

LETTER FROM THE CONSERVATION FRONT LINE

Numbers of seabirds attracted to artificial lights should not be the only indicator of population trends

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Seabirds, particularly petrels and shearwaters (hereafter petrels), are among the most threatened avian groups, mainly due to predation by introduced invasive species on their breeding grounds and interactions with fisheries at sea (Dias *et al.*, 2019; Rodríguez *et al.*, 2019). To seabirds, islands are essential in their life cycle as most seabird breeding colonies are located on islands (Spatz *et al.*, 2014). Despite petrels including some of the most well-studied seabird species (e.g. Manx shearwater *Puffinus puffinus* and short-tailed shearwater *Ardenna tenuirostris*), our knowledge of the life history of many others is quite limited (e.g. population status or distribution; Rodríguez *et al.*, 2019). Most petrels nest underground, visit colonies at night, and their colonies are usually in inaccessible remote places (islets, cliffs or mountains), making it challenging to estimate population sizes and trends (Bird *et al.*, 2021).

Fledglings of around 70 seabird species are globally grounded by artificial light during their inaugural flights from their nests to the ocean. This fallout causes high mortality and, without human intervention, it is assumed that most of them would die (Rodríguez *et al.*, 2012). To avoid mortality, rescue campaigns are coordinated and implemented by NGOs, citizens, and/or governments to give a second chance to grounded birds (Rodríguez *et al.*, 2017). Data coming from rescue campaigns can provide information on the continued survival of rare species (Le Corre *et al.*, 2003; Rodríguez *et al.*, 2020), the potential locations of their breeding colonies (Barros *et al.*, 2018, 2019), and as a proxy to infer breeding population size and population trends (Rodríguez, Rodríguez & Lucas, 2012; Ainley, Schneider & Spencer, 2023; Chevillon *et al.*, 2022).

Here, we show the case of the Canary Islands, one of the most important areas for petrels in Europe with seven species regularly breeding on these islands (Table 1). Despite its small size (7447 km²), the Canary Islands constitute one of the most important biodiversity hotspots in the EU. Currently, 40% of the land is protected by Natura 2000, but the archipelago is densely human-populated and the tourism industry (main

Table 1 Procellariiformes species regularly breeding in the Canary Islands and its category of threat according to the Spanish and regional (Canary Islands) laws and the red book of threatened birds of Spain (*Real Decreto 139/2011, de 4 de febrero; Ley 4/2010, de 4 de junio; SEO/BirdLife, 2021*)

Species	Spanish law	Canarian law	The Spanish Red Book
<i>Calonectris borealis</i>	LESRPE	Special interest	Vulnerable
<i>Bulweria bulwerii</i>	LESRPE	Special interest	Endangered
<i>Puffinus baroli</i>	Vulnerable	Special protection	Critically endangered
<i>P. puffinus canariensis</i>	Vulnerable	Vulnerable	Critically endangered
<i>Hydrobates pelagicus</i>	LESRPE	Special interest	Endangered
<i>Hydrobates castro</i>	Vulnerable	Special protection	Endangered
<i>Pelagodroma marina</i>	Vulnerable	Special protection	Critically endangered

Abbreviation: LESRPE, *Listado de Especies Silvestres en Régimen de Protección Especial*.

economic activity) increases the anthropogenic pressure, with 13 million visitors every year (ISTAC, 2022). In fact, almost two-thirds and around 13% of the endemic and native avifauna, including two endemic *Procellariiformes* species (*P. olsoni* and *P. holeae*), have gone extinct since the arrival of aboriginal people ca 2500 years ago (Illera *et al.*, 2012).

All Canarian petrel species are endangered to some degree and the main on-land threats are predation by introduced species and habitat loss by light pollution, collisions with infrastructure and urban expansion (SEO/BirdLife, 2021). We focus on four breeding species, the three commonest involved in the fallout, Cory's shearwater *Calonectris borealis*, Macaronesian shearwater *Puffinus baroli* (formerly *Puffinus assimilis* or *Puffinus lherminieri*), and Bulwer's petrel *Bulweria bulwerii*, and the recently described endemic subspecies, Canarian Manx's

shearwater *P. puffinus canariensis* (Rodríguez *et al.*, 2020). We use the annual number of fledglings rescued and admitted to *La Tahonilla* Wildlife Rehabilitation Centre during 32 nesting seasons in Tenerife Island, the largest and most populated of the Canary Islands. To interpret these data, we have to consider that rescue effort is not equal during the study period. First, the human population is increasing on the island (from 623 823 to 927 993 inhabitants in 1990 and 2021; ISTAC, 2022). Second, citizens' environmental awareness on the issue of seabird light attraction has presumably increased because of the dissemination of previous campaigns. Third, new urban areas have been equipped with public street lighting, leading to increasing light pollution levels that erode the natural night sky even in protected areas (Garrett, Donald & Gaston, 2020). Thus, a stable or declining trend in numbers of grounded fledglings should be considered as a decline in the breeding population (or a low breeding success over the years; Rodríguez, Rodríguez & Lucas, 2012).

The only species showing an increasing trend is Cory's shearwater. The other three species show a stable or decreasing trend and consequently, a presumable breeding population decline (Fig. 1). The situation appears critical for Macaronesian shearwater and Canarian Manx shearwater. The first species has suffered a decline in numbers since the 1990s, and it has not recovered to those numbers (around 40 fledglings per year). Ten years ago we warned of this decline, and we made a plea for the immediate design, publication and execution of a conservation plan as required by Spanish and Canarian law (Rodríguez, Rodríguez & Lucas, 2012). Nowadays, ten years later, the conservation plan has not been executed and our knowledge of population size and trends continues based on the admissions of grounded birds to the rehabilitation centre. For Canarian Manx shearwater, an endemic subspecies critically endangered, the low number of grounded fledglings (around 0–4 fledglings per year) are indicative of a small population size. Furthermore, the increasing light pollution levels in proximity to the breeding colonies in the north face might lead to the observed stable trend despite the population decline indicated by SEO/BirdLife (2021) according to anecdotal observations.

Trends in numbers of seabirds grounded by artificial light are affected by several sources of error (explained in detail in Rodríguez, Rodríguez & Lucas, 2012), but currently, it is the only information available to infer population breeding size and trends. To improve our knowledge of size and trend of the breeding populations and to reverse the causes of decline, we ask for the development and execution of their conservation plans. Conservation plans should be based on three key points: (1) control (or eradication when possible) of introduced predators at colonies such as cats, ferrets, mice and rats; (2) identification and assessment of other threats and (3) execution of detailed survey programmes on the distribution and population size to evaluate their demographic dynamics over the long-term. Survey programmes should use a network of passive acoustic devices and radars to annually monitor the same locations (Juhasz *et al.*, 2022). In addition, an effort should be done to find nests to protect them from

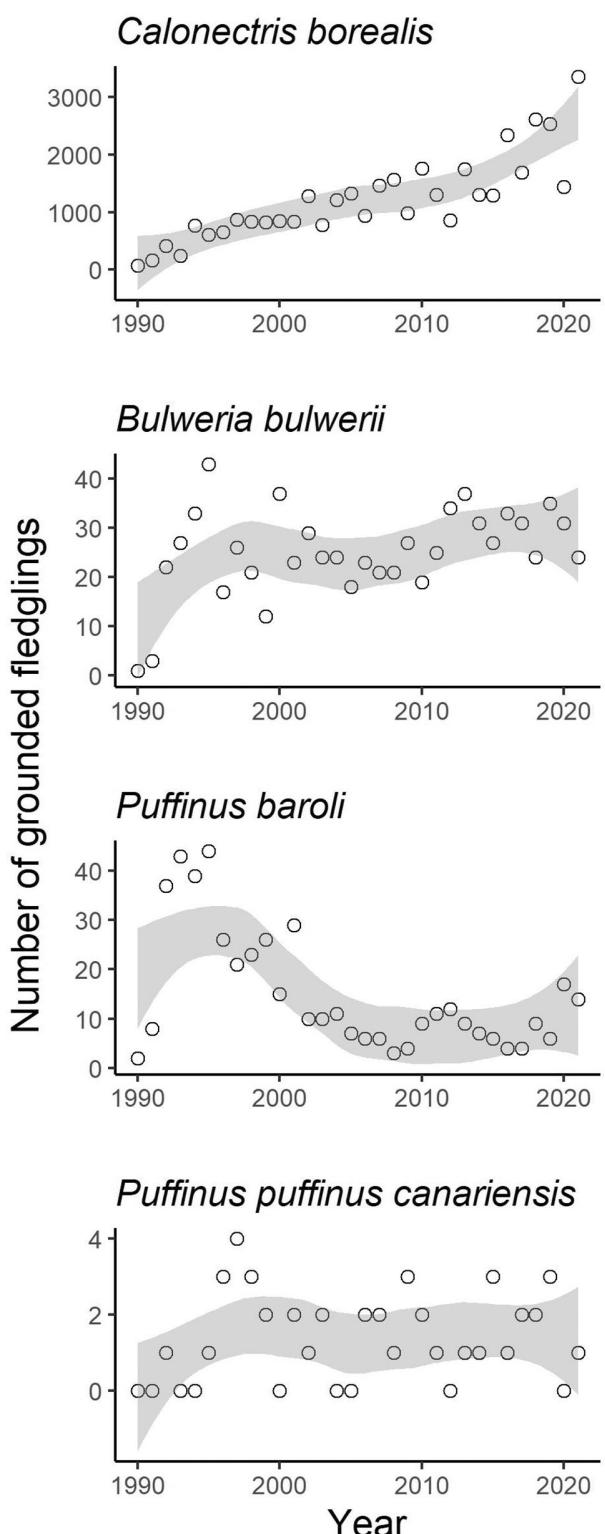


Figure 1 Annual number of fledglings grounded by artificial light in Tenerife, Canary Islands. Data come from the *La Tahonilla* Wildlife Rehabilitation Centre (Cabildo Insular de Tenerife).

predators and to monitor breeding success, by using scent dogs (Bolton *et al.*, 2021), night vision binoculars (Galase, 2019) and tracking systems on breeders captured at sea or on land (Raine *et al.*, 2022). Finally, increasing the legal protection by Spanish and European administrations is also crucial. In this sense, we urge the inclusion of Canarian Manx shearwater in Annex I of the Birds Directive. Both *Puffinus* shearwaters should be uplisted from *Vulnerable* to *En Peligro de Extinción* (the highest risk category of the Spanish law) by the Spanish Government and considered a priority for funding under the LIFE programme of the EU. All these actions will help better management of these rare and threatened species, minimizing the risk of another extinction in the environmental-destroyed Canaries.

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