# IBA IDENTIFICATION FOR SEABIRDS IN CROATIA: SUPPORTING DESIGNATION OF MARINE SPAs

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LIFE Artina (LIFE 17 ANAT/HR/000594)
Seabird Conservation Network in the Adriatic

Action C.5: Designation of new marine SPAs in Croatia
Action E.1: Advocacy for designation of marine SPAs in Croatia

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**Front cover illustration:** Audouin's Gull with GSM-GPS transmitter. Biljana Ječmenica.

This report is part of Action C.5: Designation of new marine SPAs in Croatia, and Action E.1: Advocacy for designation of marine SPAs in Croatia. It includes the deliverable 'List of proposed marine SPAs'.

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## Purpose of this work

This study is part of the LIFE Artina project (LIFE 17 NAT/HR/000594), and formally identifies important sites (Important Bird and Biodiversity Areas, IBAs) at sea for three species of pelagic seabirds breeding in Croatia, namely Yelkouan Shearwater *Puffinus yelkouan*, Scopoli's Shearwater *Calonectris diomedea* and Audouin's Gull *Larus audouinii*. The work contributes to contemporary evidence for marine spatial planning in Croatian, and surrounding, waters. A specific objective of the work is to contribute to the identification of Special Protection Areas (SPAs). Under the EU Directive on the conservation of wild birds (Birds Directive), SPA identification serves to inform the designation of Natura 2000 network sites, ultimately benefiting countries to meet targets set within globally agreed upon initiatives. The marine IBAs designated in this work, and thus the proposed SPAs, are summarized in Figure 1.

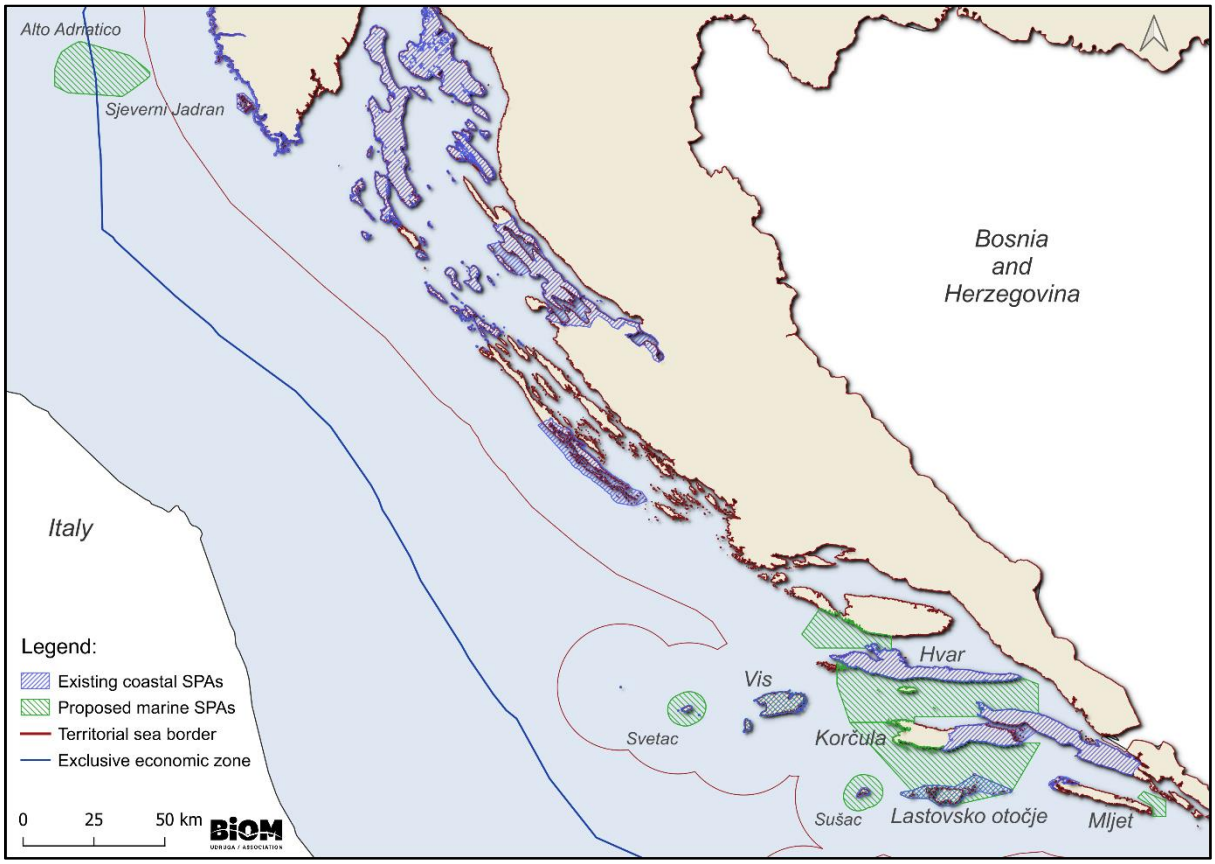


*Figure 1: Final marine IBAs/ proposed SPAs for Yelkouan Shearwater, Scopoli's Shearwater and Audouin's Gull breeding in Croatia, designated through the LIFE Artina project.*

## Background

Marine ecosystems are projected to come under increasing pressures as human populations rise and global demands for resources increase; the consequence being likely social, economic and environmental costs if pressures are poorly managed (Bindoff et al., 2019; Chamberlain et al., 2021). To avoid such scenarios, global initiatives such as the post-2020 Global Biodiversity Framework (Convention on Biological Diversity, 2020) and the Sustainable Development Goals (UN General Assembly, 2015), outline key directions that nations should work toward. Specifically, these Multinational Environmental Agreements (MEA) identify targets to achieve the sustainable use of

marine resources along with the conservation of marine biodiversity and ecosystems. Marine spatial planning (MSP) that results in effective, and implemented, management plans is a key route through which nations can achieve these targets. Complementing these political commitments is also a growing body of knowledge regarding the interventions that can support targets being met (Douvere, 2008; Hays et al., 2019; Maxwell et al., 2020). This knowledge includes decision-making products that foster identification of important areas for biodiversity in the marine environment, in which the effects of potentially harmful practices should be mitigated (Douvere, 2008; Smith et al., 2018).

A key decision-making product in the European Union is Important Bird and Biodiversity Area (IBA) data. The identification of IBAs started in Europe as a response to the need to identify Special Protection Areas (SPAs) under the EU Birds Directive and therefore the first set of IBA criteria were tailored to meet the requirements of SPAs (Waliczky et al., 2019). In 1989, the first all-European IBA inventory was published which included the first set of region-wide IBA criteria, followed by the regional IBA inventory for the Middle East in 1994. In 1996, BirdLife developed a global set of IBA criteria which have later been applied in Europe (2000), Africa (2001), Asia (2004), the Americas (2009) and the Pacific (2010) (Donald et al., 2019).

In Croatia, there are 37 SPAs (congruent with IBAs). The Regulation on management objectives and measures for SPAs prescribes management objectives (per species) and measures for all 37 SPAs. Also, in Croatia, all SPAs have designated management authorities (public institutions that are managing protected areas – both terrestrial and marine). These management authorities adopt SPA's management plans, which include both conservation objectives and measures and can include additional conservation measures. Management plans are developed for 10-year periods, and they prescribe what the management authorities will be doing to conserve target species and achieve conservation objectives. In addition to nature conservation sector that manages protected areas in Croatia, other sectors, such as fisheries, tourism, maritime domain and energy, also must implement conservation measures prescribed in the Regulation on management objectives and measures for SPAs via their sectorial management plans and other strategic and operational documents.

Of the 37 SPAs in Croatia, only a small percentage includes a marine component. There are no "only-at-sea" SPAs/IBAs neither in territorial waters nor offshore (outside territorial waters) that would encompass significant foraging/roosting areas of seabird species. This likely gap in the SPA network means that opportunities to enhance conservation measures for seabird species breeding in Croatia may not have been realised. Therefore, identifying these SPAs is critical to ensure effective conservation and management measures can be implemented for many of the globally threatened species breeding in Croatia.

Primary reasons for "only-at-sea" SPAs/IBAs not being identified yet, is because the systematic surveys of the distribution and activities of birds at sea for the delineation of IBAs and SPAs had not yet been conducted due to lack of appropriate standardized methods of recording seabirds at sea, lack of technology for monitoring seabird movements, as well as large costs of surveys at sea and lack of human capacity for research and surveys. These barriers have now been reduced; therefore, this project aims to identify the first network of IBAs at sea for seabird species breeding in Croatia with a view to informing development of the SPA network, and ultimately supporting Croatia to achieve globally agreed upon biodiversity conservation targets.

## Context of key evidence (IBAs)

Important Bird and Biodiversity Areas (Donald et al., 2018) do not afford protection to a site in themselves. However, in conjunction with informing the SPA network in Europe, IBAs as a decision-making product have informed how nations meet global targets, which sites should contribute to MEAs or be considered for enhanced protection or management, guided investment decisions, and have been recognised as important wildlife areas for local communities (Waliczky et al., 2018).

IBAs are identified using a globally agreed standardised set of data-driven criteria and thresholds (Box 1, Box 2), ensuring that sites must consistently meet the same thresholds worldwide.

Marine Important Bird and Biodiversity Areas (marine IBAs) are sites located at-sea that are of global importance for the persistence of species (Donald et al., 2018; Lascelles et al., 2016). For seabirds, examples are foraging areas around breeding colonies, non-breeding concentrations, migratory bottlenecks and feeding areas for pelagic species (BirdLife International, 2010).

Box 1: Overview of Important Bird and Biodiversity Area selection criteria (Detailed guidelines are available online: http://datazone.birdlife.org/site/ibacriteria) (BirdLife International, 2023).

**GLOBAL CRITERIA**

A1: Globally Threatened Species*
A2: Restricted Range Species
A3: Bioregion-Restricted Assemblages
A4: Congregations*

**REGIONAL CRITERIA**

B1: Species of Conservation Concern
  a: Globally near threatened species
  b: Species with an unfavourable conservation status in the region*
B2: Species with most of their range restricted to a region
  a: Species with a favourable conservation status but concentrated in the region
B3: Regionally important congregations
  a: Regionally important congregations – biographical populations
  b: Regionally important congregations – multi-species aggregations*
  c: Regionally important congregations – bottleneck sites

**EUROPEAN UNION CRITERIA**

C1: Species of global conservation concern*
C2: Concentrations of species threatened at the European Union level*
C3: Concentrations of migratory non-threatened species
C4: Large congregations – multi-species aggregations*
C5: Large congregations – “bottleneck” sites
C6: Species threatened at the European Union level*

Criteria marked with asterisks (*) are those considered in this study.

Box 2: IBA criteria species were assessed against in this study

**GLOBAL CRITERIA**

**A1: Globally Threatened Species Criterion:** The site is known or thought regularly to hold significant numbers of a Globally Threatened species. The site qualifies if it is known, estimated or thought to hold a population of a species categorized on the IUCN Red List as globally threatened (Critically Endangered, Endangered and Vulnerable). Specific thresholds apply to species in the three threat categories. For species classified globally as vulnerable (VU) at least 30 individuals or 10 pairs/ reproductive units (20 mature individuals) should regularly use the site.

**A4: Congregations Criterion:** The site is known or thought to hold congregations of ≥1% of the global population of one or more species on a regular or predictable basis.

**REGIONAL CRITERIA**

**Criterion B1b: Species with an unfavourable conservation status in the region:** The site is one of the 'n' most important in a country for a species with an unfavourable conservation status in the region, and for which the site-protection approach is thought to be appropriate.

**Criterion B3b: Regionally important congregations – multi-species aggregations:** Site known or thought to hold, on a regular basis, >= 20,000 waterbirds or >= 6,700 pairs of seabirds of one or more species.

**EUROPEAN UNION CRITERIA**

**Criterion C1: Species of global conservation concern:** The site regularly holds significant numbers of a globally threatened species, or other species of global conservation concern.

**Criterion C2: Concentrations of species threatened at the European Union level:** The site is known to regularly hold at least 1% of the flyway or EU population of a species considered to be threatened to the EU.

**Criterion C4: Large congregations – multi-species aggregations:** The site is known to regularly hold at least 20,000 migratory waterbirds, or at least 6,700 pairs of migratory seabirds, of one or more species.

**Criterion C6: Species threatened at the European Union level:** The site is one of the five most important sites in the European region in question for a species or sub-species considered threatened in the European Union.

# Methods

## Overview

For the purpose of the first marine SPA/IBA designation in Croatia, systematic surveys have been conducted by Biom as part of the LIFE Artina project. This included data collection regarding the seabird distribution at sea, along the coast and on colonies within the project area, i.e. in the Lastovo archipelago. The methods applied, include censuses of seabird colonies on islands and islets, recording of seabirds at sea by doing boat transect counts, telemetry using radio and GPS tracking, as well as bird ringing. These data were analysed to delineate marine IBAs for the purpose of SPA identification.

## Target species

Three key seabird species were investigated for the purpose of marine IBA identification. These include two shearwaters, Yelkouan Shearwater (*Puffinus yelkouan*) and Scopoli's Shearwater (*Calonectris diomedea*), and a gull, Audouin´s Gull (*Larus audouinii*). Both Yelkouan Shearwater and Audouin's Gull are globally threatened species (BirdLife International, 2021). In Croatia these species are considered Vulnerable and Endangered, respectively, and the majority (>80%) of their breeding populations are found in the SPA Lastovsko otočje (Figure 2; Table 1). The remaining Yelkouan Shearwaters in Croatia breed in SPA Pučinksi otoci, whereas other breeding sites for Audouin's Gulls are SPA Srednjedalmatinski otoci i Pelješsac, and SPA SZ dio NP Mljet (Figure 2). The population of Scopoli's Shearwater in Croatia, where the species is considered near-threatened, is more or less equally divided between SPA Lastovsko otočje and SPA Pučinksi otoci (Figure 2; Table 1).

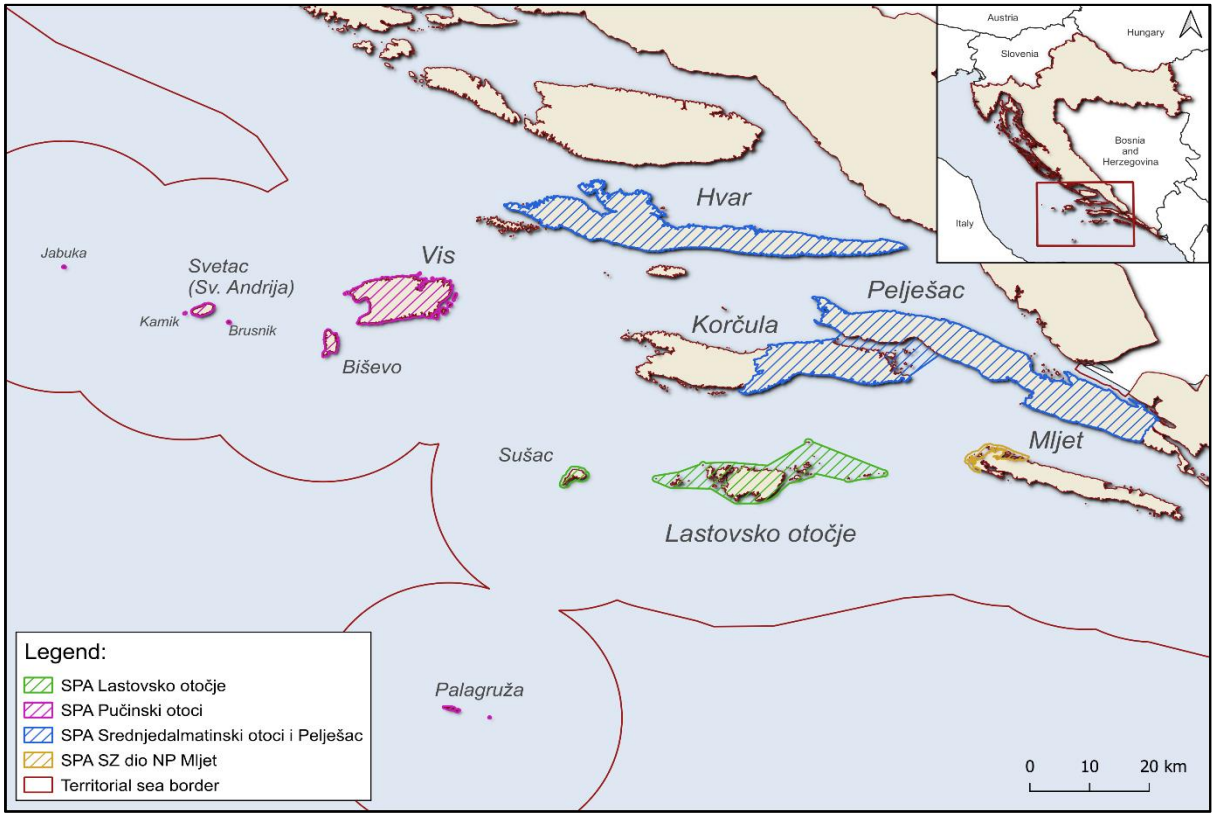


*Figure 2: All Croatian SPAs holding breeding populations of Yelkouan Shearwater (green and purple), Scopoli's Shearwater (green and purple) and Audouin's Gull (green, yellow and blue).*

## Study region

The Lastovo archipelago consists of 46 islands and islets, all of which are uninhabited except for the main island. All islands, as well as some of the surrounding waters are included in the SPA Lastovsko otočje, which has identical borders to the Lastovo Islands Nature Park (IUCN protected area category V) that was created in 2006. While censuses of seabird populations and attachment of animal tracking devices occurred on respective breeding colonies of each of the three target species within the SPA Lastovsko otočje, the at-sea surveys were conducted in the waters surrounding the SPA (Figure 3). Seabird population census data from the SPA Pučinski otoci, which covers the Vis archipelago in its entirety, is based on surveys carried out prior to LIFE Artina (Table 1).

## Delineating marine IBAs

The delineation of marine IBAs requires information on the at-sea distribution of seabirds, along with estimates of the number of birds using the sites, usually derived from the number of breeding pairs in the colony of origin (Lascelles et al., 2016) or from at-sea survey data.

## Delineating marine IBAs: Colony abundance estimates

Seabird colony data for the Lastovo archipelago was gathered by surveying known and newly discovered breeding colonies for all three target species (Table 1). Between 2019 and 2021, each year three surveys were carried out for each of the target species (corresponding to their periods for incubation, hatching of the chicks, and close to fledging of the chicks) to identify nests and assess the breeding success of all colonies. Seabird population data from other relevant breeding areas in Croatia (Figure 2: Pučinski otoci for shearwaters; Mljet and Srednjedalmatinski otoci i Pelješac for Audouin's Gull) were taken from Natura 2000 SDFs ("Natura 2000 reference portal," 2023) for each of the respective sites (Table 1).

## Delineating marine IBAs: At-sea surveys

Boat-based seabird surveys were conducted according to a manual created by the EU LIFE+ Malta Seabird Project, which is an adaptation of the European Seabirds at Sea (ESAS) methodology (Camphuysen et al., 2004); a distance sampling approach along transect lines. The at-sea surveys were conducted monthly between March and October for two consecutive years (May 2019 – May 2021), following a petal shape around the SPA Lastovsko otočje (Figure 3). A total of 12 transects, varying in length from 35 to 50km, were surveyed by two trained observers and a skipper with a semi-inflatable boat going at a speed of 15km/h. Overall, a total of 8273,6 km was covered. Birds were identified to species level where possible, otherwise using larger overarching species groups. For each observation, the number of birds and their age (if possible) was noted, as well as notes on behaviour (e.g. foraging, resting, flying over) and their distance to the boat.

At-sea survey data was aggregated into monthly estimates of abundance at point locations corresponding to survey efforts. These data were further aggregated into seasonal estimates of abundance which facilitated the assessment of hotspot identification to support IBA designation.

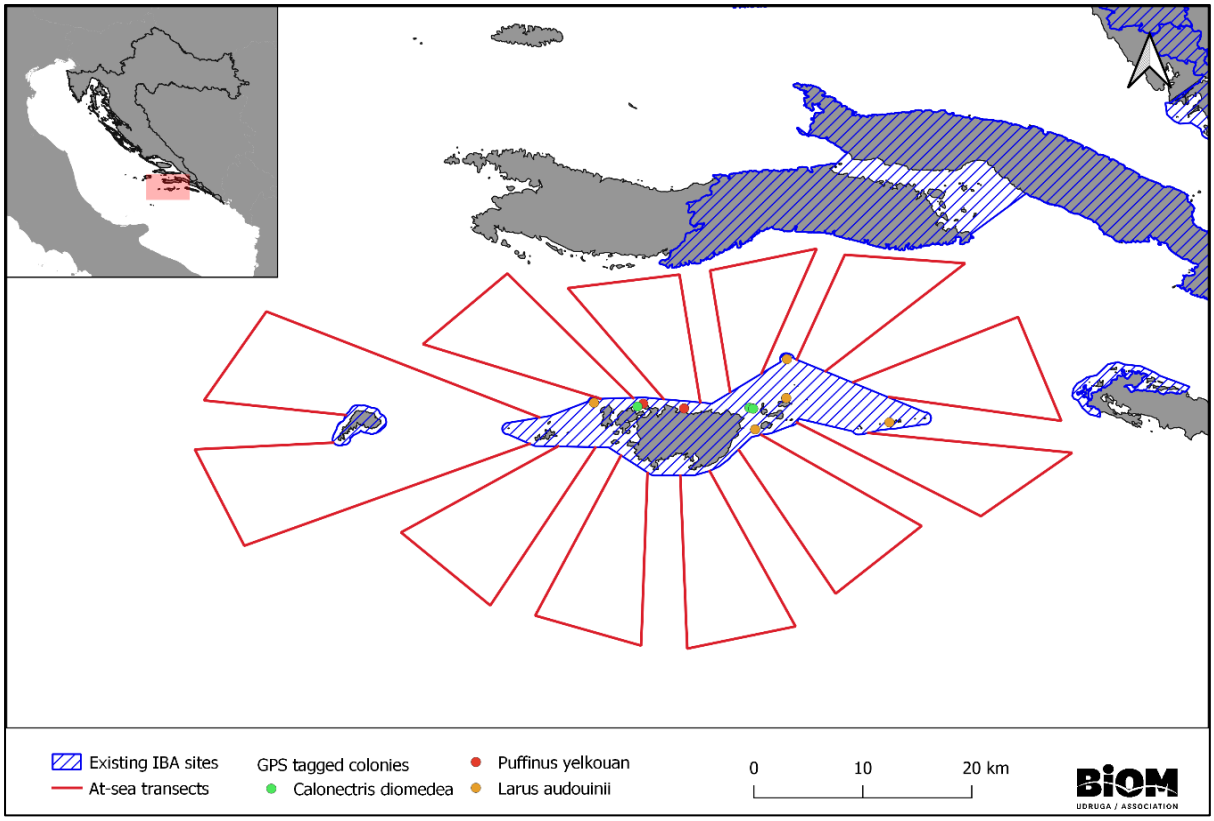


*Figure 3: Map showing SPA Lastovsko otočje with locations of GPS tag deployments and coverage of the at-sea transects.*

## Delineating marine IBAs: Satellite Tracking

Birds were tracked from several islands within the SPA Lastovsko otočje (Figure 3) over two or three breeding seasons (2019 & 2020 for Yelkouan Shearwater; 2020 & 2021 for Scopoli's Shearwater; 2019 & 2020 & 2021 for Audouin's Gull) using high-resolution GPS devices. In total, 40 adult Yelkouan and 40 adult Scopoli's Shearwaters were tagged with PathTrack nanoFix GPS/UHF transmitters (≤ 5.5 g). For the tracking of Audouin's Gulls, OrniTrack-10-3G GPS/GSM transmitters (~ 11 g) were deployed on 25 adult individuals. For shearwaters, adult birds were tagged shortly after their chicks had hatched in colonies where rats were either eradicated or their numbers controlled. This was done to ensure that the tracking data reflects foraging behaviour of chick-rearing adults (i.e. the life-cycle stage when adults are constrained in total dispersal ability given the need to return and feed chicks). Following the same rationale, analyses of tracking data for Audouin's Gull focused on their chick-rearing period between May and August.

Tracks were first assigned to data-groups (Lascelles et al., 2016) to ensure that any spatial aggregation patterns exhibited by a species during a given life-cycle stage are captured and not diluted by inclusion of data from other stages with potentially very different distributions. Where a data-group is recognised as the unique period of data representing:

**Data-group = Species / Site / Life-cycle stage**

Three key data-groups were defined for the study:

- Yelkouan Shearwaters / SPA Lastovsko otočje population / Breeding
- Scopoli's Shearwaters / SPA Lastovsko otočje population / Breeding
- Audouin's Gull / SPA Lastovsko otočje population / Breeding

Tracking data was then filtered for erroneous locations using a speed filter for the GPS tracks (Sumner, 2016) set at 100 km/h. To avoid the bias of assigning importance to areas using tracking data with different sampling frequencies, we interpolated locations in all data-groups to regular 30-minute intervals using a continuous-time correlated random walk model, implemented via the Crawl R package (Johnson, London et al. 2008, Johnson and London 2018) for the shearwaters, or using linear interpolation for the gull species (Calenge, 2006). The interpolation method and interval frequency were chosen after visually inspecting the data, and considering the pre-defined sampling interval and assessing the spread of sampling frequencies in our tracking datasets.

Given all data for species related to breeding birds – a time when birds are central place foragers regularly returning to nests between foraging trips – the tracks from individual birds were split into unique trips. Trips were defined as movements of >3 km and >1 hour, or >1 km and >1 hour, for the shearwaters and the gull, respectively. This helped distinguish between foraging trips and short maintenance forays from the colony or biased locations from GPS errors. Location data from the colony and data linked to short maintenance forays were removed for marine IBA identification.

Using the filtered data, specific sites for assessment against IBA criteria (potential IBA sites) were identified following the protocol outlined in the Track2KBA R package (Beal et al., 2021) (Figure 4). In summary this protocol:

- First, supports the identification of a necessary smoothing parameter to be used in subsequent analyses underpinned by kernel density estimation.
- Second, once an appropriate smoothing parameter is determined, the next step is to estimate from the individual tracks the core areas being used; where the core area for this study is defined as the 50% utilisation distribution (a typical value used across many seabird studies).
- Third, a key factor when you are trying to identify particular areas of importance from tracking data, is to consider how likely it is that the data you have collected is representative of the source population. We therefore estimated the sample size at which the group-level space-use pattern is unlikely to change upon further tracking and determined a percentage of how representative the data collected likely is of the sampled population. This measure of representativeness is used to scale the likely area of importance (i.e. for data with lower representativeness, a smaller final area of importance is assigned).
- Finally, identify and delineate an important site for the source population. This is achieved by first calculating the proportion of overlapping individual core areas per grid cell. Depending on the representativeness, overlapping grid cells that contain a threshold percentage of the population are then grouped together. If there is a population estimate available for the source population, an estimate of abundance for within the area identified is determined, with this estimate of abundance being downscaled the less representative the data are.

### Delineating marine IBAs: Coastal marine sites

While many seabird breeding colonies have already been identified as IBAs, their boundaries have been, in almost all cases, confined to the land on which the colonies are located (BirdLife International, 2010). However, waters adjacent to breeding colonies are often important sites for key behaviours such as feeding and rafting. Therefore, in the absence of tracking data from all key species colonies across Croatia, conservative 5km buffers were delineated as seaward extensions around the colonies which already met IBA criteria, but for which tracking data was unavailable. This conservative 'buffer' approach has been used for the identification of other marine IBAs for seabird species elsewhere (See:

Handley et al., 2021, Diversity and Distributions) as it provides an initial identification of important sites within which appropriate conservation and management measures can be considered.

## Delineating marine IBAs: Final boundaries

Following the data analyses described above, the final IBA boundaries were refined through a stakeholder consultation process in order to produce simplified rectangular or trapezoidal polygons that can more simply facilitate decision making, e.g. by seafaring vessels that need to be aware of their location relative to the IBAs. The stakeholder consultation was conducted with an expert group including LIFE Artina Scientific Committee (with representatives from the Institute of Ornithology of the Croatian Academy of Science and Arts and the Institute of Oceanography and Fisheries) and including consultation with the Ministry of Economy and Sustainable Development. During the process of designating SPAs (from IBAs) the Ministry of Economy and Sustainable Development will also consult Fisheries Directorate of the Ministry of Agriculture.

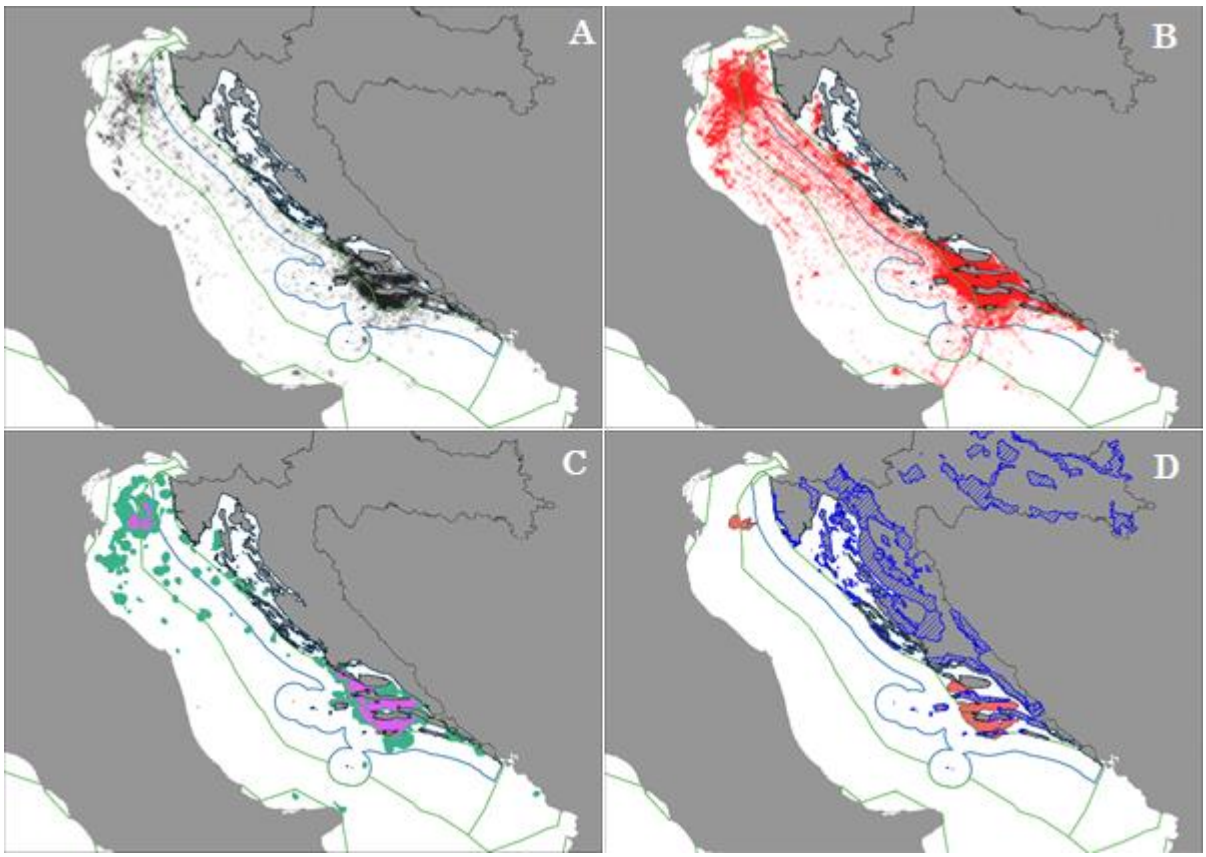


*Figure 4: Example of tracking data processing for Croatia* – Yelkouan Shearwater *example: a) Raw tracking data locations, b) Interpolated tracking locations, c) Overlapping core areas of birds (in green) with core representative areas (in pink), d) Newly identified IBA boundaries for stakeholder consultation (in red) and existing IBAs for Croatia (in blue).*

*Table 1: Global and regional population estimates for the three study species*

| Species | Area | Colony | IUCN Category | IUCN Criteria | Lower estimate (mature individuals) | Upper estimate (mature individuals) | Source |
|---|---|---|---|---|---|---|---|
| Yelkouan Shearwater *Puffinus yelkouan* | Global | | Vulnerable (VU) | A4bcde | 30667 | 61333 | IUCN Red List |
| | Europe | | Vulnerable (VU) | A2abcde | 47000 | 81800 | IUCN Red List |
| | European Union | | | | 47000 | 80700 | BirdLife International, 2021 |
| | Croatia | | Vulnerable (VU) | | 1100 | 1600 | Biom survey data* + Tutiš et al., 2013 |
| | SPA Lastovsko otočje[A] | Entire SPA | | | 1000 | 1400 | Biom survey data* |
| | SPA Lastovsko otočje | Sušac[B] | | | 200 | 400 | Biom survey data* |
| | SPA Pučinski otoci | Svetac[B] | | | 100 | 200 | Tutiš et al., 2013 |
| Scopoli's Shearwater *Calonectris diomedea* | Global | | Least Concern (LC) | | 285000 | 446000 | IUCN Red List |
| | Europe | | Least Concern (LC) | | 57000 | 94300 | IUCN Red List |
| | European Union | | | | 57000 | 94200 | BirdLife International, 2021 |
| | Croatia | | Near Threatened (NT) | | 1400 | 2400 | Biom survey data* + Natura 2000 SDF HR1000039 ("Natura 2000 reference portal," 2023) |
| | SPA Lastovsko otočje[A] | Entire SPA | | | 800 | 1000 | Biom survey data* |
| | SPA Lastovsko otočje | Sušac[B] | | | 40 | 100 | Kapelj et al., 2018 |
| | SPA Pučinski otoci | Svetac[B] | | | 480 | 1120 | Kapelj et al., 2018 |
| Audouin´s Gull *Larus audouinii* | Global | | Vulnerable (VU) | A4b | 42600 | 44600 | IUCN Red List |
| | Europe | | Vulnerable (VU) | A3bce + 4abce | 31400 | 42000 | IUCN Red List |
| | European Union | | | | 31200 | 41700 | BirdLife International, 2021 |
| | Croatia | | Endangered (EN) | | 50 | 100 | BIOM survey data* + Natura 2000 SDF HR1000036 & HR1000037 ("Natura 2000 reference portal," 2023) |
| | SPA Lastovsko otočje[A] | Entire SPA | | | 50 | 80 | BIOM survey data* |

A: Population estimates used for the purpose of marine IBA identification from animal tracking data (via Track2KBA – see details) are those that relate to the population representative of the SPA Lastovsko otočje

B: Specific colonies suggested for a 5km seaward extension of existing IBA borders

*BIOM survey data is based on the nest censuses carried out in SPA Lastovsko otočje as part of LIFE Artina between 2019 and 2021

## Results

### Marine IBA Identification: At-sea survey data

At-sea survey data for the key species considered in this report complemented the outputs from the tracking data analysis. Specifically, areas with high abundance identified from the at-sea surveys typically fell within the bounds of areas identified as IBAs from tracking data, and ultimately the final IBAs identified following the stakeholder consultation (Figure 5). Therefore, as described by (BirdLife International, 2010), these data play a critical role in identifying candidate IBA sites which can be further assessed with additional data sources such as animal tracking data.

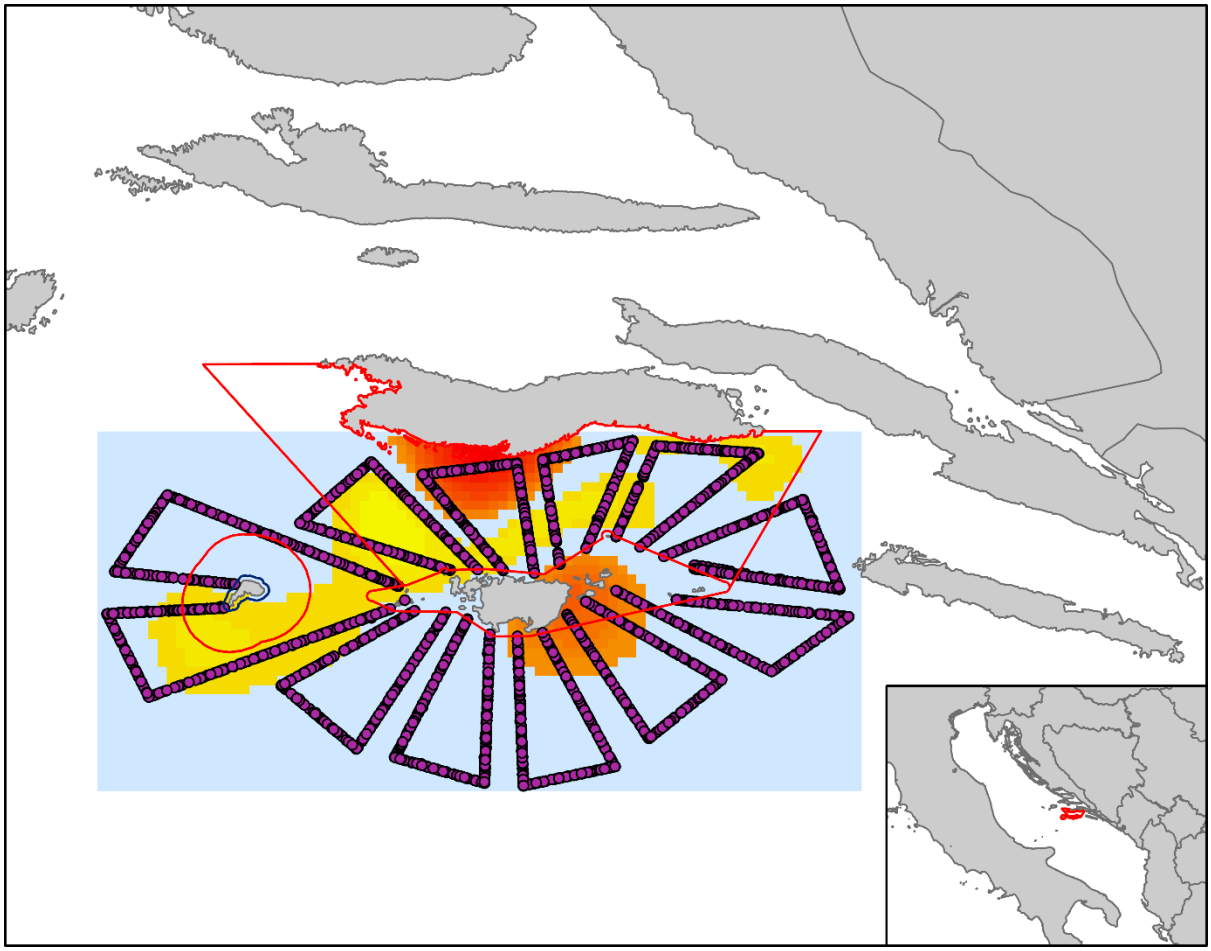

*Figure 5: An example output of at-sea survey hot-spot analysis, informed by the Yelkouan Shearwater records during the May 2019 at-sea surveys. Areas of higher abundance are denoted in red, while areas of lower abundance are denoted in yellow. Survey routes are marked in purple. Red polygons depict the final IBA boundaries following analysis of all data and the stakeholder consultation process. The inset map shows final IBA boundaries in relation to the scale of the Adriatic Sea.*

### Marine IBA Identification: Tracking data

A total of 456, 1065 and 1533 individual trips were identified for Yelkouan Shearwaters, Scopoli's Shearwaters and Audouin's Gulls, respectively, from 118 successful deployments across all species. For Yelkouan Shearwaters, the mean duration of the individual trips was 37.9 hours, the mean maximum distance from the colony across all trips was 86.4 km, while the furthest trip was 449.6 km

away from the colony. For Scopoli's Shearwaters, the mean duration of the trips was 22.8 hours, the mean maximum distance from the colony across all trips was 42.8 km, and the furthest trip was 391.9 km away from the colony. For Audouin's Gulls, the mean duration of the trips was 16.23 hours, the mean maximum distance from the colony across all trips was 24.42 km and the furthest trip was 311.8 km from the colony.

Smoothing parameters were estimated to be 3.72 km, 3.29 km, and 2.83 km for the Yelkouan Shearwater, Scopoli's Shearwater and Audouin´s Gull data respectively. These parameters were selected based on the smoothing parameter defined via the estimate of the log of the median foraging range.

Representative core areas (i.e. those areas where a threshold number of birds overlapped each other in space use) were identified for all three data-groups. For the Yelkouan Shearwaters, these core areas were situated within the Lastovo, Korčula and Hvar Channels, as well as in the Northern Adriatic, midway between Istria and the Po Delta (Figure 6). For the Scopoli's Shearwaters, core areas were situated in the Lastovo and Korčula channels, as well as off the eastern tip of the island of Mljet (*Figure 7*). And for the Audouin's Gull, which typically forage in more coastal waters, core areas were situated off the eastern and western coast of Lastovo, around the Vrhovnjaci archipelago, at the tip of the Pelješac Peninsula and in the bay of Mali Ston (*Figure 7*).

After filtering core areas to remove sites identified that were smaller than 5% of the largest site, each core area – in which the abundance of birds was also determined – was then assessed against IBA criteria thresholds. Sites meeting IBA criteria were identified for the globally threatened Yelkouan Shearwater (four sites; Figure 6) and Audouin´s Gull (one site; *Figure 7*), as well as for the non-globally threatened Scopoli's Shearwater (three sites; *Figure 7*). The relevant IBA criteria met were A1 (globally threatened species) and C1 (species of global conservation concern) for the Audouin's Gull and Yelkouan Shearwater, A4 (congregations) for the Yelkouan Shearwater and C6 (Species threatened at the European Union level) for Yelkouan and Scopoli's Shearwater (

Table 2). The individual species level IBA sites were situated in the Lastovo, Korčula and Hvar channels, one off the eastern coast of Lastovo, one in the eastern part of the Mljet channel and one in the Northern Adriatic.

*Table 2: Tabular data regarding final sites identified from tracking data for individual species meeting IBA criteria. See associated* Figure 6 *& Figure 7.*

| **Species** | **IUCN Status** | **Unique site** (see Figure 6 & Figure 7) | **Corresponding IBA site** | **Mature Individuals** | | **Season** | **Final IBA criteria met** |
|---|---|---|---|---|---|---|---|
| | | | | **Lower** | **Upper** | | |
| Yelkouan Shearwater | VU | PY4 | Northern Adriatic | 139 | 222 | Breeding | A1, C1 |
| | | PY1 | Lastovo Channel | 139 | 1110 | Breeding | A1, A4, C1, C6 |
| | | PY2 | Korčula Channel | 139 | 666 | Breeding | A1, A4, C1, C6 |
| | | PY3 | Hvar Channel | 139 | 250 | Breeding | A1, C1 |
| Scopoli's Shearwater | LC | CD1 | Lastovo Channel | 50 | 402 | Breeding | C6 |
| | | CD2 | Korčula Channel | 50 | 62 | Breeding | C6 |
| | | CD3 | East Mljet Channel | 50 | 62 | Breeding | C6 |
| Audouin's Gull | VU | LA1 | Lastovo Archipelago | 22 | 32 | Breeding | A1, C1 |

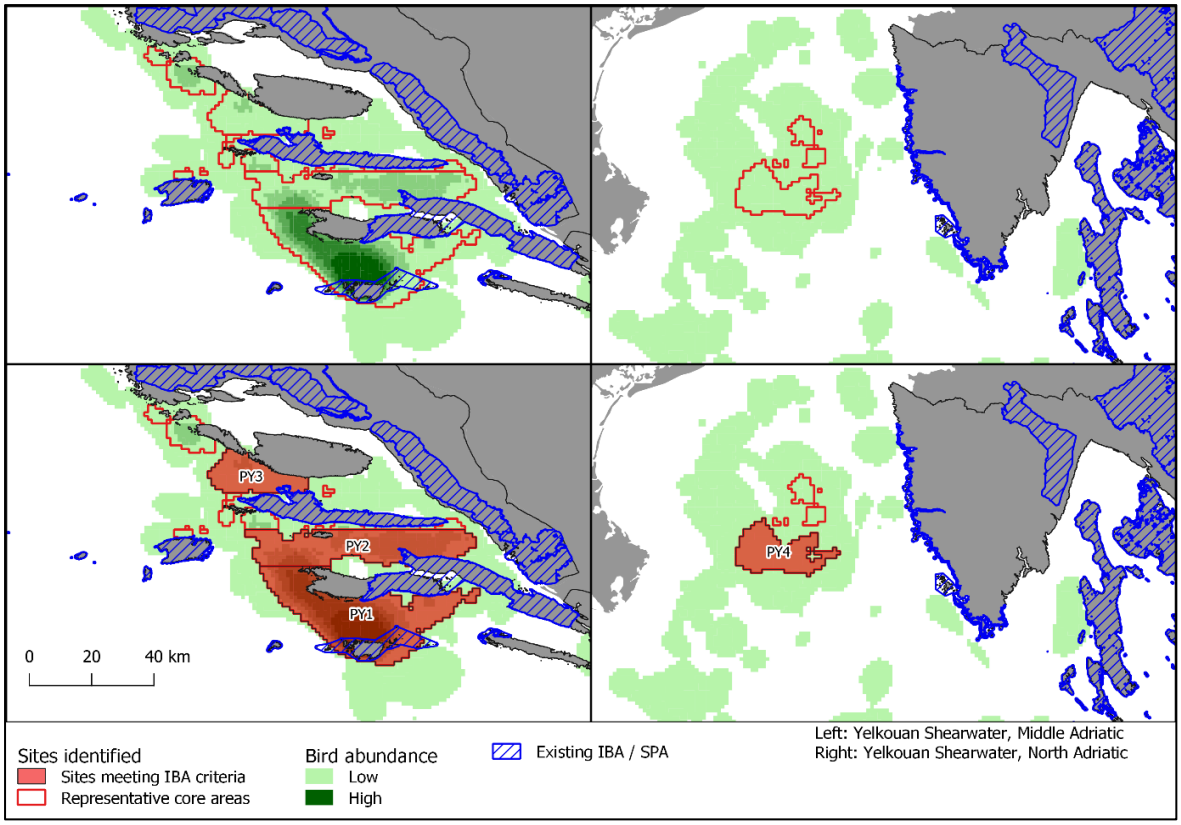


*Figure 6: Overlapping Yelkouan Shearwater core areas indicating areas of lower to higher use by birds (abundance), and the representative core areas identified following the analytical protocol outlined in the Track2KBA R Package. Lower panels highlight sites meeting IBA criteria.*

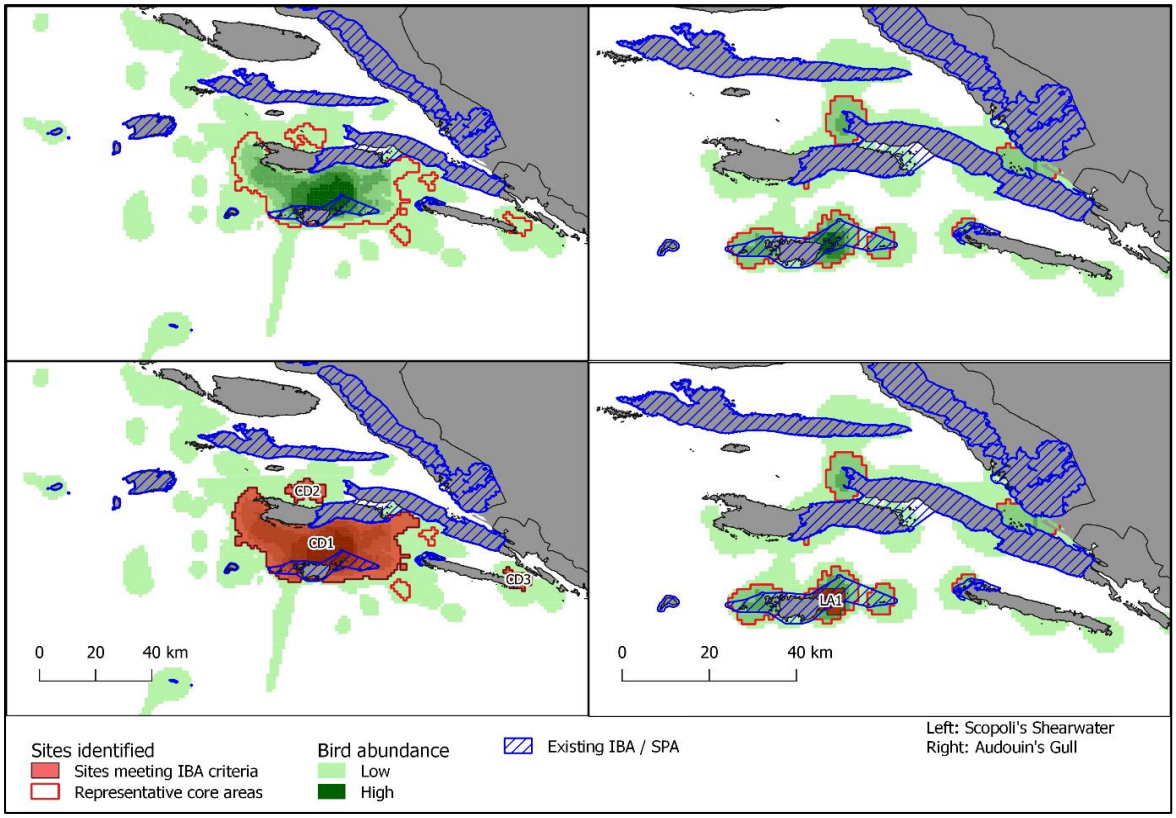


*Figure 7: Overlapping Scopoli's Shearwater (left) and Audouin's Gull (right) core areas indicating areas of lower to higher use by birds (abundance), and the representative core areas identified following the analytical protocol outlined in the Track2KBA R Package. Lower panels highlight sites meeting IBA criteria.*

## Marine IBA Identification: Colony census data

In addition to the colonies where GPS tracking was used to inform marine IBA identification, 5 km seaward extensions were designated to seabird colonies with large enough breeding populations to trigger IBA criteria. This resulted in the expansions of the currently existing IBA borders around the uninhabited islands of Sušac (403 ha) and Svetac (419 ha), situated in the Central Adriatic, far away from the Croatian mainland. Both islands are already part of existing IBAs/SPAs (Sušac in IBA Lastovo Archipelago/ SPA Lastovsko otočje; Svetac in IBA Offshore Islands/ SPA Pučinski otoci), which currently include a 500 m and 200 m buffer zones around their coastlines respectively. The new borders of the aforementioned IBAs are defined as a seaward extension of 5 km around each of the islands to encompass the area typically used for rafting around seabird colonies. Both Sušac and Svetac are home to important populations of the globally threatened Yelkouan Shearwater with 100-200 breeding pairs on Sušac and 50-100 on Svetac (Table 1), herewith triggering IBA criteria A1, C1 and C6. Furthermore, both harbour colonies of Scopoli's Shearwater (Table 1), with the one on Svetac being the currently largest known colony in the Adriatic Sea (240-560 breeding pairs) thereby triggering IBA criteria C6. Besides this, both islands are also important breeding sites for several other bird species listed on the Annex 1 of the EU Bird Directive, namely Eleonora's Falcon (*Falco eleonorae*), Peregrine Falcon (*Falco peregrinus*) and Mediterranean Shag (*Phalacrocorax aristotelis desmarestii*).

## New marine IBA Designation

In summary, the following marine IBAs are designated (*Figure 8* & Figure 9): 1) Lastovo Channel, 2) Korčula Channel, 3) Hvar Channel, 4) Northern Adriatic, 5) East Mljet Channel. As the identified IBA in the Northern Adriatic is bisected by the Exclusive Economic Zone (EEZ) boundary between Italy and Croatia, both sides have been submitted separately to the IBA database by the respective BirdLife partners in both countries (LIPU and Biom), resulting in Northern Adriatic IT and Northern Adriatic CRO. For Croatia, these are the first 'only-at-sea' IBAs to have been designated. Additionally, an expansion of the borders of two existing IBAs, Lastovo Archipelago and Offshore Islands, has been designated to include 5 km seaward extensions around the islands of Sušac and Svetac, as well as to encompass the Audouin's Gull core representative area to the southeast of Lastovo (*Figure 8*).

All newly designated marine IBAs and revised areas of existing IBAs will be proposed for inclusion in the existing SPA networks of Croatia and Italy (Figure 1; Table 3). Proposals will be submitted by Biom to the Ministry of Economy and Sustainable Development in Croatia, and by LIPU to the Ministry of Environment in Italy.

*Table 3: List of suggested SPAs to be included in the Natura 2000 network, based on marine IBAs designated in this study.*

| **SPA Name** | **IBA Name** | **Size (ha)** | **Longitude** WGS84 | **Latitude** WGS84 | **Seabird species meeting IBA criteria** |
|---|---|---|---|---|---|
| Lastovsko otočje | Lastovo Archipelago | 34.742 (formerly 19.572) | 16.89131 | 42.76523 | Yelkouan Shearwater<br>Scopoli's Shearwater<br>Audouin's Gull |
| Pučinski otoci | Offshore Islands | 24.648 (formerly 12.678) | 16.12452 | 43.02986 | Yelkouan Shearwater<br>Scopoli's Shearwater |
| Hvarski kanal | Hvar Channel | 26.100 | 16.41834 | 43.26585 | Yelkouan Shearwater |
| Korčulanski kanal | Korčula Channel | 95.084 | 16.79168 | 43.06603 | Yelkouan Shearwater<br>Scopoli's Shearwater |
| Lastovski kanal | Lastovo Channel | 79.079 | 16.85132 | 42.87100 | Yelkouan Shearwater<br>Scopoli's Shearwater |
| Istočnomljetski kanal | East Mljet Channel | 4.572 | 17.76764 | 42.71836 | Scopoli's Shearwater |
| Sjeverni Jadran | Northern Adriatic CRO | 25.134 | 13.16778 | 45.00058 | Yelkouan Shearwater |
| Alto Adriatico | Northern Adriatic IT | 21.686 | 12.98830 | 45.00052 | Yelkouan Shearwater |

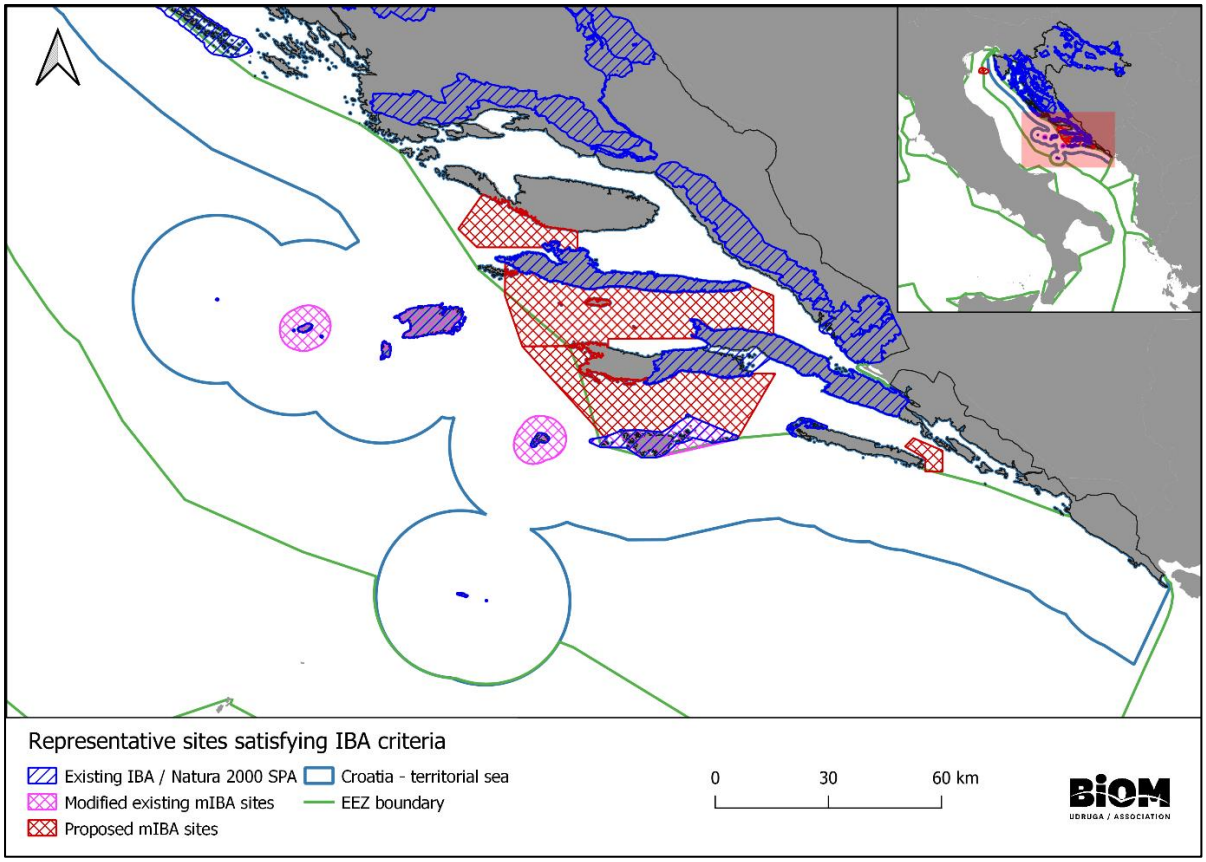


*Figure 8: Proposed new IBA sites in the Central Adriatic, including the proposed extensions of the existing IBAs Lastovo Archipelago and Offshore Islands.*

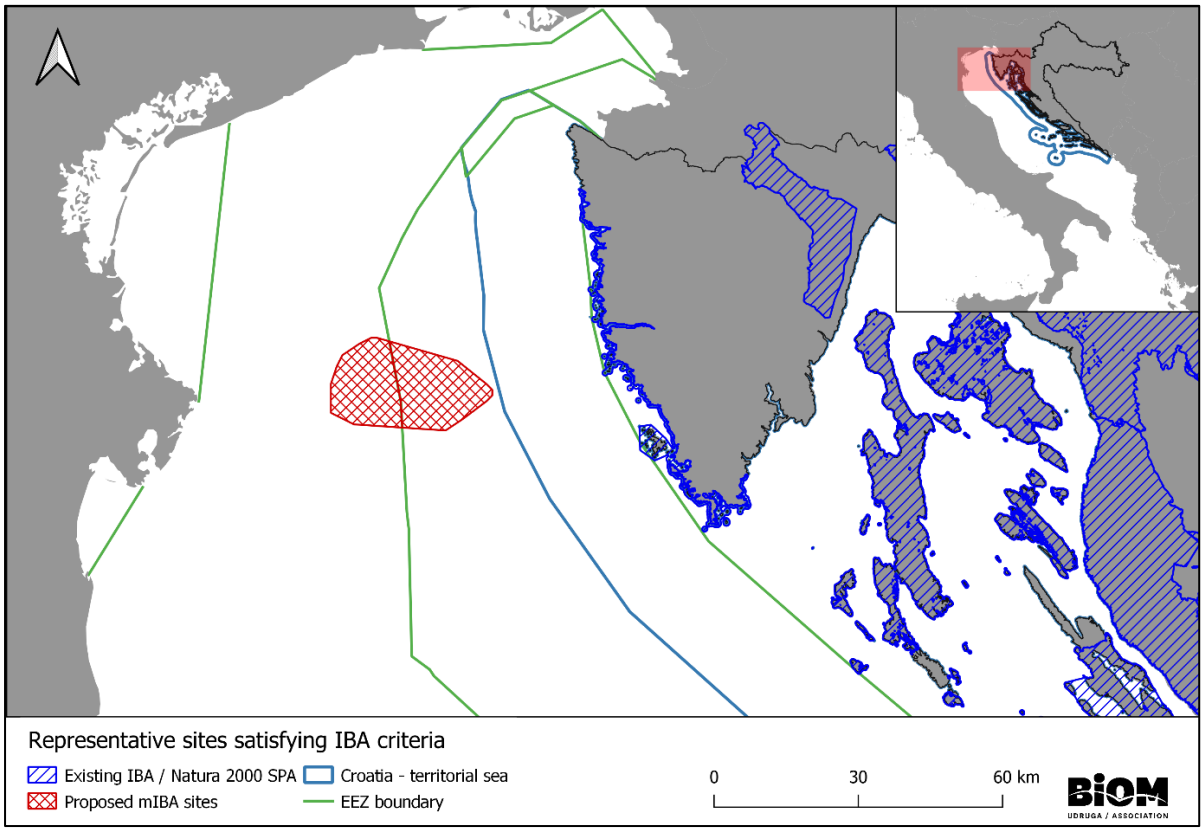


*Figure 9: Proposed new IBA sites in the North Adriatic. The identified site is bisected by the EEZ boundary between Italy and Croatia and the Italian side was submitted to the Italian BirdLife partner organisation for further designation.*

## Recommendations for management

The currently proposed SPAs need to have proper management in place to secure the conservation of seabirds in Croatia. Seabirds are among the most threatened groups of birds globally and face a number of threats which management plans should consider, such as alien invasive predators, bycatch, climate change, overfishing and pollution (Croxall et al., 2012; Dias et al., 2019). To improve their status priority actions should focus on formal and effective site protection, especially for Important Bird and Biodiversity Area (IBA) breeding sites and for marine sites, as part of national, regional and global networks of Marine Protected Areas (Croxall et al., 2012).

The Croatian Law on Nature Protection sets clear rules for institutional management – newly designated IBAs/SPAs will be managed by public institutions for management of protected areas and, in the case of the site in the EEZ (Northern Adriatic CRO), by the Ministry of Economy and Sustainable Development. The Regulation on Ecological Network and Jurisdictions of the Public Institutions for Ecological Network (Natura 2000) Site Management will prescribe management at national level (Nature Park Lastovo Islands, National Park Mljet) and regional level (of Split-Dalmatia and Dubrovnik-Neretva counties).

The Law also clearly prescribes the adoption of the 10-year management plans which will be developed after the official designation of SPAs. Management plans will be developed based on participatory and adaptive approaches to management. The management Plans for Lastovo Islands Nature Park and Mljet National Park for the period 2017-2026 already exist and the new (revised) plans will reflect the changes in the extension of IBAs/SPAs and also include the new IBAs/SPAs. The management plan for the SPA Srednjedalmatinski otoci i Pelješac, which is relevant for the Audouin's Gull, has been adopted in 2023. Besides the management plans for areas, there is also a draft management plan for shearwaters in Croatia (Kapelj et al., 2019), which is currently pending adoption by the Croatian government. This document should be updated to include management measures for protection of the species at-sea as well.

Conservation objective and measures will be proposed for both the revised IBAs/SPAs and newly designated mIBAs, which are to become mSPAs. Conservation objectives and measures will be published in the Regulation on Conservation Objectives and Conservation Measures of Target Bird Species in Ecological Network (Natura 2000) Sites. The conservation objectives for revised IBAs/SPAs will include target (now updated) numbers of breeding pairs and target coverage of relevant habitats. The colonies will be designated as strict protection (no-take-zones). The conservation objectives for marine IBAs will include the numbers of the birds that use the marine area. The areas with highest bird abundance will be considered for designation as strict protection (no-take-zones).

While conservation measures for seabird colonies should primarily focus on removing or controlling alien invasive mammalian predator populations and protecting the sites from disturbance during the breeding season, management measures for marine IBAs should deal with issues such as bycatch, overfishing, pollution, disturbance due to marine traffic, tourism and light pollution, and the upcoming increase of offshore renewables. Effective site management should consider species-specific conservation needs, due to their ecological differences (e.g. gulls moving on a small spatial scale during the breeding season whereas shearwaters utilize large foraging ranges (Oppel et al., 2018) – as also shown in this study). One of the main identified threats for seabirds in the Mediterranean, and one that will need to be tackled in marine protected areas, is bycatch in the longline fishery sector (Genovart et al., 2017). Longline bycatch mortality has high population-level impacts, responsible for the mortality of 28% of adult Scopoli's Shearwater and 23% of adult Audouin's Gull, as well as 90% of immature gulls (Genovart et al., 2017). As such, shearwaters have the highest extinction risk under

current mortality rates and require urgent conservation actions to ensure the viability of their populations. Other threats need to be addressed on a wider scale, going beyond the border of the protected areas, such as pollution control, fishery practises (overfishing, discard, etc.) and land-use planning (Gallo-Orsi, 2003; Oppel et al., 2018).

Lastly, management plans for the SPAs should also prescribe long-term monitoring of seabird populations and distribution in order to be able to adaptively manage the areas and revise management measures when appropriate. If necessary, these will also include restoration measures. The EU requires reporting for the Birds Directive every 6 years.

## Future considerations

The designation of mIBAs is a big step in highlighting important marine areas for globally threatened seabirds in Croatia. However, it should be noted that this project is the first of its kind in Croatia, and that future efforts are needed to comprehensively assess all likely areas of Croatian waters that may be identified as IBAs. Such efforts will ensure that sites critical for the persistence of species can be identified, and that these data can then contribute to necessary management plans. To achieve the comprehensive assessment, important follow-up steps to consider are:

1) Species tracking data from other parts of their distributional range in Croatia

The sites proposed in this report are based on seabirds which were tracked from colonies near Lastovo. While for the Audouin's Gull this area covers the majority of its breeding range in Croatia, this is not necessarily the case for both species of shearwater. Future tracking work should therefore also focus on individuals breeding on Sušac and Svetac (and possibly Palagruža, as explained below) to see if the currently designated sites are also representative for birds from these important colonies.

2) Improved censuses of known and potential breeding colonies

The seabird colony censuses carried out in the SPA Lastovsko otočje during the LIFE Artina Project, show that the former population estimate (Kapelj et al., 2018) of Yelkouan Shearwater especially (250-300 pairs), was an underestimate. It seems plausible that the same could be the case for the current estimates Yelkouan shearwater populations in SPA Pučinski otoci. This assumption is strengthened by the fact that calling Yelkouan Shearwaters have been recorded around Palagruža by automatic recording units (ARUs) installed by the LIFE Artina Project team. As the calls were recorded throughout the breeding season it seems very likely that the species breeds in the Palagruža archipelago, which was unknown until now. This indicates the need for more in-depth shearwater censuses in the SPA Pučinski otoci. Although the inaccessibility of some sites made it difficult before to carry out seabird censuses, new methodologies and (technological) developments should aid these efforts in the future to better map colony locations and assess populations numbers. It is important to note that given the IBA criteria threshold for the Vulnerable Yelkouan Shearwaters is 'only' 20 mature individuals, we do not expect further censuses to cause major changes to the layout or delineation of sites proposed in this report. Rather, improved knowledge – especially at other sites – will help us establish a comprehensive IBA network for seabirds in Croatia.

3) Data of other important seabird species

The proposed IBA sites in this report are focused on three target seabird species, but future efforts should also consider other seabird species breeding in Croatia, in particular the globally declining Mediterranean Shag (*Phalacrocorax aristotelis desmarestii*). The Adriatic is a stronghold for this

species and marine IBA sites have already been designated for the species in the Slovenian part of the sea (Koce, 2018). However, as Croatia holds around 20% of the entire Mediterranean breeding population (Sponza et al., 2013), it is important to identify important sea areas for the species in Croatia as well.

Finally, besides designating IBAs, it is also important for future efforts to focus on reviewing the status of existing IBAs to see if they still meet the criteria. Good practise is to have this monitoring carried out every 8 to 12 years (contrary to every 6 years for SPAs, as mentioned earlier).

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