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Yellow legged gulls' diet and foraging locations

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Abstract

The importance of anthropogenic food in the diet of the yellow legged gull, *Larus michahellis (Naumann 1840)*, breeding in the lagoon of Venice has been evaluated by the analysis of the pellets. Pellets have been collected in pre-breeding roosts close to a sub-colony in the lagoon of Venice, while during the breeding period pellets were randomly collected around the nests. Elements frequency in pellets has been recorded and classified according to pre-defined categories. This method allowed to classify elements and to operate a volumetric analysis. Biomass of the elements constituting the pellets has not been estimated due to the bias between food remains in relation to mass, volume and ease of detection. The main foraging habitats used have been identified (according to the frequencies of items and their presumed origin) and the number of foraging habitats used together from items appearing in the pellets simultaneously. We found a constant but not preponderant use of refuse tips as a foraging habitat, most probably because they represent a predictable and abundant source of food.

Key words: Yellow-legged gull; *Larus michahellis*; foraging habitat; refuse tip; chick diet

1. Introduction

One explanation of the trend towards the increasing numbers of large gulls over recent decades is the sharp increase in availability of food derived from human activities, particularly refuse dumping and trawling (Bosch *et al.* 1994; Oro *et al.* 1995). Refuse tips and fisheries waste are often considered the main food resources for gulls since they are highly predictable, renewed daily and locally abundant, which minimizes energy expenditure and foraging time (Belant *et al.* 1993; Garthe *et al.* 1996). Yellow legged gulls are known to be opportunistic feeders with a wide trophic niche, and are able to use both agricultural and natural habitats where they find plant foods and animal prey (Witt *et al.* 1981; Bosh *et al.* 1994). Bosh *et al.* (1994) focused on yellow legged gull diet in order to evaluate the influence of anthropogenic food availability on gulls' reproductive success and the growth and distribution of their colonies. They suggested that differing availability of anthropogenic food sources could bring about different growth patterns in gull breeding colonies and thus limit their growth.

For this reason, and in order to describe the importance of anthropogenic food in the diet of breeding birds and their chicks, we studied the diet of yellow legged gulls breeding in the lagoon of Venice in 2004 and 2005.

The study colonies were located in Cassa di Colmata D/E and Venice city both at short flight distance from the refuse tip areas and urban refuse collection and stocking sites in the central part of the

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lagoon (Fusina, respectively 4km and 8km, and Sacca San Biagio Island, respectively 10km and <1km). We concentrated on the pre-breeding period and the breeding period. Pre-breeding adult's gull diet is particularly important because at this time the foraging ability of the breeders strongly influences their subsequent reproductive success (Boltom, 1991; Hiom *et al.* 1991, Oro *et al.* 1999). We also analysed chick diet in the pre-fledging period in order to evaluate parents' choice in feeding chicks and to compare the results with other studies on the same species (Bosh *et al.* 1994).

2. Methods

We studied adult diet composition during the breeding seasons in 2004 and 2005, and chick diet composition in 2005, which provides a good indication of food provided by adults (Bosh *et al.* 1994). We selected a sample sub-colony in Cassa di Colmata D/E and collected pellets regurgitated in the pre-breeding and breeding periods. At this time of the year, only breeding adults were present on the sampling sites, ensuring that the pellets sampled were representative of the diet of breeding adults (Ruiz *et al.* 1996). We collected only fresh pellets, to ensure that they were from the pre-breeding period excluding old pellets from the previous period (Ewins *et al.* 1994). During the pre-breeding period (March) we collected adult's pellets at pre-breeding roosts close to the sample colony (23 in 2004 and 92 in 2005), while during the breeding period (April-May) pellets were randomly collected around the nests (39 in 2004 and 120 in 2005). In 2005 we analysed chicks' regurgitates from the same natural colony and also from the urban one in Venice itself. It was generally not possible to distinguish the elements of regurgitates by observation. However chicks, when handled for measuring or ringing, regurgitated undigested food. As in the case of adults' pellets, these regurgitates were collected and preserved frozen until identification in the laboratory. For logistic reasons, it is difficult to collect adult pellets on roof tops, and we did not obtain pellets for the urban colony. We assumed that due to the proximity of the urban colony to the natural one and to refuse tips, the composition of the adult diet is likely to be very similar to that of gulls from the natural colony.

Samples were collected, frozen, stored and analysed using the same method. We assumed there was low interannual variability in the diet since the number and location of refuse tips and the main fishing fleet did not change between years.

We used a binocular microscope to examine pellets. Food items, once identified, were classified according to pre-established categories and then attributed to their probable environmental origin (Duhem *et al.* 2003). In our study we identified four foraging habitats used by gulls, two natural habitats (lagoon and vegetated habitats) and two anthropogenic habitats (refuse tips and fishery vessels/markets).

Refuse tip foraging produces abundant and readily detectable inorganic elements, whereas soft-bodied prey consumption produces a limited number of small remains within pellets. Moreover refuse foraging produces a higher number of pellets than fish consumption (Votier *et al.* 2001). Due to the bias between food remains in relation to mass, volume and ease of detection, the assessment of prey biomass per origin was impossible (Duhem *et al.* 2003). Thus we used a qualitative approach: we classified each item into one of 10 categories and we determined for each of those the main original foraging habitat (grouped in the above mentioned four classes, see Table 2) (Table 1). The 10 categories are: 1. inorganic (glass, paper, plastic, *etc*..), 2. shallow water crustacean (ex: decapoda, C*arcinus*), 3. deep water crustacean (ex: decapoda, *Nephrops*), 4. shells (ex: mytiloida, *Myitilus*, veneroida, *Eusis, Natica scoploi*, neotaenioglossa, *Bittium*), 5. food waste, 6. small and medium size mammals and birds (ex: *Crocidura suavelens, Neomys anomalus, Oryctolagus cuniculus*, passerines), 7. small - shallow water fish and molluscs (ex: Mugilidae, *Sepia officinalis*), 8. large size - deep water fish (ex: *Bothus podas podas, Zeus faber*), 9. insects (ex: coleoptera, diptera), 10. plant fibres and unidentified items. In the lagoon, average fish size is smaller than at sea (because of the function of the lagoon as a nursery area) and thus most small fish came from the lagoon habitat, larger deeper water fish and crustaceans will have been obtained as waste food or from fishing vessels. We considered plant fibres in the same way as inorganic elements, because even if probably not directly chosen as food, they tell us about foraging sites as they are likely to have been ingested together with insects or other prey in the terrestrial habitat.

To assess the relevance of each category of items in the diet (either with category or foraging habitat grouping) we used three descriptors (Bosh *et al.* 1994): item number (N), numeric percentage (%N) and percentage of occurrence (%P).

We also identified the main foraging habitats used (according to the frequencies of items and their presumed origin) and the number of foraging habitats used together from items appearing in the pellets simultaneously (Table 3) (Duhem *et al.* 2003). Using this last variable, we calculated the mean diet diversity for each breeding season.

3. Results

The percentage of pellets that contained each of the 10 categories did not vary significantly between the two breeding seasons studied (Wilcoxon matched pairs, Z=-0.445 p=0.657) suggesting a relatively stable use of foraging resources. In both years, the most abundant category recorded was inorganic waste and food waste, but in 2005 we observed an apparent increase in the use of refuse tips as foraging habitat (χ^2_3=41.941 p<0.01; Table 2). Comparing the pre-breeding breeding periods we observed no significant differences in the percentage of pellets containing the 10 diet-categories in 2004 (2004: Wilcoxon matched pairs, Z=-1.511 p=0.131) while in 2005 we observed a higher occurrence of elements from refuse tips in the pre-breeding season (Wilcoxon matched pairs, Z=-2.223 p=0.026). Foraging habitats, too, remained the same for the whole breeding season (p>0.05 in all cases). But comparing, year by year, the individual parts of the seasons, although the overall occurrence of items was apparently unchanged in the pellets (Wilcoxon matched pairs, pre-breeding period: Z=-1.334 p=0.182; breeding period: Z=-0.711 p=0.477), we observed in both periods an increase in food waste and inorganic material. This was also significant in terms of foraging habitats (pre-breeding period: χ^2_3=12.614 p<0.01; brooding period: χ^2_3=31.571 p<0.01).

Although the chick regurgitate sample was smaller than the adult pellets sample, we considered it representative because it was confirmed by direct observations of parents feeding chicks with prey of natural origin (either fish, crustacean and birds, mainly pigeons in urban environment). There was an almost absence of anthropogenic food sources in the chicks regurgitates, even though this kind of food was well represented in the adult pellets suggest that adults do not feed the food they obtain at dumps to their chicks (Table 4 and Figure 1).

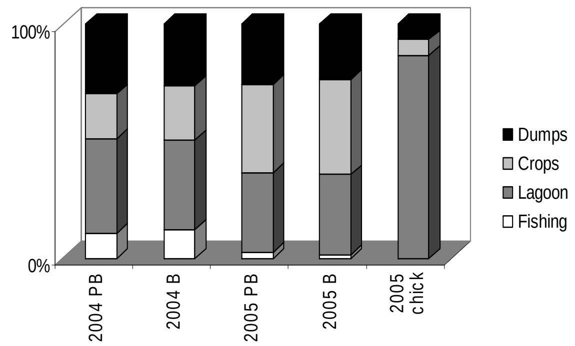

Fig. 1. Percentage of main foraging habitat use in pre-breeding periods (PB) and brooding (B) periods by breeders and their choice of food resources during chick rearing period (2005 chick) as indicated by the dietary analysis.

4. Discussion

Yellow legged gulls showed a generalist and opportunistic diet in the whole period of study. Comparing our results with other recent studies the species appears to occupy essentially the same ecological niche in different parts of its distribution area, and the same as the Herring gull in the northern European areas. Yellow legged gulls seem to make extensive use of anthropogenic food, such as garbage or fishing activities.

As expected, the composition of pellets was heavily influenced by the presence of inorganic elements and by their low digestibility. Nonetheless, comparison between and within breeding seasons outlined some differences in diet composition, and consequently in foraging habitats used.

We found a constant but not preponderant use of refuse tips as a foraging habitat, most probably because they represent a predictable and abundant source of food. In fact, in most cases pellets showed evidence of more than two foraging habitats being used. In our analysis we found that foraging habitats used by gulls involved both natural and anthropogenic, and these were probably very close to the colony. This may be maintained throughout the year, as wintering gull census results suggest (see par. 9.2.1). In 2005 most of pellets were composed of elements from three different foraging habitats. As observed by Duhem (2003) this demonstrates some ecological plasticity and dietary opportunism already exhibited by other expanding larids, such as the Herring gull (Pierotti & Annett, 1991).

Distribution of anthropogenic food resources may also influence the location of colonies, as Fig. 9.6 suggests. In fact, we observed a higher concentration of gull colonies in the proximity of refuse tips and other garbage resources (as the urban colony of Venice), suggesting that even if not essential for population survival food waste, is a useful supplement in the gulls' diet and likely to play a role in the growth of colonies. Chick diet appears to be still independent of garbage resources as the lagoon probably offers good quantities of natural food, probably closer to the colonies and is also probable that it is difficult for chicks to digest this anthropogenic kind of food. However higher densities of breeding gulls may lead to a higher exploitation of this resource even for the rearing of chicks, as observed in the south of France and in Spain (Bosh *et al.* 1994; Duhem *et al.* 2003).

Table 1

Diet of adult yellow legged gulls from the lagoon of Venice (N= number of prey; N%= percentage of total number of items identified; P%= percentage of pellets containing this item).

			2004			2005		
Categories	*Origin*[a]	*Foraging habitat*[b]	N	N%	P%	N	N%	P%
Inorganic (glass. paper. plastic)	A	(T,L)	39	22.03	62.90	142	22.65	67.30
Shallow water crustacean	N	(L)	17	9.60	27.42	59	9.41	27.96
Deep water crustacean	A	(T,F)	4	2.26	6.45	3	0.48	1.42
Shell food	N	(L)	17	9.60	27.42	57	9.09	27.01
Waste food	A	(T)	3	1.69	4.84	27	4.31	12.80
small and medium size mammals. birds	N	(L,C)	18	10.17	29.03	95	15.15	45.02
shallow water fish	N	(L)	8	4.52	12.90	26	4.15	12.32
deep water fish	A	(F)	14	7.91	22.58	11	1.75	5.21
insects	N	(C,L)	6	3.39	9.68	59	9.41	27.96
Plant fibres	N	(C,L)	28	15.82	45.16	147	23.44	69.67
not ident.			23	12.99	37.10	1	0.16	0.47

[a] A= anthropogenic, N= natural.

[b] T= refuse tip, F= fishing activities, L= lagoon, C= crops.

Table 2

Foraging sites utilised in 2004 and 2005 breeding seasons (N= number of prey; N%= percentage of total number of items identified).

			2004		2005	
Foraging habitat	*Origin*[1]	*Foraging habitat*[2]	N	N%	N	N%
Tips	A	T	42	23.73	169	26.95
Fishing Vessels/Market	A	F	18	10.17	14	2.23
Lagoon	N	L	60	33.90	237	37.80
Crops	N	C	34	19.21	268	42.74

[a] A= anthropogenic, N= natural.

[b] T= refuse tip, F= fishing activities, L= lagoon, C= crops.

Table 3

Diet of the yellow legged gull breeding adults in the laggon of Venice and their chicks (main foraging habitat and diversity in foraging habitats).

	Main foraging habitat (% of pellets)				
sample	No. Of pellets	Dumps	Fishing act.	Lagoon	Crops
breeders 2004	62	23.7	10.2	33.9	19.2
breeders 2005	211	26.954	2.2329	37.799	42.74
chicks 2005	13	6.25	0	81.25	6.25

Table 4

Number of foraging habitats recognizable in each pellet.

	Number of foraging habitats (% of pellets)				
sample	1	2	3	4	Mean diet diversity
breeders 2004	14.5	45.2	27.4	11.3	0.877
breeders 2005	19.4	33.2	45.0	2.4	0.733
chicks 2005	92.3	8	0	0	0.292

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