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A widespread gull population in a complex wetland: habitat specific methods to census breeding pairs

Cecilia Soldatini[1], Yuri Vladimir Albores-Barajas[2], Danilo Mainardi[1], Patrizia Torricelli[1]

[1] Department of Environmental Sciences, University Ca' Foscari, Campo della Celestia - Castello 2737/B, 30122 Venice, Italy (cecil@unive.it)

[2] Department of Ecology and Evolutionary Biology, University of Glasgow, Graham Kerr Bd. University of Glasgow - Glasgow G12 8QQ, UK

Abstract – The Mediterranean Yellow-legged Gull, *Larus michahellis michahellis* (Naumann 1840), has recently increased in numbers and begun to settle in urban habitat and nest on roofs. Gulls nesting on buildings are a common sight in coastal areas of Europe and North America. We censused a population of Mediterranean gulls in the city of Venice and its natural surroundings. The aim of this paper is to introduce and describe techniques to count and estimate population numbers in various habitats. In natural environments, an aerial survey can be used to identify Yellow-legged gull colonies and to count breeding pairs. In urban environments, however, different census techniques are needed in order to give a complete description of the gull population. We counted and monitored the urban breeding population by applying direct counting techniques from fixed observation points. By integrating different methods, we were able to describe the wintering and breeding populations of Yellow-legged Gull in the largest Italian wetland system. In recent times gull populations of some species have undergone a remarkable increase. The Mediterranean Yellow-legged Gull, *Larus michahellis michahellis* (Naumann 1840), is the protagonist of a recent phenomenon of general demographic increase and the settlement into urban habitat and roof nesting in many European coastal cities. The environmental problems caused by superabundant animal species, particularly "bird pests" have become increasingly acute during the past decades (Feare 1991). In particular, gulls are often found to be superabundant due to their adaptable, opportunistic and gregarious nature which makes them highly adapted to live in human-modified habitats. Owing to their high ecological adaptability, their competitive behavior and their abundance, gulls are often considered pests (Vidal *et al.* 1998). Some close relatives of this species, such as the herring gull, *Larus argentatus*, and the black-backed gull, *Larus fuscus*, started settling into towns in the 1950's (Goethe 1960). Since then gulls nesting on buildings are a common sight in coastal and, more recently, inland areas of Europe (Monaghan and Coulson 1977, Vincent 1987) and North America (Vermeer *et al.* 1988). Usually nesting gulls cause disturbance to the inhabitants of buildings due to noise, fouling and the aggression of adult gulls in defense of their young, and can also damage the façade of the building. Consequently, the spread of gulls into urban areas is a matter of growing concern and thus it is necessary to monitor population numbers and distribution. We studied the Yellow-legged Gull population in the Venice lagoon in order to monitor the population in and around the city of Venice. As city habitat is different than natural habitat, we developed a habitat-specific counting system with various existing methods. In many cases study areas are heterogeneous, e.g. consist of various habitats and so it is necessary to choose the right counting technique for each of these habitats and circumstances to perform wildlife counts. In particular this is the case of the Yellow-legged Gull in the Venice lagoon, where estimates have been done based on partial surveys but a complete description of the population is still lacking due to the extent of the lagoon, the complex habitat composition and the difficult access to some private areas. Thus, it is necessary to use an integrative approach to study the Yellow-legged Gull in the Venice lagoon. We censused both the urban and the natural Yellow-legged Gull populations living in the Venice lagoon, combining multiple census techniques in order to obtain a complex but realistic overview of the species' population present in the lagoon.

STUDY AREA AND METHODS

The complex lagoon system hosting the city of Venice, Italy, is composed of partially enclosed areas and open, tidal areas characterized by mudflats and a multitude of small islands. The lagoon of Venice (about 58000 hectares) is the widest wetland of North Adriatic Sea coast, with the city of Venice lying in the heart of the lagoon. The basin boundaries are a coastal cordon in the East side that goes from the mouth of the river Sile in the northeast to the mouth of the river Brenta in the southwest, and is separated from inland waters by numerous canals. The basin depth is highly variable: the port's mouth and main canals are about 15-20 meters deep, sheets of water are about 1-3 meters deep, and in areas locally named "velme" and "barene" depth varies from a few centimeters to emergent lands with halophilic vegetation. We find in that area the greater tide drift of the Mediterranean Sea. About 1/6 of

the whole area is separated from the lagoon by sturdy embankments, those limited basins are called "valli da pesca", where extensive fishery is practiced.

Gulls wintering in the Venice lagoon and in the urban area
We first analyzed the wintering population of gulls by reviewing the International Waterfowl Census (IWC) results. These census are conducted each January throughout the Palearctic with the aim of estimating the population sizes of waterbirds (Rose and Scott 1997). The censuses are coordinated by Wetland International and, at a local level, by the National Institute for Wild Fauna (INFS). Wintering waterfowl censuses have been conducted in the Venice lagoon area since 1993. The use of a standardized methodology has allowed the comparison of results at different scales (Rose and Scott 1997, Baccetti *et al.* 2002). After a critical review of the dataset we decided not to take into account the first three years (1993-95) because gull presence was not always recorded correctly. We therefore analyzed Yellow-legged Gull data from wintering waterfowl census surveys in the lagoon of Venice from 1996 to 2001 (Baccetti *et al.* 2002) and, in addition, analyzed unpublished data from 2002 to 2005 (Hunting and Fishing Office of the Province of Venice, unpublished).

The whole Lagoon of Venice was studied, including coasts and sea up to three kilometers offshore. The surface is subdivided in 44 territorial units or "census survey units" (Baccetti and Serra 1994). Surveys were always conducted in a three day period in mid January. Surveys were timed to correspond to the days with the highest tides, in order to easily count waders concentrated in smaller areas. Expert counters, certificated by the National Institute for Wild Fauna, were supported by learning counters and were divided into ten teams of 2-4 people that usually moved by car, boat or plane. The airplane was used to survey the sea far from the coast.

Unfortunately, the gulls' high mobility, and the directions of their movements towards mainland and sea, made it difficult to accurately estimate the total population. In the last three years, we considered in detail gulls counted in refuse dump areas and urban refuses collecting and stocking sites in the central part of the lagoon (Fusina and Sacca San Biagio Island).

Regarding Venice, as the urban area is considered a sub-unit of the whole wetland, IWC VE0923 (Baccetti and Serra 1994), we analyzed the same data as for the lagoon.

Gulls breeding in the Venice lagoon
Since the 1980s, complete censuses of Yellow-legged Gull breeding colonies in the Venice lagoon have been attempted (Scarton *et al.* 2000, Bon *et al.* 2004) with the aim of estimating the breeding population in the whole wetland. But, due to its environmental characteristics, these censuses were only partial and incomplete, and the total population estimate has been mathematically extrapolated. We decided to use a different approach, completing an aerial census in order to have a trustworthy estimate of the breeding population. This method has been extensively used in wetlands to count waterfowl (Tamisier and Dehorter 1999), but had never been employed in Italy to census breeding gulls.

Aerial surveys have been used to identify gull colonies in natural environments and thus to count breeding pairs (Dolbeer *et al.* 1997). This method is useful with regards to the peculiarities of the wetland area. Access to the wetland is very difficult. Studying the entire lagoon by boat or on foot would have been prohibitively time consuming and logistically complicated. In such cases a plane survey provides an assessment of bird populations in a few hours (Bibby *et al.* 2000). We used a high-wing ultra light amphibian plane. This kind of plane is the best to use in such surveys, as high wing allows a good visibility and the possibility of water-landing makes the survey safer and allows access to colonies when needed.

The aerial surveys coincided with peak incubation and early hatching. During two days in April 2003, a total of 16 flight-hours were completed. The whole lagoon was surveyed, including enclosed areas, "valli da pesca." The area was divided in two sections (North and South Lagoon) that were censused by flying over all mudflats and islands, proceeding on north-to-south transects from the west part of the lagoon towards the east border. The plane flew at an altitude of 30-40m and a speed of 80 km/h. Data were recorded directly on a map. Counting has been conducted by deduction (observing gulls brooding) or by direct vision of nest (occasionally, because nests and chicks are extremely mimetic). At least one of the parents is always on the nest once chicks have hatched (Bosch and Sol 1998). When the plane approached, brooding gulls stood on the nest (probably to protect it), while other individuals flew away. This behavior allowed us to distinguish between incubating and non-incubating individuals. Where nest density was high, counts were made twice in order to reduce errors. Surfaces and related densities of nests (number of nests/ha) were calculated on the basis of a digital map of natural islands ("barene") using GIS (ArcView 3.2).

Although in our census we considered the whole lagoon area, bird movements and the presence of a few highly vegetated areas are factors that may bias our estimate of the population size, since it does not take into account bird detectability. However, this bias could be adjusted by using an appropriate correction factor (*CF*) estimated by

means of a double sampling procedure, i.e. by surveying a sub-sample of chosen units using a different, "intensive" survey method, usually direct nest counts. Though highly accurate, this method is also costly and time consuming. Interestingly, the few studies which estimated *CF* using this procedure produced quite consistent results, leading the authors to propose multiplying the results of aerial surveys by *CF*=1.04 in order to obtain a realistic estimate of the population size (Dolbeer *et al.* 1997). Thus we used this correction factor for a good estimate of the population breeding in the lagoon of Venice.

Gulls breeding on Venice's rooftops

Urban surveys were conducted in three breeding seasons (2003, 2004 and 2005). Starting in the last week of March and ending when all chicks fledged (usually second part of June), we conducted weekly surveys, reporting rearing phases of all visible nests from three observation points in the city and of the rooftop nests at the cemetery. The three observation points were: car-parking building in Piazzale Roma (east side of Venice), San Marco's bell tower (southwest side of Venice) and San Francesco della Vigna bell tower (northwest side of Venice) (respectively 1-2 and 3 in Fig. 3). During each survey, nest location (both potential or certain) was noted directly on a map and in a notebook, in relation to reference points like bell towers and particular architectural structures. In subsequent surveys, it was possible to verify and update previous observations. In many cases it was impossible to see the nest directly, but the behavior of the parents and, later, chick movements and traces (faeces) led us to locate the nest position. As the architecture of Venice is quite complex, it proved to be difficult to locate all the nests, but we can say that the ones monitored are a part, certainly important, of the rooftop colony in Venice.

RESULTS

Wintering gulls in the Venice lagoon and in the urban area

The long term data we obtained from the wintering waterbird census surveys (IWC), allowed us to describe the gull population wintering in the Venice lagoon (Fig. 1). During the whole period of 10 years an average number of 11865 ± 2872.7 Yellow-legged Gulls (max 16323 in 2000 - min 6438 in 1996) were counted in the lagoon of Venice, and an average number of 1137 ± 555.5 Yellow-legged Gulls (max 1810 in 2003 - min 227 in 1997) in the urban area. Results of the complete surveys of the lagoon and the Venice urban area are significantly correlated ($r = 0.577$, $P = 0.050$). In both cases, a regression with time is not significant; thus, it is not possible to point out a trend (Venice $r^2 = 0.368$ $F_{1,8} = 4.649$, $P = 0.063$; lagoon of Venice $r^2 = 0.014$ $F_{1,8} = 0{,}116$ $P = 0.742$). This means that the population, although affected by fluctuations during the considered period, is relatively stable.

Breeding gulls in the lagoon of Venice

Aerial census results provided more information than expected. We mapped colonies of different sizes throughout the Venice lagoon (Fig. 2) We also counted nests, making it possible to estimate the nest density for each colony. The total number of colonies counted was 101 (we considered separate colonies on different islands although very close, less than 100m), 72 in the northern part of the lagoon (considering Venice in the middle, but not included) and 29 in the southern part of the lagoon. The total number of nests counted was 2,977 (1,007 in the northern part and 1,970 in the southern part). We estimated that there were 6,192 breeding individuals (5954 x *CF*, where *CF*=1.04). The mean number of nests per colony was 35.11, but colonies were smaller in the northern than in the southern la-

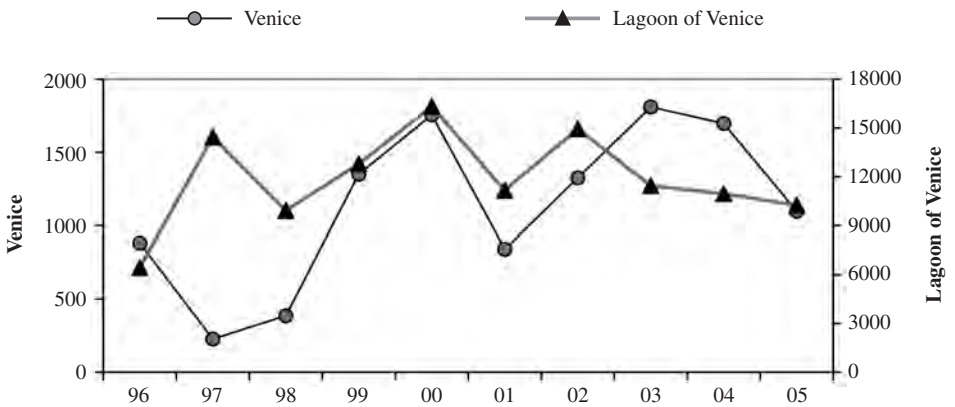

Figure 1. Population development for wintering gulls counted in the urban area (Venice) and in the surrounding lagoon since 1996.

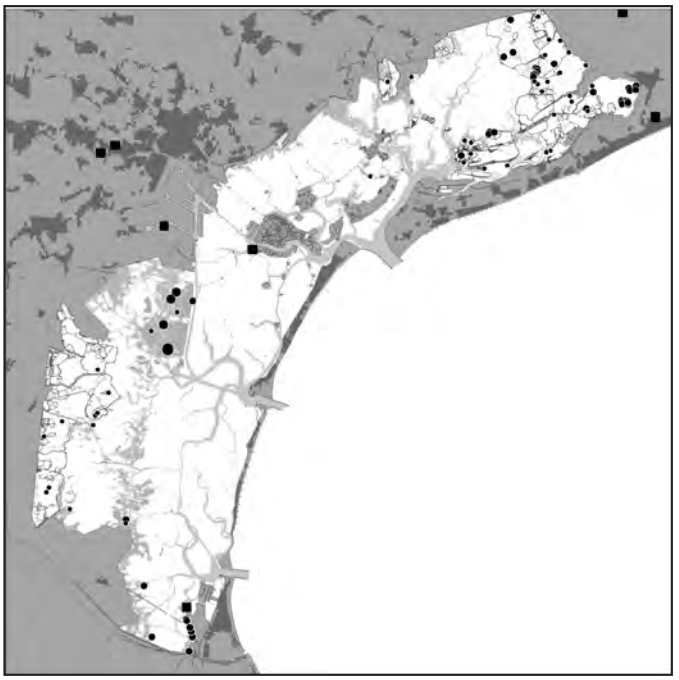

Figure 2. Results of the complete aerial survey of the lagoon. Dots indicate colony position. Small dots indicate colonies with less than 20 nests, medium dots refer to colonies between 21 and 100 nests and larger dots to colonies with more than 100 nests. Squares indicates the refuse tips present in the area.

goon (mean number of nests per colony: North = 13.9; South = 67.9). The total surface occupied by gull colonies was 548 ha, with an average density of 5.43 nests per hectare. The majority of the breeding sites were in the southern part of the lagoon (66.2% of nests). In this portion of the lagoon, colonies are wider: there are two artificial islands ("Casse di Colmata") where there are larger colonies. They are not uniformly occupied because they are composed by several kind of habitats (from forest to sandy beaches): occupied areas are mainly the boundaries of the forests where vegetation is typically halophilic. In general, the type of habitat preferred for gull colonies was "barene" (islands occasionally submerged during high tide) where vegetation cover can be sparse or abundant. Halophilic species typically present there are: *Arthrocnemum fruticosum*, *Halimione purtulacoides*, and mesophilous grass, *Calamagrostis epigeios* (Cattaneo *et al.* 2001).

Gulls breeding on Venice's roof tops

Surveys from bell towers in 2003-2004 and 2005 have shown that the colony is stable. We counted 22 nests in 2003, 25 (plus 8 supposed) in 2004 and 24 (plus 11 supposed) in 2005 (Fig. 3). The nest sites are always the same (95%), with some exception, and are sparsely distributed, as typical for "new" colonies. Nests are usually built using natural material, and are situated on flat surfaces preferably exposed to the south and protected from north winds, which are particularly strong in the region.

DISCUSSION

We described the wintering and breeding populations of Yellow-legged gulls in the Venetian lagoon and in the Venice urban environment based on long term data and on recent surveys. Fluctuations observed in the results of winter counts may be partially due to census errors, but are mainly explained by gull's high mobility through mainland, making the species difficult to count. Alternatively, there may also be a different mortality rate or, on a smaller scale, variable immigration-emigration rates due to food availability and distribution (Jokimäki and Suhonen 1998), influencing the census results. As an example, the average gull presence registered in the refuse dumps during IWC is 66% of the gulls counted in the middle lagoon of Venice (IWC VE0923). This means that spatially concentrated attractive resources may strongly influence survey results. The estimate of the breeding population (6,192 ind.), although not comparable with any other previous surveys due to different methods used (Scarton *et al.* 2000), is a

Figure 3. Urban nest locations as result of census and monitoring surveys from conspicuous points (1: Garage building in P. Roma, 2: San Marco bell tower, 3: San Francesco della Vigna bell tower).

more realistic figure of the situation. The lagoon hosts an important population of this species, meaning that the natural environment and, in addition, the urban environment, can support such a population. As some suitable areas for nesting has not been occupied yet, this gull population could continue increasing, as has been observed in other coastal systems throughout the range of the Yellow-legged Gull (Vidal *et al.* 1998). We mapped all gull sub-colonies present in the lagoon in 2003, obtaining a good estimate of the breeding population (see also Soldatini 2005). The aerial survey is an adequate method for this purpose and particularly efficient in such a heterogeneous system. Incubating gull's behaviour helped detecting nests number and distribution from the plane, while on a land survey it would have been the opposite resulting in time consuming search for the nests in the vegetation. Unfortunately, we did not have the opportunity to repeat the aerial survey, which could be a valuable way to track the dynamics of the gull population. It would also be interesting to repeat the survey in order to quantify the error affecting aerial counting and to propose a *CF* for this kind of wetland environment.

The urban population, monitored and mapped in a three year period, at present is just a small portion (1.03%) of the Yellow-legged Gull population breeding in the Venice lagoon. The overall increasing trend of the species in natural and urban environment (Vidal *et al.* 1998, and references therein) and, at local scale, the increasing trend of the lagoon breeding population, (Bon *et al.* 2004) lead us to assume that the number of urban breeding gulls is also increasing. This prediction is supported by the recent appearance of urban colonies in other Italian coastal cities (Cignini e Zapparoli 1996, Benussi and Bembich 1998). Regarding nest site choice, comparing observations made in Rome, Trieste, Livorno and Venice (Dinetti 1994, Cignini e Zapparoli 1996, Benussi and Bembich 1998, present paper), we agree that gulls prefer tile roofs and are moving to this kind of nesting sites even if flat roofs are available. In all urban colonies, gulls commonly exploit wastes, a resource that may be attracting gulls to urban nesting sites (Soldatini *et al.* 2005). We observed large numbers of "non-urban-breeder" adults that frequented city habitat only for feeding and roosting. "Non-urban-breeders" reacted quite aggressively when nests were threatened. This phenomenon leads us to postulate that breeders may choose nesting sites according to at least three characteristics: physical characteristics of the site, proximity and accessibility of feeding sites, and the protection of the site due to gulls already frequenting the area (Soldatini 2005, Soldatini *et al.*, 2008). The cities also offer new preys: gulls have adapted to predate pigeons and, more recently, swifts and starlings (C. Soldatini *pers.obs.*). Based on the literature and recent surveys, it appears that most gull colonies in Italy begin at a small size, with a few pairs of gulls for an average of 15 years, and after that a sharp increase is usually recorded. This trend may be predictable in Venice too, if no remarkable measures are taken.

From the management point of view, culling strategies extensively applied on herring gulls in Britain (Duncan 1978, Coulson *et al.* 1982), and in smaller measure attempted in Italy, have not been effective at reducing gull

populations (Rock 2005). More effort should be focused on reducing fundamental ecological resources such as breeding grounds and in particular anthropogenic food resources, which are thought to be important factors underlying gull colony maintenance and growth (Rock 2005, Soldatini *et al.* 2005). Indeed, in the Venice lagoon and in the urban area, waste food can be considered one of the main food resources for Yellow-legged gulls; therefore, a management program should consider as a fundamental goal preventing gulls from accessing tips, urban refuses in the street and vegetable and fish market discards.

The methods here presented resulted to be adequate to figure out the abundance and distribution of yellow-legged Gulls in the Venice lagoon system, that includes natural and urban habitats. These methods can also be applied on other wetland systems. They can be useful to monitor population changes of the gull population if they are systematically repeated over time in order to describe population trends and to adopt adequate management measures where needed.

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