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Leopold, M.F.; Philippart, C.J.M.; Yorio, P.  
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**NOCTURNAL FEEDING UNDER ARTIFICIAL LIGHT CONDITIONS  
BY BROWN-HOODED GULL (*LARUS MACULIPENNIS*)  
IN PUERTO MADRYN HARBOUR  
(CHUBUT PROVINCE, ARGENTINA)**

MARDIK F. LEOPOLD<sup>1</sup>, CATHARINA J. M. PHILIPPART<sup>2</sup> AND PABLO YORIO<sup>3,4</sup>

<sup>1</sup>IMARES. P. O. Box 167, 1790 AD Den Burg, Texel, The Netherlands.

<sup>2</sup>Royal Netherlands Institute for Sea Research. P. O. Box 59, 1790 AB Den Burg, Texel, The Netherlands.

<sup>3</sup>Centro Nacional Patagónico, CONICET. Blvd. Brown 2915, U9120ACF Puerto Madryn,  
Chubut, Argentina. yorio@cenpat.edu.ar

<sup>4</sup>Wildlife Conservation Society. Amenabar 1595, Piso 2, Of. 19, C1426AKC Buenos Aires, Argentina.

**ABSTRACT.**— This paper describes nocturnal, marine feeding behaviour in the Brown-hooded Gull (*Larus maculipennis*) in November 2009. The gulls assembled at night at the end of a long pier, running 800 m offshore into the Golfo Nuevo, at Puerto Madryn, Chubut Province, Argentina. Powerful lights predictably lighted the water around the end of the pier and attracted many small prey animals to the surface. Several hundreds of gulls, presumed to be local breeders, came every night to feed on this bounty, using various feeding techniques and taking several prey species and sizes. Potential prey items were caught to be identified by vertical plankton hauls. The gulls most likely took relatively large Isopoda (*Idothea* sp.), Polychaeta (*Platynereis* sp.) and fish larvae (*Patagonotothen* sp.) as well as smaller crustaceans, mostly Amphipoda (Phoxocephalidae) and Mysidacea. The gulls caught small prey items while swimming, by rapid surface pecking, while they hunted the larger prey species by flying low over the water and performing shallow, vertical plunge-dives. During daylight, only few gulls ventured from land into the bay, indicating that they took advantage of the nocturnal feeding opportunity, facilitated by artificial lighting. The clear short-term gain of exploiting this novel foraging opportunity may be offset by potential threats such as increased vulnerability to predators or contamination by oil spills from ships moored along the pier.

**KEY WORDS:** diet, marine invertebrates, night light niche, Patagonia, seabirds.

**RESUMEN.** ALIMENTACIÓN NOCTURNA BAJO ILUMINACIÓN ARTIFICIAL DE LA GAVIOTA CAPUCHO CAFÉ (*LARUS MACULIPENNIS*) EN EL MUELLE DE PUERTO MADRYN (CHUBUT, ARGENTINA).— Se describe la alimentación nocturna en un ambiente marino de la Gaviota Capucho Café (*Larus maculipennis*) en noviembre de 2009. Las gaviotas se congregaron durante la noche en el extremo de un muelle de 800 m de extensión en Puerto Madryn (Chubut, Argentina). Las aguas alrededor del extremo del muelle estaban iluminadas por potentes luces que atraían a muchas presas pequeñas a la superficie. Varios cientos de gaviotas, presumiblemente individuos reproductivos provenientes de una colonia cercana, se alimentaron diariamente en este sitio usando diferentes técnicas de alimentación y capturando presas de diferentes especies y tallas. Las presas potenciales fueron capturadas para su identificación a través de muestreos verticales con una red de plancton. Las presas que seguramente capturaron las gaviotas eran Isopoda de tamaño relativamente grande (*Idothea* sp.), Polychaeta (*Platynereis* sp.) y larvas de peces (*Patagonotothen* sp.), así como crustáceos de menor tamaño, mayormente Amphipoda (Phoxocephalidae) y Mysidacea. Las presas pequeñas fueron capturadas mientras las gaviotas nadaban, mediante el picoteo en superficie, mientras que las más grandes fueron capturadas sobrevolando bajo sobre la superficie y a través de zambullidas superficiales. Durante el día, solo unas pocas gaviotas se aventuraron dentro de la bahía, indicando que tomaron ventaja de la oportunidad de alimentación nocturna facilitada por la iluminación artificial. La clara ganancia a corto plazo de la explotación de esta novedosa oportunidad de alimentación podría ser compensada por posibles amenazas tales como una mayor vulnerabilidad a los predadores o la contaminación por derrame de hidrocarburos de los barcos amarrados junto al muelle.

**PALABRAS CLAVE:** aves marinas, dieta, invertebrados marinos, nicho de iluminación nocturna, Patagonia.

The on-going increase of artificial lighting along the world's coastlines has changed the nocturnal activities of many seabirds that rely on the coastal area for foraging, reproduction and migration. Light pollution and its effects on seabird dynamics is an emerging field of research, but published examples are still rather rare (Montevecchi 2006). Because prey become more visible under artificial light conditions, visually-hunting seabirds may take advantage of these conditions by enhancing their food intake during the night. The question how the obvious short-term gain of taking advantage of such novel foraging opportunities may affect longer-term consequences on the fitness of the seabirds concerned is, however, far more difficult to deal with.

During November 2009, we observed nocturnal feeding by Brown-hooded Gull (*Larus maculipennis*) under artificial light conditions in Puerto Madryn harbour (Chubut Province, Argentina). Brown-hooded Gulls occur throughout Argentina and neighbouring countries (Burger and Gochfeld 1996), breeding mostly inland in freshwater lakes and marshlands (Sclater and Hudson 1889, Burger and Gochfeld 1996). Foraging is mainly observed in fields, refuse tips, and freshwater habitats, but also in coastal waters, such as harbours and river mouths like the Rio de la Plata (Murphy 1936, Tickell and Woods 1972, Jehl 1973, 1974, Brown et al. 1975, Yorio et al. 2005). Further offshore, this species was never spotted during seabird surveys (Ozawa 1967, Tickell and Woods 1972, Jehl 1974, Brown et al. 1975, Jehl et al. 1979, Veit 1995, Montalti and Orgeira 1998, Orgeira 2001, Imberti 2005).

Based on their wide range in feeding grounds, the diet of the Brown-hooded Gull must be varied, but is only known in broad terms as few detailed observations have been made on this gull's feeding behaviour. Small animals (insects, worms, fish, young birds and eggs, mammals and marine invertebrates) as well as vegetable matter and human refuse have been found as food items (Gould 1841, Sclater and Hudson 1889, Murphy 1936, Bahamonde 1954, Lizurume et al. 1995, Khatchikian et al. 2002, Yorio and Giaccardi 2002, Ghys and Favero 2004, Silva Rodríguez et al. 2005, Jackson 2008). Brown-hooded Gulls regularly feed in the intertidal (Murphy 1936, Bahamonde 1954, Woods and Woods 1997,

Khatchikian et al. 2002, Yorio, pers. obs.), has been noted to follow and feed around fishing vessels (Yorio and Caille 1999, Kovacs et al. 2005), and was occasionally recorded taking strips of peeling skin from whales (Rowntree et al. 1998). Yet, prey species taken, feeding methods and distribution at sea remain largely unknown.

In this paper, we describe observations of the nocturnal feeding behaviour of the Brown-hooded Gull and its potential prey in more detail. Based on our own and other observations, we hypothesize on the light-induced changes in prey-predator relationships in coastal waters. Given the paucity of records, we believe that our observations may add to the understanding of the effects of artificial light on nocturnal feeding by seabirds in the coastal zone in general, and the consequences for the feeding behaviour of the Brown-hooded Gull in particular.

## METHODS

From 8 to 13 November 2009, we studied the feeding behaviour and the potential prey of the Brown-hooded Gull during a 6 day port call in Puerto Madryn. We worked from a 78 m long sailing vessel (Stad Amsterdam) that was moored to the seaward end of an 800 m long concrete pier, running from the beach of Puerto Madryn perpendicularly into the Golfo Nuevo. The sea around most of the pier was dark or only dimly lit at night, but powerful lamps illuminated the clipper and one other ship (a large trawler) moored at its very end (Fig. 1). The ships themselves also carried lamps.

Presence and behaviour of the gulls was followed intermittently during daylight and continuously from dusk to 01:00 during the nights. Nocturnal feeding behaviour of the gulls in the lighted patch at the end of the pier was observed directly, aided by 10×50 binoculars. Gulls on the water and gulls flying low over the water were observed, by following focal individuals, at distances varying between a few metres to about 100 m from the ship. Behavioural categories were described following Ashmole (1971) and Camphuysen and Garthe (2004). Other marine predators that entered the lighted patch at the end of the pier were observed whenever possible during night time.

To examine potential prey items during darkness, a spotlight was aimed from the side of the ship downward. The dense patch of animals swarming into the light was subsequently sampled by vertical hauls of a 40 cm cross section, 140  $\mu\text{m}$  mesh, plankton net in the first 0.5 m from the surface. To examine possible diel vertical migration of potential prey items, the plankton net was hauled vertically through the surface waters and the entire water column (approximately 10 m water depth) during day time. A selection of animals caught (several individuals per species) was preserved in ethanol and transferred to the Centro Nacional Patagónico (CONICET) for identification. Some of the animals caught were briefly kept in a small aquarium on deck, to facilitate observations on behaviour and between-species interactions.

## RESULTS

During daylight, several dozens of Brown-hooded Gull individuals (maximum count) were scattered over the bay in small numbers, flying or resting on the water or on beaches. Some feeding activity was noted in gulls walking along the waterline, pecking at small, unidentified objects in the surf. In general, however, feeding activity appeared to be low. This changed dramatically during the night. Every night, some 350–400 individuals assembled around the end of the pier, and they were clearly attracted to the lighted patch of water around the ships. All individuals seen were in full or nearly full breeding plumage. In the early hours of night, just after sunset, the gulls were mainly engaged in surface pecking, aiming at very small objects at or close to the surface. As the night progressed, feeding activity became more aerial. Birds on the water foraged like phalaropes, spinning around at one spot while pecking frequently at small unidentified objects at or just below the water's surface. Other individuals foraged by flying low over the water, into the wind. These birds caught larger prey (estimated at 1–5 cm in length by comparison with their bill length) by means of shallow vertical plunge-dives. We could not identify all prey items that were taken by these birds, but noted both isopods and polychaetes as prey. When the low-flying gulls would reach the end of the lighted patch, they would wheel back downwind, and start another searching track into the wind.

During daylight, surface hauls and hauls of the plankton net over the entire water column failed to catch any animal. In the night catches, small crustaceans (mostly Phoxocephalidae and Mysidacea, approximately 1 cm long, 2–3 mm wide) were the most numerous animals. In addition, we caught 2–3 cm long greenish isopods (*Idothea* sp.), 4–6 cm long bright-red polychaetes (*Platynereis* sp.) and 2–4 cm long silvery fish (*Patagonotothen* sp.) larvae. In situ observations on potential prey items in the water confirmed that small crustaceans were at least two orders of magnitude more numerous than the larger invertebrates and fish larvae in the lighted patch near the surface of water at night. The larger prey were thus less abundant than the small crustaceans, but clearly visible as they swam near the surface in the light.

At night, one or two Kelp Gulls (*Larus dominicanus*) would occasionally join the feeding flock. A few small schools (approximately 100 individuals each) of 7–8 cm long fishes were seen near the surface under the lights, but these could not be caught by us and remained unidentified. We never saw the

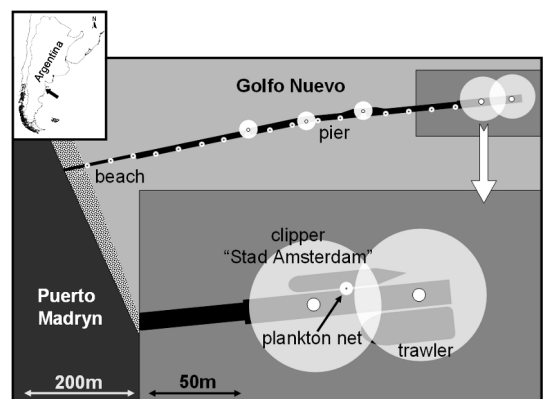


Figure 1. An 800 m long concrete pier runs from the beach of Puerto Madryn (Chubut Province, Argentina) eastward, into the Golfo Nuevo (indicated by black arrow in inset map on upper-left). The pier is dimly lit by streetlights, while three larger lamp-posts are situated at the mid-section. Two much taller and much more powerful lamp-posts are present at the end of the pier and their flood-light was further enhanced by the lights of the clipper *Stad Amsterdam* and of a large deep-water trawler moored at the other side of the pier. Plankton hauls were situated mid-ships on the starboard side of the clipper, under a downward pointing spotlight.

Brown-hooded Gull taking such large fishes, but a Great Grebe (*Podiceps major*) that came into the light occasionally, hunted these fish and successfully took three in rapid succession during one passage. South American sea lions (*Otaria flavescens*) were more or less constantly present, swimming and diving through the lighted patches along the moored ships, but they were not seen taking any prey.

Nocturnal predators such as large owls, or Peregrine Falcon (*Falco peregrinus*) (e.g., DeCandido and Allen 2006) were not present and the gulls always stayed clear of the pier and the moored ships, thus avoiding collision to the pier, the masts of the lamps or the riggings of the ships. None of the moored ships at the time of the observations leaked or spilled oil that could damage the plumage of the feeding birds (Wiese et al. 2001).

## DISCUSSION

The gathering of comparatively large numbers of the Brown-hooded Gull at the end of the pier under the lamps was noted every night during our stay in November 2009, and again during a nightly follow-up visit in January 2010. Gulls feeding at the end of the pier were likely off-duty birds from a colony of a few hundred pairs located 7 km inland (N. Lisnizer and A. Gatto, pers. com.). Nocturnal foraging under artificial light conditions thus appeared to be a recurring behavioural pattern of these gulls in the area, at least during the breeding season.

None of the potential prey items were visible during the day and none could be caught, not even by 10 m deep (from the bottom up) vertical plankton hauls. This implies that these organisms most probably live in or on the seafloor during the day and only come to the surface during the night. Many marine benthic invertebrates, including mysids, isopods and polychaetes, are known to show vertical upward migration during the night, linked to feeding conditions, predation risk or breeding cycles (e.g., Korringa 1947, Alldredge and King 1980). Isopods and polychaetes, that lack good eye-sight, should stay away from the surface during clear nights, but might have been drifting into the lighted patch around the pier by the tidal currents running through the bay. The smaller mysids were clearly predators, attacking the

much larger polychaetes and isopods when kept together in an aquarium on deck. They were probably visual hunters that might have benefited from the combination of swept-up invertebrate prey and lamp light at the surface. Both groups, however, ran a predation risk from the Brown-hooded Gull that had learned to exploit this "night light niche" (Longcore and Rich 2004).

The size and taxa of prey items caught by the Brown-hooded Gull at night generally matched with the potential prey items that we observed in the surface waters in the lamp light. The spinning gulls were probably feeding on the relatively small, but numerous crustaceans, whilst the low-flying gulls appeared to target the larger isopods and polychaetes. Although we could not confirm that larval fish were caught as well, they were also likely prey given their size and presence at the surface of the water in sufficient numbers to be caught in our plankton net. Based on these observations, we believe that the Brown-hooded Gull took advantage of the enhanced availability of prey as the result of the artificial light conditions around the pier.

During daylight, gulls showed much lower feeding activities in the bay than during the night. Numbers at sea were low during the day and most gulls were probably feeding on land, or engaged in other activities. The Brown-hooded Gull is, like most gulls, mainly a diurnal predator, but also an opportunistic forager. Several gull species have learned to exploit night light niches and have developed nocturnal foraging activities, feeding on insects, fish or fisheries waste (Wassenberg and Hill 1990, Burger and Staine 1993, McNeil et al. 1993, Garthe and Hüppop 1996, Arcos and Oro 2002).

For the Brown-hooded Gull, the bright lights at the end of the pier offered a well provisioned and predictable feeding patch. We could see no obvious hazards to the gulls, such as the risk of getting predated or the risk of collisions. Although the gulls obviously profited from this additional feeding opportunity, the longer-term effects are unknown. The sea lions were never seen to interact with the gulls but they are potential predators of swimming gulls. Also new predators may appear in the future, exploiting the night light niche and turning the gulls from predators into prey. An oil spill, even a small one, from a ship moored

at the pier, may in one night affect a large number of breeding birds from the nearby colony. As a result of the artificial light conditions, gulls have changed their diet and, possibly, also that of chicks that they provision with food, with unknown implications for chick growth and chick survival. Furthermore, the shift from diurnal to nocturnal feeding may affect nocturnal nest guarding against egg and chick predators. In contrast to the obvious short-term profit, unravelling the long-term effects of this additional food source will require more in-depth studies on the feeding ecology of these gulls and the long-term consequences for their fitness.

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