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Presence of the Eurasian otter *Lutra lutra* on the islands of Greece: a review

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Abstract. The Eurasian otter (*Lutra lutra*) is fairly widespread across much of mainland Greece but is currently known to be present on very few of the Greek islands. We reviewed otter data for the islands of Greece, based on confirmed evidence from the literature, personal records and unpublished data (e.g. alive/dead animals, tracks, spraints). The presence of otters on Mediterranean islands is documented only for Greece with recent records for Corfu, Lefkada, Euboea and Samos and older records for Lesvos and Chios. As these islands are close to the mainland, gene flow may contribute to the persistence of their otter populations. Anthropogenic habitat changes are a major threat to otter survival, including severe transformation and disturbance of island habitats. Several small island wetlands suitable to otter presence need to be protected to support otters and enhance their conservation status.

Key words: temporary wetlands, insular habitats, conservation, Mediterranean

Introduction

The Eurasian otter (*Lutra lutra*) is the most widespread otter species. It suffered a substantial decline in Europe from the 1970s to the 1990s, but it is now recovering in many countries, excluding parts of central Europe (Roos et al. 2015). A strong recovery of the species has been recorded in Western Europe, where it is now considered Near Threatened (Duplaix & Savage 2018). At the European level, the otter is included in Annexes II and IV of the EU Habitats Directive 92/43/EEC, protected in the Special Areas of Conservation (SACs) of the Natura 2000 network (European Environment Agency 2015). The species is also listed in Appendix I of CITES and included in the Bern Convention (Roos et al. 2015).

Otters live in a wide range of freshwater habitats including rivers, streams, canals, lakes, marshes, deltas, artificial reservoirs and sometimes even drainage ditches with only a few centimeters of water. They also inhabit coastal brackish and marine habitats, if freshwater is available in the surroundings (Mason & MacDonald 1986, Kruuk 2006).

The otter is fairly widespread throughout much of mainland Greece and has been recorded locally on the islands of Corfu (Ionian Sea), Euboea, Chios and Lesvos (Aegean Sea) (Galanaki & Gaethlich 2009). Few national or local surveys for determining otter presence in Greece have been conducted so far, with hardly any covering the islands except for Corfu (MacDonald & Mason 1982, 1985, Gaethlich 1988, Grémillet 1993, 1998, Ruiz-Olmo 2005, 2006, Galanaki & Coyne 2016, Ministry of Environment and Energy of Greece 2017). According to the latest EU Habitats Directive reports otters are only recorded in Corfu, Chios and Euboea (European Environment Agency 2017). In Greece, the Eurasian otter was given protection by a Presidential Decree in 1981 (PD no. 67/1981). The species is classified as "Endangered" in the latest update of the Red Data Book of Threatened Animals of Greece (Galanaki & Gaethlich 2009). Major threats for the species' survival in Greece are anthropogenic, including severe habitat alteration (i.e. loss, degradation, fragmentation), wetland drainage, water abstraction, human disturbance, pollution and persecution (Galanaki & Gaethlich 2009).

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The present study was aimed at reviewing the presence of the Eurasian otter on Greek islands. To our knowledge the current occurrence of the otter is not documented on any islands of the Mediterranean Basin other than a few Greek islands, all situated close to the Greek, Albanian and Turkish mainland (Masseti 1995, 2012, Ruiz-Olmo 2005, Galanaki & Gaethlich 2009).

Methods

Data collection was initially based on a literature search of published scientific articles and official technical reports (e.g. EU and national reports). Reviewed data also included irregular reports (e.g. alive/dead animals, tracks and spraints; for otter survey details, see Macdonald et al. 1998, Chanin 2003) and reliable records by other experts, such as from unpublished technical reports and other evidence tracked in social media or directly reported to us including mortalities (e.g. photographs of dead animals). Otter sites were split into two main categories: those with permanent otter populations and those with only occasional and/or accidental otter records. A map with the islands and locations of all confirmed otter sites is provided (Fig. 1).

Islands with permanent otter presence

Corfu (northern Ionian Sea)

Corfu (592 km^2) is located in north-western Greece (Fig. 1). Its distance from mainland Greece is 12 km, while the Albanian coastline is 3 km and 23 km away (along the Corfu Channel). The island harbours many coastal and inland wetlands such as lagoons, small estuaries and natural river mouths, marshes, lakes and ponds, small perennial rivers and temporary streams and torrents (World Wide Fund for Nature 2017). Otter occurrence in Corfu has been well documented since the late 1980s (Table 1). Historical information confirms that the species was hunted for its fur in the 1940s (Bounias 1954) and evidence of a trade in otter fur is known from the early 1960s (Niethammer 1962). At present, otters occur throughout most of the island, both in small and large wetlands along coastal rivers and other inland water bodies, but the viability of the population is unknown (Fig. 1). The most recent records date back to 2016 (authors' unpublished data, Table 1). With reference to nearby mainland populations, otters live on Greek and Albanian wetlands off the eastern and northern coastline of Corfu, such as the delta complex of the

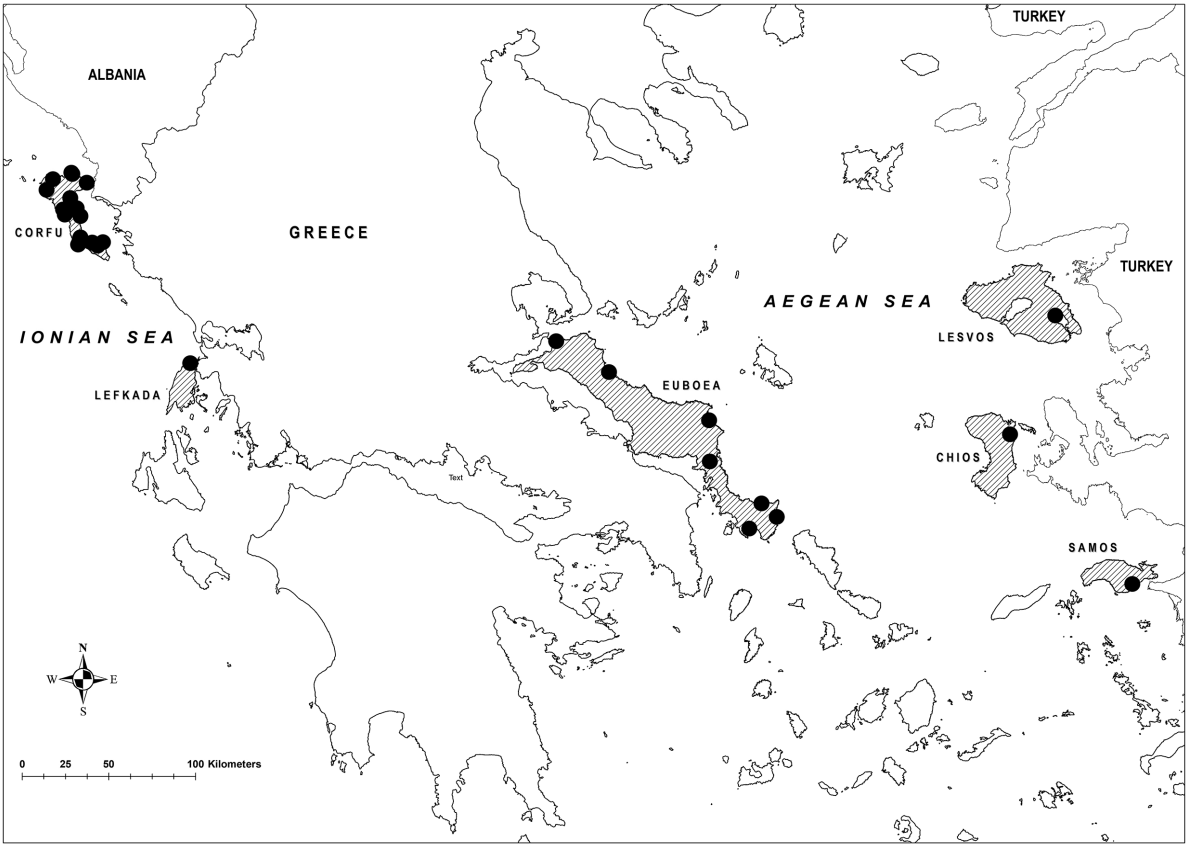


Fig. 1. The six Greek islands Corfu, Lefkada, Euboea, Lesvos, Chios, Samos – highlighted with hatched black lines – for which recent and older Eurasian otter records were reviewed in this study. Sites with otter presence are designated with black dots.

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Table 1. Summary of information on otter presence and absence on Greek islands where the species has been recorded in the last 35 years.

Island	Sites and dates of main records	Source
Corfu	River Tyflopotamos (north), River Messogi (south-east), Korrision lagoon (south-west) in 1985 and in 1986	Gaethlich (1988)
	North and south-central parts of Corfu in 1990	J. Ruiz-Olmo unpublished data (reported in Ruiz-Olmo 2005)
	Rivers Melissoudi (north), Dassia/Daphnila (north-west), Potamos (east-central), Messogi (south-east), Antinioti (north), Agios Stefanos (north-east), Chalikopoulou (east-central) and Lefkimi salt lake (south-east) in 1991, in 1992 and in 1997	Grémillet (1993, 1998) (see original references for maps with locations)
	Eight positive sites with signs in central and north Corfu (incl. the city of Corfu, in Alikes and Sidari)	Urban (1998)
	Rivers Melissoudi, Dassia/Daphnila, Potamos, Messogi, Petriti (south-east) and River Ropa (west), River Agios Giorigios (north-west) and in the lagoons of Antinioti, Chalkiopoulou and Korission	Ruiz-Olmo (2006) (see original reference for map with locations)
	Tracks in Lefkimi in the saline lagoon (1998) and along the coast (1999), in Chalkiopoulou lagoon (2011)	This study (I. Gasteratos unpublished data)
	Dead animals in Korission lagoon (2006) and in Antinioti lagoon (2012)	This study (I. Gasteratos unpublished data)
	Spraints in Antinioti lagoon, in River Pora and in River Tyflopotamos in 2016	This study (A. Galanaki & T. Kominos, I. Gasteratos unpublished data)
Euobea	Spraints and tracks in the lagoons of Mikro and Megalo Livari, in Istiaia (north Euboea) in 2000	Kominos (2000), this study (A. Galanaki & T. Kominos unpublished data)
	Kireas and Nileas and in the river mouth near Mandoudi (north-central Euboea)	Adamakopoulos et al. (1991), Oikos Ltd. (2001)
	Spraints and tracks in Mourteri and Manikiatis (south of Kymi) in 1987 and 2001	This study (Zogaris & Gaethlich 1987, S. Zogaris 2001 unpublished data)
	Spraints at Lake Dystos (central-south Euboea)	Sfougaris (1996), this study (S. Zogaris unpublished data)
	Spraints and tracks in Mount Ochi coastal stream sites (Porphyras, Dimosaris, and the Komito streams) in unusually small and isolated stream-mouth conditions in 2007	This study (S. Zogaris unpublished data)
	Spraints and tracks in Komito stream river mouth in 2017	This study (S. Zogaris unpublished data)
	Spraints, tracks and sightings first recorded in 1984 and then throughout the 1980s and 1990s, incl. an animal shot in 1986 in the Karystos Plain in the island's southernmost bay, west of the town of Karystos; Spraints and tracks in the same area in 2015 and 2017	Zogaris (1985), Dimopoulos (1998), this study (S. Zogaris, A. Galanaki & T. Kominos unpublished data)
Lefkada	Speculation of presence by local Forestry Service rangers (without any details of location and date)	Masseti (2012)
	Spraints and tracks in the Lefkada city lagoon (north-east Lefkada) in 2015	This study (A. Galanaki & T. Kominos unpublished data)
	Dead animal in the Lefkada city lagoon (north-east Lefkada) in 2016	D. Mavrona, pers. comm.
	Tracks in the Lefkada city lagoon (north-east Lefkada) in 2017	This study (A. Galanaki & T. Kominos unpublished data)
Samos	Dead animal in Pythagorion (south-east Samos) in 1998	Masseti (2012)
	Dead animal (stranded on the coastline) in Pythagorion (south-east Samos) in 2017	G. Pietroluongo, A. Miliou, pers. comm.
	Absent after survey in various wetlands in 2017	This study (A. Galanaki & T. Kominos unpublished data)
Lesvos	Dead animal in Dipi marsh in the Gulf of Gera (south-east Lesvos) in 1996 (no hard evidence)	Axiotis (1997), M. Axiotis, pers. comm.
	Evergetoulas river mouth, Dipi area, in the Gera Gulf (south-east Lesvos) in mid 1990s	Valakos et al. (2012), S. Valakos, pers. comm.
Chios	Delfini area (north-east Chios) in 1990	Gaethlich (1990)
	Presence without any details of location and date	Adamakopoulos et al. (1991)
	Presence without any details of location and date	Grémillet (1995)
	Presence without any details of location and exact date in 1993	X. Grémillet unpublished data – reported as pers. comm. in Masseti (1995)

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River Kalamas in north-western Greece (Galanaki 2015, Galanaki et al. 2016) and the Butrint National Park, a Ramsar site in south Albania (Prigioni et al. 1986, IUCN 2012, Balestrieri et al. 2016); gene flow between the mainland and Corfu is considered possible.

Euboea (central Aegean Sea)
Euboea (3654 km^2) is the second largest Greek island (Fig. 1). It is roughly parallel to mainland Greece (Sterea Hellas), separated by the Evripos Strait, which is only 38 m wide at its narrowest point at the Chalkis Bridge. Euboea is rich in natural wetlands, both coastal and inland, including the largest island lake of Greece, at Dystos (World Wide Fund for Nature 2017). Otters have been reported from at least seven distinct areas of Euboea, in both small and fairly large inland and coastal aquatic sites, even in rather degraded wetlands along the coast. The earliest records date back to the early 1980s, while the latest are from 2017 (authors' unpublished data, Table 1), showing that there are permanent populations on the island. Most records are based on irregular observations rather than systematic surveys. Wetlands on adjacent mainland Greece with confirmed otter presence are located off the west coastline of northern Euboea (Ministry of Environment and Energy of Greece 2017), and animal dispersals may occasionally occur.

Islands with occasional and/or accidental otter presence

Lefkada (central Ionian Sea)
Lefkada (325 km^2, western Greece) is connected to the mainland by a 20 m long floating bridge crossing the Drepanos Strait (Fig. 1). A few coastal and inland wetlands occur on Lefkada, including lagoons, estuaries, marshes, salty flats and a small lake (World Wide Fund for Nature 2017). Supposed otter presence (Masseti 2012) has been recently confirmed for the lagoon lying in the north-eastern part of the island (authors' unpublished data, Table 1). Extensive inland water bodies are located north and east of Lefkada on mainland Greece, immediately adjacent to the island (Lake Voulkaria and surrounding wetlands) and in the large complex of wetlands in the Amvrakikos Gulf, where otters occur (Galanaki et al. 2016, Galanaki & Kominos, unpublished data).

Lesvos (north-eastern Aegean Sea)
Lesvos (1633 km^2) lies close (5.5 km at the Mytilini Strait) to the Turkish mainland (Fig. 1). The island support many wetlands (World Wide Fund for Nature 2017). Most of Lesvos's natural wetlands lie along the coast, in the Gulf of Kalloni in the south-centre and in the Gulf of Gera in the south-east. Otter records date back to the mid-1990s (Table 1). However, the persistence of a local population should not be ruled out, as no thorough survey has been carried out. Otters occur in the coastal wetlands of western Turkey, off the north coast of Lesvos (Thol-Schmitz 2004).

Chios (eastern Aegean Sea)
Chios (842 km^2) is separated from Turkey by the 7 km wide Çeşme Strait (Fig. 1). Although it is a fairly large island, it has few natural wetlands, mainly small intermittent streams, river-mouths and marshes mostly situated in coastal areas and small artificial inland water reservoirs (World Wide Fund for Nature 2017). There are a few records of the otter on Chios (Table 1). No recent information is available and it is unlikely that a stable or self-sustaining population occurs on the island, especially since suitable habitats are scarce and degraded.

Samos (eastern Aegean Sea)
Samos (477 km^2) lies closer to Turkey than any other Greek island (1.6 km at the Mycale Strait, Fig. 1). It has few wetlands, mostly marshes, ponds, streams and estuaries, and salt flats, situated in the south-east coastal area and in the north-west of the island (World Wide Fund for Nature 2017). The few otter records from Samos are presented in Table 1. A survey in 2017 revealed no evidence of a permanent population there (Galanaki & Kominos, unpublished data). Suitable habitats for otters are rather limited, as the remaining wetlands are degraded and many freshwater and brackish aquatic habitats areas dry-out for long periods. Nonetheless, otters could occasionally or accidentally occur on the coastline of Samos. Notably a dead specimen was found there in 2017. We hypothesize that this animal probably originated from the coastal wetlands of Turkey (Thol-Schmitz 2004).

No presence

Crete (south Aegean Sea)
Crete (8336 km^2) is the largest Greek island, located in the southernmost part of the Aegean Sea. A spraint-based record was published in 2003 (de Smet & Lymberakis 2003), but it was not confirmed by successive surveys (this study, P. Lymberakis, J. Ruiz-Olmo, pers. comm.), including a recent rapid assessment in 2018 (Galanaki & Kominos, unpublished data). We exclude any possibility

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of accidental occurrences since the island is biogeographically isolated from both the European and Asian mainland (Zogaris & Economou 2017). The biogeographical distinctiveness of the island is further supported by the fossil record of an endemic mustelid, the Cretan otter *Lutrogale cretensis,* which became extinct along with several other endemic mammals on the island during the Late Pleistocene (Masseti 1995, van der Geer et al. 2010).

Discussion

Proposals for conservation

Corfu and Euboea support permanent European otter populations, with records occurring also for Lefkada, Samos, Lesvos and Chios, but for which there is no evidence of stable populations. These islands are close to the mainland, hypothetically allowing for gene flow from continental populations (Masseti 1995, 2012). To our knowledge, the species is absent from all other islands of the Mediterranean Basin, including the largest (i.e. Sicily, Sardinia, Cyprus, Corsica and Crete) (Ruiz-Olmo 2005, Masseti 2012, this study). Otters from the Balkan Peninsula and Asia Minor (Turkey) could move between marine and freshwater habitats; otters are known to travel up to 13 km by sea (Blundell et al. 2002, Kruuk 2006, Liles 2009). However, further research is needed to preserve and support the island populations and to enhance the species' conservation status on these islands.

Maintenance of good quality habitats, the main characteristics of which are an adequate food supply, resting and breeding sites and cover (Macdonald & Mason 1990) are vital for long-term otter survival. Sufficient resources for otters are limited on small island wetlands due to their restricted size where even the slightest alteration such as loss, degradation or fragmentation of suitable habitats could pose a substantial threat. Since the 1980s, many wetlands on the Greek islands (even designated as Natura 2000 sites) have been destroyed and degraded due to pressure from the development of tourism and other land-use changes (World Wide Fund for Nature 2017). In 2012, a Presidential Decree entitled "Approval of a list of small island wetlands, and provision of terms and conditions for the protection and conservation of small coastal wetlands included therein" (PD no. 229/19-6-2012) came into force, but still needs to be fully implemented.

Otters on the Greek islands may also depend on freshwater availability, a key factor for the suitability of not only breeding and resting but also for sufficient feeding sites (Beja 1992, 1996, Prenda et al. 2001, Ruiz-Olmo et al. 2001, Kruuk 2006). The Greek islands primarily have temporary wetlands, resulting from seasonally semi-arid climate conditions, climate variability and the expansion of modern land-use development. Lack of permanent freshwater wetlands and lotic waters could affect otter survival since food supply may become scarce and food availability could be a major constraint in their distribution and abundance (Ruiz-Olmo et al. 2001). Studies in Mediterranean areas, where wetlands dry-out during summer and freshwater availability is limited, show that otters may shift their diet or travel between watersheds to find suitable habitats to withstand extreme conditions (Galanaki 2000, Prenda et al. 2001, Ruiz-Olmo et al. 2001, Clavero et al. 2003, Smiroldo et al. 2009, Pedroso et al. 2014). Freshwater is also vital for otters for drinking and to wash salt out of their fur, which may otherwise lose its insulative properties (Beja 1992, 1996, Kruuk 2006).

Small inland aquatic waters and wetlands are exposed to multiple stressors that threaten their ecological integrity and biodiversity (Skoulikidis et al. 2017). Ongoing climate change may be one of these, exacerbating the loss of freshwater habitats suitable to otters. Studies on the impact of climate change on coastal and marine biodiversity in the Mediterranean Basin show a decrease in rainfall mainly during the summer and a temperature rise by the end of this century (UNEP-MAP-RAC/SPA 2010, Sauter et al. 2013). This outcome could drastically affect otter habitats on coastal areas and islands. Only recently have climate change effects been recognized as a potential threat to otter populations in mainland Europe; researchers suggest a re-consideration of protected areas due to potential shifts in the species' distribution due to climate change (Cianfrani et al. 2011). Thus, the identification of otter habitats in the wetlands on Greek islands could be used as a key tool for preserving otters on islands, while otters could be used as umbrella species (Bifolchi & Lodé 2005) for the conservation of these valuable, fragile and usually threatened, island ecosystems.

Otter habitats on the Greek islands should be strictly protected and maintained for their ecological value and their uniqueness to support a top predator in such extreme environments with multiple human-induced pressures. We, therefore, propose an up-listing of the Eurasian otter "threat status" in the Red Data Book of the Threatened Animals of Greece, only for those populations that occur on the Greek islands, by the evaluators of IUCN Red List of Threatened Species in the forthcoming evaluation.

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