

Review

The endemic Mediterranean yelkouan shearwater *Puffinus yelkouan*: distribution, threats and a plea for more data

KAREN BOURGEOIS and ERIC VIDAL

Abstract The endemic Mediterranean yelkouan shearwater *Puffinus yelkouan*, elevated to the rank of species in 2002, is poorly monitored and studied. Despite this lack of data and the susceptibility of closely related species to threats at breeding sites and foraging areas, the yelkouan shearwater is currently considered to be at low risk of extinction. This review, based on published documents, personal communications with scientists and our own observations, summarizes available data on range, population size and trends, and on threats to the species' existence. Breeding sites range from the Marseille islands (France) to Bulgarian islands in the Black Sea but many are not confirmed. The estimated global population is 11,355–54,524 pairs but most censuses are probably overestimates and the global population could be only a few thousand breeding pairs. There is evidence of a population decline and susceptibility to introduced mammals, particularly feral cats *Felis catus* and ship rats *Rattus rattus*, and to accidental bycatch in fishing gear. We highlight the lack of accurate and regular censuses of the species, and the alarming situation suggested by the little data available. We recommend that the yelkouan shearwater be categorized as Near Threatened on the IUCN Red List, encourage collaborative work to clarify its status, and make a plea for more data on the species' demography and ecology, and for the evaluation of terrestrial and marine threats.

Keywords Bycatch, introduced mammals, Mediterranean, Near Threatened, *Puffinus yelkouan*, status assessment, yelkouan shearwater.

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Introduction

Seabirds, particularly albatrosses and petrels, have experienced a dramatic deterioration of their conservation status (Butchart *et al.*, 2004), and of the 328 seabird species currently recognized, 31.1% are considered globally threatened (IUCN, 2007). Reasons are the high sensitivity of

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seabirds to the combination of both terrestrial and marine threats. Most seabirds that are threatened by invasive species on their breeding islands are also concurrently threatened by incidental mortality in commercial fisheries (Donlan & Wilcox, 2008). Unfortunately, for many threatened seabirds demographic and ecological data are sparse, and it is thus difficult to make a reliable assessment of their conservation status (IUCN, 2007).

The yelkouan shearwater *Puffinus yelkouan* is a medium-size procellariid strictly endemic to the Mediterranean Basin (including the Black Sea). It was previously considered to be a Mediterranean subspecies of the globally distributed Manx shearwater *P. puffinus* complex (Brooke, 1990; Warham, 1990) and later to be the oriental subspecies of the Mediterranean shearwater (Bourne *et al.*, 1988; Heidrich *et al.*, 1998). A taxonomic revision elevated the yelkouan shearwater to the rank of species, distinct from both the Manx shearwater and Balearic shearwater *P. mauretanicus* (Sangster *et al.*, 2002). Whereas considerable attention has been given to the Balearic shearwater, leading to its categorization as Critically Endangered on the IUCN Red List (Arcos & Oro, 2004; Oro *et al.*, 2004; BirdLife International, 2006a; IUCN, 2007), few studies have dealt with the yelkouan shearwater. Consequently, this species remains the poorest known seabird in the Mediterranean, with little documentation of its distribution, population size and trends. Zotier *et al.* (1992) emphasized this lack of data and suggested that documented population sizes are overestimates.

Despite this paucity of data the yelkouan shearwater is considered to be at low risk of extinction (BirdLife International, 2006b; IUCN, 2007) and its European threat status is Secure (BirdLife International, 2004a), with population estimates of 14,750–52,300 pairs (IUCN, 2007) and 13,000–33,000 pairs (BirdLife International, 2004a). The yelkouan shearwater has only recently (2004) been added to Annex I of the European Union Wild Birds Directive. As a consequence, the attention of conservationists and scientists has not been drawn to this endemic species. Most of the endemic shearwater species formerly included in the Manx shearwater complex have, however, recently been categorized on the IUCN Red List (IUCN, 2007): Near Threatened (*Puffinus opisthomelas*), Endangered (*P. huttoni*, *P. newelli*) and Critically Endangered (*P. auricularis*, *P. mauretanicus*).

Here we therefore provide for the yelkouan shearwater a comprehensive review of available data on range, population size and trends, and of threats to the species' existence. This review is based on an intensive literature survey, including grey and local literature (80 references, eight languages), and also includes 3 years of exchanges and personal communications with scientists, conservationists and NGOs from the 24 countries bordering the Mediterranean, Black and Azov Seas, and our own research data. Our aim is to provide an exhaustive compilation of available data concerning the yelkouan shearwater, identify the main gaps in this data, and to discuss the species' conservation status and priorities for its conservation. Finally, we make a plea for more data needed to fill the main gaps identified.

Breeding locations, extent of occurrence and area of occupancy

Seventy-five sites (i.e. islands) distributed among 10 countries were identified as certainly (40 sites) or possibly (35) harbouring yelkouan shearwater breeding colonies (Fig. 1, Appendix). The 40 breeding locations categorized as certain were those for which recent (<70 years old) evidence of breeding (i.e. eggs, chicks) were clearly stated and for which further information indicated clearly that breeding still occurs. The 35 possible breeding sites were considered as such from information linked to at-sea observations but actual breeding is unconfirmed.

Thus, if we consider only the 40 locations where breeding is certain, the area of occurrence of the yelkouan shearwater extends from the Marseille islands in the

west (France; Zotier & Vidal, 2004) to Bulgarian islands (Nankinov, 1993) in the Black Sea in the east, and from the Bulgarian islands in the north to Malta (Borg & Sultana, 2002) in the south (Fig. 1, Appendix). This gives a yelkouan shearwater extent of occurrence (IUCN, 2001) of c. 1,117,100 km². With the 35 additional possible breeding locations this could extend to 1,322,100 km². The area of occupancy (IUCN, 2001) is much smaller because of the patchy insular distribution of the species. Considering the entire surface area of the islands where the species breeds, the area of occupancy ranges from 1,209 km² (for the 40 certain breeding sites) to 2,147 km² (when the 35 possible breeding sites are included). However, yelkouan shearwater colonies are restricted to only a small part of the occupied islands (<1%; IMEP, unpubl. data), and based on this the area of occupancy is reduced to 12.1 and 21.5 km², respectively.

Breeding population estimate

Only 17 of the 40 certain breeding locations have been surveyed (nest and calling bird counts at colonies), with an estimated on-land breeding population of 2,468–3,224 pairs. The other 23 certain breeding locations were only censused approximately by counting flocks at sea, and the authors estimated 3,431–6,185 additional pairs, giving a total of 5,899–9,409 breeding pairs. For 31 of the 35 possible breeding locations, approximate counting at sea indicates a speculative additional breeding population of 5,456–45,115 pairs.

It is important to note that the estimation of shearwater breeding population by counting flocks at sea is questionable because of the risk of strong overestimation,

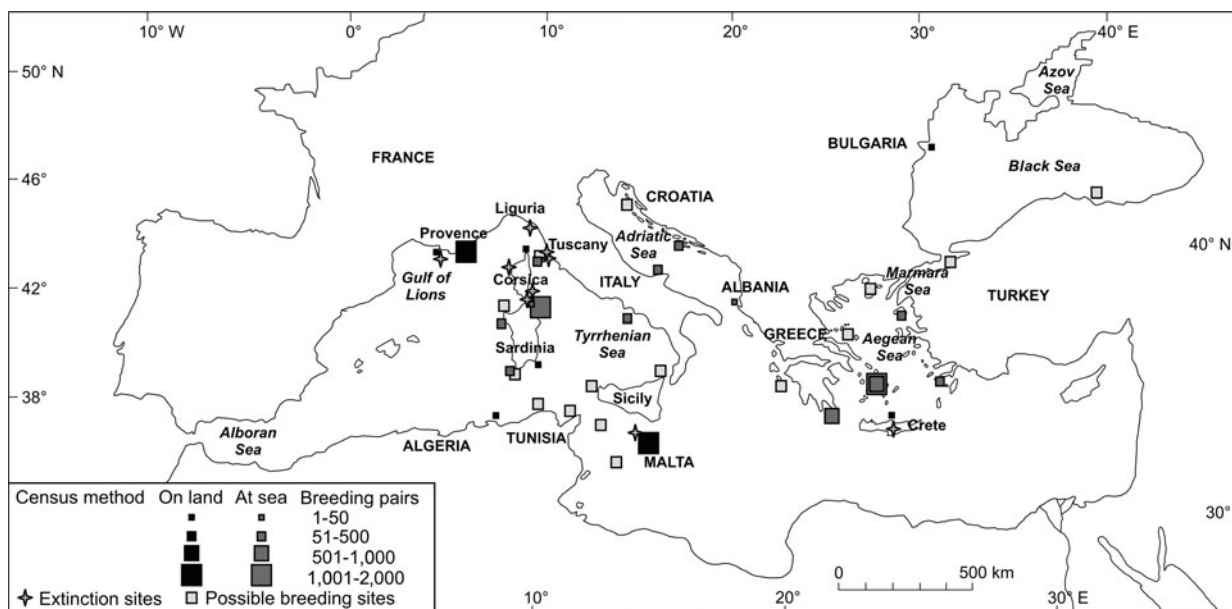


FIG. 1 Locations of breeding sites of the yelkouan shearwater in the Mediterranean Basin (including the Black Sea), with number of breeding pairs determined by censuses on land or at sea (including sites where breeding is both certain and possible, see text for details), and of the nine sites where the species appears to be extinct.

imprecision and error (Bibby *et al.*, 1992; Brichetti & Fracasso, 2003). For example, flocks of up to 10,000 birds are regularly seen off some French Mediterranean islands but 4 years of intensive terrestrial survey gave a breeding population of <1,600 pairs (IMEP, unpubl. data). Moreover, the presence of shearwaters at sea (on feeding areas, for example) does not guarantee that the species breeds on nearby islands. Thus, the high breeding numbers given for some large populations (Italy, Greece and Turkey) are speculative and could be overestimates of 5–10 times the actual figure. For 77% of all the breeding sites (certain and possible) breeding population estimates are based on counts at sea. These numbers contribute to 78.3–94.1% of the overall population size estimates. Thus the lack of breeding confirmation for many of the possible breeding sites and the imprecision and probable overestimation for most given population sizes suggest that the yelkouan shearwater world population is likely to be at the low end of previous estimate ranges (i.e. <15,000 pairs). Until data is collected from data deficient areas (especially Turkey, Italy and Greece), we cannot exclude the possibility that the global yelkouan shearwater population may consist of only 5,899–9,409 pairs.

Important marine areas

Eight marine areas have been reported as important feeding, moulting or migration areas for yelkouan shearwaters, with regular observations of flocks of thousands of birds (Fig. 2). The first returns to breeding sites occur in late October or early November, egg-laying from mid March to

early April, hatching in May and fledging in July to early August (Zotier 1997; K. Bourgeois & E. Vidal, pers. obs.). The Aegean Sea and Marmara-Black-Azov Seas are two areas used throughout the year (Handrinos & Akriotis, 1997; Nankinov, 2001). The Gulf of Lions-Provence-Liguria-northern Tyrrhenian Sea, west of Sicily and the Algerian-Tunisian coast can be considered important feeding areas during the breeding season (Thibault & Bonaccorsi, 1999; Conéjéro & Beaubrun, 2000; Insenmann & Moali, 2000; Brichetti & Fracasso, 2003; Insenmann *et al.*, 2005; IMEP, unpubl. data). The Alboran Sea, northern Adriatic Sea and the Israeli coast are important areas for moulting, feeding and passage during the interbreeding period (Markovec, 1995; Shirihai *et al.*, 1996; Stipčević & Lukač, 2001; Brichetti & Fracasso, 2003; Thévenot *et al.*, 2003).

Population trends

With the exception of Maltese and French colonies (Borg & Sultana, 2002; Zotier & Vidal, 2004; IMEP, unpubl. data), no yelkouan shearwater populations are monitored either at sea or on land. It is therefore difficult to evaluate a global population trend for this species, in contrast to literature that considers the population to be stable (BirdLife International, 2004, 2006b). There is some evidence of colony extinctions (Fig. 1, Appendix). These may be old, such as in Corsica (Lavezzi Island after the 18th century, France; Vigne *et al.*, 1991; Zotier & Vidal, 2004) and Crete (Greece, Alcover *et al.*, 1992), or recent, such as in Corsica (Forana Island 1908–1982, and Gargalo Island 1947–1980, France;

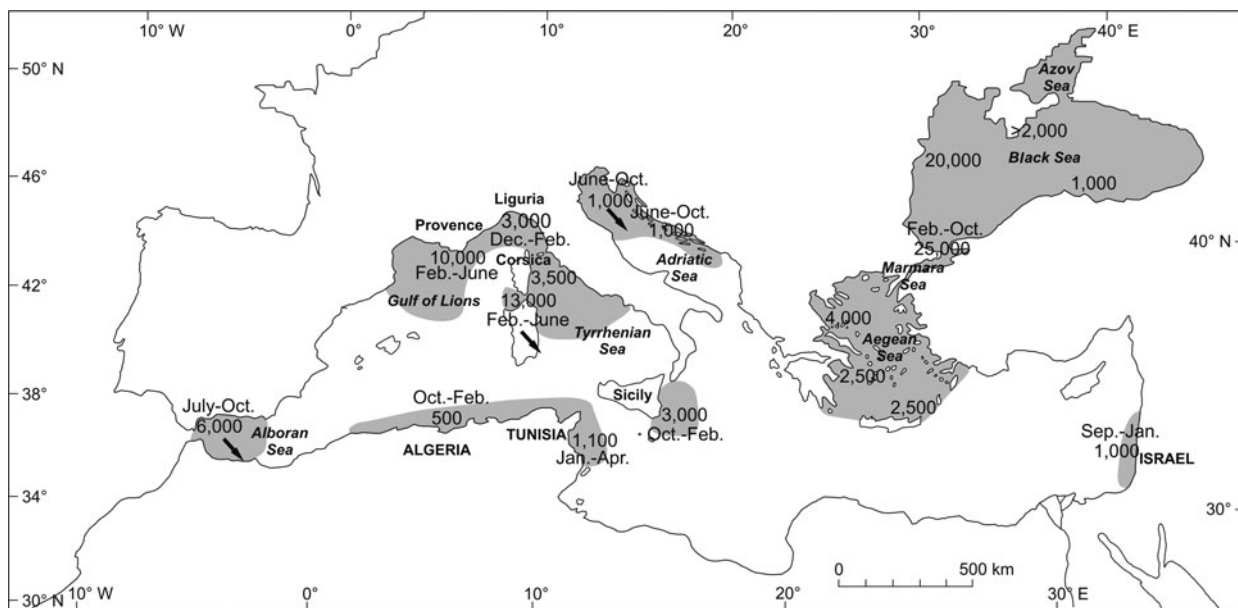


Fig. 2 Areas of yelkouan shearwater concentration at sea (passage, moulting and/or feeding), with maximum numbers, period of maximum occurrence (not indicated when occurrence is high throughout the year) and areas with decreasing numbers (indicated by an arrow).

Guyot *et al.*, 1985; Zotier & Vidal, 2004), on French Mediterranean islands (Grand Congloué Islet 1954-1981; Zotier & Vidal, 2004), Malta (Filfla Island in the early 1980s; Borg & Sultana, 2002) and on Italian islands (Palmaria Island; Brichetti *et al.*, 1992; Pianosa and Giannutri Islands 1989-2001; Tellini Florenzano *et al.*, 1997; Arcamone & Sposimo, 2002; N. Baccetti, pers. comm.). A total of nine extinctions have been documented, probably representing 300-400 breeding pairs, during the last 60 years. The causes of extinction are not clear but the authors suggested harvesting and predation by ship rats *Rattus rattus* (Vigne *et al.*, 1991; Arcamone & Sposimo, 2002). Breeding populations are also declining in the main breeding sites, with the same causes: Tuscany (Sposimo & Tellini, 1995), Sardinia (vast sectors of Tavolara and Molara islands have been deserted; N. Baccetti, G. Spano & M. Putzu, pers. comm.) and Malta (J.J. Borg, pers. comm.). Combining data for population extinctions and declines, the main yelkouan shearwater populations for which approximate data are available (France, Italy and Malta), may have decreased by 12-15% (i.e. 1,500-2,500 breeding pairs) during the last 60 years.

The number of individuals in marine areas where the species concentrates could also be declining (Fig. 2). In the Alboran Sea large concentrations of up to 6,000 birds regularly occurred in the 1960s and the early 1970s but numbers have decreased to flocks of a maximum of 1,000 in certain years only (Thévenot *et al.*, 2003). Hundreds to thousands of yelkouan shearwaters stayed around Corsica (Bonifacio Strait, north of Cape Corse, western gulfs) from December to June during the 1970s and mid 1980s but numbers now fluctuate from several tens to a few hundreds (Thibault & Bonaccorsi, 1999). In the Gulf of Trieste (northern Adriatic Sea) hundreds of yelkouan shearwaters were regularly present from June to October (up to 1,000 in September) but this number has recently decreased (Brichetti & Fracasso, 2003). These data suggest that the number of yelkouan shearwater at sea may have decreased by >50% over the last 40 years.

Major threats

Table 1 summarizes the generally scarce information about threats to yelkouan shearwaters both at sea and in breeding colonies. The most well-documented and serious threat is the impact of introduced predators, especially feral cats *Felis catus*. For example, on the Hyères islands (French Mediterranean coast) feral cats have been identified as the primary predator of yelkouan shearwaters: shearwater remains were found in up to 6% of cat scats, representing hundreds of adults killed each year, especially during the pre-breeding period (Tranchant *et al.*, 2003; Bonnaud *et al.*, 2007). The ship rat has long been introduced on most of the Mediterranean islands and is now present on all the islands

with yelkouan shearwater colonies (Martin *et al.*, 2000). Ship rats may dramatically reduce breeding success of shearwaters during rat population peaks (Vidal, 1985). Breeding success was zero because of ship rat predation on the Tavolara islands in 2006 and on Montecristo Island in some years (Italy, N. Baccetti, G. Spano & M. Putzu, pers. comm.). Rats are also the main cause of breeding failure in the largest Maltese colony (J.J. Borg, pers. comm.).

Rare cases of predation by native predators have been reported (Vidal & Bayle, 1997; Zotier, 1997; Pieper & Ristow, 2002). Competition for breeding habitat with Cory's shearwater *Calonectris diomedea* seems limited (Bourgeois & Vidal, 2007). Harvesting of yelkouan shearwaters was frequent until the 1980s on most sites (Krpan, 1970; Vigne *et al.*, 1991) but is now limited and the species is legally protected. Increasing tourism and coastal urbanization in the Mediterranean disturbs colonies and damages fragile breeding habitats (James, 1984; Gallo-Orsi, 2003; K. Bourgeois & E. Vidal, pers. obs.).

Little is known about mortality of yelkouan shearwaters at sea as a result of accidental bycatch in long-lines and fishing nets. In the 1970s net bycatch of yelkouan shearwaters off the south-east French coast was estimated at 800 per year (Besson, 1973) and dead yelkouan shearwaters are regularly found with signs of netting (head and neck without feathers and with net remains; IMEP, unpubl. data). More recently, some yelkouan shearwater deaths from long-lines have also been reported in the Gulf of Lions (J. González-Solís, C.C. Matet & S.R. Moreno, pers. comm.), Straits of Bonifacio, Italian waters and around Malta (Cooper *et al.*, 2003). At-sea mortality could be one of the major causes of the dramatic decline of the Balearic shearwater (Oro *et al.*, 2004) and is probably similarly affecting the yelkouan shearwater.

The main fish species caught by fisheries in the Mediterranean (Leonart & Maynou, 2003) are the main prey items of yelkouan shearwaters (Zotier, 1997; Conéjéro & Beaubrun, 2000; Stipčević & Lukač, 2001). Such resource competition can induce changes in food availability and may affect seabird breeding success, adult survivorship, colony attendance and prey switching (Furness, 2003; Karpouzi, 2005). High levels of some contaminants have been detected in Mediterranean seabird tissues, thus weakening adults and decreasing breeding success (Lambertini & Leonzio, 1986; Renzoni & Massa, 1993). Intense maritime traffic in the Mediterranean increases the risk of oil spills.

Reappraisal of conservation status

IUCN Red List criteria for determining the degree of threat to species are based on population size, range and trends (IUCN, 2001). Considering the probable decrease in the yelkouan shearwater population by 12-50% (breeding

TABLE 1 Overview of threats to the yelkouan shearwater in breeding colonies and at sea. Data type indicates if causes of mortality were quantified, observed, or only suspected.

Causes of mortality		Data type	Study area	Level of threat	Research priorities
In breeding colonies					
Introduced predators	Feral cat <i>Felis catus</i>	Quantified	Hyères islands, France	High	Increase study sites to quantify impacts on the overall population
	Ship rat <i>Rattus rattus</i>	Quantified	Hyères islands, France	Potentially high	Increase study sites to quantify impacts on the overall population
Indigenous predators	Eagle owl <i>Bubo bubo</i>	Quantified	Marseille islands, France	Low	Interaction studies in sympatric breeding sites
	Peregrine falcon <i>Falco peregrinus</i>	Quantified	Archipelago off Crete	Low	
	Yellow-legged gull <i>Larus michahellis</i>	Quantified	Hyères islands, France	Medium	
Competition for breeding sites	Cory's shearwater <i>Calonectris diomedea</i>	Quantified	Hyères islands, France	Low, locally high	Interaction studies in sympatric breeding sites
Disturbance	Lights	Observed	Hyères islands, France	Low	Identification & diagnosis of breeding sites
	Tourism	Observed	Hyères islands, France	Potentially high	
Habitat degradation	Urbanization, tourism	Observed	Hyères islands, France	Medium	Identification & diagnosis of breeding sites
Harvesting	Adults, eggs, chicks	Observed	Balearic islands, Corsica, Croatia, Egadi islands	Low, locally high	
At sea					
Fisheries	Accidental captures in drift- & gill-nets	Observed	Off south-east French coast	High	Impact quantification for the overall population
	Accidental captures on long-lines	Observed	Gulf of Lions, Straits of Bonifacio, Italian waters, around Malta	High	Impact quantification for the overall population
Pollution	Decrease in food availability	Suspected		Potentially high	Survey of prey availability
	Biocontamination	Suspected		Potentially high	Quantification of biocontaminants with sanitary & breeding monitoring
	Oil spills	Suspected		Potentially high	Search for affected birds

population and at sea) and the fact this reduction and its causes have not ceased and are not fully identified, the species should be considered at least Near Threatened. The Near Threatened classification acknowledges the possibility that future research will qualify the species for inclusion in a threatened category (IUCN, 2001). In the same way, the species' Secure European threat status (BirdLife International, 2004a) should be reviewed and possibly revised in the light of future research.

Discussion

This review emphasizes the lack of available data for the yelkouan shearwater. Purported yelkouan shearwater breeding sites require confirmation, particularly in Turkey and Greece. Breeding population censuses are needed at colonies, particularly on purported major breeding sites such as in Sardinia, Sicily and Greece. In addition, the biology and ecology of this species are still poorly known and research is therefore required for the design of an appropriate conservation strategy. In particular, demographic monitoring is a prerequisite for assignment of species conservation status. The impact of introduced predators on the yelkouan shearwater has been demonstrated but studied only in small populations. Control and/or eradication of introduced predators (particularly cats and rats) should be a conservation priority. The removal of rabbits and house mice from the Atlantic island of Selvagem Grande, for example, was beneficial to the breeding of Cory's shearwaters *Calonectris diomedea borealis* (Zino *et al.*, 2008).

Accidental bycatch in fishing gear has been identified as a major threat for medium and large Procellariiforms (Brooke, 2004) but few data are available for the yelkouan shearwater. Consequently, quantification of this impact is required, as is the identification of Marine Important Bird Areas (BirdLife International, 2004b) for this species. Breeding site protection, especially against introduced predators, and at-sea threat prevention, were initiated in France in 2003 (Marseille and Hyères islands) and are beginning in Malta with the help of funding from three EU LIFE Nature programmes. However, the yelkouan shearwater distribution comprises at least 10 countries and international collaboration is necessary for the preservation of this Mediterranean endemic species. We thus encourage such collaborations to assess the global situation for the species and coordinate conservation actions. Finally, we call for more data on the yelkouan shearwater, particularly regarding demography and ecology, and for an evaluation of terrestrial and marine threats. Such data are also lacking for many seabirds, particularly Procellariids (IUCN, 2007), and an effort to complete our knowledge regarding these issues would improve prioritization of conservation actions for seabirds.

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Appendix

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Biographical sketches

KAREN BOURGEOIS has been studying the ecology, biology and conservation of the yelkouan shearwater for 6 years, and previously participated in a LIFE programme on shearwater conservation on the Hyères Islands for 3 years. Her main research interests are the ecology and conservation of seabirds. ERIC VIDAL researches the ecology and dynamics of seabirds, particularly in the Mediterranean, and the functioning of island ecosystems, especially the role of biotic interactions and the impact of invasive species.