Environmental Conservation **31** (3): 219–224 © 2004 Foundation for Environmental Conservation DOI:10.1017/S0376892904001456

Unforeseen effects of ecosystem restoration on yellow-legged gulls in a small western Mediterranean island

A. MARTÍNEZ-ABRAÍN[1,2]*, B. SARZO[2], E. VILLUENDAS[2], M. A. BARTOLOMÉ[2], E. MÍNGUEZ[3] AND D. ORO[1]

[1]IMEDEA (CSIC-UIB), C/Miquel Marquès 21, 07190 Esporles, Mallorca, Spain, [2]Consellería de Territori i Habitatge, Centro de Recuperación de Fauna 'Granja de El Saler', Avenida de los Pinares 106, 46012 El Saler, Valencia, Spain, and [3]Universidad Miguel Hernández, Departmento de Biología Aplicada, Avenida del Ferrocarril s/n, E-03202 Elche, Alicante, Spain

Date submitted: 30 January 2004 Date accepted: 31 July 2004

SUMMARY

A conservation project aimed at ecosystem restoration had several unforeseen effects on a colony of the yellow-legged gull *Larus michahellis* in a small western Mediterranean island (Benidorm Island). The project included regulation of massive tourist visits to help restore the soil and autochthonous vegetation. However, gulls habituated rapidly to regulation of tourist activities, as nests located either close to or far from the main trail showed a similar hatching success. The quiet conditions produced by regulation seemingly facilitated a rapid colony increase. Partial removal of alien vegetation (*Opuntia maxima*) showed that gulls had a preference for sites with high vegetation cover because the growth of the colony was proportionally larger in well-vegetated plots. The pricking of a large number of gull eggs surprisingly coincided with a high reproductive success compared to the previous year, although indicators of food availability remained constant between years and the colony had decreased in numbers. Untreated nests were probably more successful because territory size for chicks increased and intraspecific predation decreased. Extreme care must be taken when planning ecosystem-wide management on islands with yellow-legged gull colonies, or other gull species locally considered as pests, to prevent unwanted effects.

Keywords: alien species, Benidorm, ecosystem management, island restoration, *Larus michahellis*, unforeseen effects, yellow-legged gull

INTRODUCTION

The Mediterranean basin has been intensively used by people since ancient times and is currently probably one of the locations on earth most in need of restoration, particularly coastal and island ecosystems. Humans have influenced bird species breeding on Mediterranean islands (Mayol 1986) since Neolithic times, when entire endemic faunas were rendered extinct (see Blondel & Aronson 1999). During the 20th century, many small coastal locations and islands suffered substantial changes with increasing density of the human population, especially during the breeding season of seabirds (see for example Burger & Gochfeld 1993; Tucker & Heath 1994). As a response to many years of ecological deterioration, some Mediterranean regional governments and non-governmental organizations (NGOs) are implementing conservation programmes, including holistic (i.e. ecosystem-wide) restoration of littoral sites, usually cofinanced by European Union (EU) funds (for example the LIFE Natura Programme). For the most part, island restoration targets the whole ecosystem, and it may happen that unforeseen community results are achieved when affecting key species, favouring intermediate predators or through complicated ecological chain reactions (see Towns *et al.* 1997; Towns 2002; Courchamp *et al.* 2003). For example, eradication of alien species can negatively affect some native species after centuries of coexistence (Barnaud & Chapuis 1996; Pascal *et al.* 1996; Zavaleta *et al.* 2001). Results from conservation actions should be communicated among managers to make adaptive learning possible. However, the importance of publishing results from management actions is commonly undermined when these actions include campaigns involving culling of species considered to be pests (see Bosch *et al.* 2000).

On Benidorm, management actions to reduce soil erosion and restore the original botanical community, such as regulation and supervision of tourist visits and removal of exotic vegetation, have produced some unforeseen responses in the yellow-legged gull *Larus michahellis* population, a species considered as superabundant in the Mediterranean (Vidal *et al.* 1998). Pricking of gull eggs to reduce gull breeding success has also produced unexpected results.

MATERIAL AND METHODS

Study area

Restoration actions were implemented on the small island of Benidorm, a 6.5 ha limestone outcrop, maximum altitude 73 m, located *c.* 3 km off the coast of eastern Spain (38°30′N,

---

* Correspondence: Dr Alejandro Martínez-Abraín, IMEDEA, Avenida de los Pinares 106, 46012 El Saler, Valencia, Spain, Tel: +34 9616 10847 Fax: +34 9616 10300 e-mail: a.abrain@terra.es

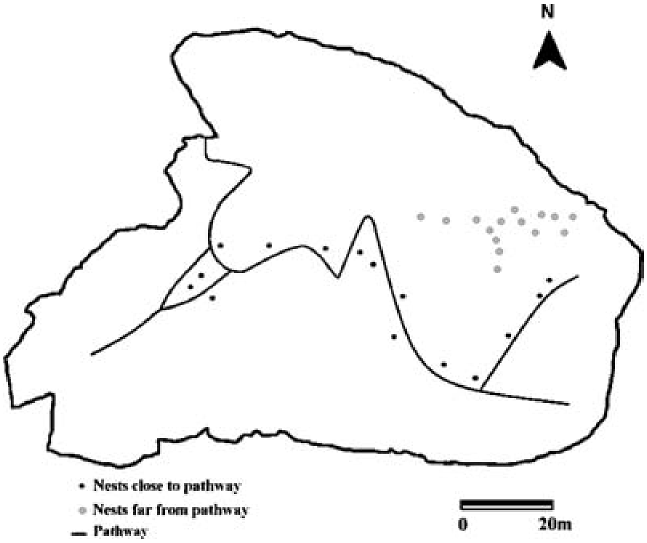

Figure 1 Diagrammatic map of the study area (Benidorm Island) and approximate location of the yellow-legged gull nests studied, close to and far from the main pathway on the island.

0°08′E; Fig. 1). This is a western Mediterranean island with a long history of human alteration and current intense tourist pressure. Vegetation is typical of an arid shrub-dominated Mediterranean island, although the exotic and invasive *Opuntia maxima*, a cactus from the New World tropics introduced to Europe by the mid 16th century, is widespread. The island was visited by an average of *c.* 350 people per day during the breeding season (April–June) in 1999–2001 (Conselleria de Medi Ambient [CMA], unpublished data 2002), as it is close to a prime tourist destination in southern Europe (the city of Benidorm). The island is home to one of the largest colonies of the European storm petrel *Hydrobates pelagicus* in the western Mediterranean (Mínguez 1994). There are also about 500 pairs of the yellow-legged gull *Larus michahellis*, one pair of peregrine falcons *Falco peregrinus*, pallid swifts *Apus pallidus*, Sardinian warblers *Sylvia melanocephala*, black wheatears *Oenanthe leucura* and blue rock thrushes *Monticola solitarius* (A. Martínez-Abraín *et al.*, personal observation 2004). In 1999, a hacking programme (i.e. local captive breeding and later release of birds) of Audouin's gull *Larus audouinii* was started. There are no mammals on the island.

The restoration project

The EU designated the island as a Special Protection Area for birds in 1990 and LIFE programmes for ecosystem restoration have been implemented since 1998. Since 1999, a team of three wardens has prevented daily visitors from wandering away from the main trail, which is *c.* 1.5 m in width and has been delimited by a line of wooden posts (0.4 m in height) linked by thick rope. Before this protection, visitors averaged 220 people per day; peaks of 450 people per day were reached occasionally (Santamaría *et al.* 1997), and the visitors could range freely throughout the island. The island also supported wild-ranging hens, peacocks and domestic pigeons. Low recruitment of native vegetation, because of herbivory by these alien species, the high density of gull guano and the human disturbance (D. García-Llinares, unpublished data 2003) fostered soil erosion (see Otero & Fernández-Sanjurjo 1999; Vidal *et al.* 2000; Mulder-Christa & Keall-Susan 2001). Management tasks for soil and vegetation restoration included the removal of all naturalized hens (68 individuals) and peacocks in 1999–2000 and partial removal of the exotic *Opuntia maxima* cactus in 2000 (*c.* 200 tonnes of the plant; CMA, unpublished data 2001), in addition to banning tourist access to zones outside the trail. *Opuntia* was removed during the winter season of 2000 and hence immediately before of the reproductive season of yellow-legged gulls. We also performed an experimental pricking of a large number of gull eggs (i.e. we decided arbitrarily to prick all the eggs of one out of three nests of yellow-legged gull [$n = 115$] found during the overall count of nests in the colony in April 2002). Eggs were punctured, by means of hypodermic needles, to reduce the number of gull offspring that year and hence contribute to the future reduction in the rate of population growth and decrease the negative effect of yellow-legged gulls on recruitment of Audouin's gulls *Larus audouinii* (see for example Finney *et al.* 2003; Martínez-Abraín *et al.* 2003) and storm-petrel predation. Vegetation and eggs were only treated at these times.

Experimental design and data treatment

To assess tourist influence on gull reproduction, a sample of nests was randomly chosen and monitored throughout the breeding seasons of 2002 and 2003, respectively, within an untreated plot (i.e. a plot where no alien vegetation was removed, which coincided with the northern half of the island delimited by the main trail; see Fig. 1). We compared hatching success (i.e. eggs hatched:eggs laid) for the nests located near to ($n = 15$ in 2000, $n = 20$ in 2003) and far from ($n = 15$ in 2000, $n = 20$ in 2003) the main trail of the island. Nests were considered to be near the pathway when they were closer than 10 m from the closest point of the trail. We recorded both the distance of these close nests to the main trail and their visibility (coded as 1 = visible by tourists from the path, and 0 = not visible by tourists from the path) to ensure whether our sample of nests was homogeneous. All nests were monitored every six days (from 31 March 2002 to 20 May 2002) and every two days (from 2 April 2003 to 23 May 2003) to record breeding variables. The influences of visibility and distance to the trail on hatching success of nests located close to the trail were assessed by means of a generalized linear mixed model (GLMM) with hatching success as the dependent variable, visibility as a fixed factor and distance (i.e. minimum distance in metres from trail to nest) as a covariate. A GLMM was used instead of a general linear model because hatching success, as defined in this study, can only take four possible values (0, 1.0, 0.33 or

0.66) depending on the number of eggs hatched in three-egg clutches, and hence the dependent variable cannot have a normal distribution, which renders GLM unsatisfactory (McCullagh & Nelder 1983). Differences in hatching success between zones (close and far) were compared by means of contingency tables, together with the χ^2 statistic with Yate's correction. Hatching success was compared among vegetation types using a non-parametric ANOVA (Kruskal-Wallis test). All tests were performed with the SPSS 11.0 statistical package (SPSS 2002).

To assess whether removal of exotic vegetation affected gull reproduction, we compared the number of pairs breeding in the treated and untreated plots in 2000 and 2001, taking advantage of the fact that a large overall increase in the number of gull breeding pairs occurred in 2001. The treated plot basically coincided with the southern half of the island delimited by the main trail (Fig. 1). We also recorded vegetation type surrounding the random sample of nests monitored in the untreated plot in order to account for the effect of vegetation cover on breeding performance. We distinguished four vegetation types according to their increasing stature and degree of cover: 1 = *Erodium chium* or/and *Chenopodium murale*; 2 = *Suaeda vera*; 3 = *Salsola oppositifolia* or/and *Whitania frutescens* or/and *Lycium intrincatum*; 4 = *Opuntia maxima* or/and *Olea europaea var. sylvestris*.

The effect of egg culling was assessed by comparing the overall productivity (i.e. number of fledglings per pair) of the colony at the end of the season of culling with productivity data from previous years. We obtained the overall number of fledglings by counting rafts of fledglings resting at the sea by the end of June and taking the maximum count of the season. Changes in productivity were tested by means of a contingency table together with the χ^2 statistic with Yate's correction by comparing the overall number of eggs that produced fledglings and those that did not in 2001 and 2002. An alternative explanation for possible differences in gull productivity between years was variation in food availability. To assess whether food supply changed between the year of egg pricking and the previous year, we used two indicators of food availability for this type of species, namely mean egg volume (of a sample of completed clutches), and the ratio of two-egg to three-egg clutches in the colony (Oro 1996). These two variables reflect food availability per caput in the area (see also Ruiz *et al.* 1998), and are thus good indicators of body condition of birds. Egg length and width were measured with a digital calliper to the nearest 0.01 mm. We used the equation of Harris (1964) with $K_v = 0.476$ to calculate egg volume, and the average clutch volume was calculated in three-egg clutches. We compared mean clutch volume between years by means of a t-test, data being distributed normally (Kolmogorov-Smirnoff test, $Z = 0.628$, $p = 0.825$) and variances being equal (F test, $F = 0.007$, $p = 0.93$). The ratios of clutch sizes were compared among years by means of a contingency table together with the χ^2 statistic.

Table 1 Relationship between hatching success and both minimum distance of the nest to the trail in meters (DIS) and visibility of the nest from the trail by human visitors (VIS), tested through a generalized linear mixed model (GLMM).

Variable	*Estimate*	*SE*	*df*	*t*	*p-value*
Intercept	0.36	0.24	14	1.526	0.149
DIS	0.03	0.07	14	0.476	0.641
VIS	0.18	0.41	14	0.438	0.668
VIS * DIS	−0.35	0.08	14	−0.397	0.697

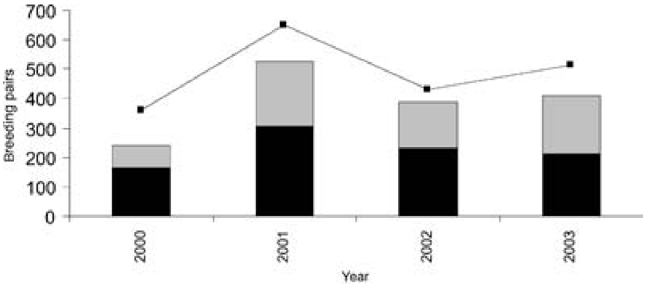

Figure 2 Plot of overall number of breeding pairs of the yellow-legged gull *Larus michahellis* on the island of Benidorm (2000–2003). Columns show the number of breeding pairs of the yellow-legged gull in the plot where alien vegetation (*Opuntia maxima*) was partially removed in 2000 (solid black) and in an untreated plot (grey). No vegetation was removed after 2000.

RESULTS

Effects of tourist regulation

Hatching success of nests located close to the trail was independent of both distance to the trail and visibility from the trail, as well as the interaction between both variables (Table 1). We therefore considered our sample homogeneous and proceeded to compare nests located close to and far from the trail. We found that hatching success (eggs hatched:eggs laid) did not differ significantly between nests located close to and far from the trail (0.41 ± 0.43 versus 0.49 ± 0.32 in 2002 and 0.50 ± 0.34 versus 0.67 ± 0.24 in 2003; mean ± SD), both in 2002 ($\chi_1^2 = 0.38$, $p = 0.54$) and 2003 ($\chi_1^2 = 0.61$, $p = 0.43$).

Effects of exotic vegetation removal

As shown in Figure 2, the large increase of the colony from 2000 to 2001 occurred both in the treated and untreated plots, but it was proportionally larger in the untreated plot (an 192% versus 84% increase; $\chi_1^2 = 260.5$, $p < 0.001$). Nests within the untreated plot showed similar hatching success regardless of vegetation type ($\chi_3^2 = 3.307$, $p = 0.347$).

Effects of egg pricking

Body condition of gulls was probably similar in 2001 and 2002, as neither egg volume ($t = 0.034$, $df = 70$, $p = 0.97$) nor the ratio of two-egg:three-egg clutches ($\chi_1^2 = 0.897$, $p = 0.34$)

differed significantly between years, suggesting similar food availability per caput between years. Nevertheless, culling of eggs coincided with a marked increase in productivity in 2002 compared to 2001 (0.7 fledglings per pair in 2002 versus 0.4 fledglings per pair in 2001; $\chi^2_1 = 260.52$, $p < 0.001$), which was contrary to the goal of such an action.

DISCUSSION

Hatching success is a reproductive parameter sensitive to human disturbance in ground-nesting colonial seabirds (see for example Brown & Morris 1994; Nisbet 2000). However, in our study, hatching success was similar for nests located close to or far from the trail; moreover, this reproductive parameter was independent of both distance and visibility from the main trail, in the set of nests sampled close to the trail. In a study conducted in 1993–1994, before island protection, Santamaría *et al.* (1997) found that Benidorm gulls had a significantly higher hatching success when breeding far from tourist presence (0.38 ± 0.66 eggs hatched as an average in nests close to the trail versus 1.68 ± 1.1 eggs in nests located far from the trail). Hence, gulls appear to have habituated rapidly to the massive, but controlled human presence close to nests (gulls can build nests right under the rope limiting the trail), and that might help explain the rapid and unwanted growth of the colony from *c.* 300 pairs before protection to *c.* 400–600 pairs after protection (Fig. 2). Habituation to human presence has previously been recorded in several marine bird species (see Burger & Gochfeld 1993). In fact, seabirds exposed to intense tourist visitation do not respond to human presence as a stressor, relative to those unaccustomed to seeing humans or only used to moderate levels of human disturbance (Burger & Gochfeld 1999; Fowler 1999). We have also observed this phenomenon of habituation to massive, but controlled human presence in a large yellow-legged gull colony located in the largely visited Penyal d'Ifach nature park, where gulls may breed on the narrow trail that channels tourists up and down the hill. However, in the more isolated colony of the Columbretes Islands reserve, where tourist visits are highly restricted, gulls are less trusting and seldom nest close to pathways.

The colony grew both in the plot where alien vegetation was removed and in the untreated plot, but showed a clear tendency to grow proportionally more in the untreated plot. This is consistent with yellow-legged gulls first occupying plots with the highest percentage of tall vegetation, as they do in the Medes Islands (Bosch & Sol 1998), but contrary to nest-density distribution being independent of vegetation parameters (cover and height) on islands off Marseille (Vidal *et al.* 2001). As the hatching success of eggs was independent of vegetation type surrounding nests, we suggest that yellow-legged gulls prefer areas with high vegetation cover in Mediterranean latitudes to prevent dangerous exposure of chicks to the sun later in the season, as well as to seek protection against other sources of disturbance (Brown & Morris 1994). Gulls might also derive some physiological benefit from perching on *Opuntia maxima* because thermoregulation is probably easier on top of the plant's high stems than at ground level. Similar cases have been reported before. For example, habitat modification (i.e. mowing of long grass at the colony site prior to the start of breeding) decreased both the density of nests and nesting success (Smith & Carlile 1993). Hence, a massive removal of *O. maxima* from the island could have resulted in a smaller increase in gull numbers, facilitated by tourist regulation. However, only areas with intermediate levels of vegetation cover should be treated, because areas with very high cover are not suitable for nest construction (A. Martínez-Abraín *et al.*, unpublished data 2003) and removal of vegetation in those areas could open up space for gulls.

The increase in gull productivity during the year of egg culling (2002) was probably because the territory size for each chick around active nests increased and intraspecific predation decreased as a result of the forced breeding failure of a third of the colony. Alternatively, external factors, such as high food availability, might have caused a higher breeding success in 2002, although this seems unlikely as indirect measures of body condition indicated similar food availability between years during the egg phase, and the regime of local fishing moratoria, known to reduce food availability for this species (Oro *et al.* 1995), remained constant. Egg pricking has reduced nesting success in silver gulls (*Larus novaehollandiae*; Smith & Carlile 1993) and cases have been reported in which the destruction of herring and great black-backed gull (*L. argentatus* and *L. marinus*) eggs was an effective method of eliminating the production of fledglings and, in the long term, reducing nesting attempts (Olijnyk & Brown 1999). To be effective, egg pricking must probably be applied to a larger percentage of the colony. We have used this method intensively on Benidorm island in 2004 and productivity has dropped by 50% compared to the previous year (0.7 fledglings per pair in 2003 versus 0.35 fledglings per pair in 2004).

Habitat management, species management and unforeseen effects

Contrary to our expectations, egg culling in 2002 did not reduce the number of fledglings per pair to levels lower than those of previous years. However, the reduction in the number of places to hide and to obtain a good thermal environment, produced by the removal of large exotic plants probably prevented a larger increase in gull numbers. Work on habitat restoration can help the management of superabundant species that depend on high vegetation cover. Habitat restoration is commonly an expensive enterprise, but it can be justified more easily if ecological benefits are wide and immediate. Restoration of the island according to holistic objectives had the unforeseen and unwanted effect of facilitating the increase of yellow-legged gull numbers, which was not a desired conservation target as gulls predate storm petrels (Mínguez & Oro 2003) and interfere with recruitment of Audouin's gulls from our hacking programme (A. Martínez-Abraín *et al.*, unpublished data 2003), a gull species of conservation concern in the Mediterranean (Tucker & Heath 1994). The increase in yellow-legged gull numbers cannot be attributed solely to the management actions performed, because it was a rapid increase probably caused by external factors (such as immigration from other colonies) and not because of change in the demographic parameters of the colony. However, it seems that management established the right proximate conditions to allow colony growth to take place (i.e. regulating human presence). In projects dealing with ecosystem-wide management in yellow-legged gull colonies or other superabundant gull species colonies, extreme care must be taken to foresee possible indirect effects of habitat manipulation on the population dynamics of gulls.

ACKNOWLEDGEMENTS

We thank all the Benidorm wardens who were in charge of tourist control and vegetation removal and helped during the pricking experiment. Suni provided data on the number of visitors. J. Santamaría provided a copy of his paper on gulls and tourism. C. Viedma, J. Jiménez, R.E. Ricklefs and G. Tavecchia provided constructive criticism of the draft manuscript. A. Martínez-Abraín, B. Sarzo and E. Villuendas were partially supported by funding from the LIFE02NATURE/E/8608 programme for the conservation of Audouin's gull in the Valencian community.

References

Barnaud, G. & Chapuis, J.L. (1996) Scientific and ethic issues on the restoration of island ecosystems. The eradication of introduced mammals in the Subantarctic Islands. *Vie et Milieu* **46**: 291–303.

Bosch, M. & Sol, D. (1998) Habitat selection and breeding success in yellow-legged gulls *Larus cachinnans*. *Ibis* **140**: 415–421.

Bosch, M., Oro, D., Cantos, F.J. & Zabala, M. (2000) Short-term effects of culling on the ecology and population dynamics of the yellow-legged gull. *Journal of Applied Ecology* **37**: 369–385.

Blondel, J. & Aronson, J. (1999) *Biology and Wildlife of the Mediterranean Region*. Oxford, UK: Oxford University Press.

Brown, K.M. & Morris, R.D. (1994) The influence of investigator disturbance on the breeding success of ringed-billed gulls (*Larus delawarensis*). *Colonial Waterbirds* **17**: 7–16.

Burger, J. & Gochfeld, M. (1993) Tourism and short-term behavioural responses of nesting masked, red-footed, and blue-footed, boobies in the Galapagos. *Environmental Conservation* **20**: 255–9.

Burger, J. & Gochfeld, M. (1999) Role of human disturbance in response behaviour of Laysan Albatrosses (*Diomedea immutabilis*). *Bird Behavior* **13**: 23–30.

Courchamp, F., Chapuis, J.L. & Pascal, M. (2003) Mammal invaders on islands: impact, control and control impact. *Biological Reviews* **78**: 347–383.

Finney, S.K., Harris, M.P., Keller, L.F., Elston, D.A., Monaghan, P. & Wanless, S. (2003) Reducing the density of breeding gulls influences the pattern of recruitment of immature Atlantic puffins *Fratercula arctica* to a breeding colony. *Journal of Applied Ecology* **40**: 545–552.

Fowler, G.S. (1999) Behavioural and hormonal responses of Magellanic penguins (*Spheniscus magellanicus*) to tourism and nest site visitation. *Biological Conservation* **90**: 143–149.

Harris, M.P. (1964) Aspects of the breeding biology of the gulls *Larus argentatus, Larus fuscus* and *Larus marinus*. *Ibis* **106**: 432–456.

Martínez-Abraín, A., González-Solís, J., Pedrocchi, V., Genovart, M., Abella, J.C., Ruiz, X., Jiménez, J. & Oro, D. (2003) Kleptoparasitism, disturbance and predation of yellow-legged gulls on Audouin's gulls in three colonies of the western Mediterranean. *Scientia Marina* **67**: 89–94.

Mayol, J. (1986) Human impact on seabirds in the Balearic Islands. In: *Mediterranean Marine Avifauna: Population Studies and Conservation*, ed. X. Medmaravis & X. Monbaillu, pp. 379–396. Berlin, Germany: Springer-Verlag.

McCullagh, P. & Nelder, J.A. (1983) *Generalised Linear Modelling*. London, UK: Chapman & Hall.

Mínguez, E. (1994) Censo, cronología de puesta y éxito reproductor del paiño común en la isla de Benidorm. *Ardeola* **41**: 3–11.

Mínguez, E. & Oro, D. (2003) Variations in nest mortality in the European storm petrel *Hydrobates pelagicus*. *Ardea* **91**: 113–117.

Mulder-Christa, P.H. & Keall-Susan, N. (2001) Burrowing seabirds and reptiles: impacts on seeds, seedlings and soils in an island forest in New Zealand. *Oecologia* **127**: 350–360.

Nisbet, I.C.T. (2000) Disturbance, habituation, and management of waterbird colonies. *Waterbirds* **23**: 312–32.

Olijnyk, C.G. & Brown, K.M. (1999) Results of a seven year effort to reduce nesting by Herring and Great black-backed Gulls. *Waterbirds* **22**: 285–289.

Oro, D. (1996) The effects of trawler discard availability on the egg-laying and the breeding success of the Lesser Black-backed Gull *Larus fuscus* in western Mediterranean. *Marine Ecology Progress Series* **132**: 43–46.

Oro, D., Bosch, M. & Ruiz, X. (1995) Effects of a trawling moratorium on the breeding success of the yellow-legged gull, *Larus cachinnans*. *Ibis* **137**: 547–549.

Otero, J.L. & Fernández-Sanjurjo, M.J. (1999) Seasonal variation in inorganic nitrogen content of soils from breeding sites of yellow-legged gulls (*Larus cachinnans*) in the Cies Islands Natural Park (NW Iberian Peninsula). *Fresenius Environmental Bulletin* **8**: 685–692.

Pascal, M., Cosson, F.J., Bioret, F., Yesou, P. & Siorat, F. (1996) Alien species eradication and the general topic of island biodiversity restoration. The special case of Brittany island mammals. *Vie et Milieu* **46**: 345–354.

Ruiz, X., Jover, L. & Pedrocchi, V. (1998) Audouin's Gull intraspecific variability in yolk and albumen egg contents: why is yolk size so constant? *Biologia e Conservazione della Fauna* **102**: 327–334.

Santamaría, J., Santamaría, T. & Serrano, R. (1997) Efectos de la actividad humana en el éxito reproductivo de la gaviota patiamarilla (*Larus cachinnans michahellis*) en la isla de Benidorm. In: *Proceedings of the XII Spanish Ornithological Conference*, coord. J. Manrique, A. Sánchez, F. Suárez & M. Llanes, pp. 229–237. Almería, Spain: Instituto de Estudios Almerienses.

Smith, G.C. & Carlile, N. (1993). Methods for population control within a silver gull colony. *Wildlife Research* **20**: 219–226.

SPSS (2002) *SPSS v.11.0. Manual del usuario*. Cork, Ireland: SPSS, Inc.

Towns, D.R. (2002) Korapuki Island as a case study for restoration of insular ecosystems in New Zealand. *Journal of Biogeography* **29**: 593–607.

Towns, D.R., Simberloff, D. & Atkinson-Ian, A.E. (1997) Restoration of New Zealand islands: Redressing the effects of introduced species. *Pacific Conservation Biology* **3**: 99–124.

Tucker, G.M. & Heath, M. (1994) *Birds in Europe: Their Conservation Status*. BirdLife Conservation Series No. 3. Cambridge, UK: BirdLife International.

Vidal, E., Medail, F. & Tatoni, T. (1998) Is the yellow-legged gull, *Larus cachinnans,* a superabundant bird species in the Mediterranean? Impact on flora and fauna, conservation measures and research priorities. *Biodiversity and Conservation* **7**: 1013–1026.

Vidal, E., Medail, F., Tatoni, T. & Bonnet, V. (2000) Seabirds drive plant species turnover on small Mediterranean islands at the expense of native taxa. *Oecologia* **122**: 427–434.

Vidal, E., Roche, P., Bonnet, V. & Tatoni, T. (2001) Nest-density distribution patterns in a yellow-legged gull archipelago colony. *Acta Oecologica* **22**: 245–251.

Zavaleta, E. S., Hobbs, R.J. & Mooney, H.A. (2001) Viewing invasive species removal in a whole-ecosystem context. *Trends in Ecology and Evolution* **16**: 454–459.