

Habitat restoration on Praia Islet, Azores Archipelago, proved successful for seabirds, but new threats have emerged

Recuperação de habitats do Ilhéu da Praia, Arquipélago dos Açores, é bem sucedida para aves marinhas mas surgem novas ameaças

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SUMMARY

As on many other islands, most of the seabird species breeding in the Azores archipelago are now restricted to tiny remnants of their former nesting range, due mainly to the consequences of the introduction of mammals by man. Praia islet (off Graciosa island) holds six seabird species, four of which are classified as species “of Conservation Concern” in Europe and another one is considered globally “Vulnerable”. Habitat restoration, combining rabbit *Oryctolagus cuniculus* eradication in 1997, installation of artificial nest boxes for terns in 1996 and for storm-petrels in 2000, and native plant re-introduction between 1998 and 2003, led to a noticeable recovery of vegetation cover and seabird breeding numbers. Here we present updated data concerning the population trends of the Common Tern *Sterna hirundo*, the Roseate Tern *S. dougalli*, the Madeiran Storm-petrel *Hydrobates castro* and the Azores-endemic Monteiro’s Storm-petrel *H. monteiroi* on Praia islet. Whereas storm-petrel numbers in artificial nests have kept increasing since 2000, tern numbers have been fluctuating since the mid-2000s. However, and despite the current absence of mammals on Praia islet, seabirds still face threats when breeding. Turnstones *Arenaria interpres* and Starlings *Sturnus vulgaris granti* consume tern eggs, and introduced Madeiran Lizards *Lacerta dugesii* may prey on Monteiro’s Storm-petrel chicks.

RESUMO

Tal como acontece em muitas outras ilhas, a maioria das espécies de aves marinhas que nidificam actualmente no arquipélago dos Açores estão restringidas a pequenas partes da sua antiga área de distribuição, devido essencialmente ao impacto dos mamíferos introduzidos pelo Homem. O ilhéu da Praia (ilha Graciosa) alberga seis espécies de aves marinhas, entre as quais quatro classificadas com estatuto de conservação “Preocupante” na Europa e uma outra considerada globalmente “Vulnerável”. Um conjunto de medidas de restauro do habitat, incluindo a erradicação dos coelhos *Oryctolagus cuniculus* em 1997, a instalação de ninhos artificiais para os garajaus em 1996 e para os painhos em 2000,

e a reintrodução de plantas indígenas entre 1998 e 2003, resultou numa recuperação notável da cobertura vegetal e no forte aumento das populações reprodutoras de aves marinhas. Neste artigo apresentamos dados actualizados referentes às populações da Andorinha-do-mar-comum *Sterna hirundo*, da Andorinha-do-mar-rosada *S. dougallii*, do Painho-da-Madeira *Hydrobates castro* e do Painho-de-Monteiro *H. monteiroi* (espécie endémica dos Açores) no ilhéu da Praia. Enquanto o número de casais de painhos a nidificar nos ninhos artificiais não deixou de aumentar, os números de andorinhas-do-mar flutuaram bastante desde meados dos anos 2000. Apesar da ausência de mamíferos no ilhéu da Praia, as aves marinhas continuam a enfrentar ameaças durante a época de reprodução. As Rolas-do-mar *Arenaria interpres* e os Estorninhos *Sturnus vulgaris granti* consomem os ovos das andorinhas-do-mar, e existem suspeitas de que as Lagartixas-da-Madeira *Lacerta dugesii* introduzidos podem prdear crias de Painhos-de-Monteiro.

The Azores archipelago, subtropical northern Atlantic, currently holds ten seabird species (Monteiro *et al.* 1996, Bolton *et al.* 2008, Bried 2008). Many of these species were extirpated from the nine main islands following the introduction of 16 mammal species by the Portuguese from the 15th century onwards (Le Grand 1993, Monteiro *et al.* 1996), and are now restricted to a few islets and remote coastal strips. Currently, six out of these ten species are considered “of Conservation Concern” in Europe (BirdLife International 2004). Situated off Graciosa island, Praia islet (Figure 1) harbours six seabird species, four of which (namely Cory’s Shearwater *Calonectris borealis*, the Barolo Shearwater *Puffinus baroli*, the Madeiran Storm-petrel *Hydrobates castro* and the Roseate Tern *Sterna dougallii*) are species “of Conservation Concern” in Europe (BirdLife International 2004), and a fifth one (the Azores-endemic Monteiro’s Storm-petrel *H. monteiroi*) is classified globally “Vulnerable” (BirdLife International 2015). Furthermore, in the Azores, the Barolo Shearwater, the Madeiran Storm-petrel, the Common Tern *Sterna hirundo* (which also breeds on Praia islet) and the Roseate Tern are considered “Vulnerable”, and Monteiro’s Storm-petrel is considered “endangered” (Cabral *et al.* 2005). Until 1997, Praia islet held rabbits *Oryctolagus cuniculus* which were introduced about 50 years earlier. As on the other ca 800 islands worldwide where they have been introduced (Courchamp *et al.* 2003), rabbits have got a catastrophic impact, depleting native vegetation, increasing soil erosion,

and competing for burrows with petrels (Bell *et al.* 1997, Monteiro 2000). However, measures of seabird habitat restoration combining rabbit eradication (in 1997), installation of artificial nest boxes for terns (1996) and for storm-petrels (2000), and native plant re-introduction between 1998 and 2003, have led to a noticeable recovery of the vegetation and a strong increase in seabird breeding numbers (Bried *et al.* 2009). In this paper, we supplement the results of Bried *et al.* (2009) by presenting updated data concerning tern and storm-petrel population trends and current threats to seabirds on Praia islet.

METHODS

Praia islet (39°03’N, 27°57’W, 0.12 km²) lies 1 km east of Graciosa island (Figure 1). Fieldwork there has been annually conducted, since 1989 to determine breeding tern numbers, and since 2000 to monitor the Madeiran and Monteiro’s Storm-petrels breeding in artificial nests.

Common Tern and Roseate Tern breeding numbers were determined by having small groups of people covering the entire islet and doing as exhaustive a nest and clutch count census as possible (Bibby *et al.* 1992) during the period when colony attendance was highest. To increase Roseate Tern numbers, and given that in the Azores, this species tends to use more sheltered nesting sites than Common Terns (Ramos & del Nevo 1995), 50 wooden nest boxes (internal dimensions: 28 x 26 x 14 cm)

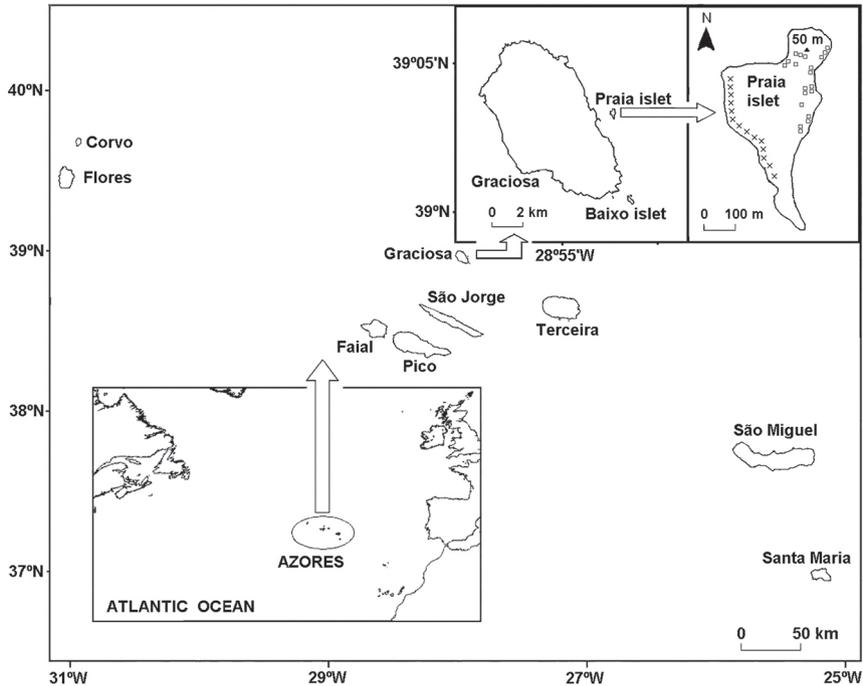


Figure 1. Situation of Praia islet in the Azores archipelago. Squares: areas with artificial nests for storm-petrels; crosses: areas with artificial nests for terns.

Figura 1. Situação do ilhéu da Praia no arquipélago dos Açores. Quadrados: zonas com ninhos artificiais de paímbos; cruzes: zonas com ninhos artificiais de andorinhas-do-mar.

were installed in 1996 in the area that was the most deprived of vegetation (along the western coast), in order to increase nesting site availability (Bried *et al.* 2009 and Figure 1).

Monteiro's Storm-petrels and Madeiran Storm-petrels breed in summer and in winter, respectively (Monteiro *et al.* 1999, Bolton *et al.* 2008). The two species occupy the same nest sites (Bolton *et al.* 2008). To increase population size, 150 plastic nest boxes were installed in 2000-2001 (Bolton *et al.* 2004, Figure 1). Since then, annual monitoring of each storm-petrel species has been conducted to determine the number of breeding attempts (that is, the number of eggs laid given that petrels lay only one egg per breeding attempt, Warham 1990) and breeding success (number of chicks fledged and near-to-fledging divided by the number of eggs

laid). However, bad sea conditions during some winters prevented access to Praia islet (see Table 1).

RESULTS

» Terns

Roseate Tern numbers strongly fluctuated during the late 1980s (del Nevo *et al.* 1993, Bried *et al.* 2009). The species remained almost totally absent from Praia islet from 1991 to 2000, when 31 pairs settled. Roseate Tern breeding numbers increased 15-fold between 2000 and 2006, then dropped until 2009, when the species did not breed, before resuming increasing with 62 breeding pairs in 2010 and 500 breeding pairs in 2011. The latter figure, which represents the highest numbers ever recorded at

Year	Chicks fledged/No. of breeding attempts		Source
	Artificial nests	Natural nests	
Monteiro's Storm-petrel			
2000	6/13	5/15	Bolton <i>et al.</i> 2004
2001	18/28	3/18	Bolton <i>et al.</i> 2004
2002	13/22	No data	Bried <i>et al.</i> 2009
2003	21/44	4/8	Bried <i>et al.</i> 2009
2004	27/46	7/15	Bried <i>et al.</i> 2009
2005	24/45	6/15	Bried <i>et al.</i> 2009
2006	26/52	7 or 8/16	This study
2007	22/56	4 or 5/13	This study
2008	23 or 24/58	5 to 7/12	This study
2009	29/71	7 or 8/12	This study
2010	24/69	5 to 7/15	This study
2011	31 or 32/76	7 or 8/15	This study
2012	30/75	5 or 6/11	This study
2013	/79	/16	This study
Madeiran Storm-petrel			
2000	14/22	6/21	Bolton <i>et al.</i> 2004
2001	No data	No data	Bried <i>et al.</i> 2009
2002	31/48	9/11	Bried <i>et al.</i> 2009
2003	34/At least 46	11/At least 12	Bried <i>et al.</i> 2009
2004	44/64	12/22	Bried <i>et al.</i> 2009
2005	43/60	11/21	Bried <i>et al.</i> 2009
2006	No data/78	No data/18	Bried <i>et al.</i> 2009
2007	37 to 48/76	10 to 18/22	This study
2008	56 to 59/85	9 or 10/22	This study
2009	At least 49/At least 58	At least 1/At least 5	This study
2010	At least 61/At least 75	13/At least 21	This study
2011	57 to 62/93	4 to 9/21	This study
2012	67/At least 84	14/At least 17	This study

Table 1. Breeding parameters of the Monteiro's Storm-petrel and the Madeiran Storm-petrel after the installation of artificial nests on Praia islet. For Monteiro's Storm-petrels, breeding success in artificial nests in 2002 was probably underestimated because the colony was visited only once, therefore we excluded 2002 from analyses (see text). Concerning the Madeiran Storm-petrel, the absence of data during some years was due to bad sea conditions preventing the access to the islet. In 2001, access remained impossible throughout the breeding period. In 2003, 2009, 2010 and 2012, bad weather prevented the access to the islet during the incubation period, so that some pairs that failed during the early stages of incubation may have been missed. In 2006, bad weather prevented us from ringing most chicks. Consequently, data from 2003, 2006, 2009, 2010 and 2012 were excluded from analyses.

Tabela 1. Parâmetros reprodutivos do Painho-de-Monteiro e do Painho-da-Madeira após a instalação dos ninhos artificiais no ilhéu da Praia. O sucesso reprodutor do Painho-de-Monteiro em 2002 foi provavelmente sub-estimado, uma vez que houve apenas uma visita à colônia; por isso este ano foi excluído das análises (ver texto). No que concerne o Painho-da-Madeira, o mau estado do mar impediu o acesso ao ilhéu em vários anos. Em 2001, o acesso foi impossível durante toda a época de reprodução. Em 2003, 2009, 2010 e 2012, não foi possível aceder ao ilhéu durante o período de incubação, por isso alguns casais que poderão ter falhado no início da mesma não foram detectados. Em 2006, o mau tempo impediu a anilhação da maioria das crias. Por isso, os dados de 2003, 2006, 2009, 2010 e 2012 foram excluídos das análises.

this location, also represents 47,6% of the Azorean breeding population in 2011 (Figure 2). In 2012 Roseate Tern numbers were high again on Praia islet with 310 nests counted and an additional 103 eggs found predated (mostly by Starlings *Sturnus vulgaris granti*) that probably account for another 80 pairs. On Praia islet, Roseate Terns tend to breed in rocky areas and also underneath the Vidálias *Azorina vidalii* and the Azores Coast Fescues *Festuca petraea* which provide good concealment to eggs and chicks. With the exception of one pair in 2011, this species never used nest boxes.

Common Tern breeding numbers on Praia islet strongly increased after rabbit eradication, and the colony became the largest one for this species in the Azores, with about one third of the Azorean breeding population between 2003 and 2006 (Figure 2). We could not obtain an accurate estimate of population size in 2004 because many chicks had hatched and were already able to wander far from their nests when we visited the islet. Therefore, we estimated Common Tern numbers for this year to be between 689 and 1196 breeding pairs. Common Tern numbers dropped between 2007 and 2009, when the species was not observed breeding on Praia islet. Common Terns resumed breeding on Praia islet in 2010 (213 pairs) but numbers still remain well below those observed between 2000 and 2006. Nonetheless, Praia islet held again the largest Common Tern colony from the Azores in 2011 with 350 breeding pairs and numbers were high again in 2012 when 300 nests were counted and an additional 254 eggs were found predated that probably accounted for another 105 pairs (Figure 2). In the Azores Common Terns nest in more open habitats than Roseate Terns (Ramos & del Nevo 1995). However, their chicks use to seek cover under vegetation (Cramp 1985). On Praia islet, Common Terns breed throughout almost the entire islet, but are found at higher concentrations in three main nesting areas. One area lies along the western coast and is covered by Azores Coast Fescues *Festuca petraea*. Here, chicks (but not adults) use nest boxes as shelters from weather and aerial predators. Another area lies along the rocky areas on the northern part of the islet with mixed vegetation, and the rest of the colony breeds in the central part of the islet, a grassy area covered with Common Velvetgrass *Holcus lanatus*.

» Petrels

Between 2000 and 2011, the number of breeding attempts by Monteiro's Storm-petrels and Madeiran Storm-petrels in artificial nests underwent an almost six-fold and a four-fold increase, respectively. The number of attempts in natural nests did not vary significantly (Table 1).

In Monteiro's Storm-petrels, overall breeding success from 2000 to 2007 included (excluding 2002, see Table 1) was significantly higher in artificial nests (minimum value, that is, when considering that the few breeding attempts whose fate was unknown were unsuccessful, 50,4%, $n = 284$ breeding attempts) than in natural nests (maximum value, i.e., after considering that the breeding attempts whose fate was actually unknown were successful, 38%, $n = 100$ breeding attempts; G -test, $G1 = 4,57$, $p = 0,032$). The reverse occurred between 2008 and 2012, and differences were significant when comparing the maximum value in natural nests (55,4%, $n = 65$ breeding attempts) and the minimum value in artificial nests (39,2%, $n = 349$; $G1 = 5,78$, $p = 0,016$; see Table 1), or the maximum value in natural nests and that in artificial nests (39,8%; $G1 = 5,37$, $p = 0,020$; see Table 1). Between 2000 and 2012, productivity in artificial nests led to a theoretical annual increase in the breeding numbers in natural nests by at least 53 ± 21 pairs and 61 ± 21 pairs at the most ($n = 12$ years; 2002 was excluded because breeding success was probably underestimated this year; see Table 1 for more explanations).

Madeiran Storm-petrels had higher overall breeding success in artificial nests than in natural nests throughout our study period ($G1$, all $p < 0,009$ except when comparing the minimum value in artificial nests with the maximum value in natural nests: 62,9%, $n = 448$ breeding attempts, vs. 55,0%, $n = 140$ breeding attempts; $G1 = 2,80$, $p = 0,094$; 2001, 2003, 2006, 2009, 2010 and 2012 were excluded from analyses, see Table 1) On average, productivity in artificial nests corresponded to a theoretical annual increase in the breeding numbers in natural nests by at least 77 ± 30 pairs and 118 ± 98 pairs at the most between 2000 and 2012 ($n = 7$ years; same considerations as for G -tests).

Following the habitat restoration measures, the first breeding attempts of Barolo Shearwaters in the artificial nests installed for storm-petrels were no-

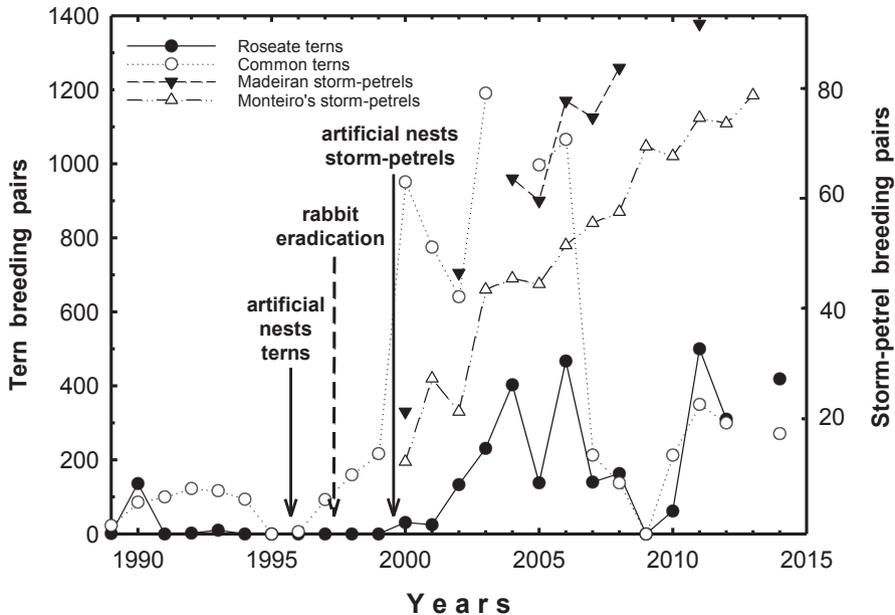


Figure 2. Variations in seabird numbers on Praia islet, since 1989 for Common Terns (breeding numbers in 2004 were not represented, see text) and Roseate Terns, and since 2000 for Madeiran Storm-petrels (data from the winters of 2001-02, 2003-04, 2009-10 and 2010-11 have not been reported, see Table 1) and Monteiro's Storm-petrels in artificial nests. Tern numbers in 2012 are minimum estimates (see text). In 2013 terns were not censused.

Figura 2. Variações inter-anuais do tamanho das populações de aves marinhas no ilhéu da Praia, desde 1989 para as Andorinhas-do-mar comuns (não foram colocados os dados para 2004, ver texto) e rosadas, e desde 2000 para os Painhos-da-Madeira (não foram colocados os dados dos Invernos de 2001, 2003, 2009 e 2010, ver Tabela 1) e de-Monteiro. Os números de andorinhas-do-mar em 2012 constituem estimativas mínimas (ver texto). Em 2013, o censo de andorinhas-do-mar não foi efectuado.

ticed in the spring of 2003, when two chicks were ringed. Since then, seven more chicks have been ringed. In 2011 we detected 13 breeding attempts by this species in the artificial nests. In 2013, we detected at least nine breeding attempts by Barolo Shearwaters in the artificial nests.

Cory's Shearwater numbers on Praia islet represent a negligible proportion of the Azorean population, with only *ca* 120-150 breeding pairs (data from this study). Therefore, restoration measures were not aimed at increasing the size of the population from Praia islet, and this species has not been monitored.

» Unexpected threats

High predation of tern eggs by Starlings on Praia islet was observed in 2008, 2010, and in 2012 when over 350 eggs were found predated.

Turnstones *Arenaria interpres* occur on Praia islet throughout the breeding season of the terns, ranging from small groups of 2 to 4 individuals up to a maximum of 16 individuals. On Praia islet, predation of tern eggs by Turnstones has not been visually observed but the pattern of predation of some eggs (especially how the broken shells looked like) strongly suggests that they were predated by Turnstones.

Another problem may be caused by the introduced Madeiran Lizards *Lacerta dugesii*. On Praia islet, we found two corpses of Monteiro's Storm-petrel chicks in 2010, which had been drawn out of the nests and partially eaten. Furthermore, we found a very freshly dead (and *ca* 3/4 grown) chick (in its nest), whose body was intact but the head feathers, skin and flesh were missing, there was only the bare skull. Since (1) Praia islet is free of mammals and (2) these chicks were all from artificial nests, a gull or a raptor could not have done this. In addition, gulls and raptors would have entirely consumed the storm-petrels and not just their heads. The only possible species is the Madeiran Lizard, even though we could not determine whether the chicks were scavenged or if the lizards had killed them. In 2011, not only we found two dead chicks under similar circumstances to 2010, but we also found a very weakened (although it seemed to be well fed and to bear no ectoparasites) half-grown chick on 29 August 2011, whose head was entirely devoid of feathers and had many small injuries compatible with lizard bites. This chick was also found in an artificial nest. In 2012, we found four dead chicks which had apparently been killed or scavenged by lizards in their nests. A fifth chick, which was *ca* 3/4 grown, was found with wounds on its head compatible with lizard bites on 9 September 2012. However, it looked in good condition and showed no apparent signs of weakening. Still, all these chicks were found in artificial nests.

DISCUSSION

» Tern populations

While tern populations on Praia islet numbered several hundreds of individuals in 1963 and 1964, that is, a few years after rabbit introduction (Bannerman & Bannerman 1966), not a single individual was observed during the next census in 1984 (Dunn 1989). Tern numbers were also very low during the late 1980s and early 1990s, but dramatically increased after rabbit eradication in 1997 (Figure 2). In 2003, the islet held about one-third of the Azorean breeding population of both Roseate Terns and Common Terns. However, and despite inter-annual fluctuations, the long-term trend

concerning the breeding numbers of each species in the entire archipelago is stable (del Nevo *et al.* 1993, V.C. Neves unpubl. data), suggesting an increasing attractiveness of Praia islet for terns, which are mobile species and can readily shift colony sites (McNicholl 1975).

The increase in tern breeding pairs during the virtually continuous presence of researchers on the island from March 2000 to September 2001 (and later, when visitation was only intermittent) supports the idea that the impacts of restoration activities are not biased by researcher presence, which may discourage tourists from landing on the islet. The decrease observed in 2005 for both tern species (Figure 2) occurred throughout most of the archipelago (authors' unpubl. data), and may have been related to adverse oceanic conditions and a likely decrease in prey availability in the colony surroundings, which are known to affect seabird colony attendance (Weimerskirch 2002). The absence of breeding Common Terns on Praia islet in 2009 is harder to explain especially as terns were observed on the islet early in the breeding season (L. Aguiar pers. comm.). There might have been a disturbance event that caused the terns not to breed on the islet this year.

In 2009, Roseate Terns did not breed on Praia islet but about 260 pairs bred on Feno islet, Terceira island (Amaral *et al.* 2010). In 2010, the low tern numbers on Praia islet may be explained (at least concerning Roseate Terns) by the presence of 207 Common Tern pairs and 175 Roseate Tern pairs on Feno islet, where both species used to breed until the arrival of Black rats *Rattus rattus* in 2003. Rats were eradicated from Feno islet in 2007 (Amaral *et al.* 2010). In other words, almost the entire Roseate Tern population from Praia islet may have shifted to Feno islet in 2009, a behaviour which is not uncommon in terns (McNicholl 1975). Support for this hypothesis was provided in 2011 and 2012. In 2011, only five Roseate Tern pairs bred on Feno islet whereas Praia islet, with 500 pairs (i.e., almost half of the Azorean population of Roseate Terns), held the largest Roseate Tern colony from the Azores this year. In 2012, 163 Roseate Tern pairs bred on Feno islet, yielding an estimate for the two islets (473 to 553 pairs) similar to that for 2011. Common Tern breeding numbers on Praia and Feno islet

summed 420 pairs in 2010, 522 pairs in 2011 and between 433 and 538 pairs in 2012, that is, fewer pairs (in both absolute and relative numbers) than during the mid-2000s only on Praia islet. These variations could be explained, at least partly, by lower Common Tern numbers in the whole Azores archipelago than prior to 2008 (V.C. Neves unpubl. data).

The fact that Roseate Terns almost never used the nest boxes for nesting on Praia islet, although they readily use them at other localities (Spendinglow 1996), suggests that the availability of suitable nesting habitat on Praia islet is sufficient for this species. In contrast, many Common Terns bred in the area containing the nest boxes, although there were many more breeding terns than boxes. The increased shelter resulting from the spread of vegetation following rabbit eradication associated with the close proximity of Tamarisks *Tamarix africana* may explain the increasing attractiveness of the nest box area for Common Terns. Common Tern chicks have been regularly observed under Azores Coast Fescue plants in this area (Bried *et al.* 2009). In addition, the concomitant (and spontaneous) recovery of the herbaceous vegetation in the central part of the islet increased the suitable area for both tern species, enabling chicks to dig tunnels through the vegetation to become sheltered from sun and rain (data from this study).

» Storm-petrels

Both species have clearly benefited from the implemented measures, although nest boxes were installed almost three years after rabbits were eradicated and estimates of breeding success in natural nests before rabbit eradication are lacking. Madeiran Storm-petrels and, until 2007, Monteiro's Storm-petrels, experienced higher breeding success in nest boxes than in natural nests (Table 1). This was also observed after artificial nests were installed at colonies of other petrel species (Byrd *et al.* 1983, De León & Mínguez 2003). On Praia islet, annual chick productivity in nest boxes was equivalent to that of almost 60% of the Monteiro's Storm-petrel population and of 38 to 59% of the Madeiran Storm-petrel population breeding in natural nests. Higher breeding success in nest boxes was probably due to the fact that the latter offer more protection against

inclement weather than natural nests and cannot be excavated by the much larger Cory's Shearwaters (in the Azores, inter-specific competition for natural nesting cavities with Cory's Shearwaters is known to result in increased mortality for the smaller petrel species, Ramos *et al.* 1997, authors' unpubl. data).

The successful use of artificial nests represents a very important conservation achievement for Monteiro's Storm-petrel. Currently, Praia islet may hold more than 50% of the world population of this Azores-endemic species (250-300 breeding pairs, Monteiro *et al.* 1999, Bolton *et al.* 2008).

» Other bird species

Some Barolo Shearwater pairs spontaneously settled in the nest boxes installed for storm-petrels, although playback of the calls of this species in the nest box areas has never been conducted, contrary to what had been done for the two storm-petrels in 2000 and 2001 (Bolton *et al.* 2004). Provided that the population size estimate given by Monteiro *et al.* (1999) for Praia islet (50 breeding pairs) was correct and that breeding numbers in natural nests remained stable thereafter, the pairs that bred in artificial nests in 2011 correspond to an increase by 26% in the size of the breeding population of Barolo Shearwaters on Praia islet. This result shows that installing more nest boxes should enable a significant increase in the numbers of this threatened species (BirdLife International 2004), endemic to Macaronesia.

Also, the increase in vegetation cover enabled the arrival of the Common Quail *Coturnix coturnix*, a terrestrial species, in 2006. Breeding attempts by Common Quails on Praia islet were first observed in 2008 and have been occurring each year since then.

» Long-known threats to Praia islet

Although Praia islet has become a site of major importance for the conservation of Azorean seabirds, especially since rabbit eradication and habitat restoration, it remains vulnerable. Public visitation to the islet is only allowed when visitors are accompanied by a warden. However fortuitous visitation still occurs, essentially in summer, that is, during the most sensitive stage of the breeding cycle of

terns, Monteiro's Storm-petrels and Cory's Shearwaters. Despite awareness campaigns and advertising, visitors may inadvertently disturb seabird colonies, for example by displacing the stones covering storm-petrel nest boxes, by walking across tern colonies without paying attention to eggs, or by landing on the islet at night despite nocturnal landings on Praia islet being forbidden (Bried *et al.* 2009). So far, tern colony sites in the Azores were always abandoned the year after a severe human disturbance (Monteiro *et al.* 1996).

Although the distance between Graciosa island and Praia islet (*ca* 1 km) probably precludes natural recolonization by rabbits, another problem might be the potential introduction of rats *Rattus* spp. following shipwrecks, especially when considering that Praia islet lies less than 2 km from the shipping route for passenger ferries, and that a cargo ship ran aground at the southern extremity of the islet in 2000 (Bolton *et al.* 2008).

Natural threats include strong (but so far sporadic) predation by Long-eared Owls *Asio Otus* which are resident in the Azores (Bolton *et al.* 2008), and by resident Yellow-legged Gulls *Larus michabellis atlantis* (Monteiro *et al.* 1996). Vagrant raptors regularly occur in the Azores (Rodebrand & The Birding Azores team 2011). They exploit the local food resources opportunistically and even a single individual staying for a few weeks can have a strong impact (Bried 2003). Therefore, it may be advisable to capture or shoot them. Bried *et al.* (2009) also noticed that feral Rock Pigeons *Columba livia* breed in the cliffs of Praia islet, where they may compete with storm-petrels and Barolo Shearwaters for nesting cavities.

» Unexpected threats

Starlings predate tern eggs. In the Azores and until 2007, this phenomenon essentially occurred on Vila islet (Santa Maria island), where it was the main cause of incubation failure in Roseate Terns, with more than 92% of the eggs being predated during some years (Neves *et al.* 2011). Our data concerning Praia islet strongly suggest that predation rates can also be high at this location. Neves *et al.* (2011) recommend using lethal control directed at the individuals that predate eggs. Turnstones are also known to

prey on tern eggs at several localities (Farraway *et al.* 1986). In the Azores, Praia islet seems to be the only location where they might exert such predation, at least for the moment. Further monitoring is needed to assess their impact more accurately.

Madeiran Lizards are known to kill and consume young Cory's Shearwater chicks on Selvagem Grande (Matias *et al.* 2009). On Praia islet, we frequently observed them on the stones and concrete slabs covering the artificial nests during the day, and during the night it was not uncommon to find one or several lizards roosting on the plastic lids put below the slabs or even inside the nest boxes, even though they did not seem to cause disturbance to incubating birds or to damage storm-petrel eggs. Given, however, that Monteiro's Storm-petrel chicks are much smaller than young Cory's Shearwater chicks, there is no reason to believe that Madeiran Lizards would not be able to kill them. In a near future, Madeiran Lizards might also pose problem at another Azorean location, namely Vila islet, Santa Maria island, where their numbers exploded from 2008 onwards (authors' unpubl. data). Vila islet is also mammal-free and is the only known breeding locality of Bulwer's Petrel *Bulweria bulwerii* in the Azores, holding a tiny population (*ca* 50 breeding pairs) of this species (Monteiro *et al.* 1999, J. Bried unpubl. data). Since Bulwer's Petrel chicks are also much smaller than Cory's Shearwater chicks, they might become vulnerable to lizards as well. Measures aimed at eradicating lizards or at controlling their populations on these two islets are welcome.

Our data confirm the importance of follow-up after eradication campaigns and habitat restoration operations. Follow-up is needed not only to assess the effects of such operations, but also to determine the existence of unexpected consequences (see e.g., Bergstrom *et al.* 2009).

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