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Diet and adult time budgets of Audouin's Gull *Larus audouinii* in response to changes in commercial fisheries

D. ORO[1,*], X. RUIZ[1], L. JOVER[2], V. PEDROCCHI[1] & J. GONZÁLEZ-SOLÍS[1]
[1] *Departament de Biologia Animal, Vertebrats, Diagonal 645, 08028 Barcelona, Spain*
[2] *Departament de Salut Pública (Bioestadística), Facultat de Medicina, Diagonal s/n, 08028 Barcelona, Spain*

The diet and feeding ecology of breeding Audouin's Gull *Larus audouinii* were examined at the Ebro Delta (NW Mediterranean) during 1993, 1994 and 1995 and found to depend on the activity of the commercial fisheries operating within the foraging range of the birds in the colony. One of the largest fishing fleets in the Mediterranean operates in this area, both diurnal inshore trawlers and nocturnal purse-seine boats. Since 1991, a trawler moratorium has coincided with the breeding season of the gull, which has affected its feeding ecology in the area. Data were collected under four commercial fishing regimes: diurnal trawling only, diurnal trawling and purse-seine fishing at night, night fishing only, and no fishing. Although Audouin's Gull usually feeds mainly on epipelagic fish (65% by biomass on average), in our study they depended largely on trawler discards (benthonic fish represented up to 73% by biomass when only trawlers operated) because they are a food source with a high energetic value and are predictable in space and time. The active capture of clupeiform fish significantly increased when trawlers were not operating, and the gull has also broadened its foraging niche to feed in rice fields, in ecotonic habitats and occasionally on refuse tips, suggesting that the clupeiform population was not large enough to meet the food demands of the colony. The presence of some discard prey in the diet when trawlers were not operating indicated that some breeding gulls were able to travel beyond the area affected by the moratorium (more than 110 km from the colony). The frequency of incubation changeovers did not change significantly when trawlers were not operating, but marked changes brought about by the moratorium were recorded during the chick-rearing stage. Chick feeding frequency significantly decreased during the trawler moratorium, although the number of prey per regurgitate delivered to chicks did not vary. When trawlers did not operate, adults seemed to compensate for the lower food availability by carrying larger prey items to the chicks. In contrast, chicks occasionally did not accept the regurgitated food, especially when trawler discards were available. The trawler moratorium affected not only the diet of Audouin's Gull but also the adult time budgets and the provisioning rates of chicks, although the species showed some ability to buffer against low food availability.

Audouin's Gull *Larus audouinii* is a rare seabird endemic in the Mediterranean region. Although their numbers have increased in recent years, the breeding population is concentrated in very few colonies (Pedrocchi & Ruiz 1995), and the species is still considered to be threatened (Tucker & Heath 1995). Since 1991, a 2-month trawler moratorium has been established in the Ebro Delta area each year, coinciding with the breeding season of Audouin's Gull. Preliminary studies recorded the changes brought about by the moratorium in the diet of the species and a decrease in its breeding success (Oro & Martínez-Vilalta 1992, Paterson *et al.* 1992). Oro and Martínez-Vilalta (1992) suggested that the dramatic growth of the Ebro Delta colony was based on exploitation of trawler discards, since food supply during the breeding season is considered one of the main limiting factors regulating the size of seabird colonies (see review in Cairns 1992). The trawler moratorium eliminated a substantial part of the food resources for the species, and it offered the possibility to analyse the influence of trawler fisheries on Audouin's Gull feeding ecology. Ruiz *et al.* (1996) recorded large differences in the diet of Audouin's Gull with and without a trawler moratorium. However, the study did not consider night fishing activity, which is known to be exploited by the gulls. Although the diet of Audouin's

* Corresponding author. Present address: Centre d'Ecologie Fonctionnelle et Evolutive, CNRS, 1919 Route de Mende, 34293 Montpellier Cedex 5, France.

Gulls has often been studied throughout the breeding range (Witt *et al.* 1981, Català *et al.* 1990, Ruiz *et al.* 1996), sample sizes were often small and diet analyses grouped different food samples, such as regurgitates, remains and pellets, with no estimation of the bias associated with each sample method (Duffy & Jackson 1986).

If the moratorium generated a shortage of food for Audouin's Gull (Oro & Martínez-Vilalta 1992), not only its diet but also the adult time budgets and the provisioning patterns of chicks during the rearing stage would be expected to change. This paper examines the diet of Audouin's Gulls in relation to trawler and nocturnal fishing activities and assesses their importance to Audouin's Gull feeding ecology. The consequences of the trawler moratorium are also quantified in terms of incubation changeovers, chick provisioning rates, number and size of food items regurgitated and response of chicks to food regurgitated by the adults.

METHODS

Study area and fishing activities

The study was made during 1993, 1994 and 1995 on Audouin's Gulls breeding in the Ebro Delta (NW Mediterranean). The colony was located in the Punta de la Banya, a protected brackish marsh habitat of 2500 ha (40°37′N, 00°35′E, Ebro Delta Natural Park). The colony was established in 1981 by a few pairs, and since then it has dramatically enlarged its numbers up to *c.* 10,300 pairs in 1994 (65% of the total world population; Pedrocchi & Ruiz 1995).

In the Ebro Delta area, both diurnal trawler and night fisheries occur. These two fleets have a timetable which shows little variation, and each day of the week has a particular fishing pattern, depending on which fishery operates (Oro 1995). During the moratorium, only two situations occurred: (1) only the purse-seine fishery operated (night fishery), (2) no fishing at any time. When trawlers operated, four different fishing activities were recorded: (1) trawling only, (2) both trawling and purse-seine fishing, (3) purse-seine fishing at night only and (4) no fishing. Samples were collected in relation to the fishing situation pertaining each day, and occasional changes in fishery activities (because of bad weather, holidays) were also considered.

Food samples

Fresh food regurgitated by adults and fledgling gulls was collected when the birds were handled for ringing or when regurgitates were produced in the subcolonies as a defensive response against intrusion by researchers. In spite of the drawbacks of this method (see review in Duffy & Jackson 1986), only regurgitates were analysed because remains and pellets are more biased samples for Audouin's Gull diet analysis (González-Solís *et al.*, unpubl.). The regurgitates from young chicks were not analyzed because they have a different diet from the older chicks, fledglings and adult gulls (Pedrocchi *et al.* 1996). The sampling period extended from the pre-laying stage (March–April) to the juvenile fledging stage (June–July).

Prey were identified using collections of fish, birds, mammals and invertebrates from the Ebro Delta area. Partially digested fish were identified using their scales and otoliths, but identification was normally possible from the entire fish bodies. Quantification procedures followed the rule of minimum numbers (Duffy & Jackson 1986).

Adult and chick responses to changes in food availability

We measured incubation changeovers, chick provisioning rates, number and size of food items regurgitated and response of chicks to food regurgitated by the adults. Data were recorded in 1994, when the moratorium coincided with the incubation and chick-rearing stages, and 1995, when the moratorium started in the beginning of the chick-rearing stage.

During incubation, watches were made over six 12-h observation periods during the trawling moratorium (1994) and three 12-h observation periods when trawlers operated (1995). Twelve pairs were monitored each year. A changeover in which material for the nest was brought in was not considered in the analysis since it did not correspond to a foraging trip. No significant differences were found in hatching dates between 1994 and 1995 (Ruiz *et al.*, unpubl.).

After hatching, five 12-h observation periods were made in both 1994 (all of them coinciding with the moratorium, which started in May) and 1995 (without the moratorium). All observations were made during the beginning of the chick-rearing stage. Thus, the 5 days sampled in the chick-rearing stage in 1994 (23, 25, 27, 30 and 31 May) were compared with those sampled in 1995 (25, 26, 29–31 May), and the bias associated with changes in adult behaviour with chick age was avoided. Sixteen nests were monitored each year. All the observations were made from a hide in the study colony between 06.00 h and 18.00 h. Watches were shared by two observers, each observer being relieved after 4 h. Nests were marked, and chicks were ringed when they hatched. Some adults were caught and ringed with colour combination codes, and other adults were already ringed and could be identified. Plumage characteristics allowed us to identify some other adults. In total, 81% of adults watched were easily identifiable in 1994 and 75% in 1995. All the regurgitations to feed the chicks of the observed pairs were recorded. We also recorded when regurgitate samples were fresh, the number and size of prey per regurgitate (the bill length was used as a guide) and the number of times that chicks did not feed on the regurgitated food (as an indicator of chick satiation). Prey were classified into three size categories: small (10–69 mm), medium (70–120 mm) and large (121–350 mm). Since the hide was close to the nests and the manipulation time of the food by the adults was long when chicks were a few days old, most

of the prey was identified (75% in 1994, 67% in 1995) and quantified. Means are given ± 1 s.d. unless otherwise stated.

Analytical methods and statistical procedures

Two criteria, taxonomic and ecological (typologic), were used to establish prey categories because the categorization procedures may have a great influence on the interpretation of diet analyses (Cooper *et al.* 1990). Taxonomic categories were based on order level to avoid analytical difficulties resulting from many groups with zero counts. Typologic groups were based on prey locomotive characteristics, which might represent different hunting behaviour, predation effort and foraging habitat.

The following descriptors of the diet were used at both taxonomic and typologic levels: prey number (N); numeric percentage (%N); percentage of occurrence (percentage of sampling units containing the prey category, %P) and percentage of biomass (in dry weight, %B). The biomass percentage was also used to compare diet composition among the different fishing situations since it is an important correction in any estimate of energetic intake.

The width of the trophic niche was measured by Brillouin's diversity index (Pielou 1975), and a jack-knife procedure was used to estimate diversity, together with the associated variance (Zahl 1977). In the present case, the niche width was based on the proportions of resources used and not on the availability of resources. The jack-knife values of diversity were matched with the values obtained using the diversity spectra for each fishing situation in order to ensure that sample sizes were large enough (Pielou 1975, Sherry 1990). Since trawler discards belong mainly to one typological category but are formed by many taxonomic categories, a diversity index was also calculated on typological categories to assess the diversity of foraged typologies in each fishing situation. Comparisons of jack-knifed diversity values were performed using a modified Student's *t*-statistic (Hutcheson 1970), and Bonferroni correction was used when appropriate.

Comparisons of diet composition among the fishing situations were carried out by means of the *G*-test (Sokal & Rolf 1981), and standardized residuals were used to interpret the detected differences. When comparing relative frequencies of each prey category between periods, we grouped some categories in order to avoid difficulties arising from categories poorly represented in the data matrix. Biomass importance was compared using the Mann-Whitney *U*-test of rank order. Changeover frequency and provisioning rates were also compared using the Mann-Whitney *U*-test, whereas the number and the size of prey per regurgitate were compared by χ^2 tests.

RESULTS

A list of the different prey items identified in the study is shown in Table 1, indicating the taxonomic and typologic categories to which prey items were assigned. The commonest prey, the Sardine *Sardina pilchardus*, was classified as epipelagic, although those coming from trawler discards should be classified with typical offal prey (benthonic and mesopelagic). The unknown amount of Sardine coming from trawler discards probably biased the assessment of the importance of discards when trawlers operated, thus its importance was likely underestimated (see Discussion).

Table 2 shows the diet at both taxonomic and typologic levels. For the whole breeding seasons of 1993, 1994 and 1995, the commonest fishing situation was when only the night seine fleet was operating (43% of days), and trawlers

Table 1. *List of identified prey items in the analysis of the diet of Audouin's Gulls in the Ebro Delta, 1993–1995*

Taxonomic category	Ecologic typology
Coleoptera	
Aquatic Beetle *Hydrophilus pistaceus*	Ecotonic
Gnathobdellida	
Leech *Hirudo medicinalis*	Ecotonic
Decapoda	
American Crayfish *Procambarus clarckii*	Ecotonic
Crab *Carcinus* sp.	Ecotonic
Sepioida	
Little Cuttlefish *Sepia orbignyana*	Epipelagic
Teuthoida	
Long-finned Squid *Loligo vulgaris*	Epipelagic
Clupeiformes	
Sardine *Sardina pilchardus*	Epipelagic
European Anchovy *Engraulis encrasicholus*	Epipelagic
Round Sardinella *Sardinella aurita*	Epipelagic
Escorpeniformes	
Gurnard *Aspitrygla* sp.	Benthic/mesopelagic
Perciformes	
Bogue *Boops boops*	Epipelagic
Axillary Sea Bream *Pagellus acarne*	Benthic/mesopelagic
Comber *Serranus* sp.	Benthic/mesopelagic
Flathead Grey Mullet *Mugil cephalus*	Ecotonic
Red Bandfish *Cepola rubescens*	Benthic/mesopelagic
Mediterranean Horse-mackerel *Trachurus* sp.	Epipelagic
Blue Whiting *Micromesistius poutassou*	Benthic/mesopelagic
Anguilliformes	
Eel *Anguilla anguilla*	Benthic/mesopelagic
Snake Eel *Ophictus* sp.	Benthic/mesopelagic
Pleuronectiformes	
Plaice *Pleuronectes* sp.	Benthic/mesopelagic
Flounder *Citharus macrolepidotus*	Benthic/mesopelagic
Anseriformes	
Mallard *Anas platyrhynchos*, chick	Terrestrial walker
Passeriformes	
Nightingale *Luscinia* sp.	Terrestrial flyer

Table 2. *Descriptors of diet importance of Audouin's Gulls in the Ebro Delta, 1993–1995, in relation to fishery activities and based on taxonomic and typologic categories. Diversity indices are also given at both taxonomic and typologic levels*

	Commercial fishing activity											
	Diurnal and nocturnal			Diurnal only			Nocturnal only			No activity		
	%N[a]	%P[a]	%B[a]	%N	%P	%B	%N	%P	%B	%N	%P	%B
Taxonomic												
Clupeiformes	57.1	63.2	56.7	22.7	33.3	21.9	72.7	64.1	70.6	46.8	54.6	58.4
Perciformes	30.2	26.3	32.1	36.4	57.1	34.0	13.2	20.3	18.2	11.7	15.9	13.3
Anguilliformes	6.4	5.3	1.9	9.1	19.1	0.2	1.7	3.1	0.1	1.3	2.3	0.1
Gadiformes	1.6	1.8	0.9	9.1	4.8	12.6	—	—	—	—	—	—
Pleuronectiformes	1.6	1.8	4.9	22.7	4.8	31.4	—	—	—	—	—	—
Aves	1.6	1.8	3.1	—	—	—	0.8	1.6	1.3	2.6	4.6	2.16
Sepioida	1.6	1.8	0.4	—	—	—	4.1	7.8	6.8	1.3	2.3	2.5
Decapoda	—	—	—	—	—	—	3.3	4.7	3.1	13.0	13.6	18.7
Gnathobdellida	—	—	—	—	—	—	2.5	3.1	0.1	15.6	4.6	0.6
Orthoptera	—	—	—	—	—	—	—	—	—	3.9	2.3	0.1
Coleoptera	—	—	—	—	—	—	1.7	1.6	—	2.6	2.3	0.7
Waste food	—	—	—	—	—	—	—	—	—	2.3	1.3	3.6
Typologic												
Ecotonic	3.2	3.5	5.0	2.3	4.8	—	6.6	7.8	3.1	33.8	25.0	26.7
Epipelagic	68.3	75.4	69.6	25.0	38.1	26.9	89.3	89.1	95.3	57.4	68.2	67.4
Benthic/mesopelagic	28.6	21.1	25.4	72.7	71.4	73.1	1.7	3.1	0.3	1.3	2.3	0.1
Terrestrial walker	—	—	—	—	—	—	1.7	1.6	—	6.5	6.8	2.3
Terrestrial flyer	—	—	—	—	—	—	0.8	1.6	1.3	—	—	—
Refuse tip	—	—	—	—	—	—	—	—	—	1.3	2.3	3.6
Diversity (s.e.)												
Taxonomic	1.6 (0.2)			2.5 (0.4)			1.5 (0.2)			2.6 (0.3)		
Typologic	1.1 (0.1)			1.0 (0.2)			0.7 (0.2)			1.5 (0.2)		
% of days involved	28.6			7.1			42.9			21.4		
No. regurgitates	57			21			64			44		
No. items	63			44			121			77		

[a] %N = numeric percentage, %P = percentage of occurrence, %B = percentage of biomass.

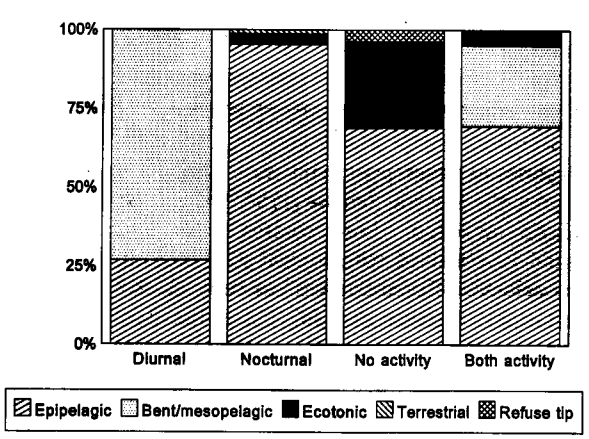

Figure 1. Percentage of prey biomass consumption of Audouin's Gull under the different fishing situations in the Ebro Delta, 1993–1995.

operated on 36% of the days. No commercial fishing activity occurred on 21% of days during the study. In all, 186 regurgitates were analysed, with a total of 305 prey items identified. Overall, clupeiforms were clearly the main resource for Audouin's Gulls. The amount of Sardine consumed was not significantly different according to trawler activity (Mann-Whitney *U*-test, $z = -0.71$, n.s.). When trawlers operated, however, perciforms and also pleuronectiform fish had more importance than clupeiforms, showing that benthonic and mesopelagic prey (typically trawler discards) may have been the most relevant prey in periods with trawler activity. The consumption of epipelagic prey relative to other typologic categories decreased significantly when trawlers operated (Mann-Whitney *U*-test, $z = -2.57$, $P < 0.01$), and thus significantly more benthonic and mesopelagic prey were consumed (Mann-Whitney *U*-test, $z = -5.67$, $P < 0.001$; Fig. 1). The *G*-test revealed a significant difference in diet among the four fishing situations at typologic level (G_6-test = 169, $P < 0.001$). Higher consumption of clupeiforms (64% by occurrence and 71% by bio-

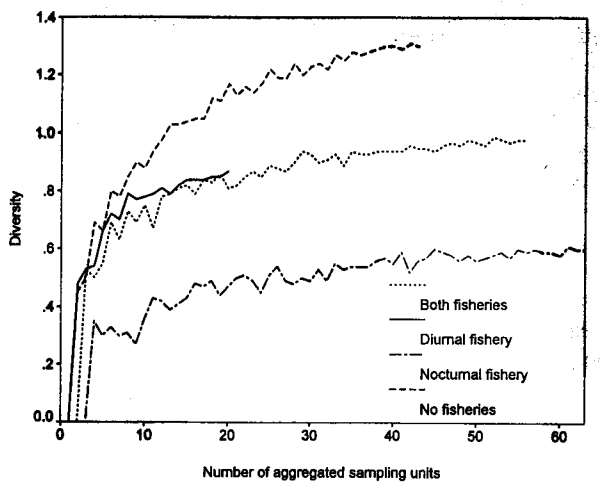

Figure 2. Medians of estimated Audouin's Gull diet diversity for 100 random runs as a function of the number of aggregated sampling units for each fishing situation.

mass) were positively associated with periods of night fisheries only, whereas perciforms were relatively more important when only trawlers operated (57% by occurrence and 34% by biomass). At typologic level, higher consumption of discards was positively associated with trawler activity (both with and without night fisheries), although this resource was especially important when only trawler activity occurred (71% by occurrence and 73% by biomass). Secondary prey (such as the American Crayfish *Procambarus clarckii* or the Aquatic Beetle *Hydrophilus pistaceus*) were consumed frequently only when no fishing fleet operated (25% by occurrence and 27% by biomass).

Figure 2 shows that the jack-knife values of diversity matched the values obtained using the diversity spectra for each fishing situation, so sample sizes were large enough for the analysis. Dietary niche width at the population level showed changes among the population diversity indices for the four situations, and the trend was similar at both taxonomic and typologic levels (Table 2). The lowest diversity indices occurred when only night fisheries operated, while higher diversity values were recorded during trawler activity and especially when no fishing activity occurred in the area (see also diversity spectra in Fig. 2). Dietary niche breadth was significantly higher when no fishing took place (Table 3). When only trawlers operated, the dietary niche width at both taxonomic and typologic levels was significantly greater than when only nocturnal activity occurred (Table 3).

The length of an incubation stint in our samples increased during moratorium periods, but differences were not significant (1994: trip length = 5.9 ± 3.0 h, n = 65 stints; 1995: trip length = 4.7 ± 0.1 h, n = 46 stints; Mann-Whitney U-test, z = 0.5, n.s.).

A total of 418 regurgitates were recorded from the watches (n = 220 in 1994; n = 198 in 1995). Provisioning rates were significantly higher when trawlers operated than when the moratorium was established (1995: 6.8 ± 4.3 feeds/nest/day, n = 5 days; 1994: 4.5 ± 3.2 feeds/nest/day, n = 5 days; Mann-Whitney U-test, z = 2.3, $P < 0.05$). The numbers of prey per regurgitate were not different between years (χ^2_3 = 0.29, n.s.), but the size of food fed to chicks was significantly larger when food shortage occurred (1994; χ^2_2 = 12.4, $P < 0.005$; Fig. 3). This trend did not change when only the fish caught actively by the gulls was considered (χ^2_2 = 10.1, $P < 0.005$). Clupeiforms measured from trawler discards were of similar size in both years (1994: 13.0 ± 0.2 cm, n = 397; 1995: 13.1 ± 0.1 cm, n = 423; t_{818} = 0.7, n.s.). Commercial fishing catches per unit effort in the area were similar in both years (D. Oro, X. Ruiz, L. Jover, V. Pedrocchi & J. González-Solís, unpubl.), suggesting that neither the size nor the population density of fish changed between 1994 and 1995. Significantly higher rates

Table 3. *Statistical differences between Audouin's Gull food diversity index values for the four fishing situations (Hutcheson modified Student's t-statistic value, d.f. in parentheses) for both typologic (above the diagonal) and taxonomic (below the diagonal) levels*

	Fishing activity			
Fishing activity	Diurnal only	Nocturnal only	No activity	Both activities
		Typologic		
Diurnal only		1.13 (127) n.s.	−1.98 (114) n.s.	−0.46 (86) n.s.
Nocturnal only	2.26 (70) *		−3.11 (184) *	1.76 (184) n.s.
No activity	−0.16 (97) n.s.	−2.85 (140) *		−1.80 (133) n.s.
Both activities	−1.96 (63) n.s.	0.54 (176) n.s.	2.52 (121) *	
		Taxonomic		

* $P < 0.05$, Bonferroni corrected.

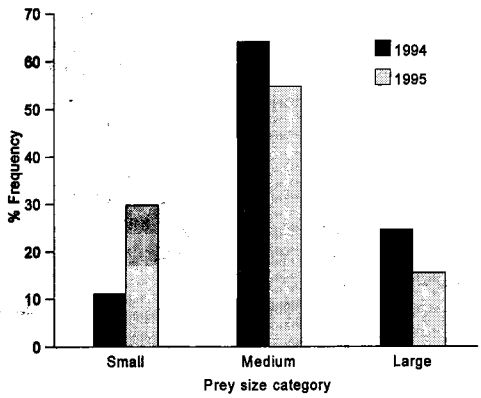

Figure 3. The percentage of prey in different size classes fed to young Audouin's Gull chicks in 1994 (n = 81) and 1995 (n = 168).

of nonacceptance of regurgitates were recorded in young chicks during 1995 (6% of regurgitates) than in 1994 (1.5% of regurgitates; $\chi^2_2 = 4.3$, $P < 0.05$).

DISCUSSION

The relevance of clupeids to the feeding habits of Audouin's Gulls under any fishing situation showed the gulls' ecological dependence on this resource. This dependence was even more marked in our study because the commonest feeding situation for breeding Audouin's Gulls was when only night fisheries operated (Table 2). For the first time, the diet of Audouin's Gull was analysed when none of the fishing fleets was operating, showing the gull's high ability to catch free-swimming clupeiforms, especially Sardines (58% by biomass), and its characteristic of being a highly specialized, nocturnal marine predator. These results, compared with those obtained when only night fisheries occurred, showed that Audouin's Gull may also exploit these fisheries (increasing the consumption of clupeiforms) and confirm that the gull has a nocturnal foraging pattern which involves the nocturnal fishing fleet (Beaubrun 1983, Oro 1995). However, the diet of Audouin's Gull largely depended on trawler discards (benthonic fish represented up to 73% by biomass when only trawlers operated). The gull behaves as an opportunistic scavenger, as do many seabird species throughout the world (Blaber & Wassenberg 1989, Furness *et al.* 1992).

Our results are similar to those given by Ruiz *et al.* (1996) for the same colony, where they also recorded a strong dependence of this colony on trawler fisheries. Audouin's Gulls benefit from this opportunism through a decrease in the time devoted to foraging (since trawl discards are resources predictable in space and time) and an increase of the temporal niche dimension since trawlers are active diurnally and Audouin's Gulls are typically nocturnal predators. Food supply is considered one of the most important factors in the regulation of seabird colony sizes (Cairns 1992), and the trawler moratorium established since 1991 has greatly affected the reproductive performance of the scavenging seabirds breeding in the Punta de la Banya (Oro & Martínez-Vilalta 1992, Oro *et al.* 1995). This suggests that the exploitation of night fisheries by Audouin's Gull does not totally compensate for the lack of trawler discards. This difference in feeding benefit from each of the two fishing fleets arises from the differences in fishing strategies and commercial interests: while the night fleet is specialized in catching clupeiforms (which entails fewer discards), trawlers often concentrate on catching benthonic fish and crustaceans and generate large amounts of discards. The significant increase in dietary niche breadth during periods of the trawling moratorium, especially at times when the night fishing fleet did not operate either, showed that the rice field ecosystem and the dunes were exploited to a large extent at that time. This increase also indicates that when no fishing fleet was operating, gulls were not able to meet their food requirements from catching clupeids, and they were forced to feed also on ecotonic prey. When food shortage occurred, the gull showed both opportunistic foraging behaviour and high diet and activity plasticity (Oro 1995) linked to the high availability of alternative resources, such as rice fields, ecotonic habitats and kleptoparasitism on other seabird species (Oro 1996). Although prey from rice fields are energetically poorer than fish, their consumption has probably prevented total breeding failure, which was recorded in the Columbretes Islands colony under the same moratorium situation but without alternative foraging resources (Oro *et al.* 1996b). The presence of some discard prey when the trawlers did not operate indicated that some breeding gulls were able to travel beyond the area affected by the moratorium (more than 110 km from the colony).

When trawlers were not operating, Audouin's Gulls did not significantly alter the incubation changeover frequency, but during the chick-rearing stage, they did decrease the provisioning rates of chicks. This difference in the response of the species probably arises from the differences in energetic demands of the two stages, which are especially higher during the chick-rearing stage (Furness & Monaghan 1987). Data suggest that adults increased the time dedicated to foraging by *c.* 50% when trawlers did not operate, especially when the moratorium coincided with the chick-rearing stage. These costs have probably increased in recent years because of the decrease in clupeiform density in the area (Palomera & Pertierra 1993). The gulls seemed to compensate for the lack of discard availability by feeding their chicks with larger fish, as recorded by Uttley *et al.* (1994) for Guillemots *Uria aalge*. This may explain why the Audouin's Gull chick growth was not significantly lower when the moratorium coincided with the chick-rearing stage (Oro *et al.* 1996a), probably because adults increased load size and chicks did not receive less energy (Uttley *et al.* 1994). In contrast, Monaghan *et al.* (1992) found that under food shortage conditions, adult Arctic Terns *Sterna paradisaea* fed their young with smaller prey but at higher rates. This difference may arise from the capacity of Audouin's Gull to gather many fish in its throat (regurgitates often contained

more than three fish, and on some occasions up to 11 medium-sized Sardines were recorded). The importance of maintaining a high proportion of Sardines in the diet of chicks, even when trawlers did not operate, is probably related to the positive correlation between dietary representation and chick growth (Monaghan *et al.* 1989, Hamer *et al.* 1991) since Sardines have high energetic value.

The results of this study showed that when the moratorium occurred, Audouin's Gull exhibited a capability to buffer against the potential food shortage. This capability included changes not only in the diet but also in the adult time budgets and the size and number of prey fed to chicks. This capability may explain why, despite the decrease in breeding success since the establishment of the moratorium in 1991, breeding failure has not been recorded in this colony.

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