.80-100 pairs of Scopoli's Shearwater *Calonectris diomedea*, less than 10 pairs of Yelkouan Shearwater, at least 15 pairs of Mediterranean Storm Petrel, 114-126 pairs of Eleonora's Falcon, and about 1,000 pairs of Yellow-legged Gull *Larus michahellis*.

INTRODUCTION

The Aeolian Archipelago, located between 38°48'-38°21'N and 15°15'-14°20'E, consists of seven islands and several islets of volcanic origin, almost entirely designated as a Special Protection Area (SPA). Apart from the Yellow-legged Gull *Larus michahellis*, which is very common and widespread in the archipelago (about 1,000 breeding pairs: Perco *et al*. 1986, N. Baccetti pers. comm.), the marine avifauna of these islands includes four species listed in the Annexe 1 of the 2009/147/EC Directive: Scopoli's Shearwater *Calonectris diomedea*, Yelkouan Shearwater *Puffinus yelkouan*, Mediterranean Storm Petrel *Hydrobates pelagicus melitensis* and Eleonora's Falcon *Falco eleonorae*.

METHODS

Field investigations have been carried out in the archipelago during a nine-year study (2005-2014) to map the species distribution and estimate their population. Surveys were carried out by counting the calling birds for Yelkouan Shearwater; by active research of nests for the Mediterranean Storm Petrel; by using both methods for Scopoli's Shearwater; and by counting the nests as close as possible from the sea and the coast for Eleonora's Falcon.

RESULTS

Scopoli's Shearwater
Calonectris diomedea

Doderlein (1872), Moltoni & Frugis (1967), Massa (1985), Iapichino & Massa (1989)

and Lo Valvo *et al*. (1993) had recorded it as a possible or probable breeding species. Its population was estimated at about 80-100 pairs by B. Massa (in Sultana 1993) and 30-80 pairs by Baccetti *et al*. (2009). During the present study the occurrence of this species has been confirmed on the islands of Vulcano (25-30 pairs), Lipari (<10), Salina (30-35), Scoglio Faraglione (off the Island of Salina, 5-8 pairs), and Alicudi (15-20 pairs). The species has also been irregularly observed near Filicudi and Panarea. Most of the nesting sites are located on islets or on the west or south-western slopes of the islands; at Vulcano one site is known locally as "Petra 'i quajetri" (Pietra Quaglietto in the IGM map), a toponym clearly derived from the vernacular name of the Scopoli's Shearwater.

Yelkouan Shearwater
Puffinus yelkouan

The Yelkouan Shearwater has been recorded on the island of Salina since the 1940s (Moltoni & Frugis 1967), the only island in the archipelago where the species has been detected so far (Massa 1985, Iapichino & Massa 1989, Corso 2005). Calling birds were counted during two surveys in March and April 2014 in a small portion of inaccessible rocky shoreline along the south-western coast of the island. The size of this population is probably less than 10 pairs. Furthermore, during the last years single birds or small groups of individuals (up to 6) were regularly observed in the channel between Salina and Lipari in winter and early spring.

Mediterranean Storm Petrel
Hydrobates pelagicus melitensis

The species has been recorded in the late 19th century by Giglioli (1881) on Lisca Nera. This small islet surface has been strongly reduced by erosion and currently consists of emerging rocks not suitable for breeding birds. During the early 1990s, a nest with a chick was found on the island of Filicudi, and a dead adult on Salina Island (Lo Cascio 1994). More recently a nesting site was discovered on Scoglio Faraglione: two damaged eggs were laid at different times in the same nest in 2005, and one damaged egg was found in 2006 and 2009. A fully fledged dead young was located in 2008, and two damaged eggs were found in two nests in 2011. Successful breeding with fully fledged young was recorded only in 2007 (Lo Cascio 2007, P. Lo Cascio unpubl. data). In late August 2013, another nesting site characterized by the typical oily smell was detected on Scoglio Montenassari (off Filicudi Island) in a partially accessible small cave. In June 2014 the cave contained at least 15 nests, and on 13 July, 6 of them had hatched chicks. There are few observations concerning the species in the seas around the archipelago, but a juvenile, originating possibly from the Aeolian Islands, was found at Cefalù (northern Sicily) on the 3 September 2010 (B. Massa pers. comm.).

Eleonora's Falcon
Falco eleonorae

The Eleonora's Falcon has been recorded from some Aeolian Islands since 1960s (Moltoni 1960, Moltoni & Frugis 1967); but the first detailed information on the size of its colonies was given by Massa (1978), who reported 28 breeding pairs on Alicudi, 30 pairs on Filicudi, 5 pairs on La Canna (off Filicudi) and 20 pairs on Salina Island. During the same period Moltoni & Pirovano (1980) recorded 5-6 pairs at Panarea. Between 1994 and 1996, numbers appeared to be stable for all colonies. However 29-33 pairs were counted on Panarea (including 3-5 nests on the nearby islet of Scoglio La Nave), and irregular occurrences of Eleonora's Falcon have been recorded on Strombolicchio Islet off Stromboli

(Lo Cascio 2000). From data collected between 1998 and 2010, Corso & Gustin (2009, 2012) have reported remarkable numerical fluctuations in some colonies, such as that on Filicudi (from 24-27 pairs in 2007 to 14-16 in 2008), and an apparent decline for those of Salina Island (from 25 pairs in 1998 to 5 pairs in 2010) and Panarea (15-20 pairs in 2008). However, the authors point out the significant increase in the number of breeding pairs in the colony of Alicudi, with a maximum of 50 counted in 2007, although apparently subject to numerical fluctuations (20-22 pairs in 2008). During the last surveys (August-September 2012, P. Lo Cascio unpubl. data), 56-60 breeding pairs have been counted on Alicudi, 30-32 on Filicudi, 4-5 on La Canna, 10-12 on Salina Island and 15-17 on Panarea Island. The size of the population occurring in the archipelago is currently estimated between 114 to 126 breeding pairs.

DISCUSSION

Despite the small size of its breeding bird populations, the Aeolian Archipelago should be considered an area of considerable importance for conservation because these islands harbour the only nesting sites for three species (Yelkouan Shearwater, Mediterranean Storm Petrel and Eleonora's Falcon) occurring in the wide basin of the Southern Tyrrhenian Sea. Furthermore, the Aeolian colonies of Eleonora's Falcon hold one fifth of the Italian population (Spina & Leonardi 2007).

The uninhabited and rat-free islets of Scoglio Faraglione and Montenassari in particular, are so far the only sites where the occurrence of *Hydrobates pelagicus* has been noticed. While the rough morphology of the latter islet is characterized by an abundance of suitable habitat for the species (small caves, deep rocky crevices), the few nests discovered at Scoglio Faraglione have been found in a rather exposed position. This could be a possible cause of the large number of reproductive failures observed during the last surveys. In fact, the breeding season of the species coincides with the peak of human disturbance. The islet lies in the bay which is a favourite destination for nautical tourism in summer, and is visited daily by hundreds of boats.

Massive tourism could be one of the major factors that cause the instability and the decline observed for some populations of Eleonora's Falcon. The colony of Salina Island is located not far from Scoglio Faraglione and therefore may be potentially affected by a high level of noise and marine traffic. At Panarea, the falcons are nesting on cliffs and on the nearby islet (Scoglio La Nave) on a stretch of coast intensely frequented by boats and other vessels. Moreover, this colony is situated just 400m from a helicopter landing pad. Although over-flying is formally banned within the boundaries of the SPA, between July and September some private companies are particularly active in daily connections from the mainland to the island. Flights are not controlled or effectively restricted, and aircraft often approach the island along routes right in front of the colony. Therefore it is not excluded that the remarkable increase recorded for the Alicudi Island population (about 100% during the last decade) may have occurred as a consequence of the shift of breeding pairs from perturbed colonies such as Panarea and Salina to Alicudi Island, where the level of disturbance and pressure is significantly lower.

Further investigations are required to assess the threats for the Aeolian marine bird populations. The above preliminary observations clearly suggest that the lack of proper management of the protected areas and designated Natura 2000 sites is likely to have harmful effects on the conservation of some priority species listed in the Annexe 1 of the 2009/147/EC Directive.

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Importance of Moroccan Atlantic coastal zones for wintering pelagic seabirds

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ABSTRACT

As part of the IBA assessment programme in Morocco, we conducted a pelagic seabird monitoring during six winters from 2008-2009 until 2013-2014 along the coastline from the south of Rabat to the north of Kenitra, i.e. 2% of Moroccan shoreline. Seventeen species were observed, six of them regularly in fluctuating numbers. The most abundant species were Manx Shearwater *Puffinus puffinus* and Northern Gannet *Sula bassana*. The critically endangered Balearic Shearwater *P. mauretanicus* regularly occurs in the area, with 28 to 112 birds counted every winter. These first results showed that the coastal waters of Morocco are fairly attractive to migratory pelagic seabirds. It is therefore useful to develop such surveys in order to determine Marine Important Bird Areas in both Mediterranean and Atlantic Moroccan coasts.

INTRODUCTION

Coastal seabirds face various threats mainly induced by human activities, such as oil pollution, over-fishing, incidental mortality in fisheries, disturbance, and habitat loss (Cury *et al*. 2011). Because many species of coastal seabirds have wide distributions, often crossing international boundaries, their conservation status may be improved through internationally coordinated conservation management efforts (Croxal *et al*. 2012). Coastal seabirds are also of economic significance, e.g. for eco-tourism and as indicators of prey stocks of commercial value. Furthermore, conditions experienced by seabirds during migration and on their wintering grounds are assumed to impact their subsequent reproductive performance (Hobson & Welch 1992). The pelagic habitats they use during the non-breeding period (i.e. often 9-10 months of the year) must therefore provide them with sufficient food resources to allow good breeding condition (Sittler *et al*. 2010).

Although Morocco is along the flyway of several pelagic seabird species, few data have been published so far on pelagic bird occurrence and migration along Moroccan shores (Thévenot *et al*. 2003). Together with some local concentrations reported in trip reports, most of the knowledge comes from the work by SEO/BirdLife on Important Bird Areas (IBA) for conservation of seabird in Spain, which partly included the Atlantic and Mediterranean coasts of Morocco (Arcos *et al.* 2009). We report here on the winter phenology and species richness of all seabird species encountered off the Rabat-Kenitra coastline in the course

of a long-term coastal birds monitoring programme initiated in 2007 to assess the importance of Moroccan marine waters for seabirds.

METHODS

The study area is situated in temperate waters on the northwestern Moroccan Atlantic coast from 33°82'65"N, 7°14'83"W to 34°26'24"N, 6°68'41"W. Seabird surveys were carried out during the year in the last week of each month from 2007 to 2014. On each trip, effort-related seabird data were collected during daylight hours by three experienced volunteer observers, from a fixed position either on a cliff at a height of 30m above sea level or from breakwaters. For each sighting the following data were registered: species name, number seen, and age and sex whenever possible. Sightings were grouped into minute-long periods, during which individual seabirds were counted only once. Notes on behavior were also taken including dead birds and associations with fishing vessels or cetaceans.

RESULTS

Seventeen seabird species were recorded during the winter period (December-February), with the following local status.

Cory's Shearwater *Calonectris borealis* / Scopoli's Shearwater *C. diomedea.*

Birds from the Atlantic breeding colonies (*borealis*) mostly winter off the coast of South America and southern Africa while the Mediterranean population (*diomedea*) partly winter off Moroccan coast (Navarro & González-Solís 2009). In the surveyed area, birds from one or the other species were regularly observed between December and February, sometimes in numbers exceeding 100 individuals.

Manx Shearwater
Puffinus puffinus

Breeds in north-Atlantic islands, mainly around the British Isles; mainly overwintering in southern Atlantic below the equator (Del Hoyo *et al*. 2014). Large numbers are reported off Moroccan coast during the trans-equatorial migration while much smaller numbers stay in the territorial waters in winter (Thévenot *et al.* 2003). During our survey, Manx Shearwater was the most regular and numerous Procellariiformes species between August and February, with a maximum number of 193 individuals observed on 12 February 2012.

Balearic Shearwater
Puffinus mauretanicus

The breeding range of this critically endangered species is restricted to Balearic Islands (Del Hoyo *et al*. 2014). During the non-breeding period the species occurs in the Atlantic from Morocco to the British Isles but in the winter months most birds re-enter the Mediterranean (Wynn *et al.* 2007). During our survey this shearwater was regularly observed between October and January. A maximum of 112 birds were counted in December 2011.

Macaronesian Shearwater
Puffinus baroli

Breeds mainly in western Canary and Azores islands. Regular migration movements are observed off Moroccan coasts (Thévenot *et al.* 2003) but numbers possibly are underestimated due to difficulty in identification. During our survey we observed this species always in very small numbers; 2 birds were seen on 3 February 2014.

Northern Gannet
Sula bassana

One of the most abundant seabirds in Moroccan waters especially during the post and pre-breeding migrations. In our area, hundreds of gannets are wintering regularly with up to 320 birds seen in February 2010 fishing in association with Bottlenose Dolphins *Tursiops truncatus.*

Eurasian Shag
Phalacrocrax aristoteli

The subspecies breeding in Morocco, *P. a. desmarestii* and *P. a. riggenbachi*, are both very rare and declining (Thévenot *et al.* 2003). Several hundred of migrant European Shags are wintering in Morocco (Thévenot *et al*. 2003), including in our study area where 2-4 birds were seen annually in December-February.

Wilson's Storm-petrel
Oceanites oceanicus

This species undergoes a trans-equatorial migration, spending the non-breeding season in the middle latitudes of the North Atlantic and North Indian Oceans (Del Hoyo *et al*. 2014). It is regularly observed off Morocco, especially during the pre-breeding migration (Thévenot *et al.* 2003); 15 birds were sighted off Kenitra in February 2012.

European Storm-petrel
Hydrobates pelagicus

It winters mainly in southern Atlantic hemisphere (Del Hoyo *et al*. 2014). In Morocco, it is regularly seen in national waters when migrating (Thévenot *et al.* 2003). During our survey a maximum of 30 individuals were seen in February 2013.

Leach's Storm-petrel
Oceanodroma leucorhoa

This species has a very large range, breeding in Northern Hemisphere islands and wintering in Southern Hemisphere (Del Hoyo *et al*. 2014). During our survey, an outstanding number of nearly 1400 birds were counted in December 2013. This observation followed 3 days of strong winds and high waves.

Red-necked Phalarope
Phalaropus lobatus

It breeds in Arctic regions (Del Hoyo *et al*. 2014) and winters at sea off central-western South America, in the Arabian Sea, and from central Indonesia to western Melanesia (Del Hoyo *et al.* 1996). In Morocco, flocks have occurred in winter off Dakhla bay (Thévenot *et al.* 2003) and scattered birds can winter off the coast of northern Morocco (Qninba *et al.* 1998). During our survey, 38 birds were seen at a coastal wetland south of Kenitra in January 2010.

Pomarine Skua
Stercorarius pomarinus

Breeding in the Arctic and wintering mostly near tropical coasts (Del Hoyo *et al*. 2014). It is the commonest skua in Morocco, mainly seen during migration (Thévenot *et al.* 2003). 14 birds were counted during January 2012.

Arctic Skua
Stercorarius parasiticus

Breeds on the northernmost coasts of Eurasia and North America and performs long migration to southern Atlantic (Del Hoyo *et al.* 1996). In Morocco, it is a regular pelagic migrant (Thévenot *et al.* 2003). A maximum of 6 birds were counted during our survey, in February 2011.

Long-tailed Skua
Stercorarius longicaudus

This species breeds in the Arctic and northern uplands and has a circumpolar winter distribution in the Southern Oceans (Del Hoyo *et al.* 1996). In Morocco it is considered as the most pelagic and irregular of the four skua species (Thévenot *et al.* 2003). During our survey, a first-winter bird was seen in February 2012 after gales.

Great Skua
Stercorarius skua

It breeds in northern Atlantic and winter mainly off south-western Europe (France and Spain) while some birds can reach more southern latitudes approaching the equator (Del Hoyo *et al.* 1996). In Morocco, Great Skua is a regular pelagic winter visitor (Thévenot *et al.* 2003). 20 birds were seen in February 2009 off Bouznika beach.

Little Gull
Larus minutus

It is a scarce winter and migrant visitor in Atlantic offshore waters (Thévenot *et al.* 2003). Small flocks of less than 20 birds were regularly sighted during the winter season near Bouzika estuary, sometimes in association with Black-headed Gulls *L. ridibundus*.

Black-legged Kittiwake
Rissa tridactyla

This pelagic seabird regularly winters off the Moroccan coasts (Cramp & Simmons 1983). Observations from the coast or inland remain rare and involve a few individuals, except after heavy storms with strong westerly winds that bring substantial groups to the mainland (Thévenot *et al.* 2003). During our survey, 2 birds were seen in January 2009.

Razorbill
Alca torda

Breeds on rocky shores in Northern Atlantic and winters at sea, some moving south as far as the Western Mediterranean (Del Hoyo *et al*. 2014) and off Moroccan Atlantic coasts mainly north of 30°N (Thévenot *et al*. 2003). 12 to 40 birds are regularly wintering in the studied area.

DISCUSSION

BirdLife's Important Bird Areas programme aims at identifying, monitoring and protecting a global network of sites, critical for the long-term viability of naturally occurring bird populations, across the range of those bird species for which a site-based approach is appropriate. Our survey is part of a process of identifying marine IBAs in Morocco using BirdLife International (2007) guidelines. However, the numbers of birds observed during our surveys remained too low to qualify as IBAs.

This is probably because our observations were made from the coast. Using a ship is strongly recommended for monitoring seabirds at sea (Walsh *et al.* 1995). However, our coastal records suffice to suggest strongly that further monitoring in pelagic Moroccan waters would reveal important numbers of wintering and migrating seabirds. Furthermore we were able to confirm the regular winter occurrence of the critically endangered Balearic Shearwater off the monitored coast, which was never reported earlier. The simple presence of this globally endangered species may justify the classification of this area as a potential Marine IBA.

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“PART III”

THREATS AND SURVEY TECHNIQUES

Rat eradications on Italian islands for the conservation of breeding seabirds

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ABSTRACT

A review of all the eradication projects involving *Rattus rattus* that have been carried out since 1999 on 14 Italian islands is presented. Data on different aspects related to the problem of rats on these islands are discussed, ranging from impact and benefit quantification, eradication methods and outcomes, to social problems such as lack of public awareness. A model aimed at identifying priority islands where eradication should be carried out was developed according to available budgets, an exercise that is worth extending throughout the Mediterranean.

INTRODUCTION

The problem of rat invasion on Mediterranean islands has particularly deep roots, mainly due to the early presence of man in the region (Audoin-Rouzeau & Vigne 1994, Ruffino *et al*. 2009). In a sample of 292 Mediterranean islands nearly all those larger than 20 hectares are occupied by the black rat *Rattus rattus* whereas the rate of presence is in the range of 40-70% on the islands belonging to smaller size classes (Ruffino *et al*. 2009). Within Italian islands, the situation is even worse; only four rat-free islands exist that are larger than 10ha (Baccetti *et al*. 2009), apart from a few larger ones where rats have recently been eradicated.

Heavy predation by rats, most often the black rat, on burrow-nesting seabirds has been widely documented worldwide (e.g. Hilton & Cuthbert 2010) and the Mediterranean is no exception, despite what may seem a paradox, that millennia of co-existence have not yet determined either the adaptation or extinction in bird populations (Ruffino *et al*. 2009). Although improving seabird productivity by rat removal may not represent a sufficient measure to balance adult mortality (Igual *et al*. 2009), urgent measures are needed to arrest such a widespread limiting factor, affecting the very start of demographic processes and featured by an unusually convenient attribute: that of being removable realistically, permanently and at affordable costs.

In this review we summarize the outcomes of all the eradication projects involving black rats that have been carried out with variable success since 1999 (Perfetti et al. 2001) on a total 14 Italian islands. Under this scenario, additional data on different aspects related to the problem of the impact of rats and their removal are discussed: i) predation by rats on Procellariiformes ('target species'); ii) the benefits for target (and non-target)

species by the removal of rats; iii) field techniques, bait delivery methods and costs; iv) the impact of rodenticides on non target species; v) re-invasions by rats after eradication; vi) and awareness and social problems. Furthermore, we developed a model aimed at identifying priority islands where eradication should be carried out according to available budgets, an exercise worthy of being extended throughout the Mediterranean. Most of these points, with the exception of the awareness problems, have been discussed more in detail by Capizzi *et al.* 2016).

RESULTS AND DISCUSSION

Rat eradication on Italian islands

With a couple of notable exceptions (Zannone and Molara islands: self-supported by local protected areas), all projects were usually supported by the EU LIFE tool. Details on all projects are presented in Table 1. Until 2005, when larger islands started being treated, bait stations were placed at a low density (4/ha), and especially until 2008, when aerial treatments came into use, these actions had a very modest contribution in terms of total surface area relieved from rat predation. The success of these early operations was usually low, due to re-colonization and inadequate evaluation of the consequences of the short distance from land (the exception was: La Scola, which will have to be treated repeatedly, see below). In the second half of the period, a similar fate was again encountered on two Sardinian islets, located 170-300 metres from land, and by a single failure (due to recolonization) on a large island, Molara (Sposimo *et al*. 2012). The outcomes of these activities can be seen in Figure 1 in terms of number of pairs relieved from rats: the failure at Molara had obvious consequences on the protected quota.

Rat predation on Procellariiformes

A re-assessment of the national population size and breeding distribution of two relatively widespread and vulnerable species (Scopoli's Shearwater *Calonectris diomedea* and Yelkouan Shearwater *Puffinus yelkouan*; Baccetti *et al*. 2009) revealed that Italian colonies are present on three coastal sectors of mainland Sardinia (all presumably including areas inaccessible to rats and other terrestrial predators) and, in particular, on 64 islands, 58 of which hosting the former species (6 of them rat-free, holding 6.5% of the total pairs) and 29 the latter (just one rat free, with irrelevant numbers): therefore, rats and shearwaters do indeed co-exist, but at a high cost. Studies on CS showed that in rat-free conditions productivity fell below 0.6 value only exceptionally, whereas whenever rats were present, it was usually zero (or a value below the detection possibility), only very occasionally – on relatively large islands – reaching the rat-free minima (Capizzi *et al*. 2015).

For Yelkouan Shearwater, where a single Italian island accounts for more than half of the known global population (Zenatello *et al*. 2012), chicks fledge in most years only in a few rat-free caverns, that are hardly relevant in terms of population (less than 1%). Factors explaining Ruffino's paradox (cf. Introduction, and Ruffino *et al*. 2009), such as periodical fluctuations of rat numbers, have probably been only partly identified and two additional possibilities can be recalled here. Despite early colonisations, present day black rat stocks may not be a thousand-years old: the populations of several Italian islands seem to have originated by a single, quite recent colonisation event, after the 'little ice age' centred on the 18th century (Colangelo *et al*. 2015). Moreover, their population size may have very recently increased to present levels, periodical rat extinctions becoming rarer, following the widespread increase of the Yellow-legged Gull *Larus michahellis*.

This species is responsible for the delivery of large amounts of exogenous food resources on many insular breeding sites, probably in all those where the shearwaters breed. This marked increase, largely man-dependent, represents the most obvious large-scale variation observed across the last 3-4 decades on nearly all the Italian islands. Food provided by gulls annually includes large amounts of olive stones that are dropped everywhere and last well beyond the breeding season (Baccetti *et al*. 2009). Their fat- and carbohydrate-rich kernels represents a high quality and durable food source for rats, to the point that gnawed olive stones are commonly used as a reliable indicator of rat presence/absence on islands.

Benefits from rat removal

Target species, in the Italian case Scopoli's Shearwater, Yelkouan Shearwater or both together, showed straightforward responses to rat eradications, as well as to rat control operations, albeit at a lesser extent (not shown). La Scola eradication of 2001 (Sposimo & Baccetti 2008), our earliest at an important Scopoli's Shearwater breeding site, can be taken as an example. It allowed productivity values passing from zero to constantly optimal values of 0.75-0.90 fledglings/pair in all years from 2001-2012, despite single rats that repeatedly returned and had to be eliminated. It also determined, after 10 years, a 2-fold local increase in the number of pairs, with current signs of levelling off at around 150-250 pairs, possibly caused by saturation of potential nests. Benefits extended to nearby Pianosa island, where pair numbers increased too despite the continued presence of rats; there is now proof of movements between the two islands from ring recoveries (one bird ringed on one island and recovered on the other and vice versa).

Recent eradication on Montecristo island in February 2012 (Sposimo 2014), and targeted at Yelkouan Shearwater, similarly brought productivity from a probable value of 0.12 in 2010 to 0.93-0.96 in the first two seasons after baiting (2012 and 2013, Gotti *et al*. 2014). As in the case of the eradication of Zembretta in Tunisia (Bourgeois *et al*. 2013), new nesting sites were occupied by prospectors immediately after the eradication, probably as an effect of increased attractiveness of very vocal, successful colonies: a foreign recruit from Provence was controlled in 2012, new sites contained breeders in 2013 and a set of 19 nest-boxes installed in autumn 2012 to facilitate future monitoring showed signs of visits right from the 2013 season, with one successful pair in 2014 and 2015 (Gotti *et al*. 2014 and unpubl.).

Field techniques, bait delivery and costs

Two basically different techniques were used (Table 1), bait stations (high-or low-density) or broadcast (hand or aerial). A detailed methodological description has been recently provided (Capizzi *et al*. 2015). The cost of the entire operations requiring delivery by helicopter was in the range of 270-343 € per hectare, comparable to using low density bait stations on relatively large islands (mean cost of the 2005-2007 land-based eradications: 400 € per hectare), and was less costly than treating very dispersed islets with high density stations (mean cost of the pre-2005 operations: 2,770€ per hectare). With the Montecristo eradication, our largest, the cost can also be expressed as c.800 € for protecting one of the existing Yelkouan Shearwater pairs.

Impact of rodenticides on non-target species

Our activities determined negligible impacts on the conservation of other animal species (cf. Capizzi *et al*. 2015, Gotti *et al*. 2014). Monitoring and field tests revealed the lack of any additive mortality in endemic invertebrates (e.g. Gastropods) and Amphibian larvae (*Discoglossus* tadpoles) that directly consumed baits. Only the Montecristo

operation, due to exceptionally dry weather that prolonged the pellets' life, caused a temporary population decrease in non-target bait consumers (wild goats introduced by man and mainly of historical value, and Yellow-legged Gulls whose numbers have been inflated by man too). Other bird species showed losses in the order of single individuals. Secondary poisoning, combined with the disappearance of rat stocks, determined local extinctions of tiny insular populations (at least on Giannutri and Molara) of the Barn Owl *Tyto alba*. This also raises the question of whether Barn Owls existed on the islands prior to their colonisation by rats. No positive impacts have been recorded on reptiles (geckos, lizards and snakes belonging to nine species).

Re-invasion by rats after eradication

Rat re-invasion was often recorded on islands closer than 500m to mainland or to other rat-infested islands, and in three cases it occurred more than once: La Scola (three times in a fifteen year period since 2001, i.e. in 2005, 2009 and 2011), Proratora and Cavalli (at least twice in the period 2008-2014). The case of Molara is different and more than 1000m offshore. Rats re-appeared there in 2010, two years after an otherwise successful aerial eradication, most probably due to a deliberate human intervention (Sposimo *et al*. 2012, Ragionieri *et al*. 2013), recalling 'recent genre fiction literature' (see e.g. Simberloff 2011).

Social/awareness problems

As the size of the operations increased, public concern also increased, usually expressed in the form of personal, negative comments on local forums in the web. A collection of some of these comments, often arrogant in tonality, but sometimes with good humour, showed the main reasons of concern 'being the waste of money' for trivial tasks or the suspect that projects are a pretext for diverting public money into private business. Second in line was the concern about human health (despite the fact the islands are un-inhabited) risks for non-target species and unknown consequences of toxic substances accumulated on such attractive islands that have been subtracted to tourism development in the name of nature conservation. Whatever the contents, disinformation or lack of awareness were the common cause of all perceived problems, nurtured by the fertile ground of typical Italian indifference to nature conservation issues, a well known plague that followed the humanistic orientation impressed into the school system and general culture since the Fascism times. Any effort to improve this situation obviously represents a challenge and a high priority for the future. Nevertheless, parallel to these personal and un-organized reactions was a less clear, but far more effective, feedback from animal-rights adherents, culminating into a legal regulation that currently forbids any aerial treatments, and in an (eventually unsuccessful) attempt of prosecuting the four representatives that had signed the partnership agreement of the 'Montecristo 2010' Life project. A between-ministry confrontation is currently the only hope for a change of the regulation and conserving Italian seabird colonies.

CONCLUSION

The expected benefits based on the shearwaters population size and distribution, compared to the costs and feasibility parameters, traced a clear way forward in selecting islands on which to carry out future rat eradications according to priority objectives thus avoiding a wrong resource allocation (Capizzi *et al*. 2009). Pending a solution of Italian internal problems, that at present do not allow putting in practice the most urgent concrete actions, a similar planning approach could perhaps be attempted on the Mediterranean scale, identifying priority islands in countries promising more positive attitudes.

Year	Season	Island	Area (ha)	Coordinates	Distance (m)	Method
1999 2000	winter	Peraiola	1	43°01'55"N-009°47'48"E	30	10 dispensers/ha with Brodicacoum and Bromadiolone baits
1999 2000	winter	Is. Topi	1.28	42°52'14"N-010°25'24"E	290	12 dispensers/ha with Brodicacoum and Bromadiolone baits
1999 2000	winter	Gemini Bassa	1.57	42°43'02"N-010°22'22"E	48	14 dispensers/ha with Brodicacoum and Bromadiolone baits
1999 2000	winter	Gemini Alta	1.86	42°43'06"N-010°22'27"E	120	13 dispensers/ha with Brodicacoum and Bromadiolone baits
1999 2000	winter	L'Isolotto	6.55	42°22'51"N-011°12'40"E	320	15 dispensers/ha with Brodicacoum and Bromadiolone baits
1999 2000	winter	Palmaiola	7.24	42°51'56"N-010°28'28"E	3000	11 dispensers/ha with Brodicacoum baits
2001	January April	La Scola	1.6	42°35'01"N-010°06'22"E	258	10 dispensers/ha with Brodicacoum baits
2006	February April	Giannutri	239	42°15'00"N-011°06'00"E	11500	4 dispensers/ha with Brodicacoum baits
2006 2008	winter	Zannone	105	40°58'09"N-013°03'21"E	4900	4 dispensers/ha with Brodicacoum baits
2008	October	Molara	348	40°52'06"N-009°43'48""E	1460	aerial delivery, 12kg/ha Brodifacum pellets
2008 2010	October	Proratora	4	40°50'47"N-009°43'23"E	173	hand broadcast and 16 dispensers/ha with Brodicacoum baits
2009 2010	winter	Piana	13.62	40°53'17"N-009°39'04"E	645	16 dispensers/ha with Brodicacoum baits
2009 2010	winter	Cavalli	2.22	40°53'08"N-009°38'25"E	300	16 dispensers/ha with Brodicacoum baits
2012	January February	Montecristo	1072	42°19'51"N-010°18'37"E	29500	erial delivery, 10,5kg/ha Brodifacum pellets

Table 1. An overview of black rat *Rattus rattus* eradications from Italian islands

Success	Funded	Reference
Re-invaded	LIFE97 NAT/IT/004153 (LIFE Capraia)	Perfetti *et al.* (2001)
Re-invaded	LIFE97 NAT/IT/004153 (LIFE Capraia)	Perfetti *et al.* (2001)
Probably Re-invaded	LIFE97 NAT/IT/004153 (LIFE Capraia)	Perfetti *et al.* (2001)
Probably Re-invaded	LIFE97 NAT/IT/004153 (LIFE Capraia)	Perfetti *et al.* (2001)
Re-invaded	LIFE97 NAT/IT/004153 (LIFE Capraia)	Perfetti *et al.* (2001)
Re-invaded Eradicated	LIFE97 NAT/IT/004153 (LIFE Capraia)	Perfetti *et al.* (2001)
Eradicated repeatedly	LIFE97 NAT/IT/004153 (LIFE Capraia)	Sposimo & Baccetti (2008)
Eradicated	LIFE04 NAT/IT/000172 (Iso Tosca)	Sposimo *et al.* (2008)
Eradicated	Circeo National Park	Francescato *et al.* (2010)
Re-invaded	MPA Tavolara and Regione Sarda	Sposimo *et al.* (2012)
Eradicated repeatedly	MPA Tavolara and Regione Sarda	Sposimo *et al.* (2012)
Eradicated	MPA Tavolara and Regione Sarda	Sposimo *et al.* (2012)
Eradicated repeatedly	MPA Tavolara and Regione Sarda	Sposimo *et al.* (2012)
Eradicated	LIFE08 NAT/IT/000353 (Montecristo 2010)	Sposimo (2014)

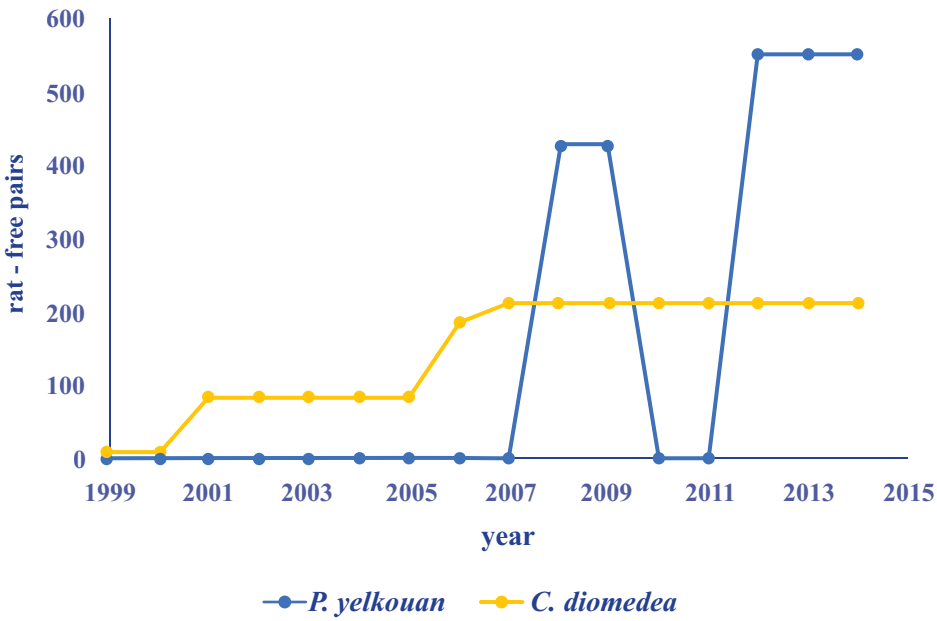

Figure 1. Cumulated fractions of seabird populations relieved from black rat *Rattus rattus* predation on Italian islands. Each island has been considered with the respective, pre-eradication number of pairs, without accounting for subsequent local increases (from Capizzi *et al.* 2015).

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A review of the literature about contaminants in Mediterranean seabirds: a work in progress

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ABSTRACT

Studies on seabirds and environmental contaminants in the Mediterranean Sea are relatively numerous. These studies show a lack of standardization and homogeneity. The Conservatoire du Littoral (France) and Medmaravis have decided to develop and disseminate protocols helping researchers and volunteers to sample contamination at Mediterranean seabird breeding sites. Protocols should allow the evaluation of the environmental quality of the marine environment, according to the Marine Strategy Framework Directive. Outcome from the first step of the project, a thorough collection of published documents and grey literature, are presented here, as well as the selection and classification criteria used to build up the Medmaravis Literature Collection (MLC). In total, about 200 scientific papers from 69 scientific journals, more than 20 scientific/technical reports, and some conference and meeting documents have been gathered, mostly published in the last decade.

INTRODUCTION

The use of birds as bio-indicators is frequently recommended, due to their sensitivity to pollutants which exposes them to negative effects such as pollution, industrial fisheries by-catch, climate change, and alien species (Thompson & Hamer 2000, Croxall *et al*. 2012). Seabirds can be studied as endpoints of contaminants or alternatively as indicators of pollution, which is mainly caused by heavy metals (HM), oil spills (OIL), organic pollutants (OP), and plastic debris (PLA). According to the literature, pollutants in the Mediterranean Sea, have mostly been studied considering birds as endpoints. Conversely, bio-monitoring of the marine environmental quality through seabirds (as urged by the Marine Strategy Framework Directive, MSFD) is rather occasional, and show a lack of standardization and homogeneity.

At the end of 2014, the French coastal protection agency *Conservatoire du Littoral* and Medmaravis have decided to develop and disseminate protocols helping researchers and volunteers to sample Mediterranean seabirds for contaminants monitoring at breeding sites. This shared project is structured in four steps. First, a literature collection will define the present state of the art.

Then protocols will be written and proposed as best practices for researchers, ornithologists and volunteers who will conduct field sampling. Sampling methods must be suitable and practical for medium or long-term monitoring, which can be achieved by non-specialists and relatively easy to be applied in the

marine and insular contexts. After testing the protocols in a series of pilot field studies, the final step will be a report on the results of the field tests. This paper presents the outcome of the first step (the Medmaravis Literature Collection, hereafter abbreviated MLC).

METHODS

Preparing protocols which use seabirds as indicators of marine pollution is a complex task which aims to tackle many aspects such as the selection of target species and biomarkers, the sampling design, the preparation of samples, and the methods for analysis; each of these aspects may affect the usefulness of the research. The interpretation of results and their comparison can be misleading without a full awareness of such a complexity and without the possibility to refer to previous studies which used similar methodologies.

In fact, when harmonization is poor, sharing the findings and comparing monitoring data with the community is very difficult (Vander Pol & Becker 2007, Law *et al*. 2010).

Compiling the MLC, by selecting papers, scientific reviews, technical reports and proceedings, was carried out to limit redundancy in information. Some literature describing features of Mediterranean species, such as biogeography, trophic level, age related parameters, reproductive biology, and phenology, have been included in the MLC as important basic information for non-ornithologists.

In order to build the MLC for easy reference, the literature has been searched at three levels of information: (a) seabirds (SB); (b) contaminants and seabirds (CO&SB); and (c) contaminants (CO). Each category has been considered at two geographical levels: Mediterranean (MED) and worldwide (WW). At MED level, any studies on SB may be potentially useful even if not especially focused on contaminants, and most of them were selected. Focused selection criteria were applied to the WW literature, selecting only representative studies on CO regarding non-Mediterranean seabird species. Since birds cannot be used to monitor contaminants without any acquaintance of pollution features, some important papers concerning basic knowledge on marine CO, at WW or MED level, have been included in the MLC.

RESULTS

The Medmaravis Literature Collection (MLC)

Building up an updated thematic bibliography is by definition an endless activity. The progress is reported here as to August 2015. In total, 197 scientific papers involving about 1,040 authors and published between 1972 and 2015 in 69 international journals, have been included. The MLC contains 160 peer-reviewed papers, 28 reviews, 5 short communications, and 3 commentaries. In addition, 21 scientific or technical reports have been selected.

Regarding conference and meeting documents, less than a dozen contributions (papers and posters) were included. Figure 1 shows the number of scientific papers collected per year of publication. The clear positive growth of production starting in 2007 is an indication of the increasing interest of researchers in the subject, particularly on plastics.

It is also the result of the selection method applied for MLC. In fact, more attention was paid to most recent publications, especially for sampling and analytical methods. In the last decade, very few papers have been found for some years (2005-2006), suggesting that more thorough searching has to be carried out.

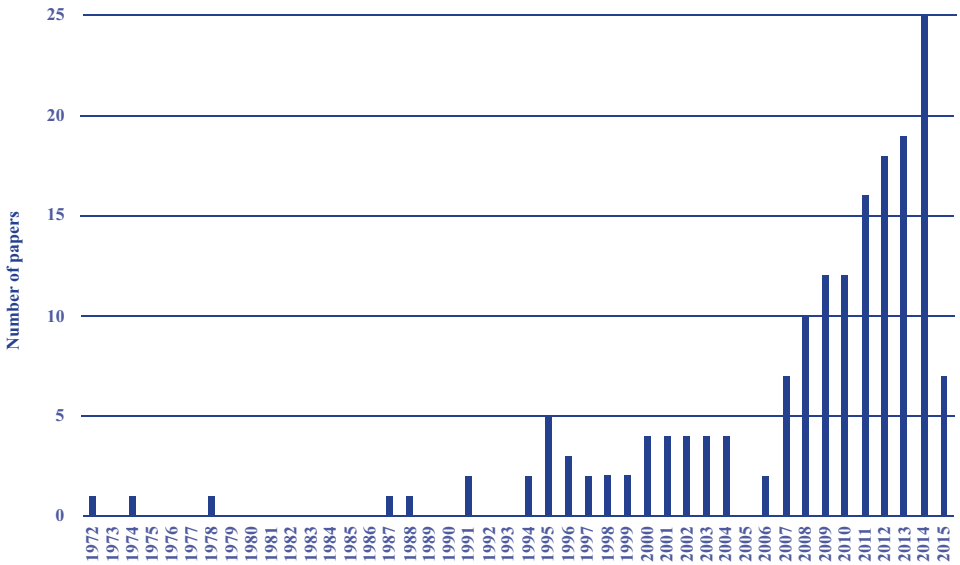

Figure 1. Number of papers published per year as stored in the Medmaravis Literature Collection (MLC, see text) to build up standardized sampling protocols for studies on contaminants and seabirds in Mediterranean.

Each paper or report has been named with the scheme <Code - First author and year - Title> and stored as a 'pdf' document (Adobe Acrobat Reader ® format). 'Code' is an alphanumeric string linked to the database (a Microsoft Excel ® document) which contains detailed information useful for browsing the MLC. The subjects for each document have been listed in detail, including the institution/university with which each Author has been associated. Table 1 reports the number of papers for main subjects, such as: Mediterranean Sea (MED); seabirds (SB); Barcelona Convention species (MAP25); contaminants (CO), with specification of the four sub-topics: metals (HM), oil spills (OIL), organic pollutants (OP), and plastics (PLA). Some combinations of these subjects are also reported in table 1. Secondary subjects, included in the MLC, such as alien species, biogeography, bycatch, Capture-Marking-Recapture, climate change, conservation, diversity estimation, food resources, general threats, Marine Protected Areas, marine sediments, population ecology, radio/GPS tracking, and trophic level assessments through stable isotopes are not reported here,

Subject	Sub-topic	Number of papers for subject (n=197)	Number of papers for sub-topic (n=197)
Mediterranean (MED)		69	
Seabirds (SB)		125	
Barcelona Convention species (MAP25)		32	
MED & SB		31	
MED & MAP25		29	
Contaminants (CO)		179	
	Organic pollutants (OP)		57
	Metals (ME)		64
	Plastics (PLA)		67
	Oil spills (OIL)		12
CO & SB		114	
	Organic pollutants (OP)		43
	Metals (ME)		43
	Plastics (PLA)		30
	Oil spills (OIL)		9
CO & MED		57	
	Organic pollutants (OP)		19
	Metals (ME)		19
	Plastics (PLA)		22
	Oil spills (OIL)		2
CO & SB & MED		24	
	Organic pollutants (OP)		14
	Metals (ME)		9
	Plastics (PLA)		2
	Oil spills (OIL)		0

Table 1. Number of papers in the Medmaravis Literature Collection (MLC, see text) for each main subject and sub-topic, and combination of subjects. One article may be focused on more than one subject or sub-topic.

Insights into the MLC

Finding key works for all the important documents, 200 in all, is difficult. However, MLC may also have a role in guiding the users when navigating in such a composite bibliography. In general, for each discipline, it can be wise to start with the most recent reviews or comprehensive reports, when available. Since Bennett found the first seabird dead due to ingested rubber (it was a Puffin *Fratercula arctica* in 1960; this work will be in MLC as a historical testimony), hundreds of studies assessed plastics in seabirds, especially from late 1980s, when Ryan & Fraser (1988) suggested the use of marine birds as indicators.

At present, the effects of PLA are topical issues worldwide, not only due to their obstruction of the digestive tract, but also for their capacity to carry other types of contaminants (OP, bacteria, fungi). Research is focusing on the biomarkers indicating the plastic exposure in birds. Exploring the literature by starting with Hardesty *et al*. (2015), every other recent reference added to MLC may be very informative.

Another example refers to OP. There are more than 200 OP chemical compounds of environmental concern and organic chemistry is a very complex discipline, which non-experts will find difficult to master. There is a profusion of studies on OP involving birds, using dozens of analytical methods, but very few have dealt with Mediterranean seabirds. A study on the eggs of three seabird species by Huber *et al*. (2015) may help one to understand the range of OP (as well as HM) that can be found in seabirds. OP has sometimes been assessed on Mediterranean species (e.g. Morales *et al*. 2012, Muñoz-Arnanz *et al*. 2012).

HM have been frequently assessed by using feathers as non-invasive sampling method. From 1980s to date the papers regarding this subject are quite numerous. Among HM, mercury (Hg) is certainly the most studied on seabirds and the Hg analytical results from feathers seem to reflect bioaccumulation (Furness & Camphuysen 1997). The Mediterranean Sea is known to have high levels of Hg (e.g. Žagar *et al*. 2013). The MLC includes some works assessing Hg on threatened Mediterranean seabird species such as Audouin's Gull *Larus audouinii* (the last one by García-Tarrasón *et al*. 2013). Arcos *et al*. (2002) assessed Hg levels in several species including Audouin's Gull and European Shag *Phalacrocorax aristotelis*, while Ramos *et al*. (2009) and Bourgeois *et al*. (2011) evaluated several HM and OP in Scopoli's Shearwater *Calonectris diomedea* and Yelkouan Shearwater *Puffinus yelkouan*, respectively.

FINAL REMARKS

The MLC is rather comprehensive, but has to be updated with future studies to be kept updated. Some gaps have still to be filled and part of the grey literature may have been overlooked. The whole community of ornithologists working on seabirds are involved in MSFD can play an important role in maintaining and improving this shared tool. Although the number of studies on contaminants and seabirds has undoubtedly increased in the last years, those addressing Mediterranean seabirds are still relatively few, beside the fact that studies concerning medium and long-term monitoring on pollution, using seabirds as indicators, are practically missing. Hopefully, the joint effort of Medmaravis and *Conservatoire du Littoral* in standardizing and simplifying sampling methods will boost more initiatives aimed to assess the Mediterranean health by using seabirds as bio-indicators, through comparable and repeatable methods.

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A shared protocol to investigate the ecotoxicological status of the Mediterranean Shag *Phalacrocorax aristotelis desmarestii* in the Tyrrhenian Sea

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ABSTRACT

When studying natural populations, particularly that of endangered species, it is essential to use repeatable non-destructive approaches in which biological material such as blood, excreta and feathers can be sampled in the course of other forms of field monitoring. The aim of this pilot study is to assess the ecotoxicological status of Mediterranean Shag *Phalacrocorax aristotelis desmarestii* from two breeding areas, the Tavolara Marine Protected Area (Sardinia, Italy) and the Tuscan Archipelago National Park (Tuscany, Italy). Samples were obtained during routine ringing operations.

INTRODUCTION

Not many seabird species breed in the Mediterranean. Their degree of endemism, however, is particularly high (Zotier *et al*. 1999). As a consequence, a conservation strategy that includes local monitoring of all known threats is needed. Seabirds are impacted by a variety of human-related threats including fisheries interactions, habitat destruction and pollution including oil spills. They have been proposed as useful bio-indicators for contamination, mainly because many of them are top predators, breed at specific place and can integrate contaminants levels of their feeding areas (Burger & Gochfeld 2004). Populations of top predators are those at greater risk, because they may be exposed to very high levels of contaminants due to bioaccumulation and bio-magnification of these compounds through the marine food chain. Organochlorine compounds (OC), such as polychlorinated biphenyls (PCB) and dichlorodiphenyl trichloroethane (DDT), are anthropogenic chemicals that are ubiquitous in the Mediterranean Sea environment and can pose health risks to wildlife. The effect of these compounds on marine organisms can be evaluated using ecotoxicological biomarkers, such as porphyrins (Fossi *et al*. 1996). Porphyrins, intermediate metabolites of haem biosynthesis, are produced and accumulate in trace amounts in erythropoietic tissues, the

liver and the kidneys and are excreted via urine or faeces. Haem biosynthesis may be altered by environmental contaminants such as OCs and trace elements, leading to changes in their profile due to accumulation or excretion (Casini *et al*. 2001).

The limited amount of data available on organochlorine compounds and their effects with respect to seabirds is probably related to the technical limitations of the sampling strategies, because the tissues most often used for such analysis (e.g. fat, liver or muscle) imply animal killing or carcass collection (Elliot *et al*. 2005). Nevertheless, it is possible to evaluate organic contaminants and biological responses by sampling non-invasive biological material such as blood and excreta. In order to decrease disturbance for the animals and to reduce the general costs, it is therefore reasonable to include an ecotoxicological approach to long-term studies which requires a sequential manipulation of birds. Developing and sharing sampling methodologies and techniques of analysis is probably the first step in this direction.

The aim of this pilot study is to develop a shared protocol using a non-destructive methodology and integrating contaminant levels and biological responses, to assess the ecotoxicological status of Mediterranean Shag *Phalacrocorax aristotelis desmarestii*, a threatened and endemic subspecies of the Mediterranean Sea, sampled in two breeding areas.

METHODS

The sampling areas are located in the Tyrrhenian Sea, Italy: Tavolara Marine Protected Area, Sardinia (Reulino islet, Fico islet and Magronagghiu coast on Tavolara Island) and the Tuscan Archipelago National Park, Tuscany (La Scola Pianosa). In both areas sampling was performed in March-April 2013 by a team of 4 persons during ringing and census operations. Whole blood samples (1ml) and excreta (1g) were sampled from chicks (Tavolara n=13, Tuscan Archipelago n=12) and subsequently stored at -20° C until laboratory analysis.

Analysis for HCB, DDTs and PCBs were performed according to method of US Environmental Protection Agency 8081/8082 with modifications (Marsili & Focardi 1997). Blood samples were lyophilized in an Edwards freeze drier for 2 days. The sample was extracted with n-hexane in a Whatman cellulose thimble in the Soxhlet apparatus for 9 hours. Prior to extraction the sample was spiked with a surrogate compound (2.4.6-trichlorobiphenyl IUPAC number 30, Ballschmiter & Zell 1980). This compound was quantified and its recovery calculated. After the extraction, the sample was purified with sulphuric acid to obtain a first lipid sedimentation. The extract then underwent liquid chromatography on a column containing Florisil that had been dried for 1 hour in an oven at 110°C. This further purified the apolar phase of lipids that could not be saponified, such as steroids like cholesterol. Decachlorobiphenyl (IUPAC number 209) was used as an internal standard, added to each sample extract prior to analysis, and included in the calibration standard, a mixture of specific compounds (Aroclor 1260, HCB and pp'- and op'-DDT, DDD and DDE).

The analytical method used was High Resolution Capillary Gas Chromatography with Agilent 6890N and a 63Ni ECD and an SBP-5 bonded phase capillary column. Capillary gas chromatography revealed op'- and pp'- isomers of DDT and its derivatives DDD and DDE, and 30 PCB congeners. Total PCBs were quantified as the sum of all congeners (IUPAC no. 95, 101, 99,151, 144, 135, 149, 118, 146, 153, 141, 138, 178, 187, 183, 128, 174, 177, 156, 171, 202, 172, 180, 199, 170, 196, 201, 195, 194, 206). Total DDTs were

calculated as the sum of op'DDT, pp'DDT, op'DDD, pp'DDD, op'DDE and pp'DDE. The results were expressed in ng/g dry weight (d.w.). The detection limit was 0.1 ng/kg (ppt) for all the OC analyzed.

Porphyrins determination was conducted by a spectrofluorimetric method. About 1g of lyophilized excreta was freeze-dried and homogenized, then 100mg homogenate was transferred to glass tubes where methanol/l N perchloric acid mixture was added. After vortex-mixing, the samples were kept in the dark for 10min then centrifuged for 5min at a low speed (De Matteis & Lim 1994). The porphyrins extract in the upper layer was then used for spectrofluorimetric determination, according to the method described by Grandchamp *et al*. (1980). The procedure is based on three different excitation/ emission wavelengths matched to each of the porphyrins (uroporphyrins 405-595nm; coproporphyrins 400-595nm; protoporphyrins 410-605nm). Porphyrin standards were obtained from Porphyrin Product Inc. (Logan, Utah).

Data were tested for normal distribution by the Shapiro-Wilks test using Statistica 7.0 software. Since normality test failed for the whole data set, the non-parametric Mann-Whitney U test was applied to test for significant differences between groups. Statistical significance was set at $p<0.05$.

RESULTS

Appreciable levels of OCs were detected in all blood samples. Among the compounds analyzed, the total PCBs result represented up to about 78% and 82% of the total OCs in the Tuscan Archipelago and in Tavolara, respectively. Shags from the Tuscan Archipelago show higher levels of total PCBs, DDTs, and total OCs compared to the Shags from Tavolara (Figure 1). This difference was statistically significant (p-value <0.05; Mann-Whitney U test). Regarding the levels of HCB, Tavolara shows higher levels, although this difference is not significant.

The results for OCs suggest that Mediterranean Shags could be affected by this type of contamination, even if the two sampling areas (Tavolara and Pianosa) receive limited direct human impacts since both are long-established marine protected areas. Further investigations are necessary to better understand the observed differences between the two areas which are only 200 km apart and present similar foraging habitat conditions (extensive *Posidonia* beds, etc.). These could be due either to different levels of contamination of the food chain in the two areas, or to a different diet, e.g commonest prey species at one site may refer to a higher trophic level than at the other site.

Porphyrin concentrations were measured in all the excreta samples. The porphyrin profile was similar in both sampling areas: protoporphyrins were higher than coproporphyrins and urophyrins. No significant differences were found between the two areas (Figure 2). This result could indicate that the animals in both areas are exposed to contaminants that can lead to an alteration of the haem synthesis and consequently, to the levels of excreted porphyrins. Further analysis are needed to assess the levels of other classes of contaminants, such as emerging contaminants and trace elements, to better understand which of these compounds mostly affect the porphyrin profiles of the two areas.

DISCUSSION

The sampling protocol, which required very little effort in the field, has allowed us to sample appropriate quantities of blood and excreta while causing minimal disturbance to the animals. The results

suggest that the Mediterranean Shag may be exposed to an ecotoxicological risk, and that further sampling in these breeding sites would allow monitoring the contamination trend over time. A long-term monitoring project will also allow the investigation of other classes of contaminants (e.g. PBDEs, PAHs, plastic additives, dioxins, and trace elements) and to develop biomarkers in order to better evaluate the effects of these compounds on organisms.

It would be useful to extend this monitoring network to other Mediterranean areas and to involve other research institutions for a comprehensive assessment of the ecotoxicological status of the Mediterranean Shag, since pollution can have cumulative effects with other anthropogenic threats. The diffusion of our protocol could represent a step forward in understanding the degree of pollution and its different modes of action, in order to define appropriate actions to mitigate threats and protect seabird species.

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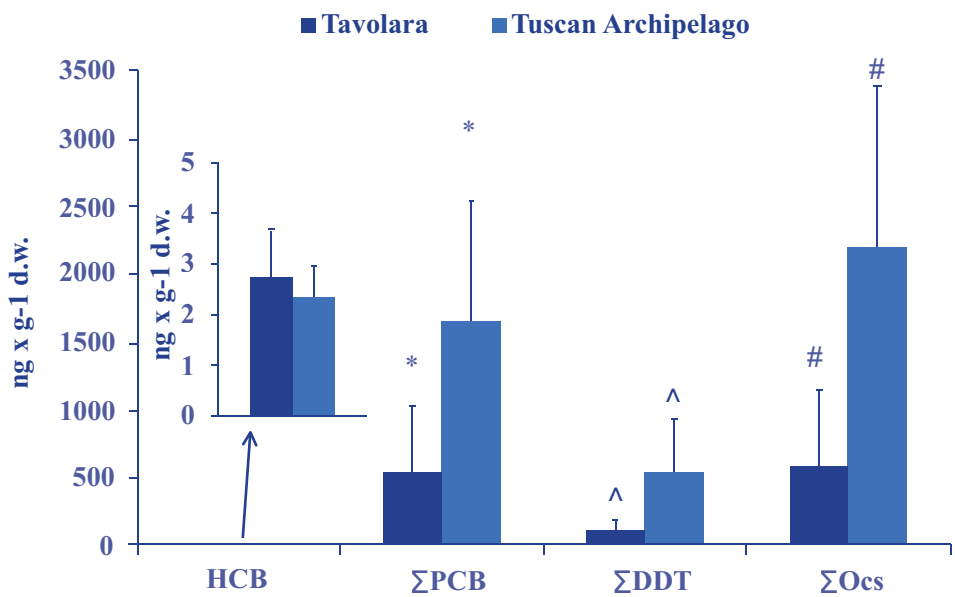

Figure 1. Organochlorines concentration (ng/g dry weight) in blood of the Mediterraean Shag *Phalacrocorax aristotelis desmarestii* in two sampling areas in the Tyrrhenian Sea. Bars show mean value ± standard deviation. ^ * # Statistically significant differences (p <0.05) Mann-Whitney U test.

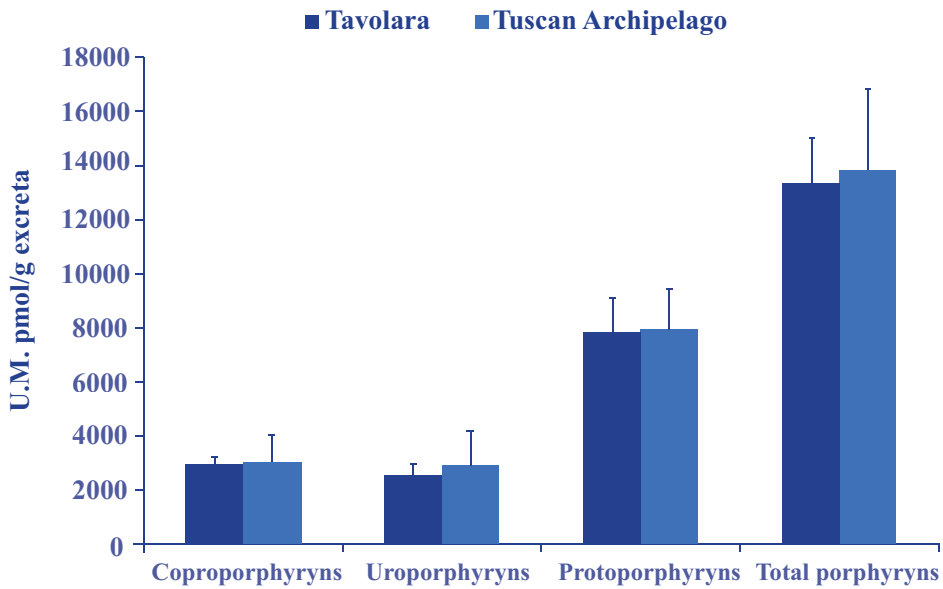

Figure 2. Porphyrin profile in the excreta samples of the Mediterraean Shag *Phalacrocorax aristotelis desmarestii* from two sampling areas in the Tyrrhenian Sea. Bars show mean value ± standard deviation.

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A regional database for seabird ringing data

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The French coastal agency '*Conservatoire du littoral*' is coordinating the Mediterranean Small Islands Initiative (PIM) conservation programme. In this context it developed since 2009 the "Project Albatross" dedicated to threatened seabirds and raptors nesting on insular sites of the Mediterranean. These emblematic species are considered as umbrella species: therefore by preserving the habitats of seabirds, raptors and other interacting species, a much needed conservation strategy will help to improve our knowledge and the birds' survival.

In 2009 the PIM Initiative brought together Mediterranean seabird conservationists to identify the target species and the main axis of the project. It was decided to focus on those threatened species nesting on Mediterranean islands, for which our knowledge was incomplete (geographic distribution, population dynamics, threats at sea and on land), species that required the implementation of a long-term monitoring programme, and to determine the availability of technical and logistic means for such monitoring.

Coordinators of the project were aware that monitoring data of these species are scattered amongst different Mediterranean stakeholders (Managers of Protected Areas, Institutions, and Universities, also NGOs and scientists involved in research programmes). Access to these data are difficult to obtain, or not immediately available, and particularly for those entities which are not part of specific research programmes. Within the framework of the "Project Albatross" we aim to facilitate the effective pooling of these data. Monographs have been prepared for each of the seven target species, therefore responding to the need for the centralization and updating of the available information of these Mediterranean island populations.

More than 40 people contributed to the preparation of these documents, using data from many contributors, thus it has been a true collegial work. In consequence these documents took long to be produced and required a lot of effort to be written and validated. In addition, these documents were immediately obsolete. With this in mind, the seabird

specialists invited to the Albatross workshop in November 2013 and held in Aix-en-Provence, France, it have decided to produce more condensed documents or "Fact Sheets" with all the important information concerning the target species and their conservation status.

Strategically the PIM Initiative would like to lower its involvement in the "Project Albatross" and allow other organizations to take the lead of its previous responsibilities in these projects. Thus another challenge for the "Project Albatross" was to conduct a shared reconsideration concerning the monitoring protocols and their harmonization. To progress in this field the PIM Initiative gathered together all the managers involved in monitoring shearwaters in islands in Provence and Corsica: the islands of Marseilles managed by CEN PACA for 20 years and the National Park of the Calanques since 2013, the islands of Hyères managed by the National Park of Port-Cros, the island of la Giraglia managed by CEN Corsica, and the southern Corsican islands managed by the National Reserve di Bucchi di Bunifaziu. During a workshop held on the island of Port-Cros, the managers were able to harmonize their techniques (synchronization of monitoring between the different sites, identification of common signs of burrow occupation and reproduction) and to determine standardized ringing protocols and biometry sample techniques.

From these discussions it became apparent that various ringing data have been produced for over 30 years in some of these natural sites, but were not fully exploited. Therefore it has been decided to create a common database pooling the ringing data from the Yelkouan Shearwater *Puffinus yelkouan* and Scopoli's Shearwater *Calonectris diomedea* in order to bridge this gap. After several months of developing, the database is now available online with access restricted to contributors. The functionalities of this numeric tool allow the user to upload the ringing data immediately after a field session, or to update a complete Excel table directly, making the process easier. The query function also permits a user to search and to obtain data on a specific site/species/date/ etc. This database is really a cooperative tool permitting users to share information, documents and photographs.

This initiative is the start of an interesting dynamic project which now needs to be extended. Indeed it would be interesting to include other areas like those in Sardinia, the Tuscany islands and Malta to attain a proper regional database. Also, the architecture of the database should allow users to develop it in order to include more species. The next step is the generalization and the creation of an acceptable and practicable regional tool.

As a conclusion, we observe that implementing this kind of collaborative tool is a good opportunity to bring together conservationists and scientists and establish an effective network. It is an opportunity for them to standardize their approach towards conservation and enhance other kinds of collaborative activities.

Far beyond the horizon - modern tracking techniques as a tool to identify marine IBAs for Maltese seabirds

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ABSTRACT

Pelagic seabirds can make use of foraging grounds far away from their nest sites to provide their chicks with high quality food. Outside the breeding season, these birds carry out larger movements to reach sea areas of high productivity. In the past, seabird conservation in the Central Meditarranean largely focused on the terrestrial breeding grounds, and did not investigate aspects of the birds' life at sea. In recent years, tracking devices have improved in size, weight and performance, helping to shed light on the seabirds' movements, which are crucial to identify important areas at sea used during their lifecycle.

During the last years, BirdLife Malta has equipped Yelkouan Shearwaters *Puffinus yelkouan*, Scopoli's Shearwaters *Calonectris diomedea* and Mediterranean Storm-petrels *Hydrobates pelagicus melitensis* breeding in the Maltese Archipelago with various tracking devices. During several breeding seasons, the movements of birds from different colonies were tracked with geolocators, GPS-loggers and radio-transmitters, respectively. The results of our tracking studies indicate that during the breeding period, pelagic seabirds nesting in the Maltese archipelago make use of Libyan, Tunisian, Italian as well as international waters. After the breeding season Scopoli's Shearwaters leave the Mediterranean to winter in the Atlantic off the Western and Southwestern coast of Africa. The results highlight the importance of international collaboration in the designation of marine protected areas for pelagic seabirds in the Mediterranean and beyond.

INTRODUCTION

The Maltese islands hold significant colonies of three pelagic seabirds, namely the Yelkouan Shearwater *Puffinus yelkouan*, the Scopoli's Shearwater *Calonectris diomedea*, and the Mediterranean Storm-petrel *Hydrobates pelagicus melitensis*. All three taxa are endemic or near-endemic to the Mediterranean basin.

While the Scopoli's Shearwater, despite declining in numbers, is listed as of Least Concern, the Yelkouan Shearwater has been recently up-listed to Vulnerable due to an overall ongoing rapid population decline. For the Mediterranean Storm-Petrel, a decline has been proposed, but sound total population estimates and trends are widely lacking (BirdLife International 2015). The majority of

the nesting sites of all three Maltese seabird species are legally protected as Special Protection Areas (SPA) within the European Natura 2000 network, but various threats to adult survival, such as incidental bycatch in fishing gear, are believed to be active at sea (Anderson *et al.* 2011, Laneri *et al.* 2010). Unravelling their spatial distribution patterns during foraging, on migration and in the wintering grounds, identifying the marine IBAs and designating these areas as marine protected areas are essential for the conservation of these species. To achieve this aim, BirdLife Malta, together with the Maltese Ministry for Sustainable Development, the Environment and Climate Change (MSDEC), the RSPB and SPEA, is carrying out an EU-Life funded project (LIFE10 NAT/MT/090) with the title: Creating an inventory of marine IBAs for Yelkouan Shearwaters, Cory's Shearwaters and Mediterranean Storm Petrels in Malta.

Standardized boat-based distance sampling along transect lines and tagging of adult birds in the colonies with tracking devices are the two main tools which can provide the essential information for the identification of marine Important Bird Areas (BirdLife International 2010, Arcos *et al.* 2012). Boat based distance sampling within the 25 nautical miles Maltese Exclusive Fishery Zone (EFZ) were carried out rigorously during two field seasons. 224 days were spent on transect routes, covering a total of 11,552 nautical miles from March to October, in 2012 and 2013.

During the breeding season, these pelagic seabirds are believed to regularly forage in sea areas of high productivity much further away from their colonies in international waters and into territorial waters of adjacent countries (e.g. Cecere *et al.* 2012). Furthermore, the colony origin and life-cycle status of the birds encountered on transects at sea remains unclear. Outside the breeding seasons, the species perform even larger movements (González-Solís *et al*. 2007, Raine *et al.* 2013). Over the last decades a growing variety of active and passive remote tracking devices have been developed to follow birds' movements around the globe. Today, a wide range of radio-transmitters, GPS-loggers and geolocators (GLS) is available; some are suitable for tracking seabirds during foraging trips, and others are useful throughout the birds' annual cycle. Results of studies on tracking Maltese pelagic seabird species during the breeding and non-breeding season are presented here.

MATERIAL AND METHODS

During three breeding seasons (2012-2014), more than 60 adult Yelkouan Shearwaters nesting in two different colonies in the North of Malta, Rdum tal-Madonna and Majjistral Nature and History Park, were equipped in with GPS-loggers (Earth&Ocean Technology, Technosmart, I-got-U). In the same period, more than 50 adult Scopoli's Shearwaters from three different Maltese islands (Malta, Gozo and Filfla) were equipped with GPS-loggers. Loggers were programmed to store one fix per 20min, sealed waterproof and attached to the birds' back feathers using waterproof tape. The GPS-tags were retrieved when the birds returned from their foraging trips.

In three breeding seasons (2010, 2012, 2013), 34 geolocators (Biotrack Mk3006) were attached with cable ties to the metal rings of Scopoli's Shearwaters captured on their nests in colonies on three islands. The GLS-tags were retrieved in the consecutive season, when the birds had returned to their colonies, approximately after one year.

During two chick rearing seasons (2012 and 2013) a total of 74 adult Mediterranean Storm-petrel recaptured

from the Filfla colony were equipped with radio-transmitters (Biotrack PicoPip Ag392). Radio-tracking was carried out on approximately 50 transect flights (two per day, 4 hours each) on board a Cessna 172 aircraft equipped with two Yagi antennae, following a fixed setup of 11 transects within Maltese airspace, with 6 of them flown regularly. Additional radio-tracking was carried out on board of a research yacht during boat based observations and during five nights from land.

RESULTS

GPS-tagging of Maltese Yelkouan Shearwaters revealed foraging trips of 48 individual birds and a total of 9,598 fixes. Main foraging areas are situated south of Sicily, Italy and in the Gulf of Ghabes in Tunisia as well as in international waters south and southwest,and to some extent also east of Malta (figure 1). GPS-tagging of Scopoli's Shearwaters from Malta, Gozo and Filfla resulted in 35,297 fixes of 51 individuals. Important foraging areas are found south and southeast of Malta, Northwest of Gozo, South of Sicily and in front of the Libyan coast (figure 2).

Cleaned and processed light data from GLS-tracking of Scopoli's Shearwaters allowed calculating complete round trips of 20 birds. All GLS-tracked birds left the Mediterranean westwards through the Strait of Gibraltar. The majority of birds spent the winter in front of the Western African coast (Mauritania, Senegambia), while 3 birds went further south wintering in front of Congo and Angola/ Namibia. On their way back into the Mediterranean in late winter to early spring, all Scopoli's Shearwaters performed a clockwise circle route over the central Atlantic.

Radio-tracking of Mediterranean Storm-petrels from Filfla during two breeding periods revealed a total of 183 fixes, 114 of which were obtained from aerial transects, 40 from onboard the research yacht, and 29 from land. Fixes from radio-tracking appeared scattered over the search area.

DISCUSSION

Our preliminary results from GPS-tracking Yelkouan Shearwaters and Scopoli's Shearwaters indicate that important foraging areas for this species during breeding and chick rearing are found not only in Maltese territorial waters but also off the south-eastern Sicilian coast, as well as off the coast of Libya and in the Gulf of Ghabes, Tunisia. All three seabird species furthermore use sea areas in international waters far away from Maltese shores.

A previous GLS-tracking study had shown that the majority of Maltese Yelkouan Shearwaters leave the Central Mediterranean to spend the non-breeding period in the Aegean and Black Sea (Raine *et al.* 2013), in line with large amounts of birds counted passing through the Bosporus into the Black Sea and back (Sahin *et al.* 2012). In line with GLS-tracking studies of Scopoli's Shearwaters from other Mediterranean colonies, we found that all adult GLS-tracked Maltese Scopoli's Shearwaters left the Mediterranean to winter in nutrient-rich upwelling areas off the African coast in the East- and Southeast Atlantic.

Our findings underline the importance of international collaboration and networking in the designation of marine protected areas for pelagic seabirds in territorial waters of adjacent countries which the birds reach regularly on their foraging trips or where they spend the non-breeding season, as well as in international waters. Joining conservation efforts among the Mediterranean member states and beyond can help to better protect the highly mobile Mediterranean pelagic seabird species

ACKNOWLEDGEMENTS AND ETHICAL STATEMENT

The work presented here is part of the EU LIFE+ Malta Seabird Project (LIFE10 NAT/MT/090), aiming to identify Marine Important Bird Areas (MIBAs) for Maltese pelagic seabirds. The project is 50% funded by the LIFE unit of the European Commission, and is carried out by BirdLife Malta in partnership with MSDEC, SPEA and the RSPB. Handling and tagging birds was carried out according to best practice regarding animal welfare and under licenses from the relevant Maltese authorities, the Wild Bird Regulation Unit (WBRU) and the Nature Permitting section of the Maltese Environment and Planning Authority (MEPA).

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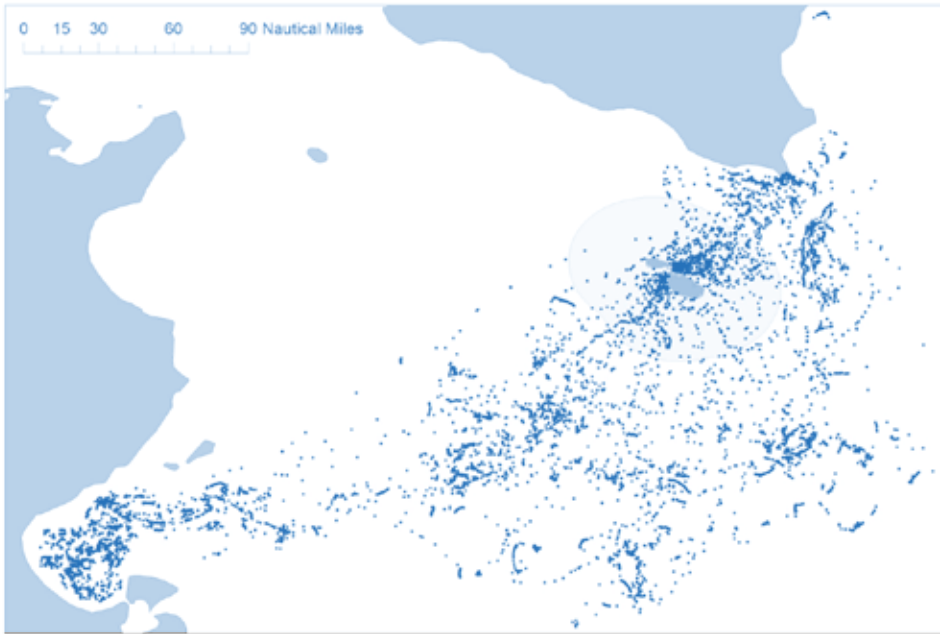

Figure 1. GPS fixes (black dots, n=9,598) of 48 adult Yelkouan Shearwater *Puffinus yelkouan* nesting in two colonies in Malta. Light grey: 25nm Maltese Exclusive Fisheries Zone (EFZ).

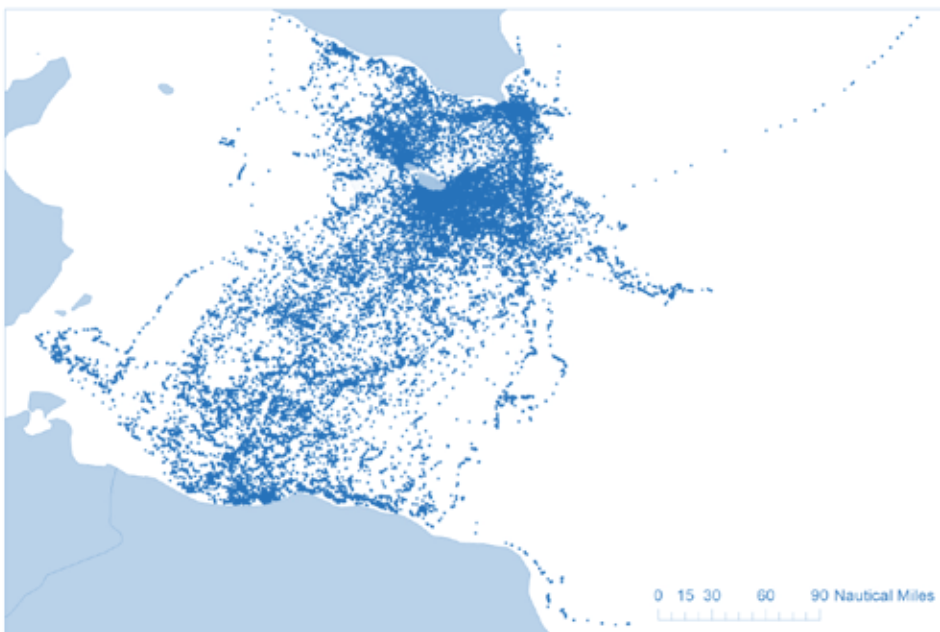

Figure 2. GPS fixes (black dots, n=35,297) of 51 adult Scopoli's Shearwaters *Calonectris diomedea* nesting on three islands of the Maltese archipelago.

Development of windfarms in Morocco: Landscape and Birds

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ABSTRACT

Wind power projects can be detrimental to landscape and bird conservation. We scrutinized the development of a wind power project in Morocco, and focused on the different impacts of a wind-farm on birds. The potential for wind power due to the topography of a landscape correlates with the behaviour of the birds flying through the area. We found that the nature of the landscape and the positions of wind turbines are very important factors to take in account in wind-farms development phase.

INTRODUCTION

As part of the national strategy for securing the country supply of electric energy and the promotion of renewable energy, Morocco has set a target of achieving 42% of the installed capacity based on renewable energy by 2020 (Anon. 2012). In 2011, a new law allowed private operators to install their own wind farms and sell power in a competitive market, including the ability to export it. With its extraordinary potential of wind and a strategic position of two coastlines, Morocco has developed a national wind programme designed to provide 2000MW, divided into 1,000 MW from public parks launched in tenders (Tanger II 150MW, 300MW Koudia Albaida, Taza 150MW, 300MW Tiskrad, Boujdour 100MW) and 1000 MW in several private wind farms (Rguibi Idrissi 2012). While in the 1980s turbines did not exceed 25m in height, today the last installed onshore turbine is measuring 200m to blade tip and manufacturers are promising wind turbines that could reach 300m at the blade tip by 2020 (http://energiepourdemain.fr/les-sources-denergie-durables/). The goal is to install these turbines in corridors of strong winds, and to achieve great heights for the better productivity. However this would have negative impacts on birds, especially migratory birds that are using

the most interesting wind corridors for easy vertical and horizontal movements and to minimize their energy consumption.

The installation of wind turbines in bird migration corridors has many direct negative impacts. First there is the risk of collision. Several field studies have shown that birds can collide with the turbines during local movements and seasonal migrations. They can be highly disturbed in their breeding, resting and foraging areas or during migration (Langston & Pullan 2003, Kingsley & Whittam 2005).

Mortality frequency ranges from 0 to at least 60 birds per turbine per year depending on the configuration of the wind farm, relief, density of birds at the site, landscape features of the wind farm and its surrounding area. Topography, vegetation, habitats and exposure pathways favour certain passages, the use of thermals, or conversely reduce fly height, which can increase the risk of collision. Adverse weather conditions are also a factor likely to increase the risk of collision. This is particularly the case for poor visibility (fog, mist, low cloud ceiling) and strong winds (e.g. Atienza *et al*. 2011, Band 2012).

There is also a barrier or scarecrow effect. The barrier is a variant disturbance for birds in flight which is usually expressed by flight bypass reaction to turbines at varying distances. It concerns both active migration and daily transits between breeding or resting and foraging areas. It depends on the sensitivity of species, and also the configuration of the wind farm and climatic conditions (Barrios & Rodríguez 2004). Good visibility is particularly important for birds to anticipate an evasion reaction when approaching the turbines. Furthermore the weather, terrain and the configuration of the park can also greatly reduce the visibility and limit anticipation. The avoidance reaction may have the advantage of reducing the risk of collisions. However, it may have significant ecological consequences if the obstacle is creating fragmented habitat, e.g. separation of a breeding area from the main feeding zone. Avoidance can also generate significant additional energy expenditure, especially when circumvention is taking significant proportions (cumulative effect of successive obstacles) or when, for various reasons, the reaction is late (e.g. panic, U-turns, breaking-up groups).

Other indirect impacts of wind farms on birds include habitat destruction, hydrological changes in environmental setting, and noise pollution. The most developed knowledge on wildlife disturbance shows that sound pollution affect birds. The functions of acoustic communication in birds are numerous, the main ones being the defence of territory and parental attraction. Man induced noise exerts selective pressure, both within a species and between species on the criterion of adaptability of the song. The need for a bird to sing louder increases its metabolism, which is tiring and which obliges it to spend more time looking for food. On the other hand, a bird can change its lifestyle in order to sing during quiet time and not when singing is induced by stress. Such a pressure is likely to reduce biodiversity (Langston & Pullan 2003, Larsen & Guillemette 2007).

The present work is the first ornithological study in Morocco that tends to help in structuring the development of wind-farms by showing how birds are affected by landscape changes induced by such projects. The aims of this work is (1) to study the birds' distribution in an existing wind-farm in the North of Morocco (Tangier) and define the autumn and spring migration corridors during the construction of wind turbines; (2) to model blades' sound effect on birds; and (3) to model the different landscape effects on birds after the construction of the wind-farm.

METHODS AND MATERIALS

Study area

Beni Mejmel Wind Farm, situated near to Tangier in the north of Morocco, is divided in two parts (Figure 1): Dchar Saadane site (total installed capacity of 75MW) situated in the SW of Ksar Essghir at 15km in the East of Tangier, and Sendouk site (total installed capacity of 65 MW) in the west of Ksar Essghir at 18km in the NE of Tangier. This park is located on two lines of parallel ridges at a 21.5° angle with the north-south axis. The first line, to the East, extends over 32km from El Mkhaled to the Mediterranean coast. The second line, *ca* 4km from the first, is *ca* 9km long from the village of Ain Ounsar to Feddane Chappo. Different types of wind turbines are used, with hub height of 49m, 55m or 65m.

To assess the importance of the frequency of the birds at the site, we extracted data (number per species) from the available ornithological studies, and modeled them under ArcGIS software. Data for autumn migration and spring migration were modeled separately. We thereafter used the WindPRO® software to model the variation of noise caused by wind turbines, and added the results to our GIS maps. Regarding landscape modeling, the lack of information led us to use Google™ Earth to map the different access roads created for the building and maintenance of the wind farm, and we calculated the various distances and areas using ArcGIS.

RESULTS AND DISCUSSION

Bird distribution

The available ornithological studies indicate that intense migration movements occur day and night in the area of wind farms (Rguibi Idrissi 2012). The site is visited by different species of large migratory birds (e.g. White Stork *Ciconia ciconia*, Black Stork *C. nigra*, Black Kite *Milvus migrans*, Egyptian Vulture *Neophron percnopterus*, and Booted Eagle *Aquila pennata*), which fly and soar mostly along the eastern ridge in autumn and along the western one in spring. They also move through the area either to hunt or to take advantage from weather conditions when gaining altitude. The majority of them however migrate at lower elevations when crossing the area, which means that wind turbines not only represent a major danger for migratory birds, but also create a barrier to them (Figures 2 and 3). The wind farm includes some overpassing areas to allow the birds to deflect the lines of turbines. However for some species, especially the gliders (i.e. most of the larger species), it is difficult to deflect suddenly when rising from the side of the mountain to its top. So the collision risk remains high for these birds.

Sound modelling

The area also hosts nesting birds, such as Pallid Swifts *Apus pallidus* which nest a few kilometres from the site and regularly forage over the forest within the site. Such nesting birds could be affected by turbines' noise, more markedly towards the top of the ridges, apart from the deforestation needed for the creation of access roads and wind platforms: clearing eliminates obstacles and thus the mitigation of noises (Figure 4).

Landscape modeling

According to the different models, the northern part of the project has generated 14km of newly created tracks and 275,450m² of terraced land. The southern part has generated 32km of access roads and 709,900m² were terraced. Engineering works at such a site have negative impact on habitats,

such as destruction of forests, and filling of cavities with concrete. There are also impacts on the hydrological components of the site: deforestation increases soil erosion and lower the water table, and fillings change the water regime and produce either dryness or the necessity of irrigation. Such changes in natural habitats affect both breeding birds and migratory ones, destroy their habitats and lower their feeding sources, leading to a reduction of the attractiveness for some species.

CONCLUSION

We recommend that large-scale landscapes such as a vast plateau or a long ridge are selected by windfarm developers looking for a project site. We see that developing a wind farm in such situations is not as dangerous as one may think, provided that developers make the right choices to avoid disturbing migratory and nesting birds. It is important not to use afforestated areas; to minimize access roads; and to organize the wind turbines in a consistent manner. One should never set up a line of wind turbines perpendicular to the birds' migration corridor. Ample spaces should be created between the turbines to allow the birds to move from side to side. Secondary developments like power lines and auxiliary structures should malso be reduced or eliminated.

ACKNOWLEDGEMENTS

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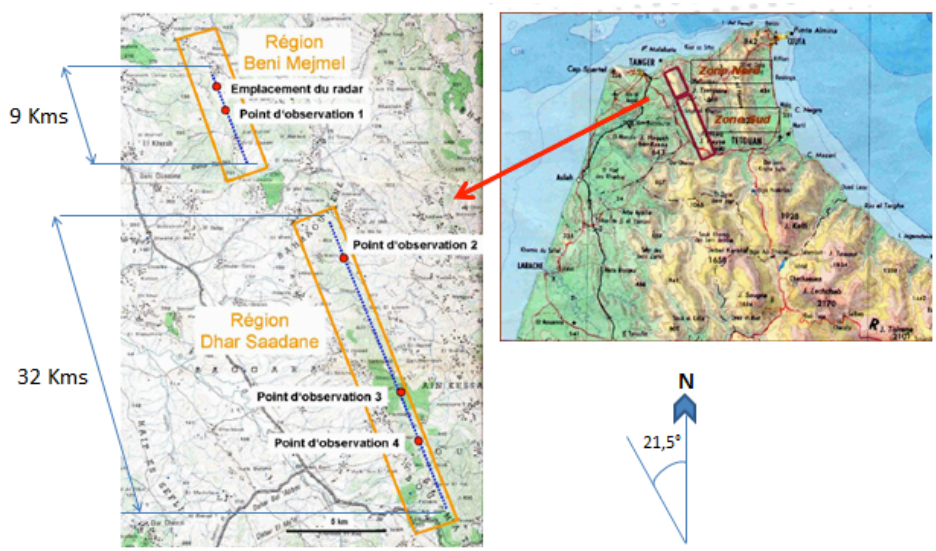

Figure 1. Location of the study area.

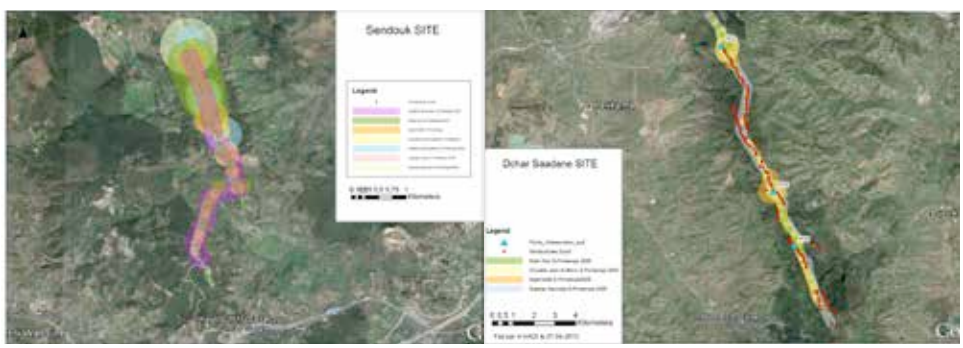

Figure 2. Distribution of birds observed in Spring at flight altitudes up to 200m.

Figure 3. Distribution of birds observed during post-breeding migration at flight altitudes up to 200m.

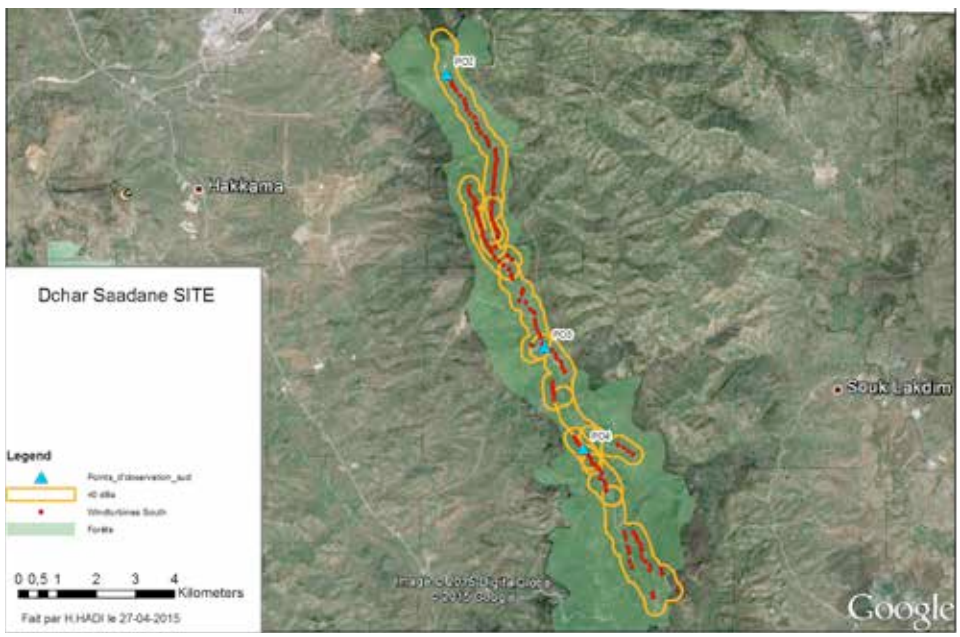

Figure 4. Sound modelling in the site

Relevance of refuse dumps in the diet of Yellow-legged *Gull Larus michahellis* from the breeding colony of Chikly Island (Tunisia): 3 years of monitoring

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ABSTRACT

The Yellow-legged Gull *Larus michahellis* is usually considered as an opportunistic species that often depends on food derived from anthropogenic activity such as garbage and fishery discards. Although it has become a problematic species in many Mediterranean countries, there is still no information about its status in Tunisia. The aim of this work was to assess the differential use of marine and terrestrial resources by the Yellow-legged Gulls breeding in an urban area on Chikly Island. Dietary reconstructions were performed through the analysis of regurgitates and $\delta^{13}C$, $\delta\delta^{34}S$ and $\delta^{15}N$ isotopes of fledgling feathers. Contrary to most Mediterranean breeding colonies and to our expectations, a Bayesian mixing model approach showed that Yellow-legged Gulls from Chikly are above all marine foragers. Whereas the Lake of Tunis was the principal source of food in 2005 and 2007, in 2006 chicks were fed mainly with prey from the Gulf of Tunis. Although the Gulf is located further from the breeding colony and has less fishing activity than the Lake, our study demonstrated that it is used as an alternative foraging habitat. The Bayesian approach proved to be a useful tool for evaluating temporal variations in the feeding ecology of the colony, which gives relevant information for the management of a wild species. This study also demonstrated the importance of year to year inconsistency in diet diversity and food availability, as inferred from isotopic variability, thereby allowing demographic forecasts when trophic resources vary in abundance or the foraging habitat is disturbed.

INTRODUCTION

The Yellow-legged Gull *Larus michahellis* is a resident breeder or a medium-distance migrant in Europe, Middle East and North Africa. The overall population trend is increasing, although some populations have unknown or even decreasing trends. The Yellow-legged Gull population of the western Mediterranean has increased by 10% annually (Thibault *et al*. 1996, Vidal *et al*. 1998, Duhem *et al*. 2007). It is a problem species in some areas because of its interaction with human activities such as aviation and agriculture, or its role in the transport of pathogens and predation on sensitive species (Finney *et al*. 2001). Food availability is a determining factor in breeding success and population dynamics of most species. Consequently the study of the trophic ecology of a problematic species is a key to the understanding of its demographic expansion and to define adequate environmental management policies.

The aim of this work was to evaluate the contribution of the open air dumps in the diet of the breeding colony in Chikly Island. This colony has at its disposal two marine foraging habitats, the Lake of Tunis and the Gulf of Tunis, as well as a terrestrial foraging habitat mostly consisting in open air dumps of the city. Defining the importance of each habitat being exploited by a population is fundamental for wildlife management and conservation, since accessibility to trophic resources and their use plays a key role in survival and reproductive success. We therefore reconstructed the diet of the Yellow-legged Gull colony over three years by combining two complementary techniques: the analysis of regurgitates of fledglings, and stable isotope analysis of their growing mantle feathers. To determine the contribution of each of the three foraging habitats to the diet of the colony and their variation over time, we applied a mixing model for each monitored year. The analysis of naturally occurring stable isotopes of Carbon, Sulphur and Nitrogen (respectively expressed as $\delta^{13}C$, $\delta^{34}S$ and $\delta^{15}N$) has become increasingly common in the study of the trophic ecology (Dufour & Gerdreaux 2001, Votier *et* al. 2003, Hobson & Cherel 2006) as it constitutes a relatively non-invasive way to obtain time-integrated information on assimilated diet. Whereas $\delta^{13}C$ and $\delta^{34}S$ provide information on the exploited foraging habitats, such as benthic/pelagic or marine/continental biotope, $\delta^{15}N$ has been widely used as a proxy for trophic level (Peterson & Fry 1987).

MATERIAL AND METHODS

Study area: Chikly Island

The island is located in the northern part of the Lake of Tunis (36°49'N, 10°13'E), a brackish urban lagoon surrounded by the city. The lake is divided into a northern and a southern part by a navigation channel. The Lake of Tunis has a well-known history of severe eutrophication with resulting anoxia and massive fish death, especially before the restoration work that was carried out in the mid-1980s (Mastouri & Brahim 1996). The northern part, which covers an area of 2,480 ha, continues to suffer from intense human pressure and is the subject of growing urban development. It also receives water inputs from several rainfall collecting channels, as well as sea water from the adjacent Gulf of Tunis.

Sampling

During the breeding periods of 2005, 2006 and 2007, we collected growing mantle feathers and regurgitates of fledglings from the breeding colony. Regurgitated prey items were individually identified to taxonomic order level and weighed. We analysed stable isotopes in feathers and regurgitates. Stable isotope ratios were expressed in parts per thousand according to the conventional equation:

$$\delta X = \frac{R_{Sample} - R_{s\tan dard}}{R_{s\tan dard}} \times 1000$$

where R_{sample} is the corresponding ratio of $^{13}C/^{12}C$, $^{15}N/^{14}N$ or $^{34}S/^{32}S$ in the analysed tissue, and $R_{Standard}$ is the corresponding ratio of $^{13}C/^{12}C$, $^{15}N/^{14}N$ or $^{34}S/^{32}S$ related to the standard values. $R_{Standard}$ values for $\delta^{13}C$, $\delta^{15}N$ and $\delta^{34}S$ were those of Pee Dee Belemnite (PDB), atmospheric nitrogen (AIR) and Canyon Diablo Troilite (CDT), respectively.

In order to estimate the contribution of the different food sources to the diet of the colony, we used a Bayesian mixing model (Philips 2001). Such a model defines the isotopic signature of the consumer as the result of those of its preys weighted by their respective contributions to its diet:

$$\delta^{13}C_{Consumer} = f_{S1}\,\delta^{13}C_{S1} + f_{S2}\,\delta^{13}C_{S2} + f_{S3}\,\delta^{13}C_{S3}$$

$$\delta^{15}N_{Consumer} = f_{S1}\,{}^{15}N_{S1} + f_{S2}\,{}^{15}N_{S2} + f_{S3}\,{}^{15}N_{S3}$$

$$\delta^{34}S_{Consumer} = f_{S1}\,\delta^{34}S_{S1} + f_{S2}\,\delta^{34}S_{S2} + f_{S3}\,\delta^{34}S_{S3}$$

where f is the contribution and S_1, S_2, S_3 are the respective foraging source. For calculation we used the SIAR package for R (Parnell *et al*. 2008).

RESULTS

Analysis of regurgitates

Identification of prey found in regurgitates showed that terrestrial invertebrates were only present in 2005. Freshwater invertebrates made a minor contribution to the colony diet, especially during 2005, when their percentage of the biomass was very low. Marine prey and landfill categories were the more recurrent and important in terms of both numeric and biomass indices. According to these indices, marine prey was the most important resource during the three years of the study.

Mixing model

In accordance with the analysis of regurgitates, the mixing model showed a minor use of the terrestrial ecosystem. The diet of the studied colony consisted mainly of marine prey from both the Lake and the Gulf of Tunis. In 2005, the use of the Gulf was at its minimum, and the use of the terrestrial resource peaked, in comparison with 2006 and 2007. The contribution of the terrestrial resource varied between 29.5% (in 2006) and 49.3% (in 2005). In 2006, the most exploited feeding habitat was the Lake of Tunis and the less used was the Gulf. The Lake of Tunis was the most important foraging habitat used by the Yellow-legged Gull colony when the three years of the study are combined.

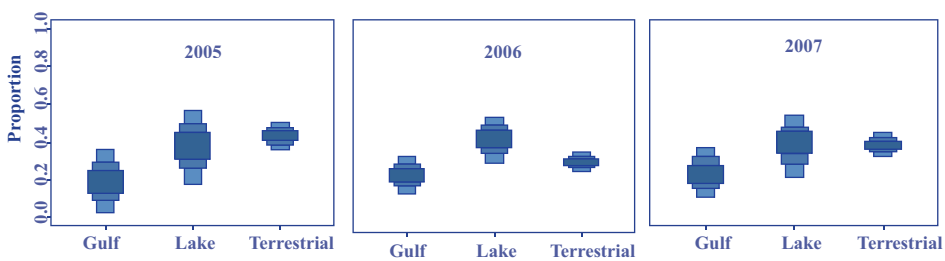

Figure 1. Contributions of the different foraging habitats to Yellow-legged Gull diet provided by the Bayesian mixing model with 95%, 75% and 50% credibility intervals.

Stable Isotopes

The isotopic composition of fledgling feathers showed a normal distribution in each of the three years of the study. $\delta^{15}N$ showed no significant difference among years ($\delta^{15}N$: $F_{2, 83} = 3.24$, $P = 0.72$). On the contrary, $\delta^{13}C$ and $\delta^{34}S$ showed a slight increase between 2005 and 2006 ($\delta^{13}C$: $F_{2, 83} = 5.4$, $P = 0.006$; $\delta^{34}S$: $F_{2, 83} = 4.5$, $P = 0.014$) revealing a change in the diet composition which seemed more marine in 2006, whereas homogeneous mean values were found in the 2006 and 2007 breeding seasons.

CONCLUSION

Yellow-legged Gulls from the Chikly colony are mostly marine foragers. Contrary to our expectations, open air dumps were not the most important foraging habitat used by these gulls. Beside, a study in the Bay of Biscay (Arizaga *et al*. 2013), interestingly showed that the closure of the local open air dump did not have any detectable effect on chicks' diet. As management decisions are usually costly, they should be based on an accurate knowledge of the feeding habits and resources exploited by each gull population. Food availability is a determining parameter to the prosperity of any population. Thus the information provided here would be of prime importance for the management of Yellow-legged Gull in the area of Lake of Tunis.

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“PART IV”

CONSERVATION NETWORKS

Seabirds and the need for a marine Natura 2000 network: the Spanish experience

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ABSTRACT

Marine Protected Areas (MPAs) play a key role in the preservation of marine biodiversity, but have being lagging behind the protection of terrestrial environments. Moreover, they have largely overlooked wide-ranging species such as seabirds. Here we describe the process to extend the Natura 2000 network to the marine environment in Spain, particularly the Special Protection Areas (SPAs) under the EC Birds Directive.

This was mediated through the previous identification of Marine Important Bird Areas (MIBAs), supported by a LIFE project in 2004-2009. These areas were adopted by the Spanish Government as the base for the SPA network. A 5-year process under the framework of LIFE+ project INDEMARES (2009-2014) allowed to assess in detail the use that seabirds make of these sites, their interaction with human activities and the potential threats that they could face. Ultimately, most of the Marine IBAs were designated as SPAs in 2014, adding 49,000 km^2 (21.000 km^2 in the Mediterraenan region) and increasing by a 20 fold the marine area covered by SPAs in Spain.

Furthermore, the Spanish Government made the commitment of implementing management plans for these sites within the next 2 years. The Mediterranean region as a whole has paid little attention to the identification and designation of protected areas for seabirds, although there are substantial differences between countries. It is essential to address this gap from a regional perspective, taking advantage of BirdLife's IBA Programme to identify hotspots, and from directives at international level such as Specially Protected Areas of Mediterranean Importance (SPAMIs) to provide effective protection.

INTRODUCTION

Protected areas are among the most useful conservation tools nowadays, focusing conservation action in the most relevant and sensitive sites (Lovejoy 2006). This approach has been largely developed in terrestrial environments, but the marine environment has received far less attention (Wood *et al*. 2008).

Moreover, most Marine Protected Areas (MPAs) are small, coastal sites, focusing on benthic habitats (e.g. coral reefs, mangroves, sea-grass prairies), whereas the dynamic open sea and its related biota have long been neglected, particularly regarding wide-ranging organisms (Hyrenbach *et al*. 2000). In line with this general pattern, few sites have been

protected at sea for seabirds, despite the relevance that the marine environment plays for these top predators, and the severe threats that they face there (Lascelles *et al*. 2012). This is particularly so for the open seas, despite the fact that pelagic seabirds are among the most threatened bird groups (Croxall *et al*. 2012). Reasons for this inconsistency include the relative little awareness regarding seabird threats at sea and, until recently, the lack of technological and logistical facilities to assess seabird distribution patterns in this environment (Arcos *et al*. 2012).

Moreover, their wide-ranging capabilities raised doubts about how feasible the concept of MPAs was for seabirds (Game *et al*. 2009). Within the global context, the Mediterranean Sea has received particular attention regarding the establishment of MPAs, including those for some wide-ranging species. Indeed, Gebrié *et al*. (2012) reported a MPA coverage of 4.56% of the total Mediterranean marine surface, over 3% of which corresponded to the Pelagos Sanctuary designated specifically to protect cetaceans (Notarbartolo di Sciara *et al*. 2008). However, this is still beyond the Convention on Biological Diversity (CBD) target to gain effective protection for at least 10% of the World's marine area by 2012 (Coad *et al*. 2009).

Moreover, the distribution of MPAs is uneven, and some particular groups have been largely ignored, as is the case for seabirds. Here, we describe the ongoing process to address this gap in Spain, as a model that could be extended to parts of the Mediterranean basin.

SPANISH DESIGNATION OF MPAS FOR SEABIRDS: PROCESS OVERVIEW

Work towards the identification and designation of MPAs for seabirds was initiated in Spain over 10 years ago, within the framework of the Important Bird Area (IBA) Programme of BirdLife International. An EC LIFE funded project (2004-2009), also supported by the Spanish Government, allowed SEO/BirdLife to produce the first inventory of marine IBAs at national level (Arcos *et al*. 2009), along with a sibling initiative conducted in Portugal by SPEA (Ramírez *et al*. 2008). This was followed by the LIFE+ project INDEMARES (2009-2014) which involved several Spanish partners (administrations, research centres and NGOs) with the aim of characterizing and designating the marine Natura 2000 network in Spain, in accordance with the EC environmental legislation.

The IBAs were taken as the point of departure for Special Protected Areas (SPAs), which the Natura 2000 sites intended to take into account for birds and their habitats following the EC Birds Directive. While the first project addressed the identification of the main seabird hotspots at the national scale, the second one required a more detailed study of these sites (seabird spatiotemporal patterns, interactions with human activities and threats) (SEO/BirdLife 2014). INDEMARES also allowed to start a participative process with the stakeholders, and produced a set of guidelines, for the future management of the designated sites.

HOW CAN MPAS PROTECT SEABIRDS? WHAT DO WE PROTECT?

As already noted, one of the initial concerns regarding the designation of MPAs for seabirds was related with the feasibility of setting boundaries at sea for wide-ranging organisms such as seabirds.

However, as highlighted by BirdLife International (2004), seabirds do not distribute randomly at sea but rather tend to use certain areas persistently for a number of reasons. One can define three different types of sites:
1 Seaward extensions to the breeding colonies (areas that show high seabird density for being adjacent to the breeding sites - seabirds may either forage there, or just fly across during their trips between the nest and distant foraging areas).

2 Migratory corridors: areas where the flow of migrating seabirds is concentrated (straits and channels are the most obvious corridors, but other coastal areas can also act as such).

3 Foraging areas at sea which are unrelated to the breeding colonies (seabirds tend to congregate in such areas for their high food availability).

HOW WERE THE SPANISH MARINE IBA/SPAS IDENTIFIED?

The identification of the marine SPAs was based on scientific criteria, combining information from different sources. Slightly different approaches were undertaken according to the type of site.

Foraging areas for pelagic species were the most challenging sites to address, and their identification consisted of the following steps (see Arcos *et al*. 2012 for further details):

1. *Seabird data collection*. This phase was focused on boat-based transect surveys (over 60.000 km covered) and remote seabird tracking using different devices (GPS loggers, satellite transmitters and others; in total about 1000 marked birds of 6 species, and nearly one million locations). Other seabird data were also compiled from bibliography or collected in the field.

2. *Species distribution modeling*. Habitat models were built to combine seabird distribution data with environmental information, helping to identify areas with high habitat quality for the different seabird species.

3. *Identification and delineation of the main seabird hotspots*. This process largely relied on models but was necessarily supported by direct seabird data, and refereed by expert opinion.

4. *Validation of pre-identified hotspots by applying BirdLife IBA criteria* (Heath & Evans 2000). These are basically numerical criteria, the overall rule being that the site holds at least 1% of the regional or global population of a given species.

5. *Combination of hotspots from different species to set the final limits of the marine IBAs* (Figure 1).

The methodology for the identification of the marine IBAs, developed in coordination with BirdLife International and several experts, largely contributed to set a standard procedure for the identification of marine IBAs elsewhere (BirdLife International 2010).

THE SPANISH MARINE IBA & SPA NETWORK IN A GLIMPSE, WITH A MEDITERRANEAN PERSPECTIVE

A total of 44 marine IBAs were identified by SEO/BirdLife, covering an area of 54,826 km^2. These sites were taken as the reference list for the designation of SPAs, which ended with 39 new sites and 49,124 km^2 designated in 2014. Previously, there were already about 135 SPAs designated

by the regional governments, but these were mostly small and coastal sites, totalling slightly over 2,600 km^2. Thus, the new SPAs represented a 20-fold increase in area coverage. As a result, the SPA network is now formed by 174 sites and 51,788 Km^2, slightly more than 5% of the Spanish marine territory. It extends from the coast to cover a representative fraction of all the Spanish territorial waters, thus addressing for the first time the full protection of the pelagic seabirds, as well as that of other coastal species.

Focusing on the Mediterranean, there are 21 marine IBAs totalling 26,780 km^2 (Figure 2). Of these, 17 were designated as SPAs, covering 21,691 km^2. Other 2 sites had already been designated by the regional governments, and 2 more sites were left pending for designation since their limits extended beyond Spanish waters - the Gibraltar Straits and the waters surrounding Chafarinas Islands. The new SPA inventory included seaward extensions to colonies, migratory corridors, and foraging areas at sea.

Occasionally, a single SPA included different types of sites simultaneously. In the Mediterranean context, seaward extensions to colonies predominated in the Balearic Islands, whereas the Iberian shelf provided important foraging hotspots. The only migratory corridor identified as IBA in the region corresponded to the Straits of Gibraltar, which has not been designated as SPA yet. A total of 27 seabird species met IBA criteria in the network of IBA/SPAs, including 14 species in the Mediterranean (Table 1). The latter included 10 of the species listed in Annex II of the Barcelona Convention, while other priority species could also benefit from the network.

Moreover, SPAs may act as an umbrella that contributes to the conservation of other marine biota, and hence to the marine ecosystem as a whole.

WORK AHEAD

In Spain, the obvious and crucial next step will be to elaborate and implement the management plans for the SPAs. This process is due for 2016, and will depart from the management guidelines elaborated during LIFE+ INDEMARES. It should also go through a participative process with the stakeholders and the general public, to ensure acceptance of the plans. Management actions should aim to minimise the identified threats to the seabirds and their habitats, and to either keep the relevant populations at current levels or recover them if appropriate. The main philosophy is not based on prohibition, but on proper management of the human activities to ensure a minimum impact. It is also necessary to designate the pending IBAs. Beyond that, it is important to implement monitoring programmes that will evaluate the long-term stability of the SPA network, and identify potentially overlooked hotspots.

At the Mediterranean scale, the picture is quite heterogeneous. While some countries have recently made important advances in the identification of marine IBAs (Spain, Greece, Malta, France), others are by far lagging behind in this task. Progress has been less accomplished regarding the protection of sites, with only Spain and France having designated an acceptable network of SPAs (BirdLife International 2013). It is therefore urgent to prompt other EU countries to extend their Natura 2000 networks to the marine environment, including seabirds. Furthermore, since the Mediterranean extends beyond the EU, it is important to find other ways of protection which can also contribute to the conservation of seabirds. In this sense, the Specially Protected Areas of Mediterranean Importance (SPAMIs) under the Barcelona Convention should play a key role, providing protection to seabird hotspots across the whole Mediterranean (Gabrié *et al*. 2012).

SPAMIs should be of particular relevance to provide regional coherence, and would be most useful in those cases of sites that encompass waters from different countries, such as the Strait of Gibraltar.

It is also important to coordinate this work with the identification of Ecologically or Biologically Significant Marine Areas (EBSAs), under the CBD, thus ensuring an ecosystem perspective to the network of marine protected sites. The BirdLife IBA Programme could be beneficial to the process of MPA designation regarding seabirds, by ensuring a coherent network approach at regional level.

Finally, it is important to keep in mind that MPAs are useful conservation tools; however these should be combined with other conservation approaches at the wider scale to ensure the conservation of seabirds and of the Mediterranean marine ecosystem.

ACKNOWLEDGEMENTS

The identification of marine IBA and SPA in Spain was a long process in which several people and institutions collaborated, too many to be quoted here. For a full disclosure, the reader is referred to Arcos et al. (2009) and SEO/BirdLife (2014).

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English name	Scientific name	Global	Regional	EU	Total
Scopoli›s shearwater*	*Calonectris diomedea*	2	6	2	10
Balearic shearwater*	*Puffinus mauretanicus*	17	0	0	17
Yelkouan shearwater*	*Puffinus yelkouan*	2	1	0	2
European storm-petrel*	*Hydrobates pelagicus*	0	9	0	9
Atlantic gannet	*Morus bassanus Phalacrocorax*	1	0	0	1
Mediterranean shag*	*aristotelis desmarestii*	0	4	2	6
Great skua	*Catharacta skua*	1	0	0	1
Mediterranean gull*	*Larus melanocephalus*	1	0	2	3
Slender-billed gull*	*Larus genei*	0	4	0	4
Audouin›s gull*	*Larus audouinii*	16	1	0	17
Yellow-legged gull	*Larus michahellis*	0	1	0	1
Sandwich tern*	*Sterna sandvicensis*	1	1	0	2
Common tern	*Sterna hirundo*	0	2	1	3
Little tern*	*Sternula albifrons*	0	4	0	4

Table 1. Seabird species that met IBA criteria in the Spanish Mediterranean IBA/SPAs. For each species the number of IBAs identified is indicated, according to the level of importance (global, regional or European Union – EU). Astherisks indicate those species included in the list of endangered or threatened species of the Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean (Annex II of RAC/SPA – Barcelona Convention).

Figure 1. Marine IBA delimitation, taking as example the Ebro-Delta-Columbretes shelf. This area included both foraging areas and seaward extensions for a variety of seabirds. The commbination of these hotspots resulted in the proposal of IBA ES *Marine shelf of the Ebro Delta-Columbretes Islands*, which was later designated as an SPA. All the hotspots shown in the figure met the required IBA criteria to corroborate their relevance.

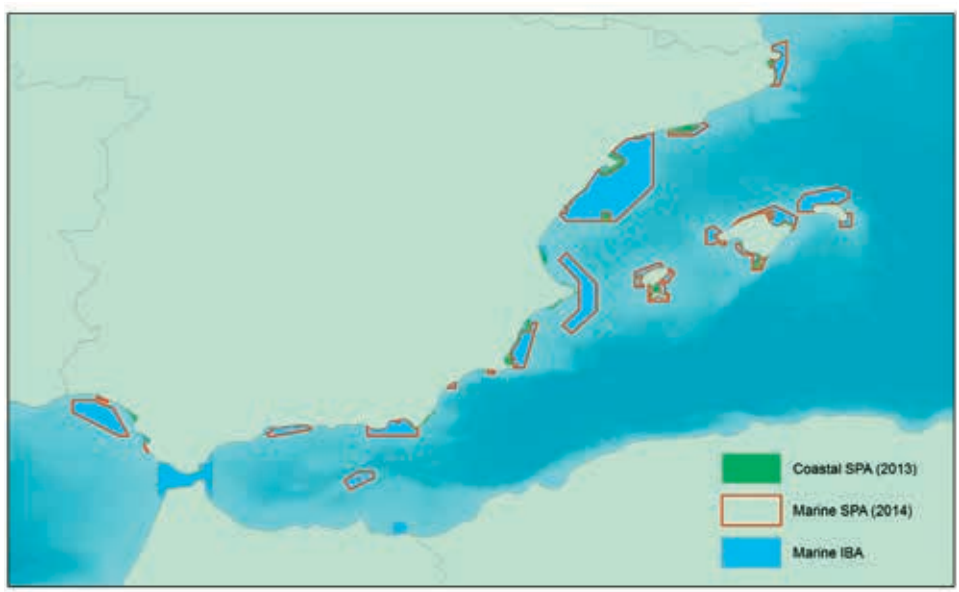

Figure 2. Network of marine Important Bird Areas (IBAs) and Special Protection Areas (SPAs) in Spain. The marine IBAs were taken as the reference to guide the recent designation of marine SPAs under LIFE+ Project INDEMARES (2014). Previously, only a few small, coastal sites had been designated as SPAs.

The importance of the marine IBAs network and marine protected areas for the conservation of Mediterranean seabird species

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ABSTRACT

The protection of areas important for birds is one of many tools used to halt the decline of bird species and to ensure their-long term recovery. Seabirds' survival is depending on the protection of both land and sea areas to counter their worldwide documented decline. The Mediterranean Sea, with its fair share of endemic species, is no exception and there is an urgent need for immediate conservation efforts to sustain the future of its seabirds. BirdLife International has established a system of Important Bird Areas, which have been the precursors of Specially Protected Areas (SPA) within EU under the Natura 2000 network. The need to designate and protect these areas is driven by the EU Biodiversity Action Plan (2008) which had set a target to declare and manage SPA sites on land by 2010, and at sea by 2012. Unfortunately to date, many member states across the EU have fallen short of this target, with a pronounced shortage of sites in the Central Mediterranean. The Yelkouan Shearwater *Puffinus yelkouan* revised IUCN status in reaction to further decline, and the recognition of distinct taxonomic species such as the Scopoli's Shearwater *Calonectris diomedea*, are two cases which necessitated a drive to gather more knowledge on Mediterranean seabirds, and secure the areas important for their survival. Research programmes such as the LIFE+ Malta Seabird Project continue to give insights into the range of these highly pelagic seabird species. As further information is gathered on seabird foraging and migratory ranges, the need for trans-national efforts beyond territorial waters as well as across political boundaries and continents is becoming a necessity rather than an objective. International conventions such as the Barcelona Convention offer the possibility for cooperation between countries and international NGOs at designating important bird areas across territories within the Mediterranean Sea.

INTRODUCTION

The Mediterranean is blessed with a variety of seabirds. Without the need to go into the specifics of each species, we know that the majority of the seabirds in the Mediterranean are suffering from unfavourable conservation status, with the exception of a few that have learned to adapt and integrate within the heavily urbanised Mediterranean such as Yellow-

legged Gull *Larus michahellis*. These species are covered under various international conventions and directives and a good proportion of them, such as Yelkouan Shearwater *Puffinus yelkouan* and European Storm-petrel *Hydrobates pelagicus*, are afforded the highest protection under the European Birds Directive featuring as Annex 1 species – high priority species for which it is mandatory to designate protected areas.

Protecting them at sea is no easy task however, given their highly pelagic nature and the simple fact that seabirds know no administrative boundaries. While some species contain themselves within the Mediterranean, others venture out to other continents such as the Scopoli's Shearwater *Calonectris diomedea* which we have managed to track down to the west coast of Africa. This renders the protection of seabirds at sea even more challenging if not impossible to achieve all throughout their range. While advances are being made in researching their whereabouts, to date we still have many gaps in our knowledge on various species. For example, the European Storm-petrel remains a very elusive species rarely encountered out at sea, let alone knowing where these birds forage and migrate. The differences in the legislative and policy priorities of different countries around the Mediterranean also present their challenges. While within the EU the Birds Directive demands the designation of Special Protection Areas for Annex 1 species, non-EU countries surrounding the Mediterranean lack this tool or obligation, thus relying on other mechanisms by which to acknowledge the importance of important sites to seabirds.

WHAT ARE IBAS?

IBAs refer to Important Bird Areas, and are defined by BirdLife International as being key biodiversity sites recognised not simply for their importance to birds but collectively also for other species. The identification of IBA sites is an on-going process with BirdLife International partners boasting no less than 12,000 sites worldwide.

Sites are selected on the basis of scientific information, often collected by BirdLife partners and subjected to scrutiny against a number of criteria for which an important bird area may qualify. Such criteria normally look at the quantitive value of the site in terms of the numbers of birds it holds or attracts, versus the trend of the particular species on a global or regional level. Criteria also vary slightly between European IBAs, Middle-Eastern IBAs and Asian IBAs which qualify under slightly different applicable criteria developed over the years. Historically such IBA criteria have been easy to prove for land areas, given the availability of scientific information and the easier access to knowledge. This has resulted in a wealth of land IBA, with a much lesser wealth of marine sites

Within the EU, IBA sites have very much been the precursors of a great number of Natura 2000 sites – a network of protected areas demanded by the Birds and Habitats Directives with the objective of achieving a network of staging, feeding and nesting areas for birds, with a special focus on those afforded the highest protection – namely Annex 1 species. The establishment of IBA sites into Specially Protection Areas (SPAs) under the Birds Directive has on the other hand enabled a wealth of mechanisms to ensure the effective conservation of these areas and the birds they host. IBAs and SPAs appear to have been a success story due to obligatory management measures and the availability of EU funding for research, and for the conservation and management of sites,.

IBAS AND MALTA'S FIRST EU LIFE PROJECT

Despite the fact that in Malta the land areas were well known, they were not afforded enough protection. Following an exercise to map and identify all IBAs in Malta in 2004 (Borg & Sultana 2004), all sites eligible for Annex 1 species qualified for designation of SPAs within the Natura 2000 network. This has opened up the opportunity of funding such as LIFE projects and the ability to use such projects to manage effectively important areas as well as to set the way forward for addressing the gap in our knowledge on important sites for seabirds at sea.

Malta's first LIFE project on seabirds – the EU LIFE Yelkouan Shearwater Project – was the very first step at securing Malta's largest colony of Yelkouan Shearwater at Rdum tal-Madonna. This SPA site qualified for EU LIFE funding, which secured various threats on land and addressed some of the knowledge gaps. Funding was invested in tracking these birds at sea and getting a very first idea of the important sites at sea for this species.

ADDRESSING THREATS ON SEABIRD

Identifying IBAs for seabirds bring about a number of challenges. Whereas nowadays we are pretty much well aware of the threats on land at colony sites on which these seabirds depend, evaluating the threats at sea is more difficult to achieve. Whereas we know which management measures protect them on land, knowing which management measures are required at sea, requires a wealth of knowledge that for various species is still lacking. Various aspects are to be considered for the adequate protection of seabirds at sea, ranging from simple disturbance at their colonies to overfishing and plastic pollution in their foraging areas. Knowledge on the biology and movements of the species is essential and is the very primary tool at finding where IBAs at sea occur.

MARINE IBAS

Due to the difficulty in getting adequate knowledge on the important sites for seabirds at sea, marine IBAs have mostly been seen as an expansion of conservation efforts following the designation of land IBA sites. Marine IBAs essentially tackle three primary criteria: (a) seaward extension to colony sites – for seabirds we are tackling mostly rafting areas; (b) seabird congregation areas – where for reasons of foraging, staging, resting or migration, birds congregate in great numbers in these areas; and (c) more specifically – migration corridors or bottlenecks – areas which either link other important sites, or because of climatic, behavioural or geographical reasons result in the concentration or common use of a particular route during migration.

MARINE IBA TOOLKIT

BirdLife International's Global Seabird Programme has established what is called the Marine IBA toolkit (BirdLife International 2010). This is a document which was revised and refined following various workshops and aimed at defining those criteria against which BirdLife International accepts a site as a marine important bird area. The toolkit identifies four main criteria which qualify Marine IBA sites: (a) seaward extensions to breeding colonies; (b) coastal congregation areas; (c) migratory bottlenecks; and (d) off-shore congregation areas.

MALTA-GOZO CHANNEL – MALTA'S FIRST MARINE IBA

Further to the LIFE Yelkouan Shearwater Project, seabird tracking data for this

species along with other information collected by BirdLife Malta were scrutinised under the Marine IBA criteria leading to the creation of Malta's first Marine IBA, which has triggered three of the main criteria for which Marine IBA are recognised.

The Malta-Gozo channel addresses in particularly: (a) a 7km seaward extension for the Yelkouan Shearwater at its largest colony at Rdum tal-Madonna to the North-east of Malta; (b) a 5km seaward extension for the Scopoli's Shearwater at is largest colony of Ta' Cenc along the South west cliffs of Gozo; (c) coastal congregations of both species within the channel; and (d) migratory bottleneck for the Ferruginous Duck *Aythya nyroca* which congregates in significant numbers during its spring migration within the channel area.

MALTA'S FIRST MARINE IBA: WHAT ARE THE IMPLICATIONS?

The implications of this very first step have already led to a number of important results. Having been officially recognised by BirdLife International, the site has been included in BirdLife International's Marine IBA e-atlas. The IBA designation process has put forward the proposal to the Maltese government to designate this vast area as Malta's first Special Protection Area – a requirement Malta needed to fulfil in 2012 but as with various European countries is very much delayed in this process. On 19 February 2015 the environment authority in Malta has rejected a government proposal to construct a wind farm of 19 wind turbines which would have stretched over the whole eastern part of the Marine IBA. The impacts of this farm were expected to cause the abandonment of Malta's largest colony of Yelkouan Shearwaters. The abandonment of this project has not just secured the colony but also the whole Gozo Channel area for migratory species and other seabirds. The Marine IBA designation has already put on high alert government authorities who are currently considering creating a permanent link between Malta and Gozo via the construction of a bridge between the islands. This would have disastrous effects and the designation of the site as a SPA would render such a move even more difficult. Its designation as a SPA site would further incentive sustainable tourism in the form of eco-tourism which is already becoming popular thanks to the unique attraction of thousands of Scopoli's Shearwaters congregating in the area.

CONCLUSION

The case of Malta shows that Marine IBA sites allow to prioritise work and resources on most threatened seabird species; initiate further designation at government level (such as Natura 2000 sites); constitute an extension of past conservation efforts on land; attract funding which in return can consolidate further research and conservation; do not necessarily concern breeding species; and provide the tools to protect species against various human activities and development.

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Status and conservation of seabird species in Greece and the current Marine Important Bird Area network

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ABSTRACT

The present article provides an extended summary of the publication of the Hellenic Ornithological Society (HOS) *Important Areas for Seabirds in Greece* (Fric *et al*. 2012). The identification of key sites for seabirds in the marine environment, i.e. marine IBAs, is a vital step in the Important Bird Areas (IBA) Programme with the ultimate goal to promote the conservation of the marine environment and its biodiversity and to contribute to the marine Natura 2000 network. In Greece, the marine IBA inventory was realized by HOS in cooperation with BirdLife International, other BirdLife partners in Europe, as well as national environmental, research and academic institutions and organizations through the implementation of the project LIFE07 NAT/GR/000285.

THE AREA AND SPECIES COVERED

In Greece, the marine IBA identification process focused specifically on the marine areas under the direct jurisdiction of the Greek state, i.e. within national territorial waters, which extend up to 6 nautical miles from the coastline in the Aegean and Ionian Seas. Greece holds a unique insular environment, with the second longest coastline in Europe, stretching for 17,400 km (Policy Research Corporation 2011), with more than 2,000 islands and islets, of which only 227 are inhabited (GNTO 2012), and thousands more rock formations. The marine and coastal environment exhibits a variety of ecosystems and habitats, in their majority cliffs and rocky shores of igneous and calcareous origin, as well as beach and deltaic formations (SoHelME 2005). The sea bottom topography of the Aegean Sea is characterized by a relatively narrow continental shelf and three main depressions (Poulos *et al*. 1997, SoHelME 2005). The most prominent trench is the Hellenic Trench which extends west of the Ionian Islands and arches south and southeast of Crete.

Although the whole Mediterranean Sea is characterized as oligotrophic, the Aegean Sea presents a high south-to-north gradient of chlorophyll–a concentrations, mainly due to the outflow of the nutrient rich Black Sea water and the river discharge into the northern Aegean. Of particular interest are also the upwellings of nutrient rich waters along the coast of the eastern part of the Aegean Sea, associated to the strong 'Etesian' winds occurring during summer and the fronts

created at the convergence of two water masses with different characteristics (Black and Levantine Seas) all of which influence primary productivity and distribution of fish, as well as other marine fauna including seabirds. Despite of the high variety of coastal and marine habitats of Greece, seabird abundance and diversity are lower than expected. Among 39 species of seabirds and waterbirds recorded in Greek waters, six are considered purely seabird species and were used in marine IBA criteria selection and application, namely Scopoli's Shearwater *Calonectris diomedea*, Yelkouan Shearwater *Puffinus yelkouan*, Mediterranean Storm Petrel *Hydrobates pelagicus melitensis*, Mediterranean Shag *Phalacrocorax aristotelis desmarestii*, Audouin's Gull *Larus audouinii* and Yellow-legged Gull *Larus michahellis*.

DATA COLLECTION

For the delineation of marine IBAs, systematic collection of data on land and at-sea commenced in 2007 with the project 'Survey and Conservation of Seabirds in Greece' (Dimalexis *et al.* 2007a) and was greatly expanded in 2009 with the LIFE-Nature project 'Concrete conservation actions for the Mediterranean Shag and Audouin's Gull in Greece, including the inventory of relevant marine IBAs' (HOS 2013). In addition to these marine IBA oriented projects, all available data collected by HOS during the last 15 years (Gatzelia 1999, Dimalexis *et al.* 2007b, Dimalexis *et al.* 2009, Portolou 2015) and relevant to marine IBAs were utilised. Data from seabird colonies included the compilation of existing estimates of breeding populations while new data were collected using various methods; in the case of large shearwater colonies, sample quadrat monitoring was applied (Bibby 1992, Walsh *et al*. 1995, Gilbert *et al*. 1998). Marine surveys comprised the main source of information with respect to seabird distribution and abundance in marine areas adjacent to their breeding colonies and further out at-sea, the geographical extent of area used by seabirds at migration bottlenecks and staging areas, and the bird's behaviour at-sea. More than 270 coastal survey counts were carried out during all seasons in order to include breeding, non-breeding and migration periods of each seabird species (Figure 1). The largest proportion of marine areas were surveyed using the European Seabirds At Sea (ESAS) methodology (Tasker *et al*. 1984, Camphuysen & Garthe 2004) carried out primarily along predefined routes by HOS and from opportunity vessels (e.g. ferry boats). In total, a distance of 26,500 km was covered during ESAS surveys, resulting in a total surveyed area equivalent to 10,330 km^2. Boat-based line transect surveys along the coastline of islands and the mainland were also used to record seabirds in the coastal marine areas, covering 11,106 km of coastline, equivalent to a marine area of over 3,300 km^2.

Telemetry data were collected through various tracking devices, namely radio-tags, geolocators, GPS dataloggers and compass-data loggers, mounted on Audouin's Gulls, Mediterranean Shags, Scopoli's Shearwaters and Yelkouan Shearwaters at 16 colonies in the Aegean and Ionian Sea (Table 1). Data from 80 tracks were acquired through telemetry and provided thousands of locations of tracked individuals which were then available for further analysis. Seabird behaviour was determined at these positions, either based on direct observations or inferred through speed data. Telemetry data were analysed with kernel density estimators to reveal those marine areas with the greatest probability of seabird presence and foraging or resting hotspots. These data were used to establish the maximum radii of marine IBAs seaward extension from breeding sites.

Data sets of environmental variables were collected and analyzed through modelling in order to explore parameters influencing seabird distribution and abundance at-sea. These data sets included static (e.g. bathymetry, seamounts) and dynamic environmental variables (e.g. depth, seabed slope, sea temperature, chlorophyll-a density, salinity, fronts, primary productivity). Seabird distribution models also allowed for the extrapolation of seabird densities to areas which could not be surveyed.

DATA ANALYSIS AND IDENTIFICATION OF CANDIDATE MARINE IBA SITES

Identification and delineation of candidate marine IBAs was carried out for each species separately, following the standardized protocol developed by BirdLife International (2010), as well as the experience of other BirdLife partners which had already completed their marine IBA inventories, i.e. SPEA / BirdLife Portugal (Ramirez *et al*. 2008) and SEO / BirdLife Spain (Arcos *et al*. 2009). BirdLife's IBA criteria were then applied to each species per candidate marine IBA identified in order to verify and justify or reject them as part of the final marine IBA inventory. Overlapping candidate sites for different species which fulfilled IBA criteria were merged into single marine IBAs (Figure 2).

Where appropriate, the boundaries were simplified so as to allow easier identification of the limits of the marine IBAs and facilitate their future use as distinct units for the conservation of seabirds at sea. The resulting marine IBA inventory included those areas which were recognised as the key marine sites for seabirds in Greece and was submitted to the BirdLife International Secretariat for validation.

THE GREEK MARINE IBA INVENTORY

The Greek marine IBA inventory currently consists of 66 sites, of which 41 were identified through the above-mentioned process in 2012, while 25 comprise marine components of terrestrial IBAs designated back in 2000 (Fric *et al*. 2012). The majority of the sites are *colony seaward extensions*, while the remaining includes *areas for pelagic species* (7), *migratory bottlenecks* (2), and *non-breeding (coastal) concentrations* (4). The marine IBA inventory covers a total area of 10,602 km^2 which is equivalent to approximately 2.1% of the territorial waters of Greece (http://www.marineregions.org), while most of the sites (56) are located in the Aegean Sea. Their size varies from 0.85 km^2 to 1,866 km^2 and more than 77% of the sites include shallow waters of 0-30m depth. In the vast majority of marine IBAs, the 4 main seabird species (Scopoli's and Yelkouan Shearwaters, Shag, Audouin's Gull) have been fulfilling the IBA criteria (Figure 3), while overall 28 sites were selected as they host populations of globally threatened or near threatened species, i.e. Audouin's Gull and Yelkouan Shearwater, meeting criteria A1 and C1 respectively (Figure 4).

When it comes to site protection, the true marine area of the marine IBAs only overlaps with 11% of the existing designated marine SPA network, while the whole area of those IBAs with a marine component exhibits a 28% overlap. Following BirdLife International's initiative to collate bird population data at a pan-European scale to produce *Birds in Europe 3* (BiE3), seabird population estimates and trends were provided (Table 2). Compared to data from the previous decade (BiE2), increased populations have been recorded for the Scopoli's Shearwater, European Storm Petrel and Mediterranean Shag, mainly explained by the more efficient coverage of the breeding areas and increased knowledge

on the distribution, movements and ecology of these seabirds. However, an apparent decline of approximately 29-61% of the Audouin's Gull national population has been recorded. The exact reasons for this remain unknown, although colony size and productivity has declined, while colony fragmentation has been recorded (Saravia *et al*. 2012).

FUTURE STEPS

The marine IBA identification process is not yet considered complete in Greece. There are still several pelagic areas important for shearwater species, as well as coastal marine areas which host significant numbers of waterbirds, where, due to insufficient information and reduced funding, marine IBAs have not been delineated until now. HOS's future aim includes the collection of additional data on shearwater species in order to identify new marine IBAs for this seabird group. Further studies are also required for the assessment of threats, particularly the levels of bycatch and food availability. Finally, HOS is dedicated into providing support to the Greek authorities in order to achieve progress in the designation of marine SPAs.

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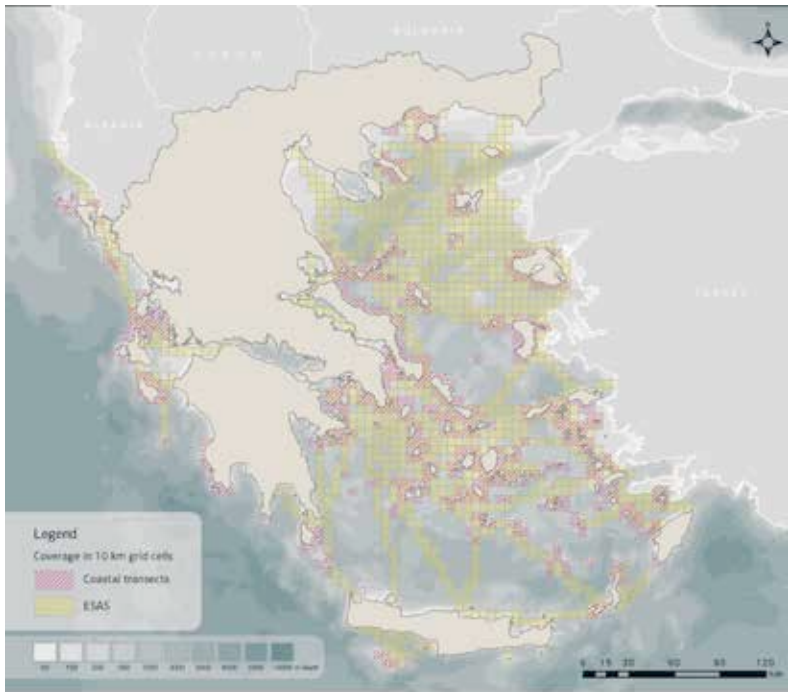

Figure 1. Spatial coverage of marine areas in the Aegean and Ionian Sea by boat-based surveys.

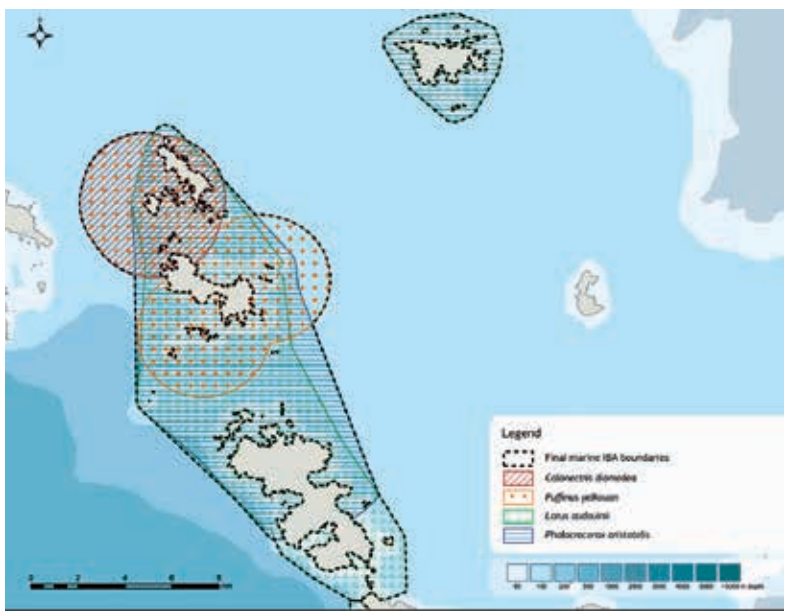

Figure 2. Final marine IBA boundary resulting from the individual trigger seabird species (IBA GR160 as an example).

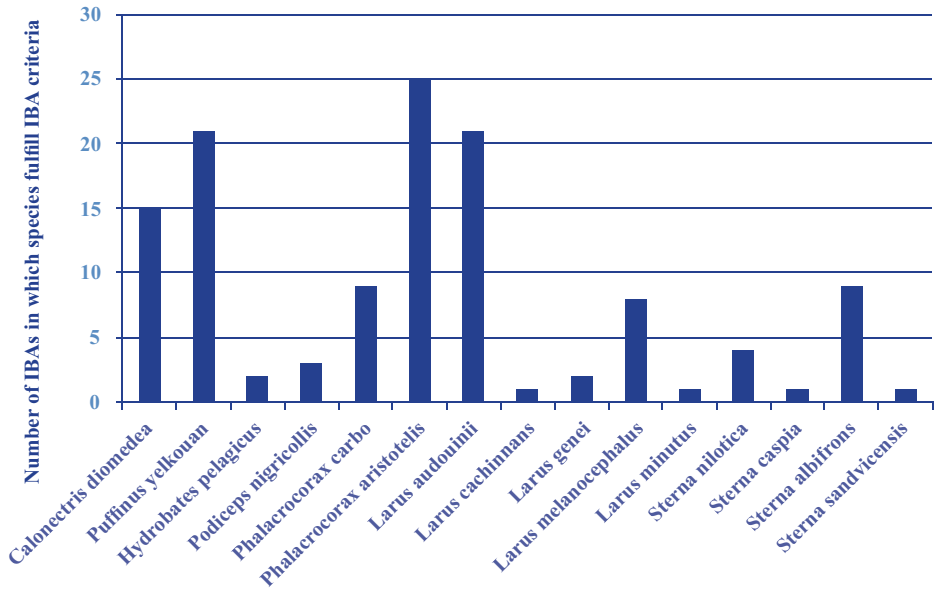

Figure 3. Number of IBAs in which species fulfill marine IBA criteria in Greek waters.

Tracking method	Audouin's Gull	Mediterranean Shag
Radio-tags	12	24
GPS dataloggers	8	8
Geolocators	5	
Geolocators		
Number of colonies	6	5

Table 1. Number and type of tracking device mounted on seabirds for marine IBA identification in Greece.

Common Name	Breeding Populatio n (pairs) - BiE2		Breeding Population (pairs) - BiE3	
Scopoli's Shearwater	5000	5000	8000	11000
Yelkouan Shearwater	4000	7000	4000	7000
European Storm Petrel	10	30	100	150
Mediterranean Shag	1000	1200	1300	1450
Audouin's Gull	750	900	350	500

Table 2. Population estimates and trend estimates for seabirds in Greece.

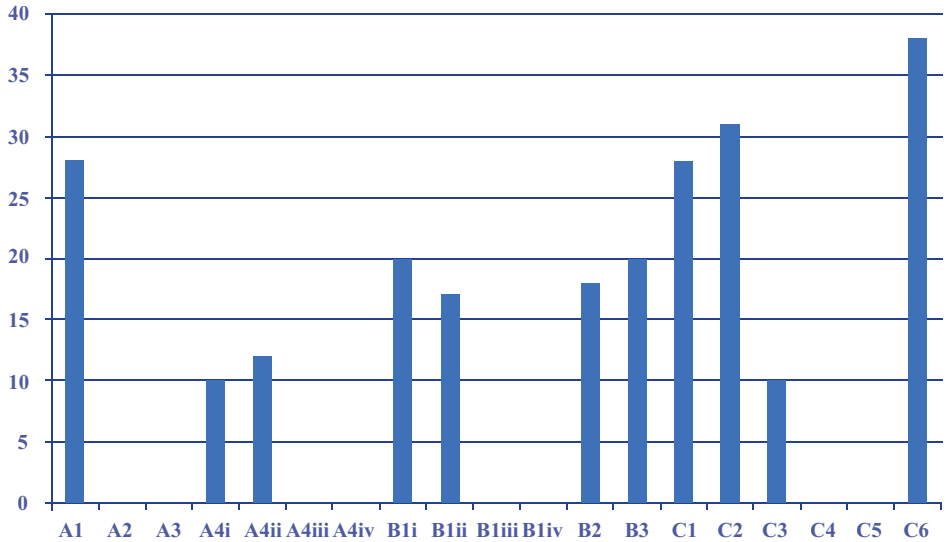

Figure 4. The number of IBAs triggering each criterium in the Greek marine IBA inventory.

Scopoli's Shearwater	Yelkouan Shearwater
30	2
30	
3	
4	1

Greek RDB (1992)	Greek RDB (2009)	Population Trend BiE2	Population Trend BiE3	Trend min-max	Year
-	-	0	Stable	0	2001-2012
-	NT	0	Stable	0	2001-2012
R	DD	0	Unknown	-	2001-2012
V	NT	(0)	Stable	0	2001-2012
E2	VU	0	Decrease	29-61	1998-2010

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2ND SYMPOSIUM ON THE CONSERVATION OF MARINE AND COASTAL BIRDS IN THE MEDITERRANEAN

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RAC/SPA

The Regional Activity Centre for Specially Protected Areas (RAC/SPA) was established in Tunis in 1985 by decision of the Contracting Parties to the convention for the Protection of the Mediterranean Sea against Pollution (Barcelona Convention), which entrusted it with responsibility for assessing the situation of natural heritage and assisting the Mediterranean countries to implement the Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean (SPA/BD) Protocol which came into force in 1999.
RAC/SPA's mission is to provide assistance to Mediterranean countries in the implementation of their commitments under the (SPA/BD) Protocol, especially in regard to developing and promoting Specially Protected Areas (SPAs) and reducing the loss of marine and coastal biodiversity.

MEDMARAVIS

MEDMARAVIS is an international NGO dealing with the study and conservation of coastal habitats and marine avifauna throughout the Mediterranean region. Its main goal is to study, monitor, and protect coastal biotopes, with main focus on small islands, unspoilt coasts, and seacliffs which harbour breeding seabirds and other endemic or threatened species. Medmaravis, enjoying a network of marine biologists, ornithologists and conservationists, organizes a major seabird conference every three years. It is engaged in the compilation of a conservation strategy for the Mediterranean Sea, propagating the importance of the seabirds' rôle in the ecosystem, and encouraging governments and local authorities to protect the last wild coastal ecosystems in the Mediterranean countries. Since late 2014, as an effect of a liaison with the Conservatoire-du-Littoral (CdL, France), Medmaravis is in charge of producing simple and reproducible protocols that will be applied across the Mediterranean, in order to harmonize the methods applied to monitor chemical and plastic contaminants throughout the Mediterranean coast.

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