Managing the Natura 2000 network in Cyprus and shaping a sustainable future

ACTION A.5

Study the ecological requirements of key qualifying species for SPAs (Annex I bird species of Directive 2009/147/EC)

DELIVERABLE A5.9

Report on key nesting sites for *Gulosus aristotelis desmarestii*

Antaia Christou, Stalo Leontiou, Nikos Kassinis.

Nicosia, October 2025

LIFE IP PHYSIS - LIFE18 IPE/CY/000006
Το έργο συγχρηματοδοτείται από το πρόγραμμα LIFE της ΕΕ

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Διαχείριση του Δικτύου Natura 2000 στην Κύπρο και διαμόρφωση ενός βιώσιμου μέλλοντος

ΔΡΑΣΗ Α.5

Μελέτη των οικολογικών απαιτήσεων ειδών ορνιθοπανίδας που περιλαμβάνονται στο Παράρτημα Ι της Οδηγίας 2009/147/ΕΕ

ΠΑΡΑΔΟΤΕΟ Α5.9

Μελέτη κύριων περιοχών φωλεοποίησης για το είδος *Gulosus aristotelis desmarestii*

Ανταία Χρίστου, Στάλω Λεοντίου, Νίκος Κασίνης

Λευκωσία, Οκτώβριος 2025

LIFE IP PHYSIS - LIFE18 IPE/CY/000006
Το έργο συγχρηματοδοτείται από το πρόγραμμα LIFE της ΕΕ

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Περίληψη

Ο Θαλασσοκόρακας (*Gulosus aristotelis desmarestii*) είναι ένα από τα τρία θαλασσοπούλια που αναπαράγονται στην Κύπρο. Μέχρι πρόσφατα, η γνώση μας σχετικά με τις περιοχές φωλεοποίησης του περιοριζόταν σε μια μόνο αποικία που βρίσκεται σε περιοχή που η Κυπριακή Δημοκρατία δεν ασκεί αποτελεσματικό έλεγχο, και συγκεκριμένα στις νησίδες Κλείδες στο βορειοανατολικό άκρο του νησιού. Επιπλέον, παρατηρήσεις του είδους σε άλλες περιοχές υπέδειξαν τη συγκέντρωσή του στις νοτιοδυτικές και βορειοδυτικές ακτές. Στο πλαίσιο του έργου "LIFE IP Πανδώτειρα" (LIFE+18 IPE/CY/000006), η Υπηρεσία Θήρας και Πανίδας Κύπρου και ο Μη Κυβερνητικός Οργανισμός (ΜΚΟ) BirdLife Cyprus συνεργάστηκαν για να καλύψουν τα κενά στη γνώση για αυτό το είδος. Πραγματοποιήθηκαν έρευνες για τον καθορισμό της αναπαραγωγικής κατανομής του Θαλασσοκόρακα στην Κύπρο, καθώς και των σημαντικότερων περιοχών ξεκούρασης και τροφοληψίας.

Στο πλαίσιο της μελέτης, πραγματοποιήθηκε ανασκόπηση στη βιβλιογραφία όπου εντοπίστηκαν οι σημαντικότερες περιοχές φωλεοποίησης του είδους, καθώς και εκτιμήσεις του πληθυσμού ανά τα χρόνια. Περιοχές όπως οι γκρεμοί στο Ακρωτήρι και οι νησίδες Άγιος Γεώργιος - Κακοσκάλι και Γερόνησος, επιβεβαιώθηκαν από πρόσφατες έρευνες ότι αποτελούν περιοχές φωλεοποίησης του Θαλασσοκόρακα.

Η μεθοδολογία που ακολουθήθηκε σε αυτή την μελέτη αφορούσε στο συνδυασμό επιτόπιων ερευνών και χρήση ειδικών πομπών που τοποθετήθηκαν σε νεαρά και ενήλικα πουλιά. Έπειτα, έγινε ανάλυση των δεδομένων για τον προσδιορισμό των σημαντικότερων τοποθεσιών φωλεοποίησης, τροφοληψίας και ξεκούρασης του είδους. Τα δεδομένα έδειξαν πληροφορίες σχετικά με τα ενδιαιτήματα που χρησιμοποιούν τα πουλιά, τονίζοντας τη σημασία των Θαλάσσιων Προστατευόμενων Περιοχών (ΘΠΠ), όπως της Ωκεανίς, του Ακάμα και της περιοχής Πόλις - Γιαλιά.

Επιπλέον, η μελέτη κάνει αναφορά στις διάφορες απειλές που αντιμετωπίζει ο Θαλασσοκόρακας συμπεριλαμβανομένων της όχλησης από αλιευτικές και τουριστικές δραστηριότητες, της θήρευσης των αβγών από τρωκτικά στις νησίδες φωλεοποίησης, αλλά και στις πιθανές επιπτώσεις εξαιτίας της κλιματικής αλλαγής στην αναπαραγωγική τους επιτυχία.

Οι προτεινόμενες δράσεις διατήρησης περιλαμβάνουν τη νομική προστασία των σημαντικότερων περιοχών για το είδος, ειδικά τη νομική κάλυψη των νησίδων όπου το είδος αναπαράγεται. Προτείνεται η επέκταση της θαλάσσιας προέκτασης της ΖΕΠ Ακάμα για να συμπεριλαμβάνει τις νησίδες Άγιος Γεώργιος - Κακοσκάλι και Γερόνησο. Επιβάλλονται συγκεκριμένα μέτρα για προστασία των νησίδων. Προτείνεται επίσης η συστηματική παρακολούθηση του πληθυσμού, καθώς και η ευαισθητοποίηση των τοπικών κοινοτήτων. Συγκεκριμένες δράσεις περιλαμβάνουν τη ρύθμιση των τουριστικών και αλιευτικών δραστηριοτήτων, τη δημιουργία ζωνών προστασίας γύρω από τις περιοχές τροφοληψίας και την εφαρμογή μέτρων ελέγχου των τρωκτικών για τη διασφάλιση υψηλότερης αναπαραγωγικής επιτυχίας.

Summary

The Mediterranean Shag (*Gulosus aristotelis desmarestii)* is one of three breeding seabirds in Cyprus. Until recently, our knowledge of its nesting areas was limited to a single colony located in an area over which the Republic of Cyprus does not exercise effective control, namely the Kleides islets at the northeastern tip of the island. Sightings of the species elsewhere indicated that the species is also concentrated in the southwest and northwest coasts. Within the framework of the project "LIFE IP Pandoteira" (LIFE+18 IPE/CY/000006), the Cyprus Game and Fauna Service and the Non-Governmental Organization (NGO) BirdLife Cyprus have joined forces to fill in the gaps in the knowledge for this species. Surveys were performed to identify the breeding distribution of Mediterranean Shag in Cyprus, and the important resting and feeding areas.

The report outlines the historical context of the species in Cyprus, documenting previous nesting sites and population estimates. It identifies critical areas such as Akrotiri Cliffs, Ayios Georgios - Kakoskali, and Geronisos islets, where recent surveys confirmed active nests.

Methodologically, the study employed a combination of field surveys, the attachment of tracking devices to both juvenile and adult birds and data analysis to identify nesting, feeding, and resting locations. Tracking data revealed insights into the habitats utilized by the birds, emphasizing the significance of Marine Protected Areas (MPAs), such as Oceanid, Akamas and Polis – Gialia.

The report also highlights various threats to the Mediterranean Shag, including human disturbance from tourism and fishing activities, predation by rodents on nesting islands, and potential climate change impacts on their nesting success.

The proposed conservation actions include legal protection for key habitats, especially the legal protection of the islets where the species nests. It is proposed to expand the marine extension of the Akamas SPA to include the islets of Ayios Georgios - Kakoskali and Geronisos. Specific measures need to be imposed to protect these islets. In addition, we propose systematic monitoring of the population, and community engagement to raise awareness among local stakeholders. Specific actions involve regulating tourism and fishing activities, creating buffer zones around feeding grounds, and implementing rat control measures to ensure higher breeding success.

1. Introduction

1.1 About the project

LIFE IP Physis (*Pandoteira*) is a LIFE Integrated Project that aims directly at the improvement of the conservation status of species and habitats of community interest through actions in the whole Natura 2000 (N2K) network in Cyprus (for the areas under effective government control). The project includes actions affecting the whole network and other actions affecting certain species and habitats in specific N2K sites (including both Special Protection Areas (SPAs) and Sites of Community Importance (SCIs)).

1.2 Action description

Action A5 is a preparatory action under the LIFE IP Pandoteira project. The implementing partners for this action are the Game & Fauna Service (GFS) and BirdLife Cyprus (BC). Under this action, one study has already been completed and five more studies were carried out (between 2022 and 2025), with the overall objective of informing conservation actions to be undertaken later during the project (2023-2030). The current report comprises one of these preparatory studies, and provides information on the Mediterranean Shag sub-species (*Gulosus aristotelis desmarestii*)[1]. More specifically, the current report covers information about the breeding colonies of the species, as well as feeding and resting locations. The Mediterranean population of the species is included in Annex II of the Bern Convention, and the sub-species is listed in Annex I of the Birds Directive 2009/147/EC.

1.3 Special Protection Areas (SPAs): Focus Areas of this report

Special Protection Areas (SPAs) are designated under the European Union (EU) Directive on the Conservation of Wild Birds (2009/147/EC). Under this Directive, all EU Member States are required to safeguard the habitats of migratory birds, as well as certain rare, localised or threatened bird species.

In Cyprus – areas under the effective control of the Republic of Cyprus – there are Marine Protected Areas (MPAs) designated under different legal frameworks. Four marine areas are designated under the Birds Directive (2009/147/EC) and three marine areas are designated under the Habitats Directive (92/43/EEC). Other nationally designated MPAs exist, such as artificial reefs and important biodiversity areas where fishing is prohibited.

Additionally, within the Sovereign Base Areas (SBAs), three areas have been identified for the Mediterranean Shag. Two of them, Episkopi Cliffs and Akrotiri Cliffs, have been designated as SPA-

[1] Previously *Phalacrocorax aristotelis desmarestii*

equivalent areas for the species (SBBA, 2012)[2]. The third site, Cape Pyla, is designated as a Special Area of Conservation (SAC).

Despite the designation of the four marine SPAs, none of them was designated for the protection of the Mediterranean Shag. Additional marine SPAs have been proposed for inclusion in the Natura 2000 network, however the process still lags behind. In addition, and up to the preparation of this study, the government has yet to issue Ministerial Decrees for the protection of Natura 2000 sites (including MPAs or marine SPAs). Here, it is worth noting that relevant Management Plans for the majority of SPAs have been prepared since 2016, but they have not gained legal standing yet. However, there is a Ministerial Decree in place for the protection of fishing resources and aquatic organisms in the Kakoskali Marine Protected Area (Κ.Δ.Π. 258/2019), which falls under the Chersonisos Akamas (CY4000010) Natura 2000 site, a site where Mediterranean Shags nest. Although Kakoskali is a nationally designated MPA aiming at the protection of fishing resources and aquatic organisms, indirectly it benefits the population of the Mediterranean Shag in the area through the prohibition of fishing and the establishment of 'no take' zone. Figure 1 shows the network of existing MPAs under the different legal frameworks in the areas under the effective control of the Republic of Cyprus and the Sovereign Base Areas.

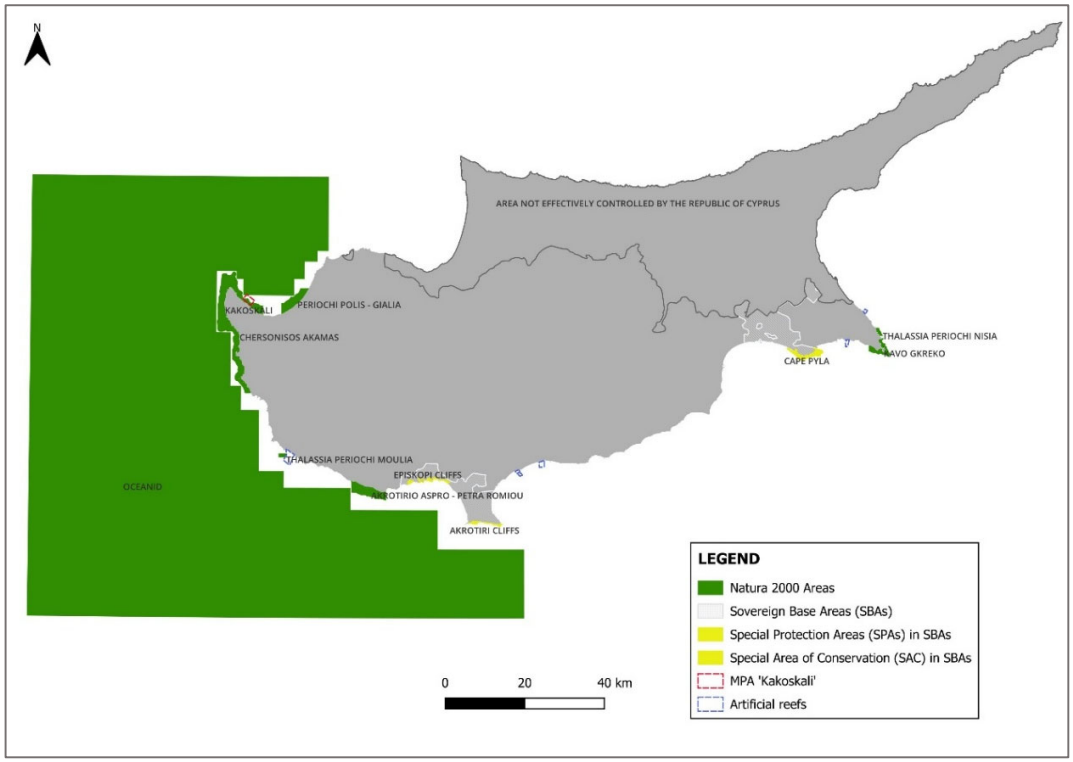


Figure 1: Marine Protected Areas network in the areas under the effective control of the Republic of Cyprus and in the Sovereign Base Areas. Credits: Stalo Leontiou

[2] Both these sites fall under the jurisdiction of the British Sovereign Bases, where the EU acquis does not apply, but they are designated as SPA-equivalent under the SBA 2008 Game & Wild Birds Ordinance mirroring the Republic's Law 152(I) 2003 implementing the Birds Directive.

Since the breeding distribution of the species is relatively poorly known, this Action primarily focused on locating breeding colonies through targeted surveys within the SPAs mentioned above. Apart from the focus on marine and relevant terrestrial SPA and SAC sites, the management solutions that this study will propose are potentially applicable to other SPAs in the European Union and can also lead to the designation of additional marine SPAs in Cyprus to ensure the effective protection of the species.

1.4 Historical evidence for Mediterranean Shag nesting in Cyprus

According to earlier publications (Bannerman 1971), the best-known breeding sites for Mediterranean Shags, used to be Cape Gata (Akrotiri), Cape Aspro and Kormakitis. In addition, birds were also seen breeding on the North West coast and on Kleides islands, as well as the south part of Cyprus, at islets in Polis Chrysochous bay. Flint and Stewart (1992), mention breeding at Kleides islands, Episkopi and Akrotiri cliffs. They also mention possible breeding at Cape Aspro, Cape Kormakitis, Orga Cliffs (Flint & Richardson 2024), Ayios Georgios; Kakoskali islet (Chrysochous bay), and Mazaki islet. Flint and Stewart also mention that Mediterranean Shags formerly bred on an islet close to Kyrenia (probably referring to Nisida Glykiotissa), where Bucknill counted 15 pairs in April 1909 (Bucknill, 1910). Kourtellarides (1998) mentions confirmed breeding on the cliffs of Episkopi Bay, one in 1971 and one in 1995. Both nests are described as located on very steep inaccessible cliffs, around six meters above sea level. The first population estimate for the species was at 40-50 pairs in 1992 (Flint and Stewart, 1992).

The best-available data on key sites to date, that were based on collating all available data and knowledge in addition to surveys, are the publications of Important Bird Areas (IBAs) of Cyprus. In the 2000 publication, the minimum national breeding population was calculated at 80 pairs (Charalambides, 2000). The two IBAs identified were the Kleides islands, with 25-50 pairs and Cape Aspro with 10-50 pairs (both sites meeting IBA criterion B1i[3] of BirdLife international). In the 2004 IBA publication (Iezekiel et al, 2004), the identified IBAs were Karpasia Peninsula - Kleides Islands*[4] with 40-50 pairs (meeting the IBA C6 criterion), Akrotiri Peninsula-Episkopi Cliffs* with 35-40 pairs (meeting the IBA C6 criterion[5]), Cape Aspro* with 5-10 pairs and Akamas Peninsula. In the updated publication of 2014 (Hellicar et al., 2014), Mediterranean Shags were regularly observed at the IBAs of Cape Greco, Ayia Thekla-Liopetri River, Kormakitis Peninsula, Larnaca Salt Lakes, Akrotiri Peninsula-Episkopi Cliffs*, Akamas Peninsula and Agia Aikaterini – Agia Paraskevi Gorges* and Cape Aspro*; although not in numbers sufficient to meet any criteria. The only IBA identified in 2014, that met any criteria (C6 criterion) for designation was Karpasia Peninsula, specifically Kleides Islands,* with 5-25 pairs estimated to nest there. Even though data collected

[3] Site known to or thought to hold ≥1% of a flyway population or other district population of a congregatory waterbird species.
[4] Asterisk after the site name, means that the species was recorded as breeding on the site. In the rest of the areas, the species was recorded as present.
[5] The site is one of the five most important in the European (NUTS or marine) region in question for a species or subspecies considered threatened at the EU level.

for these publications were conducted outside the breeding season of the species (May, June, September), this data is the only systematic data that exist on the species and points out the key sites used by Mediterranean Shags.

Other studies (Charalambidou et al, 2008) report breeding colonies at Episkopi and Akrotiri Cliffs, Cape Aspro and Cape Arnaouti, however the biggest breeding colony of the species was found at Kleides Islands where Charalambidou and Gücel (unpublished data) recorded 70 to 90 pairs in spring 2007. Bazin and Imbert (2012), mention only 11-31 pairs of Mediterranean Shags across the whole of Cyprus, with four colonies identified at Cape Aspro, Akrotiri, Galounia islets (Dhavlos area), and Kasteletta islet (part of Kleides Islands). In a 2016 publication (Hellicar 2016), Mediterranean Shag counts from 2007-2015 in late May on Kleides Islands, show a variable number of individuals roosting on the islands outside the breeding season, with a minimum count of 12 adults and 20 immature birds in 2010, and a maximum count of 45 adults and 87 immature birds in 2011. The latest published study on Mediterranean Shags, is that of Snape (2018), where the author reports, through personal observations, that the Karpasia Peninsula holds a breeding colony of more than 50 pairs, while a smaller breeding colony was confirmed at Limnidis islet (Kuskor, 2022).

Data from local and visiting birdwatchers are published every year since 1980 in BirdLife Cyprus annual bird reports. Several interesting sightings of both nesting and roosting Mediterranean Shags are reported, which are worth mentioning. Nests of Mediterranean Shags were reported at Akrotiri cliffs in 1984 (Cyprus Ornithological Society, 1985) and Cape Gata in 2002 (BirdLife Cyprus, 2003). Nests at Episkopi Cliffs are also reported in the annual bird reports of 2013, 2015, 2018 and 2019 (BirdLife Cyprus, 2014; 2016; 2019; 2020). One of the nests at Episkopi Cliffs was observed 20m high up on the cliff. In BirdLife Cyprus annual bird reports of 2015 and 2016, Lefkonisos islet is mentioned as another potential breeding site, with ten adults and two juveniles observed in April 2015 and 2016 (BirdLife Cyprus 2016; 2017). In recent years (2022-2023), breeding on Lefkonisos islet has been confirmed by Kuskor (Kuskor, 2025). Several roosting locations are also mentioned, from 1980 until 2021(BirdLife Cyprus, 2022). In 1980, sightings of around 20 individuals were reported on buoys in Akrotiri (Cyprus Ornithological Society, 1980). From 1999 onwards, a feeding or roosting site at Dhekelia is mentioned, on the moorage buoys of the power station there, and on buoys at Meneou in Larnaca, where around 10 individuals were recorded throughout summer, autumn or winter in most years (Cyprus Ornithological Society, 1999). Another interesting sighting worth mentioning is in March 2002, where 50+ individuals were recorded on Mazaki islet (BirdLife Cyprus 2003). Juveniles were also observed in Mandria, Polis Chrysochou bay and Paphos Lighthouse in most years (BirdLife Cyprus Annual Reports 2003-2017). Another roosting location in Paphos was reported at Aphrodite's Rock (up to 6 birds seen in May 2008 (BirdLife Cyprus, 2009), with a potential nearby nest (Whaley & Dawes, 2003). Also, two adults and one juvenile were observed in March 2014 (BirdLife Cyprus, 2015).

The literature indicates that the stronghold and main breeding colony of the species is at Kleides islands, followed by Cape Aspro, and Akrotiri Peninsula-Episkopi Cliffs. However, the numbers of breeding pairs reported vary. Surprisingly, Geronisos islet (Akamas) is not mentioned in any

published study, apart from one brief mention by local ornithologist George Konstantinou in an interview in 2021 (Tala News Blog, 2021). Most of the roosting sites observed are located in Paphos and Limassol districts within relatively close proximity to the nesting grounds of the birds. Interestingly, some roosting sites observed by birdwatchers, are located in the eastern site of the island where breeding has never been reported.

Figure 2 shows the historical distribution of the species' breeding and roosting sites. Historical breeding sites that remain active until today, are represented separately, along with potential breeding sites (i.e. breeding is not yet confirmed).

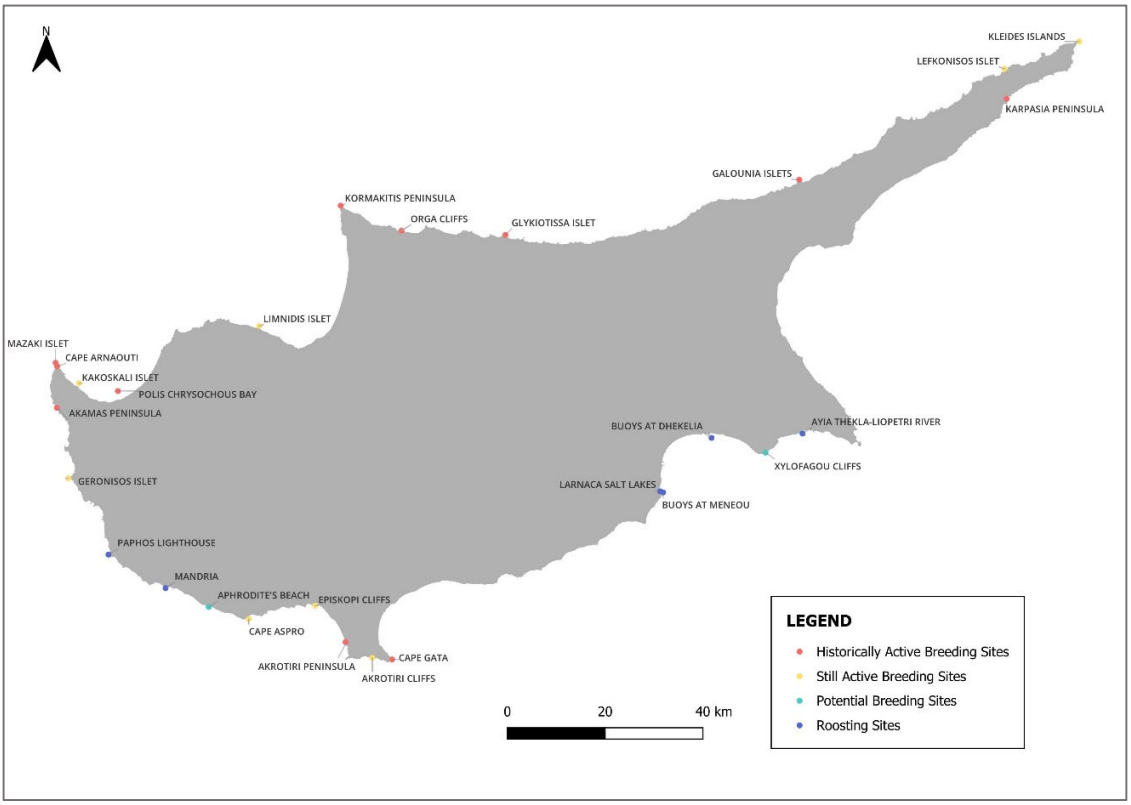


Figure 2: Map of the historical breeding distribution of the Mediterranean Shag on the island of Cyprus. Breeding sites that remain active until today are represented separately, as well as potential breeding sites. Roosting areas remain as such until today. Credits: Stalo Leontiou

1.5 Objectives of current report

The objective of this study is to fill in the gaps in current knowledge regarding the key breeding, resting and feeding sites of the Mediterranean Shag, and based on these findings to identify management solutions to enhance breeding, resting and feeding opportunities for the species, including the reduction of disturbance and mitigation of threats. This report will be crucial for the designation of new Special Protection Areas or Marine Protected Areas and will be used to guide possible conservation actions such as rodent control on breeding islands.

Conservation actions based on this study will take place during 2026 - 2029 and will likely include identifying new potential protected areas and providing legal protection measures through Ministerial Decrees for the management of access and fishing activities, especially related to the breeding colonies, but also to identified important foraging grounds. Locating the focus sites for these conservation or C-actions is the purpose of this study.

1.6 Description of sections of the report

This report will provide information on the resting, breeding and feeding behaviour for the Mediterranean Shag in Cyprus. Data gathered in the field, as well as data from tracking devices fitted to the birds, will be presented in the form of maps, to enable visualization of possible connections between behaviours and parts of the coast or sea, and identification of the spatial relationships between foraging, roosting and breeding grounds.

In addition, the report will explore disturbance factors that can affect breeding success, resting or feeding behaviour. These disturbance factors include, among others, the presence of rodents on breeding islets or nesting colonies along the coastline and human presence, such as fishing or tourism-related activities.

Rodents can directly affect avifauna, particularly nesting seabirds, by preying on chicks or destroying nests, which can significantly reduce breeding success. Human activities such as fishing and tourist boat trips also pose threats, disturbing the birds and negatively affecting their survival and reproductive success. These disturbances may be direct, such as people accessing breeding colonies and causing nest abandonment, or indirect through boat traffic near key resting and feeding grounds. Furthermore, fisheries bycatch - although seemingly low in Cyprus (Papadopoulou et al., 2019) - has been occasionally reported for this species (DFMR, 2022). Bycatch can lead to serious injury or even death for seabirds, including the Mediterranean Shag.

2. Methodology

2.1 Identifying nesting activity

Data collection for this study took place between September 2022 and January 2025, in Paphos and Limassol Districts. Surveys took place between the hours of 06:00 / 08:00 and 15:00 / 16:00, or 14:00 / 15:00 and 22:00 / 23:00 and each survey usually lasted around 8 hours. In total, the survey effort involved approximately 360 hours of field work. The fieldwork was carried out by both BirdLife Cyprus (BC) and Game & Fauna Service (GFS) officers. British Sovereign Base Area (SBA) officers escorted the team during surveys within the SBAs.

Based on a review of the available data from previous studies and historical references, targeted boat and land surveys were conducted to scope for active breeding colonies. Once colony locations were identified, breeding census counts took place. The main colonies identified were at Episkopi and Akrotiri cliffs, Ayios Georgios - Kakoskali and Geronisos islets. The breeding census counts took place during three periods of the year. Before the breeding season (November and December), during the breeding season (January and February) and after the breeding season (July and September). During the breeding counts, data collection was carried out by at least two surveyors simultaneously, using binoculars and spotting scope. Nest location (coordinates), number of birds seen and age of birds (adults, juveniles, breeding plumage) were recorded to a high level of accuracy. Whenever detected, both active and older nests were marked digitally using a GPS device and physically using a permanent marker (Photo 1).

Standardised datasheets (see Annex 8.1) were used to collect nest data. For each active nest located, the number of eggs and chicks was recorded, where visible.



Photo 1: Physically marking Mediterranean Shag nests with a permanent marker (see the blue dot), to make it easier to re-locate during the next field visits. Credits: Antaia Christou

2.2 Fitting of transmitters & colour rings

The aim of this study was to fit tracking devices on at least three individual Mediterranean Shags. As nesting locations were not well known before this study started, there were no site-specific targets. Once nesting colonies were identified, we assessed them in regards to whether individual birds could be safely trapped there. We concluded that it was not possible to safely capture individuals nesting on high cliffs (Akrotiri, Episkopi and Cape Aspro). We also made significant efforts to trap birds on Geronisos islet, but it was deemed impossible to trap birds safely, due to the rough terrain of the islet and its unstable nature. For these reasons, we focused our efforts on Kakoskali islet, where it was safer both for the birds and for project team to operate.

2.2.1 Trapping methods

Five Mediterranean Shag chicks (around 5-6 weeks old) were captured by hand from identified nests, during the breeding seasons of 2022-2023 and 2023-2024. Two adult birds were captured during the breeding season of 2023-2024 by hand from the nests or with the use of clap-nets close to their nests. Another adult bird was captured by hand from the nest during the breeding season of 2024-2025. All birds were placed in cotton bags and their weight was measured with a digital scale, accurate to $\pm$ 5grams.

2.2.2 Tracking devices

The birds were fitted with tracking devices purchased from ornithological telemetry applications company, Ornitela. The device models used were the OrniTrack-25 and the OrniTrack-20 bird transmitters, which weigh 25 and 20 grams, respectively (Photo 2). The devices were fitted with an additional diving sensor (capable of recording depth of every dive at 1 second resolution), which allowed for collection of detailed information on the diving behaviour of the birds. The tracking devices also record date, time, latitude and longitude, direction of travel, speed, temperature and altitude. The tracking devices were programmed to record data every 10 minutes.

Teflon tape was used to secure the transmitters on the birds as a backpack harness. The consensus in the scientific community is that such devices should be under 3% of the birds' body weight (Phillips et al, 2003). The four chicks that were captured from the nests in February 2023, had an average weight of 1,471 grams, therefore the bird transmitter weighed around 1.7% of the total weight of the bird.[6] The two adult birds that were captured in January 2024 had an average weight of 1,703 grams, thus the bird transmitter weighed around 1.2% of the total weight of the birds. The adult bird that was captured in January 2025 weighed 1,320 grams, thus the transmitter weighed around 1.5% of its weight.



Photo 2: Mediterranean Shag chick, fitted with an OrniTrack-25 transmitter. Credits: Zoltán Tölgyesi

2.2.3 Colour ringing

Colour ringing allows monitoring of the birds without transmitters through re-sightings, without the need to recapture the bird (Photo 3). Colour rings were placed on Mediterranean Shags during the 2023-2024 and 2024-2025 seasons. A total of 14 birds were colour-ringed (8 in 2024 and 6 in 2025).

[6] The average weight of Mediterranean Shags based on other studies, ranges between 1750 - 2250 grams (https://ciesm.org/marine/programs/seabirds/mediterranean-shag/).



Photo 3: Colour ringed Mediterranean Shag chick. Credits: Antaia Christou

2.3 Data analysis

Data for each bird were downloaded from the Ornitela control panel in csv format. Unfortunately, the mortality rate of chicks was very high and all five birds died within 5 months of tagging, with an average lifespan of 2.9 months. Comparable juvenile mortality has been recorded in other studies, attributed mainly to low foraging proficiency (Daunt et al., 2007). Adult Mediterranean Shags appear to suffer a lower mortality compared to chicks and all three adult birds are still alive at the time of writing this report.

Table 1 shows the date of deaths for each bird, amount of data available in terms of days and cause of death if known. Given that the amount of data available for each bird was relatively little, all data from the five birds were combined into a single file. Data was then imported into QGIS. The data was cleaned by removing all points within a 200-meter radius of the Kakoskali breeding islet. This was done to exclude the high concentration of chick and adult movements around the islet, which was expected, given that all birds hatched or bred there. Removing these points minimizes the bias from site-specific clustering that could skew the density estimates. This is a commonly used method, that ensures that the results reflect the broader usage patterns, rather than the localized clusters (Garrard et al., 2018; Kery & Royle, 2016). Kernel density analysis was used to identify hotspots of movements and create density maps (Figure 4 and 4).

Table 1: Showing date, data available (in terms of days) and cause of death for the Mediterranean Shags that were tagged.

Metal ring	Age of bird	Satellite Tag Device ID	Tagging date	Date of death	Data (days)	Cause of death
K021	Chick	227500	5/3/2023	23/07/2023	140	Bycatch.
K022	Chick	227501	5/3/2023	29/05/2023	85	Internal bleeding caused by heavy parasitic load.
K023	Chick	227502	5/3/2023	23/06/2023	110	Unknown. Bird was not found.
K024	Chick	227503	5/3/2023	05/05/2023	61	Internal bleeding caused by heavy parasitic load.
K025	Adult	238430	18/01/2024	N/A (bird is still alive)	651+ (ongoing)	N/A (bird is still alive)
K026	Adult	238431	20/01/2024	N/A (bird is still alive)	649+ (ongoing)	N/A (bird is still alive)
K030	Chick	238433	25/4/2024	09/06/2024	46	*Pending results*
K038	Adult	238429	17/01/2025	N/A (bird is still alive)	286+ (ongoing)	N/A (bird is still alive)

3. Results

3.1 Identifying Nesting Sites

The table below (Table 2) summarizes the data from all the sites visited since 2022 and shows confirmed breeding sites (where birds were recorded on nests, or eggs or chicks were seen). Results from each site are described in more detail in the sections below.

Table 2: Summary of number of nests per site, per breeding season, during the duration of the survey period.

Site name	Number of nests 2020-2021	Number of nests 2022 - 2023	Number of nests 2023 - 2024
Akrotiri cliffs	Not monitored	6	15
Aphrodite's Beach	Not monitored	1	1
Ayios Georgios - Kakoskali islet	3	5	10
Cape Aspro	Not monitored	Not monitored	Not monitored
Cape Greco	Not monitored	Not monitored	0
Episkopi cliffs	Not monitored	Not monitored	Not monitored
Geronisos islet	5	5	8
Paramali	Not monitored	Not monitored	Not monitored
Total number of nests	**8**	**17**	**34**

3.1.1 Akrotiri Cliffs

The necessary permits could not be obtained to perform a detailed breeding census during the breeding season of 2021-2022. Military restrictions within the SBAs required the application for special permits and that all surveys within SBAs take place with an escort. The conditions of this permit, in combination with unpredictable weather during winter, affected the survey efforts. Unfortunately, it was not possible to carry out monitoring during 2021-2022 due to delays in permit issuing. However, the permitting process proceeded smoothly in the following seasons and it was possible to perform detailed breeding census in 2022-2023 and 2023-2024 seasons. We also took advantage of the ongoing monitoring of Eleonora's falcon colony at the Akrotiri cliffs, carried out annually by the SBAs in collaboration with GFS and BLC. During our visit to the Akrotiri cliffs on 27 September 2023, 30 Mediterranean Shags were recorded, with the largest group consisting of 16 individuals, including 6 juveniles. The area was re-visited in November 2023, where six nests were identified, with the possibility of an additional four being present in the area. The area was re-visited in January 2024 and ten active nests were identified. The cliffs were last time visited on the 25 September 2024. where 24 Mediterranean Shags were counted, including 2 juveniles.

3.1.2 Aphrodite's Beach, Kouklia

A nest was discovered within the rock formations at Aphrodite's Beach in Kouklia in June 2023. No chicks or eggs were present and so the area was re-visited in the breeding season of 2023-2024. The area was re-visited in early February 2024 from land, where potential cavities were identified. Four birds were seen (2 in breeding plumage, 2 second-year birds) on a nearby rock. It is possible that 1 pair nests there, but it is unlikely that the pair can have a successful nesting, due to the extensive disturbance by people climbing on the rock, and littering (Photo 4).



Photo 4: Entrance to an otherwise suitable nesting cavity (left), Rubbish inside this cavity (right). Credits: Antaia Christou

3.1.3 Ayios Georgios - Kakoskali islet (Akamas SPA)

Three active nests were identified during the 2021-2022 breeding season, however the surveys were carried out late into the breeding season (Photo 5). During the 2022-2023 breeding season five active nests were located, with either chicks or eggs. The surveys were carried out as early as November to observe the pre-breeding behaviour of the birds as well. This facilitated the discovery of nests with more success than the previous year. Ten active nests with either chicks or eggs were located on the islet during the 2023-2024 breeding season.



Photo 5: Mediterranean Shag nest that was not active during our 2022-2023 surveys but showed evidence of use during the 2021-2022 breeding season. Credits: Antaia Christou

Motion detection cameras were installed at three of the active nests on Kakoskali, to collect data on the birds' behaviour during the chick-rearing period (Photo 6).



Photo 6: The photo was captured with a motion detection camera. Photo shows an adult Mediterranean Shag bringing food to the nest and feeding two chicks. Credits: Nikos Kassinis, Game and Fauna Service.

3.1.4 Cape Aspro

Surveys were conducted only during the Eleonora's falcon breeding census[7], on 3 October 2023 and 25 September 2024. Six and two Mediterranean Shags were sighted in the same area on these dates, respectively. Signs of old nests were identified, but no visits were made during the breeding season, so the number of active nests could not be confirmed. This site requires further monitoring.

3.1.5 Cape Greco

A coastal survey was conducted in February 2024, covering the entire peninsula from the Xylofagou fishing shelter to Paralimni Marina. Islets along this route (i.e. Nisaki Ayias Theklas, Green Bay and Fig Tree), were approached and examined either from the boat or, where deployment was safe, on foot (Figure 3). Although no nests were observed, we recorded 7 Mediterranean Shags, including one first year bird and one adult in breeding plumage that flew off Xylofagou cliffs, suggesting a possible nest.

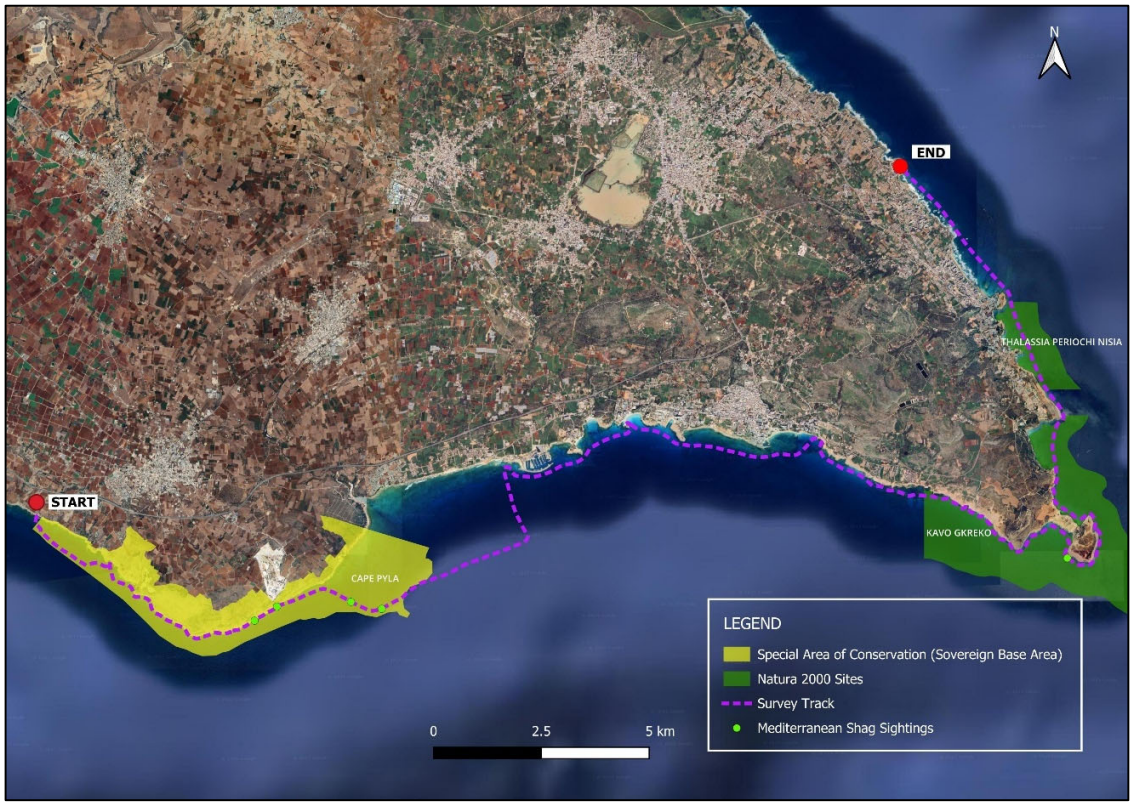


Figure 3: Track of the survey (purple dotted line) conducted in the eastern coast of the island. The area covered included Cape Pyla (SAC) of the SBAs, Kavo Gkreko (SPA and SAC) and Thalassia Periochi Nisia (SCI). Credits: Stalo Leontiou

[7] Eleonora's Falcon (*Falco eleonorae*) colony monitoring carried out annually by the SBAs in collaboration with GFS and BLC.

3.1.6 Episkopi cliffs

The necessary permits could not be obtained to perform a detailed breeding census during the breeding seasons of 2022-2023. Military restrictions within the SBAs required the application for special permits and that all surveys within SBAs take place with an escort. The conditions of this permit, in combination with unpredictable weather during winter, affected survey efforts possible within this area. However, during the breeding census for Eleonora's falcons[8] on the 3rd October 2023 and on the 25th September 2024 in the same area, 4 and 2 Mediterranean Shags were recorded, respectively.

3.1.7 Geronisos islet (Akamas SPA and SAC)

Five confirmed nests with either chicks or eggs were located on the islet during the 2021-2022 and 2022-2023 breeding season. Another two potential nests were identified, but they were not accessible and thus, breeding was not confirmed during the 2022-2023 period. Eight confirmed nests with either chicks or eggs were located on the islet during the 2023-2024 breeding season.

3.1.8 Paramali

The necessary permits could not be obtained to perform a detailed breeding census during the breeding season of 2022-2023. Military restrictions within the SBAs required the application for special permits and that all surveys within SBAs take place with an escort. The conditions of this permit, in combination with unpredictable weather during winter, affected survey efforts possible within this area. However, during the breeding census for Eleonora's falcons[8] on the 3rd October 2023 and on the 25th September 2024 in the same area, 2 and 12 Mediterranean Shags were recorded respectively.

3.2 Telemetry results

3.2.1 Resting and Feeding Sites

Juvenile birds

Kernel Density Estimation analysis (KDE)[9] was used to produce a density map for all five juvenile birds that were tagged in 2024 combined (Figure 4). The locations represent either feeding or resting activity, as the birds often emerge from a dive and then rest or feed on a nearby rock. Results show that young Mediterranean Shags take advantage of any rocky surfaces, especially

[8] Eleonora's Falcon (*Falco eleonorae*) colony monitoring carried out annually by the SBAs in collaboration with GFS and BLC.

[9] Kernel Density Estimation (KDE) is a method used to understand how data is spread out. Instead of assuming the data follows a specific pattern, KDE looks at all the data points and smoothly connects them to create a continuous curve. This helps us see where the data is concentrated and understand its overall distribution more clearly.

those within close proximity to their breeding grounds. For example, all five birds used the nearby rocky coastline, as well as the islet of Mazaki, which could be a good resting place or a place where they sit to eat their catch. The most interesting finding is a hotspot area west of the breeding site, which is not a rocky islet. The location corresponds to a Poseidonia prairie site, which suggests a possible feeding ground for juvenile birds. Some of the juvenile Mediterranean Shags made use of other islets, such as Chamili islet, rock formations at Zephyros cape and other rocky surfaces, such as the wave-breaks at Polis Chrysochou (Christou et al, 2025).

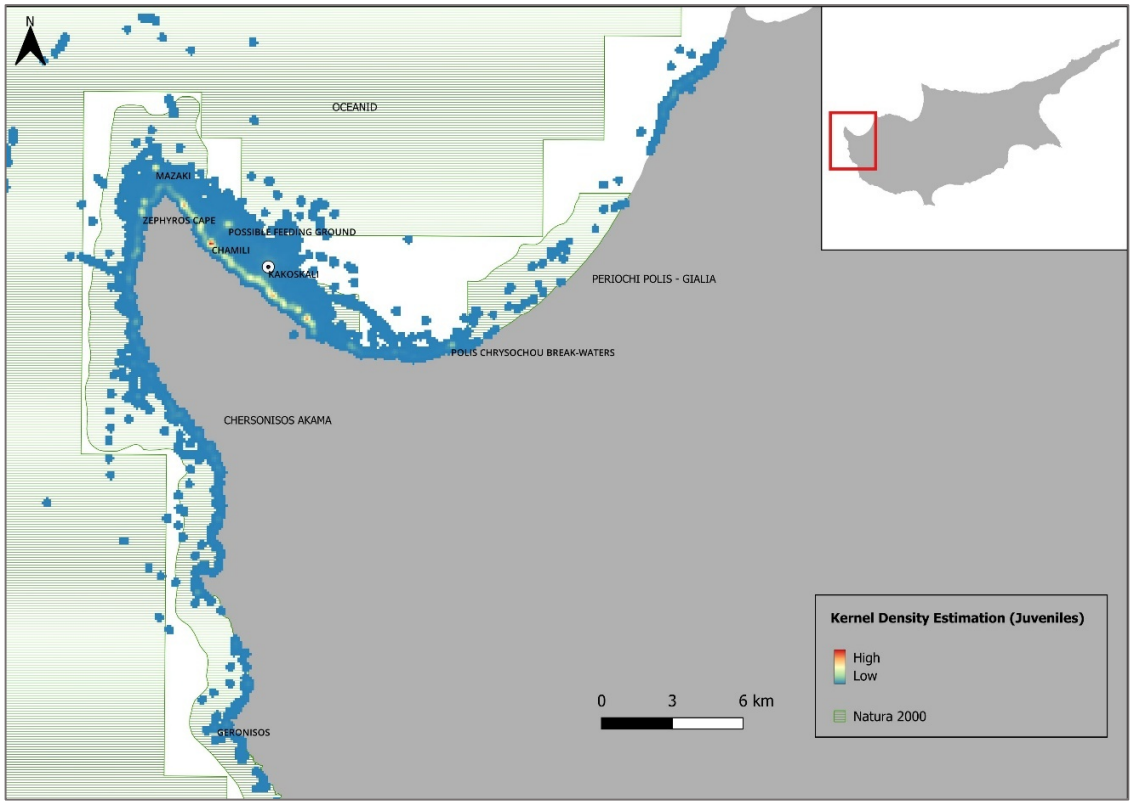


Figure 4: Density map showing high and low concentration areas for juvenile birds. Red indicates high density and blue indicates low density of GPS fixes. Credits: Stalo Leontiou

Adult birds

A KDE density map was produced for the two adult tagged birds combined (Figure 5)[10]. The locations represent both feeding and resting activity. The data show that adult Mediterranean Shags make significant use of the coastline within close proximity of the breeding grounds and avoid travelling large distances. Mazaki is again a popular site, frequently used by both adult birds, as well as the rock formations at Zephyros cape.

[10] This analysis only included the adults that were tagged in 2024, so that results were comparable with the juvenile bird data.

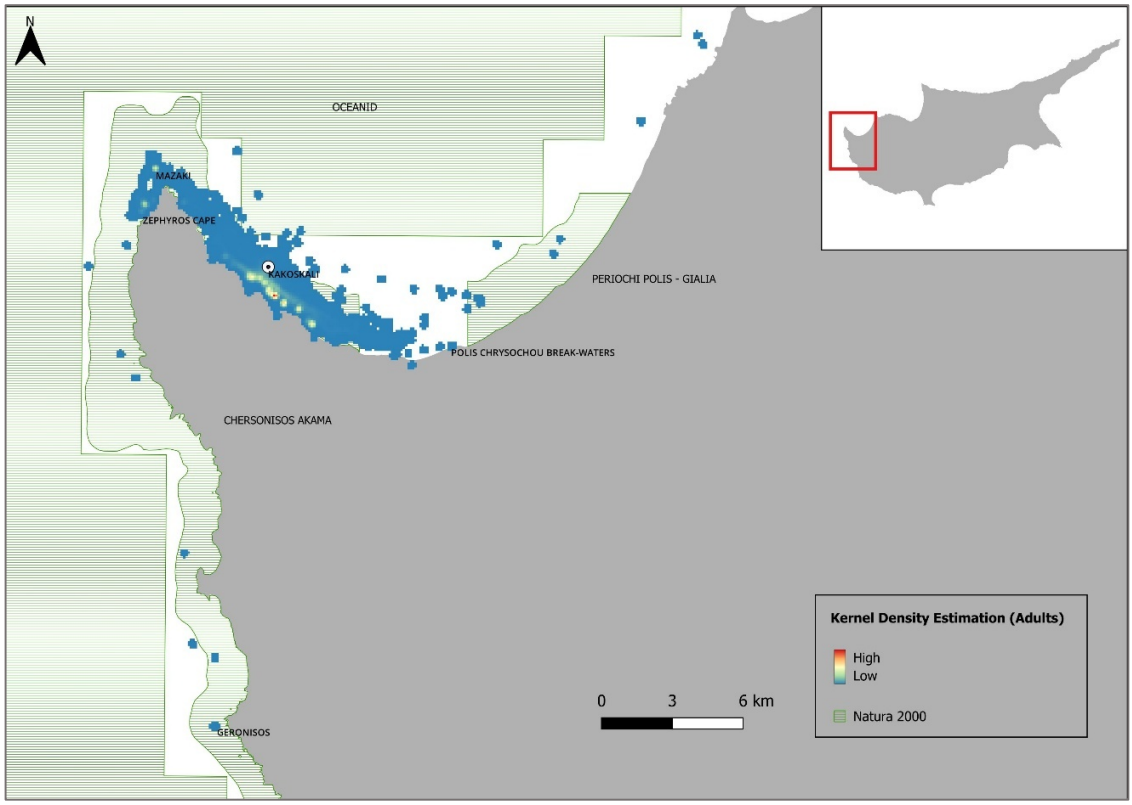


Figure 5: Density map showing high and low concentration areas for adult birds. Red indicates high density and blue indicates low density of GPS fixes. Credits: Stalo Leontiou

Contrasting adult and juvenile bird movements

The adults seem to be more targeted and consistent in their movements when compared to juvenile birds. Adult birds made trips mainly around the breeding islet, while any movements covering distances above 10 km were rare. In general, juveniles were observed to have more exploratory tendencies than adults and travelled further away from their nesting area (Table 3).

The average diving depth for adults was 9.55 m, while the maximum diving depth was recorded at 34.56 m. The combination of all available information from the transmitters fitted to the juvenile birds shows an average diving depth of 4.67 m, while a maximum diving depth of 40.4 m was recorded (Christou et al, 2025).

Table 3: Comparison of diving depths and distances travelled between adults and juvenile Mediterranean Shags.

	Average diving depth (m)	**Maximum diving depth (m)**	**Maximum distance travelled from breeding grounds (km)**
Juveniles (*n = 5*)	4.67	40.40	72.10
Adults (*n = 2*)	9.55	34.56	38.71

Both adult and juvenile Mediterranean Shags make significant use of the islet of Mazaki. Additionally, both age classes were observed to take advantage of any available rock near the coast (including the wave-breaks at Polis Chrysochou). It is also worth noting, that the majority of the areas that both juvenile and adult birds used, are within Marine Protected Areas, such as Oceanid, Akamas and Polis – Gialia (Christou et al, 2025).

3.3 Threats

3.3.1 Bycatch/Discarded nets

Fisheries bycatch is a top threat for seabirds globally (BirdLife International, 2022). Even though there were no reports of bycatch of the species under a relevant bycatch monitoring programme in Cyprus (Papadopoulou, 2019; Snape et al, 2019), there is anecdotal evidence of Mediterranean Shags being caught in nets, as reported to BirdLife Cyprus staff by local fishers (authors' unpublished communications 2022, 2023). Evidence of bycatch was also gathered from social media, especially when accompanied by photos or videos, making species identification possible (Photos 7, 8, 9). The Marine Strategy Framework Directive (MSFD) Report also notes a bycatch incident on the 25/11/2020 on trammel nets at a depth under 15 m (DFMR, 2022). The same publication estimated that during 2017 – 2022, on average four Mediterranean Shags per year were killed through bycatch.



Photo 7: Facebook post on the 13/03/2022 reporting a Mediterranean Shag bycatch incident, at 29 meters deep at Latchi, Paphos. Credits: George Karamanos



Photo 8: Mediterranean Shag with metal ring K021, found dead on the 23/07/2023 entangled in discarded fishing nets.



Photo 9: Juvenile Mediterranean Shag caught on small-scale fishermen's nets on the 19/01/2024 in Limassol. Credits: Department of Fisheries and Marine Research (DFMR).

3.3.2 Disturbance of nesting sites

People operating drones were observed on Geronisos islet, and boats were seen sailing very close to Ayios Georgios - Kakoskali and disturbing the breeding birds. People were also observed to disembark on Geronisos islet and walk among the nests. Even though disturbing nesting birds is illegal under the National Protection and Management of Wild Birds and Game Law (N. 152(I)/2003), there is currently no legislation explicitly prohibiting access to the islets.

3.3.3 Rat Predation

Predation by rats is a major threat to seabirds across the world (BirdLife International, 2022). Geronisos islet is within close proximity to the mainland (less than 300 meters), making it easily accessible for rodents. During the surveys, signs of predated Mediterranean Shag eggs and a predated week-old chick were observed. Furthermore, a dead rat (*Rattus sp.*) was recorded (Photo 10) along with many rat droppings. Rats were also captured on the motion detection cameras that were installed on the islet (Photo 11). This evidence suggests a well-established rat population on Geronisos. At Kakoskali, there were no observations or signs of rats recorded, either during the surveys or through the motion detection cameras that were set up on the islet.



Photo 10: Dead rat (Rattus sp.) found on Geronisos islet. Credits: Antaia Christou

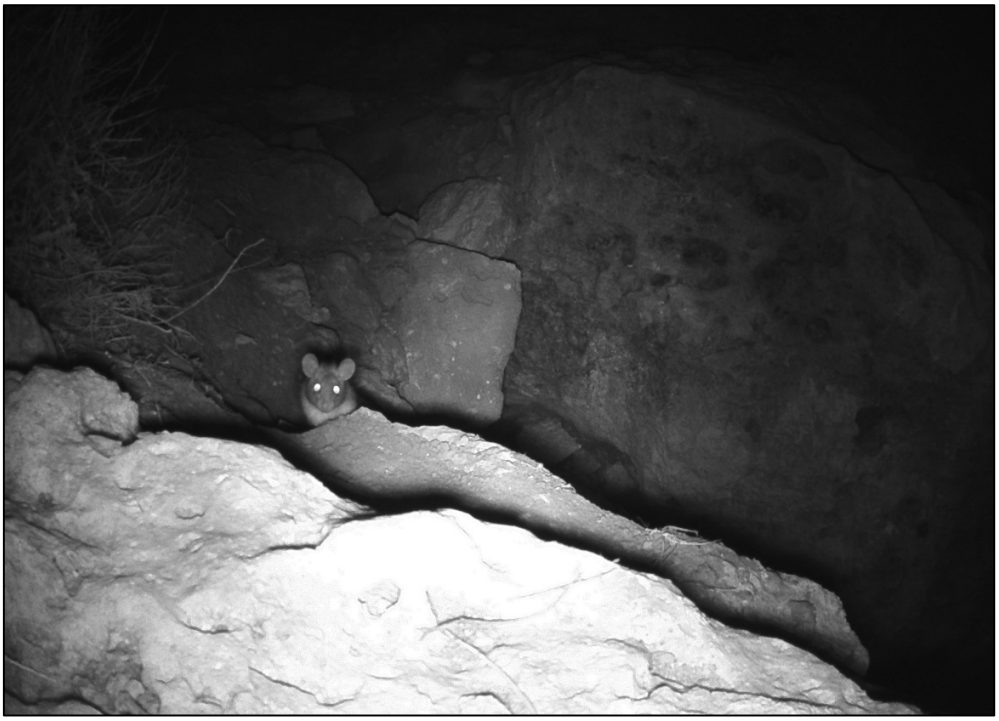


Photo 11: Rat caught on motion detection camera at the entrance of a Mediterranean Shag nest on Geronisos islet. Credits: Antaia Christou

3.3.4 Climate change

Climate change is considered a significant threat to seabird populations around the world (BirdLife International, 2022). Current literature highlights the vulnerability of seabirds to climate change through their food chain but also through extreme weather events (Johnston et al., 2025). Based on the landscape (geological and topographical structure) of the breeding islets around Cyprus, extreme weather events could potentially cause nest failures as some of the nests, especially on the more exposed islets (Photo 12), while there is risk of both nest and cliff collapse following prolonged rainfall. Further research on Mediterranean Shag diet in Cyprus is needed in order to understand the possible effects of climate change on food availability for the species, and to assess the severity of this threat.



Photo 12: Snapshot from a camera trap showing an exposed nest of Mediterranean Shag. Credits: Antaia Christou

4. Proposed conservation actions

Conservation actions for the species should focus on ensuring legal protection of their breeding, feeding and roosting sites and include proposals of new protected areas for Mediterranean Shags, as well as raising awareness about this species.

4.1 Legal protection of key breeding, feeding and roosting sites

Most of the areas that the tagged birds use are within already designated Marine Protected Areas (MPAs), such as Oceanid, Chersonisos Akamas and Polis – Gialia. However, though these areas are protected on paper, the legislative framework for their management is not yet established. The Management Plans of these areas should consider the results of this study and include protection measures for the Mediterranean Shag. Conservation actions should include robust regulations for protecting feeding, roosting and breeding areas of the species. Touristic activities should also be regulated, such as boat trips or abseiling down the cliffs. Fishing should be regulated within close proximity to important areas for Mediterranean Shags, especially breeding colonies, to avoid disturbance and bycatch incidents. Adequate protection of Poseidonia meadows, including buffer zones around them, add an extra level of protection to the feeding grounds of Mediterranean Shags and ensure sufficient food availability for the species. All these activities can be regulated through site-specific Management Plans and put into force through Ministerial Decrees. Finally, systems should be put into place to enforce the Ministerial Decrees through legal protection on the ground.

4.2 Awareness raising and outreach

The importance of protecting key sites for the species should be communicated with local stakeholders, such as fishers and tour boat operators. This can be done through participatory meetings and events, where locals will have the chance to express their opinions about possible restrictions. Information signs at key locations (i.e. ports) can be installed so that the public is made aware of the species, its presence in the area, as well as the risks of disturbance and any legal restrictions. Furthermore, tourists and locals should be made aware of their possible contribution to the protection of the species, through reporting colour-ringed individuals to the project team.

4.3 Systematic monitoring and research

Intensifying the research and monitoring efforts for this species, with a focus on the breeding colonies can ensure accurate data on population size, as well as breeding success. Rat eradication or rat control efforts should also be considered on islets where predation significantly affects the breeding success of the species.

Furthermore, future studies can focus on the diet of this species, since there is a gap of knowledge in Cyprus and generally the eastern Mediterranean. Based on other studies in the Mediterranean region, it is clear that Mediterranean Shags are not competing with commercially important fish, as they form a very small part of their diet (Aguilar et al, 1999; Morat et al, 2014; Lipej et al, 2016). A relevant study in Cyprus can be combined with community and outreach work, targeting professional and recreational fishers and aiming to increase awareness about the species and its diet. Such a programme can also build a level of trust with the local stakeholders, encouraging fishers to report sightings of the birds, whether seen alive or caught accidently on their fishing equipment (especially the easily seen colour ringed individuals). This action can enable scientists to collect data, through local knowledge.

Finally, it is worth noting that Mediterranean Shags could act as an umbrella species to protect other birds breeding on rocky coasts and uninhabited islets, such as the Eleonora's and Peregrine falcons (*Falco peregrinus*), Yellow-legged Gulls (*Larus michahellis*), Common and Pallid swifts (*Apus apus* and *Apus pallidus*).

5. Conclusions

This work has, for the first time identified key breeding, resting, and feeding sites of Mediterranean Shags in Cyprus, providing essential data to support targeted conservation actions and the establishment of new protected areas and expansions of already protected areas. For the first time systematic nesting data have been collected and tagged individuals provided vital ecological information. These findings underpin advocacy for legal protection measures, such as Ministerial Decrees, to enforce access restrictions and manage activities like fishing and tourism near colonies and foraging grounds. Our extensive field surveys revealed the critical importance of safeguarding these habitats against threats including human disturbance and predation. To ensure effective conservation, we recommend designating Special Protection Areas for the species. One such measure could be legal protection of the islets where the species breeds, through the expansion of the marine extension of the Akamas SPA to include the islets of Ayios Georgios - Kakoskali and Geronisos. Specific and concrete management measures need to be imposed to protect these islets and other key areas for the species. To ensure effective conservation, we recommend designating Special Protection Areas, implementing management strategies, and fostering collaboration with local stakeholders. Continuous monitoring and enforcement are vital to protect the Mediterranean Shag and other species sharing its habitat, such as Eleonora's and Peregrine falcons, Yellow-legged Gulls, and both Common and Pallid swifts. Collectively, these efforts will promote the long-term resilience of Cyprus's avian biodiversity.

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7. Annexes

7.1 Acknowledgements

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[11] This exchange visit was part of "The breeding status of Scopoli's (*Calonectris diomedea*) and Yelkouan Shearwaters (Puffinus yelkouan) in Cyprus" project, which was funded by the Trevor Poyser Grant, administered by the Ornithological Society of the Middle East (OSME).

8. Annexes

8.1 Datasheet template used during nest monitoring surveys

Datasheet that was used to note down activity within the discovered nests, such as presence of adult birds, chick and egg number.

WORKERS	DATE& TIME	NEST ID	GPS TAKEN	EGG NUMBER	CHICK NUMBER	CHICKS AGE	RING NO. (if new)	DATE OF RINGING	PHOTO TAKEN	NOTES