ALBATROS PROJECT *MONOGRAPH* *2012*

THE OSPREY,

Updated state of knowledge and conservation in the Mediterranean basin.

Flavio MONTI (Ferrara and Montpellier Universities)

Reviewers and data providers:

Olivier Duriez *(CEFE/CNRS)*
Jean-Marie Dominici *(Parc Naturel Régional de Corse)*
Rafel Triay (Institut Menorquí d'Estudis)
Joan Mayol Serra (Conselleria de Medi Ambient)

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Abstract / Résumé

ABSTRACT :

With less than 100 breeding pairs distributed within Corsica, the Balearics, Morocco and Algeria, the osprey *Pandion haliaetus* shows traits of weakness and instability within a long time span, in the Mediterranean. During the last century, persecution by man and habitat alterations determined local extinctions which resulted in a reduction of its distribution range. Direct management actions (e.g. creation of nature reserves, environmental improvements and strict conservation laws) have allowed a partial recovery of this raptor species, in Corsica and Balearics, but present population numbers represent about 1-third of individuals living during the first half of the XXth century. In Morocco and Algeria, some surveys have been carried out to count breeding pairs, but data are still scarce. One of the most crucial strategies for conservation of the Osprey is its recovering at historical breeding sites (e.g. Spain, Italy), within a framework of a sound conservation strategy, at the Mediterranean/European scale. Here, a state of knowledge of the osprey is reported in the form of a monograph, in the framework of the Mediterranean Small Island Initiative (PIM) coordinated by the Conservatoire du Littoral. My paper includes a review of basic information on biology, ecology and geographical distribution of this species. Data are reported on trends of the populations and their conservation status. The main threats, at the Mediterranean scale, are identified and discussed. Some aspects of the biology and spatial ecology of ospreys in the Mediterranean far from being comprehensive, future research should be addressed to fill the gaps. In particular, collecting information about movement patterns and dispersal strategies of the Mediterranean Ospreys represents a primary condition for conservation purposes. In this way, it will be possible to detect any key conservation-related measures that should be applied in order to progress into an effective management of the species.

Keywords : Osprey, *Pandion haliaetus*, state of knowledge, geographical distribution, Mediterranean, threats, suggestion of action of conservation

RESUMÉ :

Avec moins de 100 couples reproducteurs répartis entre la Corse, les Baléares, le Maroc et l'Algérie, le Balbuzard pêcheur *Pandion haliaetus* est une espèce présentant une population méditerranéenne instable dans le temps. Durant le dernier siècle, les persécutions et les dommages causés à son habitat par l'homme ont eu pour conséquence des extinctions au niveau local puis une diminution globale des effectifs. Des actions directes de gestion (ex : création d'espaces protégés, amélioration des habitats et établissement d'un cadre juridique de conservation) ont permis une réaugmentation partielle des effectifs en Corse et aux Baléares, cependant la population actuelle en Méditerranée représente seulement un tiers de celle estimée pour la moitié du XXème siècle. Au Maroc et en Algérie, quelques suivis sont mis en place pour évaluer les effectifs nicheurs mais relativement peu de données sont produites. Une des stratégies de conservation les plus importantes est la réoccupation des sites de nidification historique (ex : en Espagne et Italie) dans le cadre de programmes de réintroduction issus d'une coopération à l'échelle méditerranéenne ou européenne.
Cette monographie propose un état des connaissances réalisé dans le cadre de l'initiative pour les Petites Iles de Méditerranée coordonnée par le Conservatoire du littoral. Ce document comprend un rappel des connaissances basiques concernant la biologie, l'écologie et la distribution des effectifs. Les principales menaces y sont aussi explicitées à l'échelle du bassin Méditerranéen.
Certains aspects concernant la biologie et les phénomènes de dispersion des individus en Méditerranée étant loin d'être complètement compris, des programmes de recherche doivent être mis en place pour pallier à ces manques de connaissance. La collecte d'information sur les modèles de dispersion en particulier représente un enjeu important pour la conservation de cette espèce. Ainsi, il sera possible à l'avenir de détecter les mesures de conservation essentielles qui devraient être appliquées afin d'aller vers une gestion conservatoire plus efficace de cette espèce.

Mots-clés : Balbuzard pêcheur, *Pandion haliaetus*, état des connaissances, distribution des effectifs, Méditerranée, menaces, préconisation d'action,

The Mediterranean Small Islands Initiative (PIM):

The Conservatoire du Littoral has been coordinating , since 2005, an international programme for the promotion and assistance for the management of Mediterranean insular micro-spaces, known as the PIM Initiative for the Mediterranean Small islands, which is co-financed by the Fonds Français pour l'Environnement Mondial (FFEM) (French Global Environment Facility), the Agence de l'Eau Rhône Méditerranée-Corse and the city of Marseilles. The PIM initiative is developing a mechanism for the exchange and sharing of knowledge which is necessary for the emergence of good management practices of exceptional spaces. The "Albatros project" has been set up within the framework of this program to enhance the knowledge of Mediterranean nesting bird species. To update the knowledge on these species, the PIM initiative has coordinated the preparation of monographs for each of the project species.

L'Initiative pour les Petites Iles de Méditerranée (PIM).

Depuis 2005, le Conservatoire du littoral coordonne un programme international de promotion et d'assistance à la gestion des micro-espaces insulaires méditerranéens, baptisé Initiative PIM pour les Petites Iles de Méditerranée, co-financé par le Fonds Français pour l'Environnement Mondial (FFEM), l'Agence de l'Eau Rhône Méditerranée-Corse et la Ville de Marseille. L'Initiative PIM développe un dispositif d'échange et de partage des connaissances nécessaires à l'émergence de bonnes pratiques de gestion sur des espaces exceptionnels. Dans le cadre de ce programme, le projet Albatros vise notamment à améliorer les connaissances concernant les espèces d'oiseaux nicheurs de Méditerranée. Afin de fournir un état des connaissances actualisé concernant ces espèces, l'initiative PIM a donc coordonné la réalisation de ces monographies qui doivent à terme servir de document d'aide à une réflexion sur la conservation de ces espèces au niveau méditerranéen.

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GENERAL DATA

Scientific name : *Pandion haliaetus*
English name : Osprey
French name : Balbuzard pêcheur
Spanish name : Águila pescadora
Catalan name (Balearic archipelago) : Àguila peixatera
Italian name : Falco pescatore

Code de protection :
Bonn convention Appendix II
Bird directive: Annex I
Bern convention : Annex II
IUCN : Least Concern
Barcelona convention: Annex II

DESCRIPTION OF THE SPECIE

- **Field characters**

L 55-58 cm (tail 14-21 cm); wing-span 145-170 cm.

Medium-sized raptor with long and narrow wings showing only four “fingers”. Upperparts dark brown while ventrally pale with contrasting black carpal patches, blackish bands on greater coverts and long black tips to primaries. Tail short and square-cut. Diagnostic black stripe through eye to hindneck. Sexes similar with females that tend to be 5-10% larger than males and showing on average prominent brown breast-band; no seasonal variation. Juveniles distinguishable from adults if observed at close distance.

Adult : Mainly white head characterized by an evident black streak through eye. Upperparts feathers uniformly brown whereas under body and under wings generally white coloured (except for darkish bands on greater coverts and black marks on carpals and primaries). Yellow eye. Black beak, getting paler on its base. Feet grey with black claws.

Juveniles : Similar to adult but with feathers of upperparts clearly tipped of whitish and under wings more cross-barred. Tail finely cross-barred below as well as the greater coverts. Eye orange. Indistinguishable at c. 18 months.

Pullus : Completely different from any other bird of prey. First down short and generally smoke-brown; darker patch in front and behind eye. Under parts generally pale. After about ten days a second down

develops, woolly and browner than the first. Feathers completely growth at c. 42 days (Cramp & Simmons, 1980).

Moult : Osprey has an irregular moult sequence of the primaries (Prevost, 1983). Juveniles started to moult at age 6 months. It occurs in successive waves, each starting at primary 1 and moving outwards to primary 10 (descendant). If interrupted, it resumes from the points where it let off. Moult of the secondaries progress towards the body (ascendant) and is completed after 17-19 months. Tail feathers' moult starts at age 5-7 months and entirely terminates at 14 months. First moult cycle is not concluded until c. 5 years (Cramp & Simmons, 1980). In the migratory population of northern Europe, individuals tend to moult mainly from June-July to August-September and from October-November to February-March, resulting in a interruption during migrations (Prevost, 1983). During breeding, males do most fishing; this force them to postpone moult until after the breeding season, whereas females normally moult several flight-feathers while breeding (Hake *et al*., 2001). At lower latitudes (e.g. in the Mediterranean basin), where sedentary populations (or that seem to not perform a complete migration) can be found, patterns of moult would be investigated in a detailed manner since that any differences could be arise (Cramp & Simmons, 1980; Thibault & Patrimonio, 1992).

- **Distinctive characteristics with close species**

Ospreys can be confused with few other raptor species that show a white plumage below: Buzzard *Buteo Buteo*, Short-toed Eagle *Circaetus gallicus*, Bonelli's Eagle *Hieraaetus fasciatus* and Booted Eagle *Hieraaetus pennatus* when in pale morph. During flight, if observed in head-on silhouette, it can recalls a large gull *Larus*. Nevertheless, identification remains relatively easy due to the distinctive configuration of the plumage of the head and of the underparts (Cramp & Simmons, 1980; Poole, 1989).

- **Characteristics of its flight**

The wings angled together with carpals held forward when gliding confer a bowed appearance to the bird on flight. Wingbeats are usually shallow consisting of a series of beats combined with long glides. Captures fish by hovering over water with powerful wingbeats before diving feet-first. During aerial courtship display an undulating flight high up dangling feet is performed.

- **Song description**

Mostly silent outside the breeding season and away from nesting territory, although it may call at times. During the breeding season a variety of high-pitched whistled notes are performed. Three main types of calls have been recognized: guard calls, alarm calls and solicitation calls (Poole, 1989). Both male and female utter notes as "tioop-tioop.." which rise in pitch when intruders approaches near the nest (guard call). The alarm call show a clear sexual dimorphism, stronger in females probably due to their larger body size (Poole, 1989; Bretagnolle & Thibault, 1993). It is composed by repeated strong squeals uttered when a threat approaches close to the nest ("ick-ick…"). Solicitation call (or begging call; "quee-quee..") are often emitted for a long time by females and chicks in order to power male in providing fish. More detailed call descriptions are to be found in Cramp & Simmons (1980) and in Bretagnolle & Thibault (1993).

Worldwide distributed between 49° S and 70° N of latitude because of a wide climatic tolerance, especially in range of temperature and humidity. Osprey's habitat varies in different parts of its extensive range. Although most exclusively tree-nester in the vicinity of rivers and lakes in northern parts of Palearctic range, osprey chooses rocky cliffs for nesting and fishing in marine or brackish water environments in the Mediterranean area (Cramp & Simmons, 1980; Francour & Thibault, 1996), even if some recent cases of tree nesting were observed in Majorca. At times, individuals can also frequent estuaries, marshes and other coastal waters as well as lakes and pools inland located. During migration, any kind of body water where fishing may be possible (medium-sized fish obtainable near the surface; no deeper than 1 meter) can be used. Generally intolerant to disturbance, has locally adapted to intensive human activity (Bai *et al*., 2009). In some cases, osprey nests can be found on power lines, bridges and other artefacts (e.g. artificial nest-sites or platforms erected on poles) (Poole, 1989).

- **Foraging ecology and diet composition**

The species has evolved specialised physical characteristics and exhibits unique behaviour to assist in catching prey, consisting of live fish only (Cramp & Simmons, 1980; Poole, 1989). Adaptations to its specialized manner of feeding are particularly manifest in the structure of the tarsus, that is provided, as well as the lower surface of toes, of sharp spicules essential to catch and manipulate slippery fishes. In addition, the outer toe is reversible and permits to the bird to grip the prey with two toes forward and two toes back (Cramp & Simmons, 1980; Poole, 1989).

Being opportunistic, concentrating on fish that are most available, the species shows a wide diet that can shift during year, depending on region and season (e.g. most marine fish migrate seasonally) (Cramp & Simmons, 1980; Poole, 1989). Diversity of fish species leads to a variety of diving techniques that can be performed at different heights, in flight or from a perch. The diet includes both freshwater and marine species. It concentrates on fish weighing 150-300 grams (about 25-35 centimetres in length) although larger and smaller fish can be taken (Poole, 1989; Francour & Thibault, 1996). Within the Mediterranean

basin, osprey commonly eats mullets (e.g. *Mugil* spp.) and other euryaline species of medium-sized fish caught near the sea surface as: *Liza* spp., *Diplodus sargus*, *Dicentrarchus labrax*, etc. (Thibault & Patrimonio, 1992). For example in Corsica, the diet of breeding ospreys has been studied by identifying fish remains at nests; the identified species mainly belonged to mullets (e.g. *Liza ramada*, *L. aurata*, *Chelon labrosus* and *Mugil cephalus*) and breams (e.g. *Diplodus sargus* and *D. vulgaris*) and to other less representative species (Francour & Thibault, 1996). In Balearic Islands the most representative species detected by direct observation and remains of fish at nests are mullets (*Mugil spp*), salema (*Sarpa salpa* saddled bream (*Oblada melanura*) and gild-heat bream (*Sparus auratus*) (R.Triay unpublished data).

In Majorca, ospreys also often fish in fresh waters, over introduced species (*Cyprinus, Carasius*,...)

Detailed information on the localization of the foraging areas is still deficient, especially outside of the breeding season.

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- **Breeding**

At Mediterranean latitudes, the breeding season starts between February and April, when pairs gradually return to their own nest, that are generally used for several years (Thibault & Patrimonio, 1991). The nest consists of a large structure of branches and twigs stuffed with grass or other soft material (e.g. *Posidonia oceanica*) for lining. Materials are taken from the ground or snatched from trees or plants provided of dead sticks at their top. Generally built by both sexes, nests are placed on cliffs or rock pinnacles close to the sea. The laying mainly occurs in March and April. One to four (3 on average) eggs, creamy-white coloured with brown-red spots, are normally laid in a clutch with an interval of 1-3 days (Thibault & Patrimonio, 1992; Bretagnolle & Thibault, 1993). Replacement clutches could be possible (Cramp & Simmons, 1980). Eggs sized 47x60 mm and weighed about 72 grams (Cramp & Simmons, 1980). The incubation phase, performed by both parents but mostly by the female, lasts 34-40 days (37 days on average; Green, 1976; Cramp & Simmons, 1980). Fledging occurs between June and July, generally after about 50 days from the hatching date (Stinson, 1977; Bretagnolle & Thibault, 1993). For the Corsican population, first flights were mainly recorded during the first week of July (Thibault & Patrimonio, 1991). Parents feed juveniles even after fledging, with fish left at nest. Brood start to follow male to the fishing place after *c.* 10 days; juveniles mature fishing techniques at about 7 weeks after the first flight (Stinson, 1977; Cramp & Simmons, 1980).

Subfossil osprey remains are surprisingly scarce if compared with bones of other bird species; few records were found in Central Europe (Zachos & Schmolcke, 2006), while little archeozoological records are reported for the Mediterranean (Alcover *et al*., 1989; Thibault *et al*., 2001). In the 19th century and early 20th century the species became extinct in many parts of Europe and especially in the Mediterranean area, mainly because of the strong direct persecution (e.g. shooting, egg-collecting and habitat destruction). Most of the areas belonging to the ancient distribution range have been lost and local populations have disappeared (Tab. 1). Nowadays the Mediterranean osprey population is scattered and threatened, confined in few islands and stretches of coast: it is distributed between Corsica, the Balearic Islands, Morocco and Algeria. Thanks to reintroduction programs, the species is returned to breed in mainland Spain and Italy, in 2009 and 2011 respectively (further details in the next chapters).

Table 1. Areas of the ancient range of distribution; year of extinction and lasts breedings.

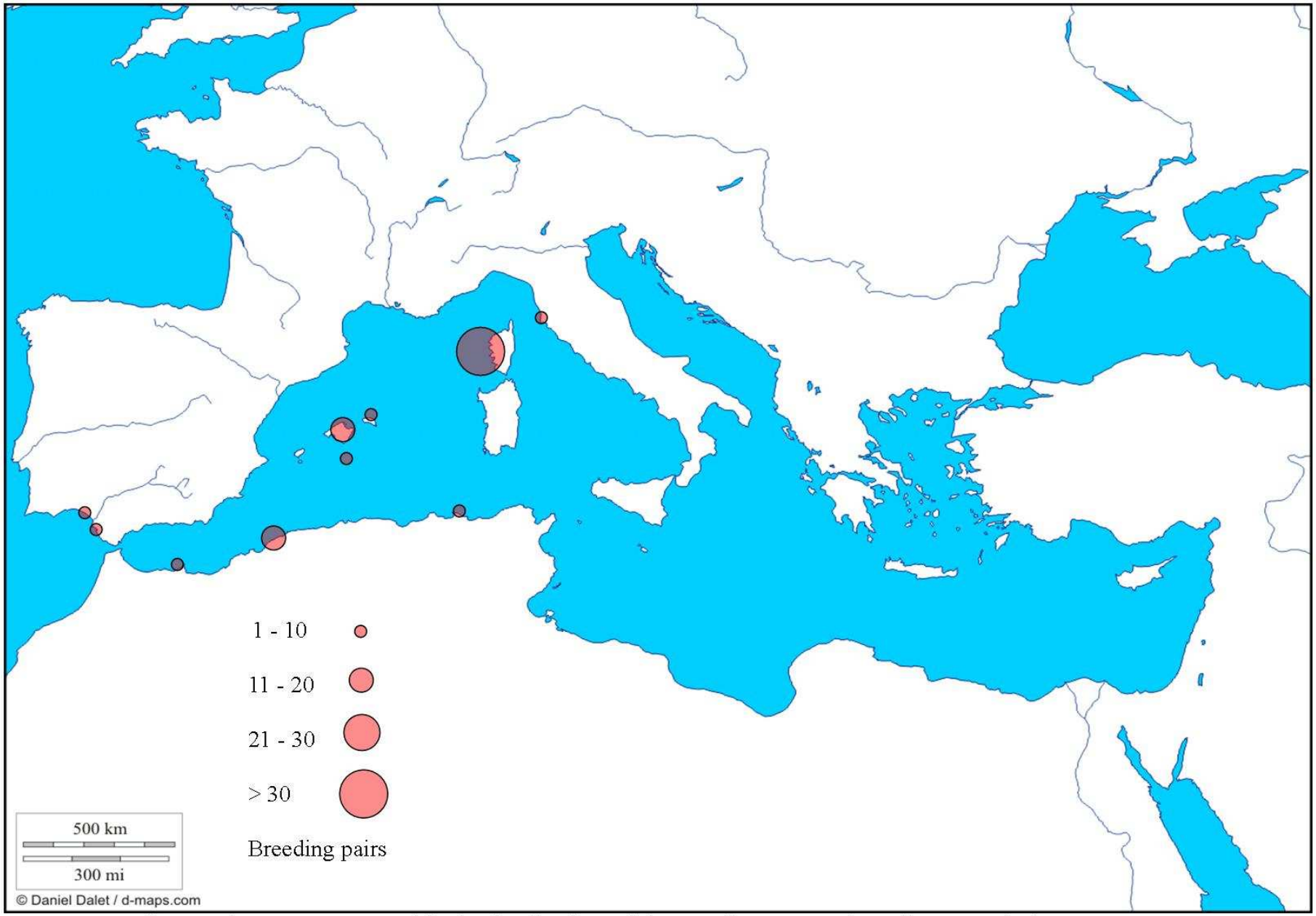
Country	Year of extinction	Last breeding	Reference
Spain (mainland)	1981	Province of Alicante	Urios *et al*., 1991
Greece	1966	Evros delta	Cramp & Simmons, 1980
Italy	1968	Sardinia and Sicily	Brichetti & Fracasso, 2003
Turkey	1966	Thrace and Black Sea coast	Cramp & Simmons, 1980
Tunisia	1943	North and east coast	Cramp & Simmons, 1980
Portugal	1997	Southwest coast	Palma, 2001

Adults and young are thought to not migrate outside the Mediterranean Sea because of occasional sightings in their breeding sites during the winter (Thibault & Patrimonio, 1992; Thibault *et al*., 1996; Thibault *et al*., 2001). Some individuals were observed along sea coasts and wetlands in the Mediterranean and Northern Africa, suggesting reduced movements within the basin (Thibault *et al*., 1996). Some recoveries of Balearic young in the Atlantic coast of Morocco and inland of Morocco and Algeria, suggest wider movements, at least for the young individuals (R.Triay unpublished data; Triay, 2002). Nevertheless, movements, dispersal and migratory schedules are not yet investigated in a detailed manner and basic information on spatial ecology of osprey is still lacking at this scale of resolution and should be better analysed.

Table 2: Geografical distribution of Osprey in the Mediterranean

Geographic Area	Location	Breeding pairs	Total	Reference
Balearic Islands (*Spain*)	Mallorca	12	19	Triay (unp.data, 2011)
	Menorca	5		
	Cabrera	2		
Spain (*mainland*)	Marismas del Odiel (Huelva)	1	2	Muriel *et al*., 2010
	Embalse del Guadalcacin (Cadiz)	1		
Chafarinas Islands (*Spain*)	Isla de Congreso	1	1	Triay & Siverio, 2008
Italy	Maremma Regional Park (Tuscany)	1	1	Monti *et al*., 2011
Morocco	Parc National d'Al Hoceima	<10	10	PIM mission, pers. com. Monti F., Rguibi H., Dominici.
Algeria	West coast (Oran)	15	17	Orueta & Cherckaoui, 2010
	Est coast (El Kala national park)	2		Abdelaziz Salah Telailia *com. pers.*
Corsica (*France*)	West coast (Scandola MPA)	32	32	Dominici, 2008 LPO Mission Rapaces, 2011
Total			82	

- **On the basis of this table, a cartography of the geographical distribution of the breeding pairs has been done. (see below)**



Pandion Haliaetus - Geographical Distribution of the Mediterranean breeding populations– PIM 2012

- **Breeding phenology :**

Breeding Season	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct
Mating												
Laying												
Hatching												
First flight												

Data reported refers to: Thibault & Patriomonio, 1991; Bretagnolle & Thibault, 1993, example given for Corsican population.
A few differences can be observed in this pattern regarding to the population considered: in the Balearic Islands, the mating regularly occurs until April.

Within the Mediterranean area no significant variation in the timing of the breeding season between populations was reported.
Outside from the Mediterranean basin: in the Canary Islands, courtship and nest building activities usually start between February and March (Siverio & Siverio, 1997). In the Cape Verde Islands laying occurs from January to early March, exceptionally December (Cramp & Simmons, 1980). Winter breeders (egg laying mainly occurring between November and December) are found in the Red Sea (Fisher *et al*., 2001).

- **Monitoring periods :**

According to the phenology shown above, here are the monitoring periods corresponding:

	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct
Fieldwork				1st control		2nd control		3rd control				
Ringing periods				adults				juveniles				

- **Population dynamics**

Mediterranean population:

The Mediterranean osprey's population counts less than 100 breeding pairs and consists of small and isolated groups of breeders. Therefore, it shows traits of weakness and instabilities within a long time span. At this regional scale, the species is considered as "endangered". In the red book of the birds of Spain is considered as "critically endangered" (CR) (Triay & Siverio, 2004).

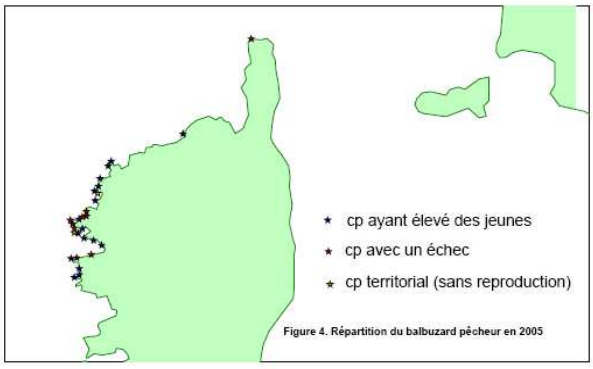
Corsica:

At the beginning of the 20th century a swinging number of 40-100 ospreys' breeding pairs occupied the majority of Corsican rocky coasts. In 1974, because of the strong direct persecution only three pairs remained (Thibault *et al*., 2001; Thibault and Bretagnolle, 2001; Bretagnolle *et al*., 2008). In 1975, the Natural Reserve of Scandola, a dual marine and terrestrial protected area located along the north-western coast of Corsica, was created. In the same years a new law about the protection of nature and birds of

prey (1976) came into force and direct management actions were adopted: a rigorous watch on osprey's last nest sites, and the building of several artificial nest on the rocky cliffs in order to recover the ancient suitable habitat nesting sites and to facilitate the recolonization phase. Thanks to these actions, osprey population gradually recovered, but it has never recolonized its former range from the early 20th century. Two main phases can be detected:

1. a first period of rapid increase in population size between 1974 and 1990;
2. a period of relative stability with fluctuations in population size after 1990 (Bretagnolle *et al*., 2008).

Due to the high philopatry of the species and to the local shortage of available nest sites, birds returned to breed in a relatively small area. Consequently, the mean distances between breeding territories reduced drastically (from 12 km during 70's to only 2 km since 80's); an increase in neighbours' numbers was recorded and the competition for nest sites became intense. In fact, an increase in the number of floaters and a greater frequency of interactions between conspecifics were observed. This lead to important changes in the demography. Both, population growth rate and number of young fledged per pair have decreased with the population increase. In particular, a reduction in hatching and fledging success were recorded (Bretagnolle *et al*., 2008). The latter authors suggested that attracting non-breeders to other areas would reduce interference in the original area. Hence between 1991 and 1998, nine artificial nests were built in Corsica, outside the original breeding area. In 1995, five new territories were established (Bretagnolle *et al.,* 2008). Nowadays, Corsican osprey population counts 32 breeding pairs, but it is considered still threatened (Bretagnolle *et al*., 2008). So in order to accelerate the return of the species, actions aiming at the recovery of the historical osprey's breeding sites like those in Corsica, Tuscany and Sardinia were considered fundamental to re-establish the ancient range of distribution in the Central Mediterranean area.

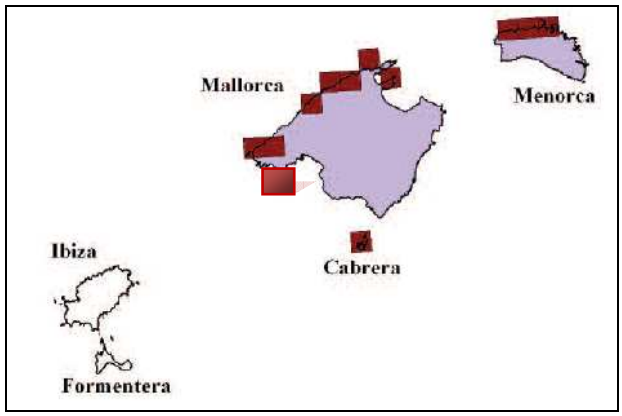


Distribution of the osprey population in Corsica (from: Dominici, 2005).

The Balearics:

During the 20th century, about 35-40 pairs inhabited all the main islands of the archipelago, before disappearing from Ibiza and Formentera (Terrasse & Terrasse, 1977; Mayol, 1978) in the 70's. Because of the strong direct persecution only 8 pairs remained in the 1980s. Successively, thanks to new laws about the protection of nature and birds and to direct management actions, the osprey population gradually recovered, reaching rapidly a total of 16-18 breeding pairs in 1999 (Triay & Siverio, 2008). Nevertheless, the positive trend stopped and a decrease phase occurred between 2001 and 2007 with a reduced population of only 13 pairs. In 2008, two more pairs added to the population that hence counted 15 territorial pairs. A sound monitoring highlighted the high mortality rate of adult birds, especially recorded

in Cabrera and Menorca, as the main problem affecting the population's health and threatening its stability in a long-time span. Electrocution, due to the presence of power lines pole running close to sea shores, was identified as the major cause of mortality, with 10 cases recorded in Minorca of 15 cases of mortality (66,67 %) between 1993 and 2010 (R.Triay unpubished data). The partial recovery might have happened from the historic Balearic nucleus; therefore, genetic analysis would help understanding if there has been a population bottleneck in the recent years, and consequently if there are risks of inbreeding due to small population sizes and evaluate the extinction risk of the population.



Distribution of osprey population in the Balearics (from: Triay & Siverio, 2008).

Morocco and Chafarinas Islands:

The first exhaustive survey on the coast of Morocco occurred in 1983 (Berthon & Berthon, 1984). The osprey population was estimated in 10-15 pairs scattered along the rocky coast from Cabo Negro to Al Hoceima, maintaining a stable trend during the period 1983-1993 (Thibault *et al*., 1996). More recent data showed few variations in numbers: 19-21 pairs in 1993 (Thibault *et al*., 1996) and 15-20 pairs mentioned by Franchimont (1998). During the last surveys carried out by the AGIR association a total number of 14-18 pairs was reported within the territory included in the Park National d'Al Hoceima (PNAH) (Orueta & Cherckaoui, 2010).

Map of the area interested by the conservation plan for the osprey within the PNAH (Orueta & Cherckaoui, 2010).

In the Chafarinas Islands, belonging to the Spanish territories, osprey was present with two breeding pairs in the 1950 (Terrasse & Terrasse, 1997). Since 1994, only one pair inhabits the archipelago; in particular

breeding in the island of Congreso (GENA, 2004-2007; Triay & Siverio, 2008). Other kind of information is still deficient since that population has not yet been investigated in any way. The actions put in place is until now limited to surveys and census for counting the breeding pairs. Nevertheless, a conservation plan has been prepared for this population (Orueta & Cherckaoui, 2010).

Algeria:

Data referring to the past are very scarce. During the 60's, information available only refers to the fact that osprey reproduced along the rocky coast. A survey conducted in 1978, allowed to detect two breeding areas. The first located west of Oran and the second near El-Kala, as reported by Jacob *et al*. (1980) and after confirmed by Boukhalfa (1990) and Thibault *et al*. (1996). During the period 1989-1993 the population was estimated at 9-15 pairs (Thibault *et al*., 1996), similarly to data previously collected by Jacob *et al*. (1980). Repeated surveys carried out in the framework of the Mediterranean Small Island Initiative (PIM) co-ordinated by the Conservatoire du Littoral, allowed to detect the presence of the species between 2004 and 2006, in the Habibas islands (Mouret, 2008). Both in 2007 and 2008, a breeding pair was found in the island of Grande île (nest located in the Baie de la morte). In 2011, no breeding pair was observed.

MAIN THREATS IDENTIFIED IN SMALL ISLANDS

- **Persecution:**

In the beginning of the 19th century, the osprey was breeding throughout Europe. During the first decades of the 20th century, because of the strong direct persecution, local populations decreased rapidly, until extinction in several cases. Human disturbance mainly consisted of trapping and egg-collecting, together with shooting both on the nesting grounds and on migration. In other cases, conflicts with owners of fish pond probably provoked local killings (Poole, 1989). Thanks to the legal protection given to the species less than 50 years ago, the hunting pressure significantly decreased all over Europe (Saurola, 2005). This brought some small populations to slowly recover their ancient numbers. Nevertheless, the illegal shooting is carrying on to affect osprey populations, mainly hitting migratory birds crossing dangerous hot-spot during migration (e.g Malta, Messina's Strait) or individuals that winter in Africa where the persecution still represents a heavy threat.

- **Disturbance:**

Other various kind of indirect human activities can be considered as a potential factor of disturbance. Low-flying aerial passages are noisy and potentially disturbing, although they seem to have little effect on the reproductive success (Poole, 19989; Trimper *et al*., 1998). In many cases, the species has locally adapted to intensive human activity becoming rather tolerant to that "regular" disturbances like for example the car passages on main roads (Poole, 1989; Bai *et al*., 2009). Generally, osprey appears not to be bothered by objects travelling at great distance and that aren't heading toward nests. In Corsica, Bretagnolle & Thibault (1993) analysed the effect on breeding individuals caused by boat passages at the neighbourhood of nesting sites. At less than 250 m the alarm call was performed whereas birds took off from the nest at less than 100 m. These results highlight the need of regulation of the nautical touristic traffic within the protected area and recall the importance of adjusting monitoring plan and management guidelines to local situations. In Spain there are some cases of disturbance by trekking activities and photographers (Triay, 2010). In many cases some conflicts can arise from fishermen that can potentially disturb breeding sites during their activity (e.g. dynamite fishing activities in Morocco coasts; Orueta & Cherckaoui, 2010).

- **Pollution:**

In the late 1940s and 1950s, DDT and other environmental contaminants represented the main threat for many osprey populations all over the world (e.g. Poole, 1989). DDT metabolites caused disturbances in calcium metabolism of females, leading to a significant decrease in the eggshell thickness and causing the eggs broke during the incubation phase. This affected the breeding success of breeding pairs that was reflected on a negative demographic trend of populations (Ames, 1966; Wiemeyer *et al*., 1975; Saurola, 2005). Only after banning the use of this toxicant, concentrations of DDT metabolites in the osprey eggs have decreased, and the populations gradually recovered (Spitzer *et al*., 1978; Saurola, 2005). Nowadays, problems can arise with the absorption of other toxic substances (e.g. dieldrin, mercury and other emerging contaminants) spread in the environment and that can be concentrated rapidly on the osprey through aquatic food webs and by means of the bio-magnificence effect (Poole, 1989; Henny *et al*., 2010)

- **Electrocution:**

Electrocution represents today one of the main threats for ospreys that tend to use electric poles as resting sites or perches during feeding (while the feathers are wet). Collisions with power lines are widely reported for osprey on migration, but several occurrences are also referred to Mediterranean individuals. Both in Corsica and in the Balearics it is considered the main cause of adult mortality (data showed in: Thibault *et al*., 2001; Triay & Siverio, 2008). In the framework of the Italian reintroduction project, a translocated juvenile bird was victim of electrocution in 2010 (Monti, 2011). Although electrocution

remains a cause of mortality difficult to estimate, it is certain that it can strongly affect small populations and influence their demographic trends (e.g. Mediterranean populations). Losses can be reduced by structural modifications to the pylons, and existing structures could be replaced by others with less dangerous design.

Osprey killed by electrocution in mainland France (Nadal & Tariel, 2008-2012)

- **Habitat change:**

At present, land use is one of the main conflicts between osprey and man. In many Mediterranean areas, the species have been forced to move away from historical habitats along the seashore because of the strong habitat modification largely addressed to tourism and recreation (Nadal & Tariel, 2008-2012). For example: in the Balearic four nest sites has been occupied by new houses in the 70's.
The loss of suitable nesting sites is considered as one of the main causes that drove the species to extinction in many countries (e.g. Portugal, continental Spain and Italy). In Corsica, for example, consequently to the high urbanization of the coasts, mainly occurring during the half of the 20th century, the availability of suitable nesting sites drastically reduced (many sites were disappeared) and the population remained to breed in a small area along the west coast (Thibault *et al*., 2001; Bretagnolle *et al*., 2008). Since 1990 the population stopped growing and remained stable in numbers, due to this shortage in nest site availability (Bretagnolle *et al*., 2008). The recolonization of some stretches of coasts occupied during the 19 and 20th centuries seems to be difficult because they are built or visited by an increase number of visitors and sailors during the breeding season (Thibault *et al*., 2001).

Here is reported a scheme of the main threats nowadays identified for singular osprey breeding sites within the Mediterranean basin. Each threat was ranked in different levels of importance and recognized at the site scale.

Table 3: Threats identified for the Osprey in the Mediterranean

Levels of Threat: 1- high / 2- medium / 3- low / 4- unknown

Geographic Area	*Persecution*	*Disturbance*	*Pollution*	*Electrocution*	*Habitat change*
Spain (*mainland*)	3	2	3	2	1
Balearic Islands (*Spain*)	3	1	2	1	2

Chafarinas Islands (*Spain*)	3	2	2	3	3
Italy	2	2	4	2	1
Corsica (*France*)	3	1	3	1	2
Algeria	1	1	4	4	4
Morocco	2	1	2	1	1

Finally, other kind of factors can be considered as a potential threat and limit the expansion of the populations. For example, the over-exploitation of natural resources by man can influence the availability of prey; the dynamite fishing activities along the rocky coasts of Morocco can reduce the presence of fish banks in the bays leading to a reduction of a fundamental year-round resource for the osprey (Orueta & Cherckaoui, 2010). Predators can be another important factor of disturbance during the breeding season; within the Mediterranean area the potential predators of osprey's eggs and chicks are represented by foxes, rats, raven and gulls that can easily reach nesting sites located on the rocky coasts. Survival and breeding success can also be affected by inter- and intraspecific interactions both at wintering and breeding sites (Prevost, 1982; Poole, 1989; Bretagnolle *et al*., 2008).

CONSERVATION STAKES , CURRENT AND OLD CONSERVATION PROGRAMS CARRIED OUT ON MEDITERRANEAN SMALL ISLANDS

▪ Monitoring techniques generally set up for this specie

- Correction of electric lines to avoid electrocution (Balearic according to the Conservation Plan for the species available at:

http://www.caib.es/sacmicrofront/archivopub.do?ctrl=MCRST272ZI47665&id=47665

- Monitoring by means of binoculars, scopes and cameras (Corsica, The Balearics, Chaffarinas Islands and Italy)
- Surveys along the coasts by means of a boat (Corsica, The Balearics, Morocco and Algeria)
- Video monitoring of translocated birds and breeding pairs (Spain and Italy)
- VHF telemetry (Spain, Balearic islands, and Italy; Muriel *et al*., 2010; Monti *et al*., 2009; Triay, 2007)
- Satellite telemetry (only 7 in the Balearics: 3 young in Menorca -Triay, 2002-, and 4 adult in Mallorca, one of these a wintering Sweden individual - http://www.gobmallorca.com/peixatera/seguiment.htm -)

▪ Typology of conservation actions carried out until now.

- Census and Status of the breeding population (Corsica, The Balearics, Morocco and Algeria)
- Population monitoring throughout years (Corsica and The Balearics)
- Studies on osprey biology and ecology (Corsica and The Balearics)
- Ringing programs (Corsica, The Balearics, Italy and Spain)
- Analyses of the demographic trends (Corsica and The Balearics)
- Building of artificial nesting sites (Corsica, Italy, The Balearic and Spain)
- Reintroduction programs (Spain and Italy)

Ringing programs carried out until now.

Several ringing programs actually occur in the following sites of the Mediterranean basin:

- The Balearics = by means of metal and coloured rings (marking chicks), starting in 1980 and still ongoing (Triay & Siverio, 2008);
- Corsica = during '80s with metal rings and from 2010 by means of coloured darvic rings (marking chicks) (Thibault *et al*., 2001);
- mainland Spain = starting in 2003 with coloured darvic rings in the framework of the reintroduction project (marking translocated chicks) (Muriel *et al*., 2010);
- Italy = starting in 2006 with coloured darvic rings in the framework of the reintroduction project (marking translocated chicks) (Monti & Troisi, 2008).
- Morocco and Algeria = birds belonging to the African populations both breeding along the coasts and on the small islands (e.g. Habibas and Chafarinas islands) have never been ringed.

Reintroduction programs

Two reintroduction projects are currently going on in the Mediterranean area. Therefore, one of the most crucial strategies of conservation of this species at the Mediterranean scale appeared to be the recovery of the historical osprey's breeding sites like those in Tuscany, Sardinia and in other Mediterranean places.

The most ancient data of a breeding osprey refers to the end of the XIX century (Straits of Gibraltar in 1776; Irby, 1895; Triay & Siverio, 2008). During the XX century, the osprey population suffered a continuous decline since the 1960's. The species gradually disappeared from its historic territories in Southern Spain until it was completely extirpated from mainland Spain in 1981 (Triay & Siverio, 2008; Muriel *et al*., 2010). The last pair bred in the province of Alicante (Urios *et al*., 1991).
In spite of the suitable breeding conditions and its current important role as stop-over and wintering area for migrant birds, the species has been unable to recolonize the region almost certainly due to strong natal philopatry (Casado & Ferrer, 2005; Muriel *et al*., 2010).
Thus, a reintroduction program started in 2003 in Andalusia to re-establish a breeding population in the Iberian Peninsula (Casado & Ferrer, 2005; Muriel *et al*., 2010). Between 2003 and 2009, 129 young ospreys were released by means of the hacking technique at two different locations: the Barbate Reservoir (in the province of Cádiz) and the Marismas del Odiel Natural Reserve (in the province of Huelva). The hacking technique foresees the transfer of chicks (at few weeks old) to another area where they will fledge and, likely, return once the sexual maturity age is reached (between 2 and 4 years old; Poole, 1989), thanks to

the natal philopatry of the species. The translocated nestlings were taken from wild nests in Germany (65.1%), Scotland (20.2%) and Finland (14.7%) (Muriel *et al*., 2010).
Birds were equipped by means of a conventional tail VHF transmitter to track movements during the post-fledging period. In addition, twelve birds were also fitted with satellite PTTs to track them during migration and wintering. During the pre- and post-fledging periods the mortality rate was 10.6% (Muriel *et al*., 2010). Translocated individuals started migration between the end of August and beginning of October. The PTT transmitters of the fitted ospreys allowed to detect the location of wintering grounds in Sub-Saharan Africa (Senegal, Gambia, Guinea-Bissau and Mali). The cumulative return rate to the hacking localities calculated for ospreys released between 2003 and 2007 was 10.5% (Muriel *et al*., 2010). Both in 2005 and 2006, first breeding attempts occurred with the laying of eggs by non-reintroduced ospreys in a reservoir close to the release point in Cádiz (Guadalcacin reservoir). Due to problems during the incubation period, eggs did not hatched. Two chicks from Germany were hence fostered each year, in order to encourage the site fidelity of the pair (Muriel *et al*., 2006). In 2009 for the first time in mainland Spain since 1981, the first successful breeding occurred. One pair consisting of two returned ospreys previously released in 2005 (a female from Scotland and a male from Germany), reared three chicks in the Odiel Marshes. Also in 2009, another pair consisting of two non-reintroduced individuals bred and successfully raised two chicks, in the Guadalcacin reservoir (Muriel *et al*., 2010).

A program of reintroduction also started in Portugal

Italy:

In Italy, the osprey became extinct as a breeder during the last years of the 1960s (Bulgarini *et al*., 1998; Brichetti & Fracasso, 2003). A strong human persecution (especially made by shooting and egg-collecting) together with the loss of suitable nesting sites are considered as the main causes that drove the species to extinction (Spina & Volponi, 2008). The species is protected in Italy since 1977. In 1929, Arrigoni degli Oddi recorded the osprey as a breeding species in Sardinia, Sicily and Tuscany Archipelago (Montecristo Island). More recent references attested the last breeding sites for the species: in 1968 in Sicily (Egadi islands) and during 1968-1969 in Sardinia (along the cost of Baunei) (Thibault & Patrimonio, 1992; Brichetti & Fracasso, 2003).
Since 2006, a common project started between the Parc Naturel Régional de Corse (France) and the Maremma Regional Park (Tuscany-Italy), both to re-establish an osprey breeding population and to secure the future of the Corsican population. Birds were managed by means of the hacking technique (Monti & Troisi, 2008; Monti *et al*., 2009). Between 2006 and 2011, 33 juvenile ospreys were translocated from Corsica and Tuscany. In 2010, first breeding attempts, but unsuccessful, were carried out by reintroduced adult males that attracted wild females at nests.
In 2011, the osprey bred again successfully in Italy. The pair, consisting of a Corsican male translocated in 2006 and a wild female, settled in a salty swamp in the Maremma Regional Park (Tuscany), at the end of January. Courtship and nest building activities were observed between February and March, while laying occurred in the first days of April. Two chicks were successfully raised by the pair (Monti *et al*., 2011). In addition, another territorial pair, formed by another male belonging to the 2006's translocation cohort and a wild female, established in the Diaccia Botrona Natural Reserve (only 15 km North from the Park).
In the next future, a gradual increase in the number of the breeding pairs is expected. The promise of a new Italian population would assure a local conservation to the species. At the same time, a spread of the Corsican population through the connection with the Italian one is expected and favoured by the creation

of artificial nests in the islands of the Tuscany Archipelago that, operating as “stepping stones”, could allow easier exchanges between the two populations. These seven islands located in the Mediterranean Sea, between the west coast of central Italy and Corsica, were officially recognized as National Park and Marine Protected Areas (MPA), in 1996. The final aim is to create a new self-sustaining population in the long term.

CONSERVATION ACTIONS PROPOSALS FOR SMALL ISLANDS OF THE MEDITERRANEAN

Although migratory strategies and movement patterns of larger osprey populations in northern Europe and North America were well described (Hake *et al*., 2001), the dispersal dynamics and the areas used outside from the breeding season (wintering sites) were not yet investigated in a detailed manner in the Mediterranean basin, nor for any greater spatial and temporal different scales of resolution. Until now, only 6 ospreys, from Balearic, were equipped with satellite telemetry (Triay, 2002, http://www.gobmallorca.com/peixatera/seguiment.htm) while northern African populations traits have not yet been investigated in any way. Therefore, basic information on spatial ecology of osprey in the Mediterranean basin is still lacking. A better understanding of the factors affecting osprey population dynamics in the Mediterranean is a key prerequisite for an effective conservation and management of the species. In particular, collecting information about movement patterns and dispersal strategies of the Mediterranean ospreys represents a primary condition for conservation purposes. Thus, a sound biological approach would be to study dispersal over multiple scales (both spatial and temporal scales) and describe movements within this context.

Ringing network

The promotion and creation of a ringing program (chicks and adults), common to all Mediterranean populations (Corsica, The Balearics, Algeria and Morocco, and eventually also the insular population of Canary islands in the Atlantic) would be a direct method to study the existence of connectivity between Mediterranean populations. A long-term monitoring of resightings of ringed birds will allow gathering more information about movements, fundamental in order to plan sound conservation actions.
Together with ringing actions, all ringing, resighting and recovery data should be pooled in a common database, shared by all participants of the monitoring.

Satellite tracking

Osprey ranging behaviour should be investigated in order to gather information on dispersal strategies and movements during the annual cycle. The main question is to know where do Mediterranean ospreys spend the winter, when they may face additional and unknown mortality sources. Do they remain close to the breeding sites during winter as commonly believed? Tagging adults would be of great interest since some adults are known to remain in winter close to the breeding sites while others seem to move further at unknown locations (Thibault *et al*., 1996). The second important question is: do they visit populations and colonies different from their own natal or breeding population? This information is crucial to evaluate the potentiality of natural recolonisation and transfer of genes between populations, and would therefore the future conservation actions.

Population genetics

The connectivity between Mediterranean populations could also be studied by the indirect methods of molecular biology, and especially genotyping techniques using micro-satellites. From blood samples, collected during ringing actions in all Mediterranean and insular populations, it would be possible to determine the genetic distance between individuals and populations and the rate of exchanges of individuals between populations as well as the state of health of each population (e.g. genetic variability).

Action of conservation suggested on the breeding sites :

- Regular population monitoring

  In order to prevent disturbance during the incubation period and to collect data about breeding success; ringing all the nestlings (common ringing program for the whole Mediterranean populations).
- Building of new artificial nesting sites

  In order to increase the habitat nesting quality and encourage new settlement.
- Sensitization of the public

  To reduce the disturbance, limit the access in the neighbourhood of nest sites; for example avoiding the approach of touristic boats.
- Promotion of a common networking

  Establishing collaborations with north African countries, involving also local workers in collecting data with the aim of both reinforcing the value of their MPAs for stronger management actions and using the common interest for the species as an effective vehicle for conservation and for promoting activities of local environmental education.

  These collaborations could permit the elaboration of harmonized protocols of monitoring between the Mediterranean breeding sites.
- Promotion actions to eliminate the risk of electrocutions, involve the electric companies to promote legal changes in order to use only innocuous systems.

Action suggested outside the breeding sites :

- A better knowledge of the feeding areas

  Conventional and satellite tracking could help understanding the foraging areas used by breeding adults and their localization will allow to plan adapted conservation measures within these areas. New insights concerning the importance of Marine Protected Area as fundamental tool in conservation would be highlighted and better conservation actions (adopting to the scale of reference) proposed.
- A better knowledge of the movements, dispersal and wintering areas

  Movements, dispersal dynamics and the areas used outside from the breeding season (wintering sites) were not yet investigated in a detailed manner in the Mediterranean basin. A study focused on these arguments will allow to plan sound management actions aiming at reducing the impact of human activities in these important areas.

Expected outcome

Once all these traits have been outlined, key conservation-related measures would be applied in order to progress into an effective management of the species. For example the protection of key areas for

migration, stop-overs and wintering grounds; the establishment of other reintroduction programs or the installation of new artificial nests at key sites to promote natural recolonisation and support the other populations in the Mediterranean basin. Finally, starting a common collaboration between France, Italy, Spain, Morocco and Algeria would be a first fundamental step in the optics of a future connected network for osprey conservation within the whole Mediterranean basin.

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