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ESTIMATING THE SIZE OF THE *LARUS MICHAHELLIS* J.F. NAUMANN, 1840 COLONY ON BERGEGGI ISLAND (LIGURIA, NW ITALY) DURING THE BREEDING SEASON 2024 USING THE DOUBLE-OBSERVER METHOD

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ABSTRACT
This work aims to apply the double-observer method to estimate the number of nesting *Larus michahellis* in the Marine Protected Area of Bergeggi Island in the province of Savona (Liguria, NW Italy). The study was carried out in 2024, during the nesting period of the seagulls on the island. The double-dependent observer method was applied, carrying out two samplings per month from March to June, for a total of eight replicates. The monitoring consisted of dividing the island in three sectors, positioning a boat from a fixed point in front of the island and counting the seagulls that were perched. The data obtained were analysed using DOBSERV and processed through RStudio. The estimated average number of seagulls present on the island during the nesting period was 196.5 ± 53.6. High detection probability and the particular conformation of the study area led to a positive outcome for the application of the method to count the number of seagulls present during the nesting period.

KEY-WORDS: Detection probability, DOBSERV, population size estimation, western yellow-legged gull.

INTRODUCTION

The monitoring of gull colonies and breeding populations is typically based on counting active nests (Bibby et al., 2000), frequently through the use of strip-counting method. However, using the strip-counting method on gull colonies implies significant limitations: it requires multiple observers, whose experience may vary; it can disturb dense colonies, altering reproduction; and it assumes that all nests are detected, which is a strong and not always realistic assumption (Barbraud et al., 2014). The particular conformation of the study area, the presence of vegetation and very steep cliffs, makes this type of monitoring problematic, also preventing the detection of nests at a short distance, as already done by Barbraud & Gélinaud (2005) in some gulls' colonies in France. For this reason, the double-observer method was used to estimate the population size of *Larus michahellis* during the nesting period (Brichetti & Fracasso, 2006), by counting gulls and not nests. The method, originally developed for aerial surveys (Cook & Jacobson, 1979), is applied today to correct counts affected by imperfect detection biases when monitoring a species. Indeed, single observer counts tend to be incorrect due to both the ability of observer and the detectability of species, which could result in highly biased abundance estimates. However, with the double-observer approach, the overall probability of detection (i.e. the probability that a bird is

detected by at least one of the two observers) is usually very high (>0.95), allowing for more accurate estimates of bird abundance (Nichols et al., 2000).

MATERIAL AND METHODS

The study area includes the Island of Bergeggi, within the Protected Marine Area of the Island of Bergeggi (SV). The island is located between Bergeggi and Spotorno in the Province of Savona in front of Punta Maiolo (Liguria, NW Italy). Its surface area is 2.01 hectares and its perimeter is 632.6 metres. The island has an approximately triangular cross-section at the base and steep slopes; this characteristic has permitted it to be easily divided into three sectors for monitoring (Figure 1).

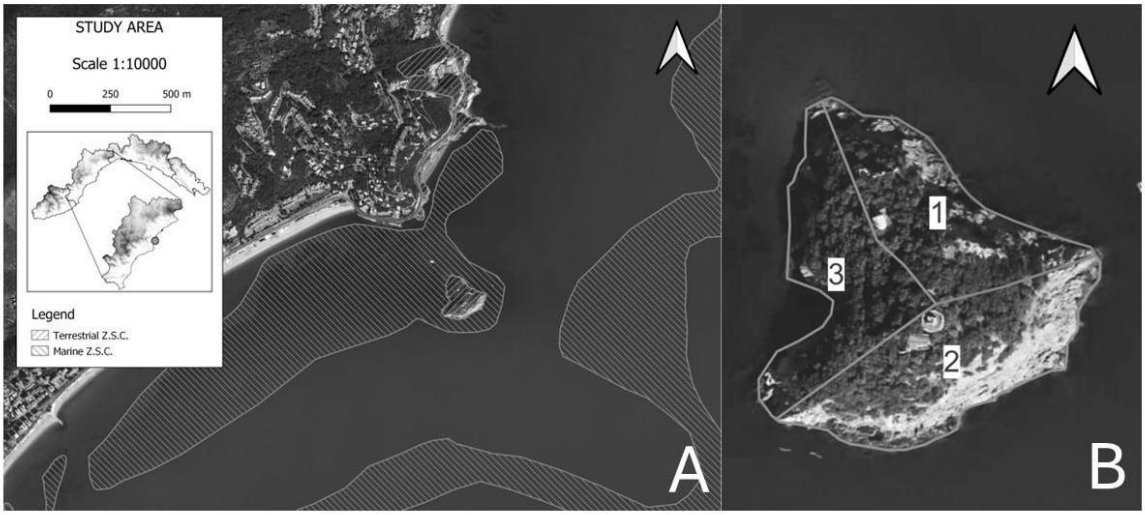

Figure 1. A: Study area, B: Island of Bergeggi and respective sectors.

The method selected for data collection is known as 'double-observer dependent' (Nichols et al., 2000). In this method two observers record data simultaneously, one designated as the primary observer and the other as the secondary observer. The primary observer reports all the individuals counted to a secondary observer who records the data. In addition, the secondary observer takes records of any gull that the primary observer failed to detect. Therefore, an individual could be detected: (i) by the primary observer; (ii) by the secondary observer but not by the primary observer; (iii) from neither observer. In the various replications, the observers alternated their roles for the correct application of the method. This method was chosen because the survey required reaching an observation point opposite the island using only one boat. As a result, the two observers sharing the same boat inevitably influenced each other. Furthermore, according to Forcey et al. (2006), the detection probability with the dependent double observer was higher than with the independent double observer for point counting. This method is easy to apply in this context since the observation radius is limited to the island and disagreements on identification are zero, because the target species can be identified without uncertainty. The monitoring was done in 2024 during the nesting period of this species on the Island of Bergeggi. Eight inspections were carried out with optimal weather and sea conditions. The count was carried out by positioning the boat at a point that allowed a view of an entire sector, being careful not to

get too close to the island to avoid making the seagulls fly away. Each sector was divided into areas by means of an imaginary grid to facilitate the counting of the gulls and the correct application of the method.

The obtained data were analysed using the DOBSERV software (Nichols et al., 2000), exploiting the option for dependent observers. This programme makes it possible to generate estimates of the probability of detection (*p*) through various models. Model selection was carried out using AIC values and the best model was that accounting for constant detection probability across observers. Based on the detection probability estimates and considering the observed gull numbers, the programme estimates the population size (N) for each survey. The data obtained through the DOBSERV software were analysed and processed in the R environment. From the results obtained, the 95 % confidence interval for the population size estimate (N) and detection probability (*p*) was calculated and plotted on graphs. Finally, the mean of N, together with the relative 95 % confidence interval, was calculated to obtain an overall estimate over the entire nesting period.

RESULTS

The results show a decreasing trend during the monitoring period (Figure 2), with a peak of observed gulls on late March and a minimum at the end of June. The confidence intervals are narrow with a maximum of 3.1 in mid-April. The overall detection probability is very high (Table 1), indicating that the species is easy to contact in the study context. The resulting estimated mean population size is 196.5 ± 53.6.

Table 1. Estimates for population size (N) and detection probability (p), together with 95% confidence intervals (CI) and standard error (SE).

Date	***N***			***P***		
	mean	**SE**	**95% CI**	**mean**	**SE**	**95% CI**
05/03/2024	245.4	0.7	1.3	0.9985	0.001	0.00196
21/03/2024	325.3	0.6	1.2	0.999	0.0007	0.001372
05/04/2024	221.6	0.9	1.7	0.9973	0.0017	0.003332
19/04/2024	150.6	1.6	3.1	0.9882	0.0061	0.011956
21/05/2024	155.2	0.6	1.2	0.9989	0.0007	0.001372
28/05/2024	155.1	0.3	0.5	0.9996	0.0005	0.00098
18/06/2024	180.0	0.1	0.2	1	0.0001	0.000196
29/06/2024	138.4	0.7	1.4	0.9971	0.0022	0.004312

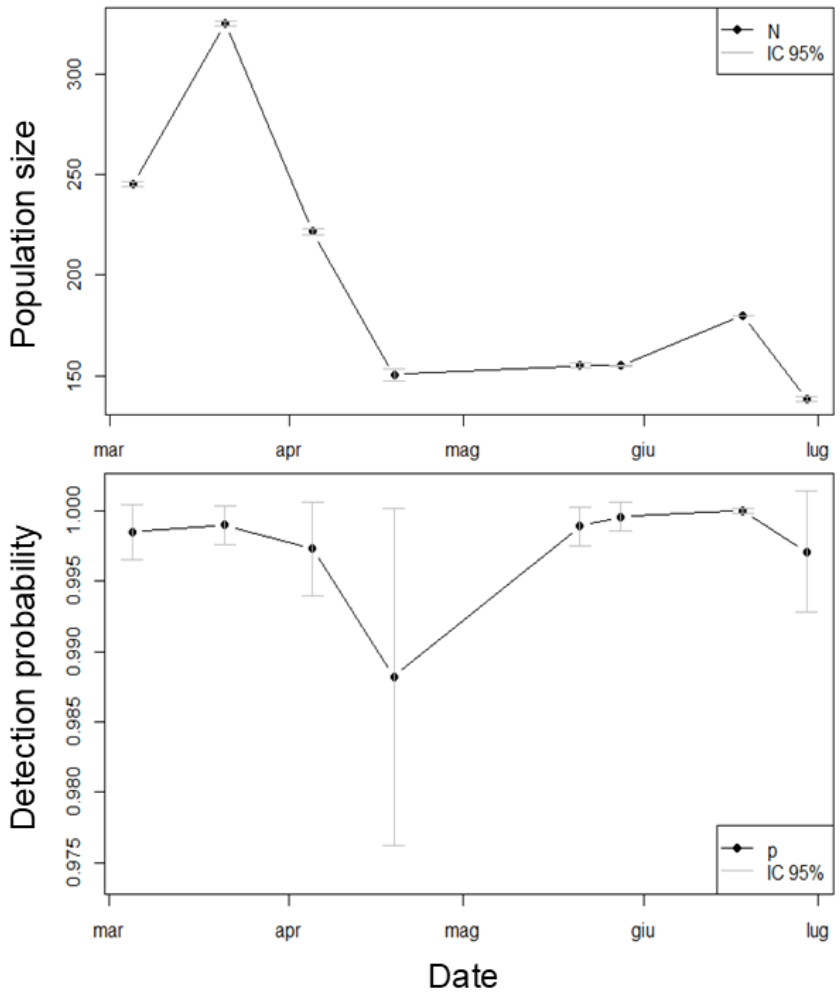

Figure 2. Trends of population size and detection probability during the study period.

DISCUSSION

The estimated population size of 196.5±53.6 can be considered comparable to what is known from previous studies for the Island of Bergeggi. In fact, Borgo et al. (1989), Ghiglia (2002) and Maurici (2015), respectively estimated the presence of around 100 and 103-148 breeding pairs on the island during three different monitoring periods (1988-89, 2001-02 and 2015). This estimation was based on the number of nests surveyed, both on land and at a distance from a boat. The results of the present study, based exclusively on the actual count of specimens perched from fixed observation points, and the relative confidence intervals, show that the gull population nesting on the Island of Bergeggi is now numerically similar to those surveyed during the above-mentioned research. The numerical decrease observed from March to late June in the present research could be directly linked to the greater difficulty of contacting the brooding birds, depending on the nest location, which could be often hidden in the vegetation. This factor could represent a limitation of the method applied, but the high detection probability and the high number of replicates, carried out during the entire nesting period, led to a wide confidence interval

associated with the mean. This suggests that the apparent decrease in gull numbers is related to the more secretive behavior of the species while nesting.

The easy application of the double-observer method, the low sampling effort together with the very limited disturbance of animals, and the high detection probability found in all replicates, makes this type of monitoring very effective in this environmental context. For this reason, the method will be employed in the coming years for carrying out a population monitoring over the long term.

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