

Fisheries and daily activity cycles of Audouin's *Larus audouinii* and Yellow-legged Gulls *L. cachinnans* breeding at the Chafarinas Islands (Moroccan coast)

By Jacob González-Solís, Xavier Ruiz and Lluís Jover

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From 1993 to 1995 we analysed the influence of purse-seine and trawler fisheries on the activity cycle of Audouin's *Larus audouinii* and Yellow-legged Gull *L. cachinnans* at the Chafarinas Islands (Moroccan coast). Yellow-legged Gulls showed an activity cycle mainly diurnal. However, they take advantage of the fish attracted to the surface by purse-seine boats during the night and dawn. Purse-seine fisheries use powerful lamps that aid the gulls in localizing and exploiting schools of fish concentrated around lamps. Audouin's gull did not show any activity peak either during the day or at night. Although Audouin's Gulls showed conspicuous activity peaks depending on the trawler time-table in other colonies, the difficulty of predicting trawling fishery discards at Chafarinas Islands probably underlies the absence of clear peaks of activity linked to this fishery. Data suggest that parents foraged and relieved each other continuously. The capacity to maintain a continuous trophic activity, day and night, could be an additional advantage when the energetic costs increase during the reproductive period.

Key words: Audouin's Gull *Larus audouinii*, Yellow-legged Gull *Larus cachinnans*, activity cycle, trawler fishery, purse-seine fishery.

Addresses: (J. G.-S. and X. R.) Universitat de Barcelona, Dept. Biologia Animal (Vertebrates), Diagonal 645, 08028 Barcelona, Spain (present address J. G.-S.: British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET, United Kingdom. E-mail: jacob@porthos.bio.ub.es); (L. J.) Dept. de Salut Pública (Bioestadística), Universitat de Barcelona, Casanova 143, 08036, Barcelona, Spain.

1. Introduction

The use of commercial fisheries by scavenging seabirds has been carefully documented (eg. GARTHE *et al.* 1996), showing that discards are usually the main foraging resource for some seabird populations (ORO *et al.* 1997). The interactions between larids and commercial fisheries revealed a great plasticity in the activity patterns of gulls. Both nocturnal and diurnal larid species can change their patterns of activity depending on the peculiarities of commercial fisheries around the colony studied. To date, most of the information on the commercial fisheries concerns the use of trawler fisheries discards, during the daylight (BOSWALL 1960, ORO 1995, CASTILLA and JIMÉNEZ 1995) as well as during the night (GARTHE and HÜPPOP 1993, 1996). Although purse-seine fisheries are very important in the Mediterranean, few studies have considered their relevance to the trophic ecology of seabirds (BEAUBRUN 1983, ORO 1995, ORO *et al.* 1997).

In this contribution we compared the activity cycles of Audouin's and Yellow-legged Gulls breeding at Chafarinas Is. (SW Mediterranean) and we analysed the influence of purse-seine and trawler fisheries on the activity of both species.

2. Study Area and Fisheries

The Chafarinas Islands (Melilla, Spain: 35° 11'N, 3° 46'35"E) are three small volcanic islands (total area = 53ha) situated 4.5 km offshore from the Moroccan Mediterranean coast. In 1995, 2124 nests of Audouin's Gull and 1829 nests of Yellow-legged Gull were recorded. Two types of commercial fishery operate around the Chafarinas Is.: purse-seine and trawler, and gulls obtain food from both. Purse-seine fisheries (15 boats) operate at night and at dawn, catching epi-pelagic fish (mainly sardine *Sardina pilchardus*) attracted to the surface by powerful lamps, around which schools of fish concentrate. Although few fish are discarded during this operation, the lamps aid the gulls in localizing easily exploitable patches of increased fish densities (Beaubrun 1983, pers.

obs.). This fishery operates every night except Thursdays, during local religious celebrations, and bad weather conditions. In contrast, trawler fisheries operate continuously throughout the day and night, catching benthic and mesopelagic fish until vessels reach storage capacity. This fishery frequently discards large amounts of fish of no commercial interest, which are taken by seabirds, as in other places (e.g., FURNESS *et al.* 1992, GARTHE *et al.* 1996). However, the number of trawlers within the foraging range of the gulls is highly variable and trawlers usually operate further from the colony than purse-seine fisheries do. As a result trawler fisheries are a much less predictable resource, but trawlers cancel operations only during stormy conditions.

3. Methods

We analysed the daily activity cycles of Audouin's and Yellow-legged Gulls by counting the number of adults that remained at the colony site (e.g. BURGER 1976). Two kinds of census were performed: a) counts using a telescope, which covered large colony areas at two hour intervals and b) counts by naked eye from a hide every 30 min, on a small portion of the colony. Census were performed during the daylight except for 3 nocturnal censuses performed from a hide with the help of the moonlight and a lantern.

The results of both counts were standardized to the largest number of birds observed and the number of counts per day. We grouped the different counts into 2h intervals by calculating the average number of individuals for each interval until we obtained 7 counts per day, from 6:00 to 18:00 G.M.T. Every count was divided by the sum of the 7 counts. Further, we calculated the average between days for each of the 7 counts. Comparisons between activity patterns were performed using Mann-Whitney test on the average increment for each time interval calculated as follow: for each day with 7 counts we calculated one value for every interval resulting from the difference between the precedent and the subsequent value of the interval; further, we calculated the average of the differences between days for each of the 7 counts.

All counts were done during the breeding seasons of 1993, 1994, and 1995. Differences among breeding periods (prenuptial, incubating, chick rearing and postnuptial) were only significant for two intervals in the case of Audouin's Gull and one interval for Yellow-legged Gull (GONZÁLEZ-SOLÍS 1996). Effects of the tides were ignored since the Mediterranean sea show only slight differences in the sea level depending on the time. Thus, all census were pooled to analyze the effects of fisheries and the species.

We compared two fishing situations: (1) when both types of fishery operate (60% of days), (2) when only trawlers operate (40% of days). Stormy days, when none of the fisheries operate, were not considered. When only trawlers operated there were no sardine catches, therefore the catch records from the harbour of Ras el Ma (days with and without catches) was used as an indicator of the fishing situation. In addition, we compared the average number of individuals remaining at the breeding grounds with or without purse-seine fishery activity, as the time gulls spend at the colony may be determined by food availability (see MARTIN 1992 for a review). We assessed the effects of purse-seine activities, by comparing, using a Wilcoxon matched-pairs signed-ranks test, the average number of birds present in a particular subcolony during the same hours, on days with and without sardine catches. For this, we only used days separated by a maximum of one day.

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4. Results

No activity peak was apparent either during the day or at night for Audouin's Gull at Chafarinas Is. (Fig 1). In contrast, there was a high proportion of Yellow-legged gulls at the colony during the first and last hours of daylight and a low proportion during the afternoon. However, the proportion of birds reached the maximum from 16:00h to 18:00h (Fig 1).

Increments for each interval between the two larid species were significantly different for most of the time intervals (Fig 1). There were no significant differences in the activity cycle of gulls between days with and without purse-seine activity, for either species. However, the median number

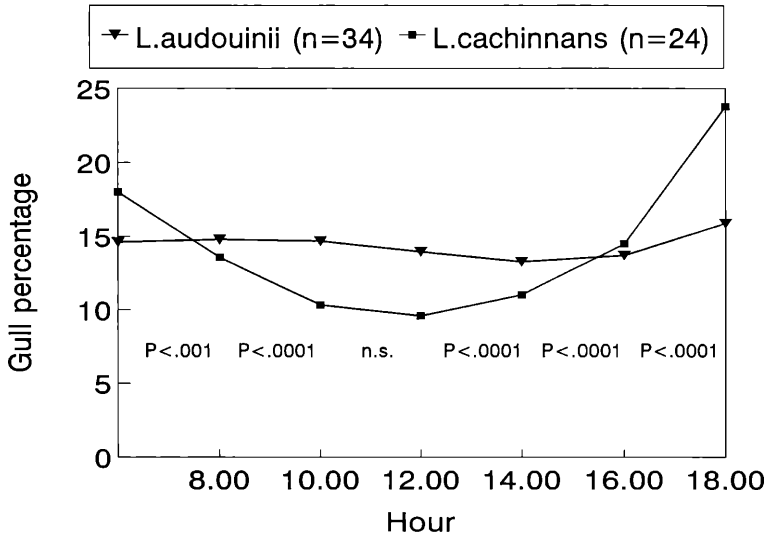


Figure 1: Percentage of gulls at the colony, for Audouin's (*Larus audouinii*) and Yellow-legged gulls (*L. cachinnans*) at Chafarinas Is. P = probability of the U-test between gulls species on the mean increment for each time interval. N = Number of days. Note that „Gull percentages“ do not represent the actual percentage of gulls in the colony (see methods).

Abb. 1: Tagesgang der Anwesenheit (%) von Korallen- und Weißkopfmöwe auf den Chafarinas. P = U-Test der Artunterschiede in der mittleren Veränderung pro Zeiteinheit. N = Anzahl Tage. Die Prozentsätze entsprechen nicht den tatsächlichen Prozentwerten der Möwen in der Kolonie (s. Text).

of Audouin's gulls remaining in the colony was significantly higher (by 24%) on days with purse-seine activity the night before (Wilcoxon matched-pairs signed-ranks test, $Z = -2.63$, $n = 18$, $P = 0.0084$, two-tailed). The counts of Audouin's gulls performed during the night show a slight decrease in the proportion of adults remaining at the colony site compared to the day.

Additionally, we observed one case of predation of an Audouin's Gull chick by Yellow-legged Gull in a full moon night.

5. Discussion

In our study, the Yellow-legged Gull mainly shows a diurnal activity cycle at Chafarinas Is. as in other colonies (Bosch & Sol 1996). However, birds reached the maximum proportion in the colony at late afternoon showing that some individuals left the colony before dawn and were able to exploit the last catches of purse-seine fisheries during the night (González-Solís *et al.* 1997a, 1997b; pers. obs.). Feeding during the night was also observed in Herring Gull *Larus argentatus*, Great Black-backed Gull *L. marinus*, and Black-backed Gull *L. fuscus*, in the North Sea (GARTHE & HÜPPOP 1996). Although these larids are thought to be mainly diurnal, there were no major differences between diurnal and nocturnal scavenging at trawler discards. Diurnal larids take advantage of the night light beam of trawlers (GARTHE & HÜPPOP 1996) as well as the powerful lamps used by the purse-seine vessels to attract epi-pelagic fish to the surface. Diurnal larids are also able to take advantage of moonlight nights to forage (MCNEIL *et al.* 1993). As in our study, predation during

moonlight nights has been recorded for several larid species (PIEROTTI & ANNETT 1987, 1990, NOCERA & KRESS 1996).

The Audouin's Gull has been defined as a specialized nocturnal predator (WITT *et al.* 1981, PEDROCCHI *et al.* 1996, ORO *et al.* 1997). However, our data suggest that parents foraged and relieved each other continuously, since no activity peak is apparent either during the day or at night. Purse-seine activity coincides with the natural specialization for epipelagic fish, and the presence or absence of this activity did not change the natural activity cycle of Audouin's Gull. However, significantly high numbers of Audouin's gulls remained at their breeding grounds on days following purse-seine activity, suggesting that they took advantage of this fishery during the night before. Likewise, high proportion of prey of Audouin's Gull are benthic and mesopelagic fish in all colonies studied including Chafarinas Is. (ORO *et al.* 1996, PEDROCCHI *et al.* 1996) showing that Audouin's gulls are able to exploit trawler discards. In the Ebro Delta and Columbretes Is., the activity patterns of Audouin's Gull depend on the activity of trawler fleet (CASTILLA & JIMÉNEZ 1995, ORO 1995). In these localities, the trawler fleet has a fixed time-table, discarding fish only during the morning of working days. Therefore, this predictable and repetitive resource is reflected in the activity patterns of gulls. Nevertheless, the difficulty of predicting trawling fishery discards in Chafarinas probably underlies the absence of clear peaks of activity linked to these fisheries. In summary, during the day, Audouin's Gull exploit trawling discards and at night they actively fish clupeiforms either alone or in association with purse-seine fisheries (BEAUBRUN 1983, GONZÁLEZ-SOLÍS *et al.* 1997a), taking advantage of fish attracted to the surface by boat lamps. The continuous activity could be an additional advantage when the energetic costs increase during the reproductive period (FASOLA 1984, MCNEIL *et al.* 1993).

6. Zusammenfassung

Fischerei und tageszeitliche Aktivität von Korallenmöwe (*Larus audouinii*) und Weißkopfmöwe (*L. cachinnans*) auf den Chafarinas Inseln.

Von 1993 bis 1995 analysierten wir den Einfluß der Fischerei (Sardinenfischerei, Trawler) auf die Aktivität von Weißkopfmöwe und Korallenmöwe auf den Chafarinas Inseln an der marokkanischen Mittelmeerküste. Weißkopfmöwen waren tagaktiv, nutzten aber auch die von der Sardinenfischerei eröffneten Nahrungsquellen während der Nacht- und Morgendämmerung. Sardinenfischer locken mit starken Lampen die Fische zur Wasseroberfläche. Der Lampenschein dient auch den Möwen zur Lokalisierung und Nutzung dieser Nahrungsquellen. Im Gegensatz zur Weißkopfmöwe und zu anderen Koloniestandorten zeigten Korallenmöwen auf den Chafarinas keine täglichen Aktivitätsschwankungen in Abhängigkeit von der Fischerei, deren Aktivität schwer vorhersagbar ist. Die Daten legen nahe, daß die Altvögel sich kontinuierlich ablösen und auf Nahrungssuche gehen. Die Fähigkeit, tags und nachts Nahrung aufzunehmen, könnte ein Vorteil während der energieaufwendigen Reproduktionszeit sein.

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