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SURVEY OF THE MEDITERRANEAN SHAG *Gulosus aristotelis desmarestii* BREEDING COLONIES IN WESTERN ISTRIA DURING 2024 WITH BREEDING POPULATION ASSESSMENT

Terenski obilazak kolonija i procjena gnijezdeće populacije morskog vranca Gulosus aristotelis desmarestii u akvatoriju zapadne Istre tijekom 2024. godine

Luka Meštrović[1]*, Sandro Dujmović[1]

[1]Public Institution Natura Histrica, Riva 8, 52100 Pula, Croatia

ABSTRACT

Between January and May 2024, we conducted a survey to assess the breeding population size of the Mediterranean Shag *Gulosus aristotelis desmarestii* within the majority of Special Protected Area (SPA) HR1000032 – Akvatorij zapadne Istre. In total we counted 198 active nests. When combined with the known breeding population within the National Park Brijuni (not included in this study), which consists of 150-250 breeding pairs, 2024 findings could almost double the previously estimated breeding population of the Mediterranean Shags in mentioned SPA site (150-180 breeding pairs). Considering that seabirds are among the most endangered groups globally and serve as indicators of marine ecosystem health, these findings underscore the need for additional research and regular monitoring.

Keywords: Ecological network, Natura 2000, Special Protected Area, Akvatorij zapadne Istre, European Shag

INTRODUCTION

The European Shag *Gulosus aristotelis* can be found throughout European coastline ranging from the Atlantic coast, through Mediterranean Sea all the way to the Black Sea (BirdLife International 2024). Three subspecies have been described – nominal *G. a. aristotelis* with established populations in the Atlantic

*Corresponding author: e-mail: luka.mestrovic@natura-histrica.hr

coast of western Europe, *G. a. riggenbachi* with a small population on the Moroccan coast, and *G. a. desmarestii* which is present in the Mediterranean and Black Sea, including the Adriatic Sea. Subspecies *G. a. desmarestii* is also referred to as Mediterranean Shag. The European Shag belongs to the Cormorants family Phalacrocoracidae and together with Pygmy Cormorant *Microcarbo pygmeus* and Cormorant *Phalacrocorax carbo,* they represent the only three species from this family that regularly occur in Croatia.

Together with the Yellow-legged Gull *Larus michahellis*, the Mediterranean Shag is probably the most emblematic and recognizable member of the Croatian coastal bird fauna. These birds are known to the general public and at the same time they have been in the spotlight of ornithology studies for many years (www.info.hazu.hr 2024). Rucner (1998) describes the area around island Krk (Croatia, North Adriatic) *"There isn't a single month throughout the year that I don't encounter these birds (Mediterranean Shags) on the sea surface"*. The Croatian population of the Mediterranean Shag is estimated at 1600-2000 breeding pairs (Kralj *et al.* 2013) and it represents almost the entire breeding population of the Adriatic Sea. Small numbers breed in Albania (10-24 pairs; www.unep-aewa.org 2023), the islands Tremiti on the east coast of Italy (up to 2 pairs; Liuzzi *et al.* 2020) and in 2024 two breeding attempts (both of which ultimately failed) in the Gulf of Trieste have also been reported (www.ampmiramare.it 2024). Within SPA Akvatorij zapadne Istre, the current estimated population is 150-180 breeding pairs with moderate data quality, based on partial data with some extrapolation, while National Park Brijuni, according to available data, represents the population stronghold (Bioportal 2024). Regarding the Adriatic Sea, the majority of the Mediterranen Shags are migratory with more than 80% of the population migrating outside the breeding areas in the post-breeding season. Birds migrate towards the northern Adriatic and spend summer and autumn along the Slovenian coast, in the Gulf of Trieste and the Venice lagoon (Scridel *et al.* 2024).

The European Shag can have prolonged breeding season that can last from February to September, depending on location and season (BWPi 2006), but the *desmarestii* subspecies mostly breeds from December until June (Kralj *et al.* 2013). In the Adriatic Sea, the Mediterranean Shags commonly begin their breeding activities earlier in the season in the southern part of the Adriatic compared to the rest of the Adriatic Sea (Kralj *pers.comm*.).

They are colonial species that usually build their nests on cliffs above the sea, typically ranging from the high tide level and upward. Nests are mostly made of branches, seagrass, and other materials and are almost always located on a protected and sheltered part of the cliff, away from direct exposure to the sea, rain or other weather-related impacts (BWPi 2006). Indeed, Lovrić (1971) described breeding grounds around Krk in the same way "*abraded reefs and lower parts of cliffs in supralitoral and lower adlitoral"*. Rucner (1998) documented that around

Kvarner and northern Dalmatia this subspecies is dependent on numerous islets, inaccessible coastal areas and uninhabited islands where they nest on the ground. The situation on the west coast of Istria is much closer to Rucner's than Lovrić's description because in this area Mediterranean Shags almost exclusively nest on uninhabited islands on the ground, inside thick coastal bushy vegetation that creates perfect protection against predators and bad weather. Observations of cliff nests are rather scarce. By moving through bushy vegetation, they create some sort of a tunnel network ranging several meters deep inside the thick vegetation, which is otherwise too thick, impenetrable, and not suitable for nesting.

Although Mediterranean Shag ringing in known colonies in Croatia is continuously organized since 2005 (Kralj *et al.* 2013), specific research on nesting success, diet and foraging behaviour, and threats, as well as regular monitoring activities, are still seldom conducted or are restricted to smaller areas. Few noteworthy examples are partial surveys conducted within the National Park Brijuni area in 2012, 2015, 2016 and 2017 (Pavoković 2012, Pavoković 2015, Pavoković 2016, Pavoković 2017) as well as a master thesis on morphometric characteristics of eggs of Mediterranean Shag in the Brijuni Islands (Jensterle 2014). The goal of this study was to determine the breeding population of Mediterranean Shag in the coastal parts of western Istria and to compare it with available historical data.

MATERIALS AND METHODS

SPA Akvatorij zapadne Istre consists of a buffer zone ranging 500 meters from the coastline of 15 municipalities on the west and south coast of the Istrian peninsula (Fig. 1.). This SPA covers more than 15,000 ha of primarily marine area with roughly 100 km of coastline. Management of SPA Akvatorij zapadne Istre is divided according to local jurisdiction among three public institutions responsible for management of protected areas: PI National Park Brijuni (within the National Park boundaries), PI Kamenjak (within boundaries of Medulin Municipality) and PI Natura Histrica (rest of the SPA area) (Narodne novine 2023). Survey and breeding population assessment were conducted within the area under PI Natura Histrica jurisdiction – Pula coastline, Bale, Rovinj, Vrsar, and Poreč islands with addition of islands Frašker and Fraškerić which are situated in Medulin Municipality.

The survey was conducted between the end of January and the end of March 2024 following the survey schedule presented in Table 1. Two additional visits were conducted in May but were not taken into account in the breeding population assessment because, at that point, fully feathered young birds outside the nests were already observed. All sites were surveyed at least once either by conducting a survey from the boat or by conducting a detailed on-foot inspection.

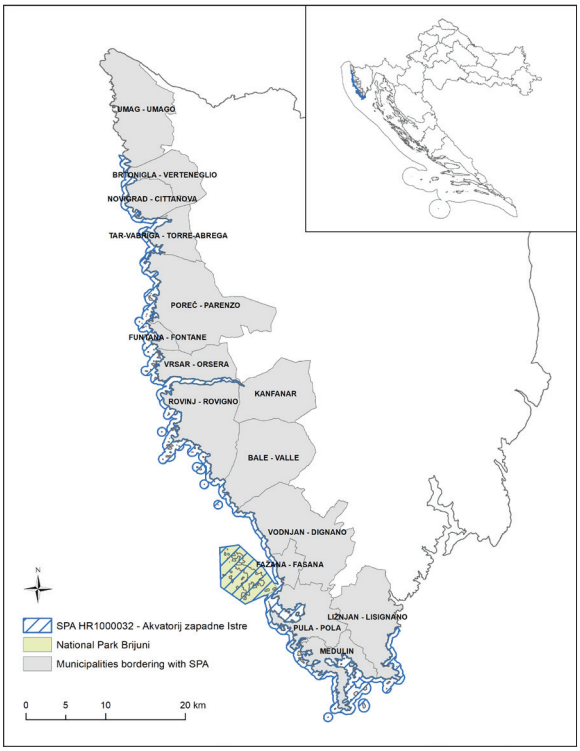

Figure 1. Survey area with municipalities

Slika 1. *Popisno područje navedenim jedinicama lokalne samouprave*

Some sites, according to the results of the first-round survey and accessibility by boat, were surveyed again in the second round. Detailed fieldwork and inspection on foot was not conducted on the islands where no adult bird activity was registered while circumnavigating around the island or we didn't notice any suitable nesting site. Smaller islands without vegetation and with no obvious shelters were only inspected from the boat, as we considered this method sufficiently accurate for these sites.

The first round of visits to the sites was conducted in January and February, to inspect the presence of potential breeding shags. For this purpose, we only used a larger boat (Marservis G23 – 7.70 m length) to conduct a visual census while circumnavigating the islands. However, when possible, we also landed on islands suitable for safe landing using this type of boat. We registered the total number of adult individuals in breeding plumage that were located on the coast, swimming along the shore or leaving the site, sometimes spontaneously and sometimes due to disturbance as we approached by boat. We used these cues as an indicator of possible breeding of the Mediterranean Shags at a given site. In cases when we could identify active nests based on the behavior of Shags (i.e. adult individu-

als in breeding plumage entering and exiting tunnels in bushy vegetation) we marked them using a GPS device.

The second round of visits to the sites was conducted in March when, apart from using only a larger boat we also used a smaller rubber dinghy (approx. 2 m long) which allowed us to land on islands and islets, regardless of their size, challenging coastal morphology, shallow sea or the absence of piers. By adopting this approach, we were able to carefully examine the sites that were otherwise inaccessible using only the larger boat. While conducting the visual census in March we again registered the total number of Mediterranean Shags and took notes on potential nesting sites which were later upon landing carefully inspected on foot. We walked along the coastline examining bushy vegetation and searching for tunnel exits with cues that indicated active nests (i.e. feces, lost feathers, fresh pellets, vocalization of birds inside the nest). All active nest locations were marked using a GPS device and later processed using GIS software (ArcGIS 9.3. and QGIS 3.38 Grenoble) to add additional information gathered while conducting the survey (i.e. other bird species registered nearby, the possible location of older inactive nests, did we hear just the vocalization or were we able to access the nest, number of eggs etc.).

RESULTS AND DISCUSSION

In order to cover the entire survey area throughout the breeding season we needed five days in which we visited 44 sites in the vicinity of Pula, Bale, Rovinj, Vrsar, Funtana, Poreč and Vabriga. Islands under significant tourist pressure or which have vast tourist or industrial infrastructure (Sv. Nikola near Poreč, Sv. Katarina, Sv. Andrija/Crveni otok and Maškin near Rovinj, island Veruda near Pula, islands Katarina and Andrija in the Pula Bay), island with only lighthouse infrastructure (Sv. Ivan na pučini) or the one connected to the mainland by bridge (Koversada near Vrsar) were not visited. These nine islands were considered unsuitable for breeding due to various factors, including lack of suitable habitat, constant human disturbance during the breeding season, light pollution, and other environmental impacts. The final survey schedule is shown in Table 1.

Table 1. Survey dates with sites visited during this research.
Tablica 1. *Terenski dani i lokacije koje su obiđene tijekom popisivanja.*

	SITES			
	Vabriga, Poreč, Funtana and Vrsar islands	**Rovinj and Bale islands**	**Muzil (Pula)**	**Frašker and Fraškerić***
Survey dates	January 31st	February 16th	February 20th	February 20th
	March 21st	March 20th	March 20th	

*Survey approved by PI Kamenjak

We registered 198 active nests of Mediterranean Shags. Nests were found at eleven sites within the SPA Akvatorij zapadne Istre (Table 2., Fig. 2.). Together with breeding population within the National Park Brijuni, which is estimated at 150-250 breeding pairs (Pavoković 2017, ZZO-HAZU *et al.* 2013), these results could almost double the previously estimated breeding population of Mediterranean Shags in the SPA (150-180 breeding pairs; ZZO-HAZU *et al.* 2013).

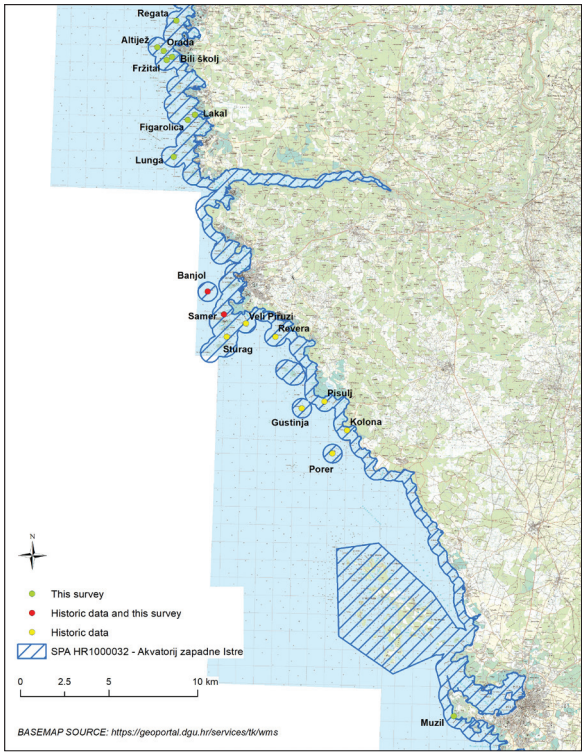

Figure 2. Sites with active nests of the Mediterranean Shags, registered in this survey or that have been the subject of previous studies (Pavoković & Radalj 2009, Pavoković 2011)

Slika 2. *Otoci i lokacije gdje su tijekom ovogodišnjeg monitoringa zabilježena aktivna gnijezda (prema rezultatima navedenim u Tablici 2.) ili su bili predmet prijašnjih istraživanja (Pavoković & Radalj 2009, Pavoković 2011)*

This survey, together with available historic and present data from other locations, confirmed the assumption of a prolonged breeding season of Mediterranean Shags in the Adriatic Sea. Also, we once again confirmed the fact that Mediterranean Shags begin their breeding activities earlier in the southern Adriatic Sea. We observed nests with eggs on Rovinj islands on February 16 while in the same year on island Korčula (Dalmatia) nests with eggs and also some nests with chicks were observed already on January 25 (Ilić 2024). Nests with eggs but also fully feathered

young birds standing on the coast were observed throughout the study area in late March 2024 (March 20 and 21) while in previous years nests with eggs have been observed as late as May 9 on Veli Piruzi (Pavoković & Radalj 2009).

Table 2. Sites with confirmed Mediterranean Shag breeding (historic data and this survey) with the number of nests registered during the survey in 2024, along with available data from population assessment conducted in 2009 and 2011 (Pavoković & Radalj 2009, Pavoković 2011)

Tablica 2. *Lokacije s potvrđenim gniježđenjem morskih vranaca (povijesni i novi podaci) te broj aktivnih gnijezda zabilježenih tijekom terenskog obilaska 2024. godine s osvrtom na prijašnje procjene brojnosti iz 2009. i 2011. (Pavoković & Radalj 2009, Pavoković 2011)*

	SITE NAME	NUMBER OF NESTS 2024 (this study)	NUMBER OF NESTS 2011 (NGO Animalia)	NUMBER OF NESTS 2009 (NGO Animalia)	Municipality
1	Muzil	7	X	X	Pula
2	Porer	0*	X	3	Rovinj and Bale
3	Kolona	0	X	X	
4	Palin/Pisulj	0	X	2	
5	Gustinja	0*	1	0	
6	Revera	0*	X	1	
7	Sturag	0*	20	22	
8	Veli Piruzi	0*	39	33	
9	Samer	4	10	10	
10	Banjol	19	0	8	
11	Lunga	69	X	X	Poreč and Vrsar
12	Lakal	1	X	X	
13	Figarolica	3	X	X	
14	Fržital	12	X	X	
15	Bili Školj	24	X	X	
16	Orada	3	X	X	
17	Altiješ	26	X	X	
18	Regata	30	X	X	
	TOTAL	**198**	**70**	**79**	

"0" – no active nests were found on the site during the detailed fieldwork on land.
"0*" – no active nests were found on the site, but the site was only inspected from the boat.
"X" – these sites were not included in the study and monitoring in 2009 and 2011.

On the island Banjol, which was visited twice in 2024, on the 16th of February we observed only three nests with eggs but with suitable habitat (i.e. vegetation) throughout the island. Upon our return on the 20th of March, we counted nineteen nests spread around the island. This observation underscores the necessity of conducting more than one visit to the islands to effectively cover the entire breeding season of Mediterranean Shags. During our visit to the island Banjol,

we also observed locals picking up wild asparagus, an activity previously addressed as a potential threat for Mediterranean Shags, as people move through thick vegetation with limited visibility, where nests are often hidden beneath dense bushy cover (Pavoković & Radalj 2009).

Islands Sturag and Veli Piruzi previously hosted high numbers of nests while this year we didn't find any nests on Sturag while conducting detailed on foot inspection and no significant adult bird activity was observed at Veli Piruzi from the boat, so we didn't land there to examine it carefully on foot. Both islands seem to have sufficient vegetation and suitable habitat for breeding so we would discredit habitat degradation as possible reason for this discrepancy. Distance between Veli Piruzi and the nearest coast is approx. 500 meters and Sturag approx. 300 meters (island Maškin) so disturbance during breeding season could be one of the reasons for this decline in numbers. It was reported in previous study that numerous birds had been observed resting on the coastal rocks of Veli Piruzi (Pavoković & Radalj 2009), however, we observed only one adult bird at this site during our study. Due to these differences, Sturag and Veli Piruzi should be examined more thoroughly on foot in future monitoring activities to prevent inadequate survey methods from influencing final results but also to detect possible local reasons for absence of Mediterranean Shags.

Nests were mostly found in thick coastal vegetation (predominantly *Pistacia* sp.) which is in accordance with observations in previous studies (Pavoković & Radalj, 2009, Pavoković 2011). However, in two cases we observed active nests on cliffs – on the island Banjol and on the location Muzil near Pula. On the island Banjol we observed a nest on a cliff above vertical entrance into a submerged cave and some nests in rocky hollows covered with vegetation. The features of nest sites at Muzil completely differ from other observed sites in western Istria. We found seven nests on cliffs above the sea ranging from approximately four to ten meters of height. Previous study also reported active nests on the ground in a former military bunker carved into the rock on the island Porer near Barbariga as well as two nests in natural rock – karrens (Pavoković & Radalj 2009).

The previous surveys of the Mediterranean Shags in western Istria (Pavoković & Radalj 2009, Pavoković 2011) were somewhat pioneering in Croatia regarding methodological approach. They determined habitat preferences with great quality and emphasized potential threats accordingly but they were deficient in terms of regularity and comprehensiveness. These gaps were addressed in our study which represents the first comprehensive Mediterranean Shag census with breeding population assessment within part of the SPA Akvatorij zapadne Istre under PI Natura Histrica management, carried out during a single breeding season.

The results presented here complement previous data on the breeding population of the Mediterranean Shags in the subjected SPA and in Croatia altogether. Due to the absence of an official monitoring scheme or protocol on a national level, the Mediterranean Shag extended breeding season and the divided man-

agement between three public institutions, future collaboration and joint activities throughout the SPA are essential. The importance of coordinated counts of Mediterranean Shags is also highlighted by the trilateral Mediterranean Shag census in the post-breeding season conducted simultaneously in Italy, Slovenia, and Croatia (Scridel *et al.* 2024). We suggest that the future priority should be monitoring of breeding population, which would then be upgraded by nesting success monitoring and identification of threats specific to breeding sites in the study area (BirdLife International 2024).

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SAŽETAK

U razdoblju od siječnja do svibnja 2024. godine proveli smo terenske aktivnosti s ciljem praćenja stanja i procjene gnijezdeće populacije morskog vranca *Gulosus aristotelis desmarestii* unutar područja očuvanja značajnog za ptice (POP) HR1000032 – Akvatorij zapadne Istre. Ukupno smo izbrojali 198 gnijezda. Uz populaciju od 150-250 gnijezdećih parova unutar NP Brijuni koja nije predmet ovog istraživanja, dobiveni podaci ovogodišnjeg praćenja stanja gotovo udvostručuju dosadašnju procjenu brojnosti morskih vranaca u akvatoriju zapadne Istre (150-180 parova). Uzmemo li u obzir da su morske ptice među najugroženijim skupinama na svijetu te da su izuzetno dobar pokazatelj stanja morskog ekosustava, prikupljeni podaci i nove spoznaje svakako ukazuju na potrebu za dodatnim istraživanjima i redovitim praćenjem.