

Lessons from
the management of
Audouin's Gull
Larus audouinii
in Eastern Spain (1999-2008):
recommended guidelines

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SUMMARY

This report presents the management of the Audouin's Gull (*Larus audouinii*) in the Iberian Peninsula, specifically in East Spain (Valencian Region), carried out by the Regional Ministry of the Environment (Consellería de Medio Ambiente) between 1999 and 2008. Firstly, the report evaluates the social facilitation measures (decoys and hacking) performed for both the recovery of the colony on the Columbretes Archipelago (2003-2008), which had significantly declined since the beginning of the nineties, and the establishment of a new colony on the Benidorm Island (1999-2007) in order to connect the colonies of the South Mediterranean (Chafarinas, Alborán, and Grosa Island-Murcia) and the Ebro Delta-Columbretes systems. Secondly, this report evaluates the management of the Yellow-legged Gull (Audouin's Gulls' main competitor) in both areas, specifically culling and dissuasive actions (balloons, firecrackers, laser, etc.). In this report, we describe the undertaking of these actions and suggest some recommendations for future projects with this or other similar species for conservation purposes. We hope that this report serves as a guide for future conservation and management projects, not only for the Audouin's Gull in the whole distribution area, but also for other seabirds with similar characteristics.

After nine years of managing this species, the population of East Spain was seen to significantly recover with the incipient growth of the Columbretes colony and the establishment of two new colonies at the Albufera Valencia and Lagunas de La Mata-Torre Vieja Natural Park with 140 and 700 pairs in 2008, respectively). The assessment of the social facilitation measures indicated that, although artificial decoys did not facilitate nesting, live decoys and hacking played an important role in this recovery. Irrecoverable individuals attracted the nesting of wild individuals, and the 382 released chicks were an important source of individuals for the new colonies of this species in East Spain and in other parts of the Mediterra-

nean. However, a new colony has not been established on Benidorm Island despite a few reproductive attempts since 2005. In Columbretes Archipelago, hacking was seen to have important social reinforcement effects because it facilitated the settlement and breeding of pairs on the islands of this archipelago where the cage with Audouin's Gull chicks was installed. On the other hand, the measures to control the Yellow-legged Gull population (a natural competitor of Audouin's Gull) were not successful and did not contribute to the nesting of Audouin's Gulls.

On the basis of the results obtained, and of the intense recovery of this species worldwide, we conclude that we do not consider it necessary to continue with population reinforcement actions, particularly hacking. Indeed other measures are required, such as population monitoring, knowing the evolution of the species, habitat protection, guaranteeing the establishment and maintenance of healthy colonies, fishing management for food availability, all of which are apparently essential for the conservation of Audouin's Gulls.

FOREWORD

The objective of this report is to describe and assess the management measures of Audouin's Gulls (*Larus audouinii*) during the period 1999-2008 in the Valencian Region (East Spain). This assessment aims to suggest recommendations for the conservation of this species and to serve as a guide for similar management projects of either this species in other Mediterranean areas or other seabirds with similar characteristics.

We describe and assess social facilitation measures (decoys and hacking) and the control actions of Yellow-legged Gulls. This report includes the actions carried out on the Benidorm Island between 1999 and 2007, in the Columbretes Archipelago between 2003 and 2008 and among the new colonies of this species located at both the Albufera of Valencia Natural Park (since 1992) and the Lagunas de la Mata-Torrevieja Natural Park (since 2004). We describe and assess these measures independently in each species. Subsequently, we provide a final valuation.

The framework for most of this management period was the two LIFE nature projects: "Conservación de ZEPA insulares de la Comunidad Valenciana" (1998-2001) (BA 3200/98/447) and "Conservación de *Larus Audouinii* en la Comunidad Valenciana" (2002-2006) (LIFE02NAT/E/8608), cofinanced by the European Union and the Valencian Government.

The information used in this report is derived from the technical reports on the monitoring of seabirds in the Columbretes Archipelago, on the Benidorm Island and in South Alicante carried out by the Mediterranean Institute for Advanced Studies (IMEDEA-CSIC) in a scientific consultancy agreement framework with the Environmental Ministry of the Valencian Government. Information on the management actions performed in relation to Audouin's Gulls originated from the final reports of the LIFE projects produced by the Biodiversity Service of the Environmental Ministry of the Valencian Government, and from the peer review and other publications as a result of this management.

In conclusion, this report aims to compile all the information on the management of Audouin's Gulls obtained in the last ten years, that is actually in the form of unpublished reports, with a view to making this information available to all the persons and institutions interested in the management of seabirds worldwide, and to making a mature and comprehensive assessment of the actions undertaken and the results obtained.

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1 BACKGROUND INFORMATION

The main distribution area of Audouin's Gulls (*Larus Audouinii*) is located in the Mediterranean Sea (Figure 1) (BirdLife International 2004). There are limited dispersed colonies with few pairs in the eastern Mediterranean whereas the most important colonies are located in the western Mediterranean, especially Spain where the species breeds in the Ebro Delta (Catalonia); the Columbretes Archipelago, the Albufera Valencia and the Lagunas de La Mata-Torreveija Natural Park (Valencian Region); the Balears Islands; the Grosa Island (Murcia); the Alborán Island (Andalusia) and the Chafarinas Island (Melilla, N. Africa). Recently, a new colony on the southern Atlantic coast of Portugal has been established (Leal & Lecoq 2005).

In the mid 20th century, the species was considered to be one of the most endangered gull species in the world, with a population of 800-1000 breeding pairs distributed as small colonies on the Mediterranean coast (Oro 1998). Since then, the

population has increased considerably. In 2000, the European population was estimated at 18000-19000 pairs, mainly distributed along Spanish coasts (85-90%) (Oro et al. 2000). This recovery is mainly due to the important increase of the colony in the Ebro Delta. This colony, established in 1981 from 36 pairs, included 12000 pairs in 2000 (62% of the world population) (De Juana & Varela 1989; Oro & Ruxton 2001) (Figure 2).

In the Valencian Region, the Audouin's Gull species breeds nowadays on the Columbretes Nature Reserve, at the Albufera of Valencia, at the Lagunas de La Mata-Torreveija Natural Parks and occasionally on the Benidorm Island (Figure 3). Although most individuals migrate to the western coast of Africa in winter, some stay in the Mediterranean Sea. In winter, Audouin's Gull individuals are sighted in the Valencian Region, specifically on the Columbretes Archipelago (up to 2000 individuals) (Jiménez & Cardá 1997) and in the La Mata-Torreveija Natural Park.



Figure 1: Mediterranean distribution of Audouin's Gulls.

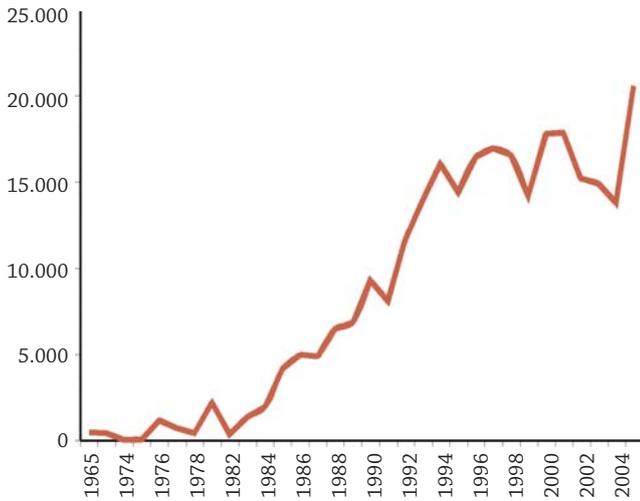


Figure 2: Evolution of the Audouin's Gulls population in Spain (1965-2005) (Source: Grupo de Trabajo de Gaviota de Audouin).

On the Columbretes Archipelago, the most ancient colony of the species in the Valencian Region (the first reproduction sign was in the seventies), Audouin's Gulls numbers significantly increased until 1991 (Table 1 and Figure 4). Since then, the colony started to decrease (one exception was the peak occurring in the mid nineties when an important migration of individuals from the Ebro Delta took place due to the presence of a predator in the Punta de la Banya) (Travecchia et al. 2007) (Table 1 and Figure 4). The important population decrease of this colony was due to the emigration of individuals (especially young birds) to other colonies (mainly the Ebro Delta and the Grosa Island of Murcia) (Oro et al. 2003; Cam et al. 2004) given a temporal coincidence of the breeding season with a fishing moratorium in the area that affected food availability (Oro et al. 2004).

Due to this important population decline, in 1992 the Environmental Ministry of the Valencian Government initiated a trial involving captive breeding in the Fauna Recovery Centre "Granja de El Saler" (hereafter the WRC) with eggs firstly from the Columbretes Archipelago and then from the Ebro Delta. In the same year, five chicks were released in the Albufera Valencia Natural Park, where this centre is located. Two chicks of the irrecoverable pairs which remained at the WRC were also released. From 1995 to 2000, several pairs of Audouin's Gulls were observed and attempted to

breed at this Natural Park (some of them were individuals released at the WRC) (Table 2) (Martínez-Abraín et al. 2001).



Figure 3: Audouin's Gulls colonies in the Valencian Region.

These results were a starting point for the management of Audouin's Gulls in the Valencian Region. This management included social facilitation measures in the Columbretes Archipelago and on the

Benidorm Island. Until recent years, the results of these measures, in conjunction with the immigration of individuals from nearby colonies (the Ebro Delta and the Grosa Island of Murcia), have

Table 1: Evolution of Audouin's Gulls in the colony on the Columbretes Archipelago. PE=Number of pairs; ER=Reproduction success; TP=Cluth-size. (Source: Consellería de Medio Ambiente, Agua, Urbanismo y Vivienda).

	PE	TP	ER
1974 (Pechuan 1974)	40-50		
1975 (Pechuan 1975)	100-105		
1978 (Mayol 2006)	130		
1982 (Pechuan 1982)	200		
1983 (Gómez 1987)	333		
1984 (Gómez 1987)	300		
1985 (Gómez 1987)	381		
1986 (E.O.A. 1986)	300		
1987 (E.O.A. 1987)	250-300		0.08
1988 (Dies et al. 1990)	225		1.85
1990	430	1.72	1.4
1991	225	2.26	0.06
1992	170	1.94	0.13
1993	100	1.93	0
1994	275	2.47	0.16
1995	625	2.23	0.35
1996	525	2.54	0.57
1997	500	2.50	0
1998	200	2.33	0
1999	75	2.01	0
2000	80	2.02	0.08
2001	70	1.92	0.14
2002	30	2.13	0
2003	28	1.93	0
2004	25	-	0
2005	21	1.7	0.90
2006	59	2.10	0.59
2007	79	2.16	0.66
2008	60	-	-

favoured the recovery of Audouin’s Gulls in the Valencian Region, and two new colonies had been naturally created: one at the Albufera Valencia Natural Park and the other at the Lagunas de la Mata-To-

rrevieja Natural Park. In the following sections, a detailed description of the evolution of these colonies and an analysis of the role that the management measures had on their creation are provided.

Table 2: Main breeding parameters of Audouin’s Gulls at the Albufera Valencia Natural Park (1995-2000). Source: Martínez-Abraín et al. (2001).

	1995	1996	1997	1998	1999	2000
Number of laid eggs	2	2	2	3	3	0
Number of hatched eggs	0	2	0	2	3	0
Number of fledged chicks	0	2	0 (a)	0 (b)	0 (c)	0
Date of the first egg laid	9 May	9 May	8 May	24 April	20 April	-

(a) One chick died after an ant attack and two chicks were hand-reared; (b) One egg was not fertile and two chicks were preyed on by dogs; (c) Three eggs hatched but one chick died after a few days and two chicks were removed and hand-reared for hacking.

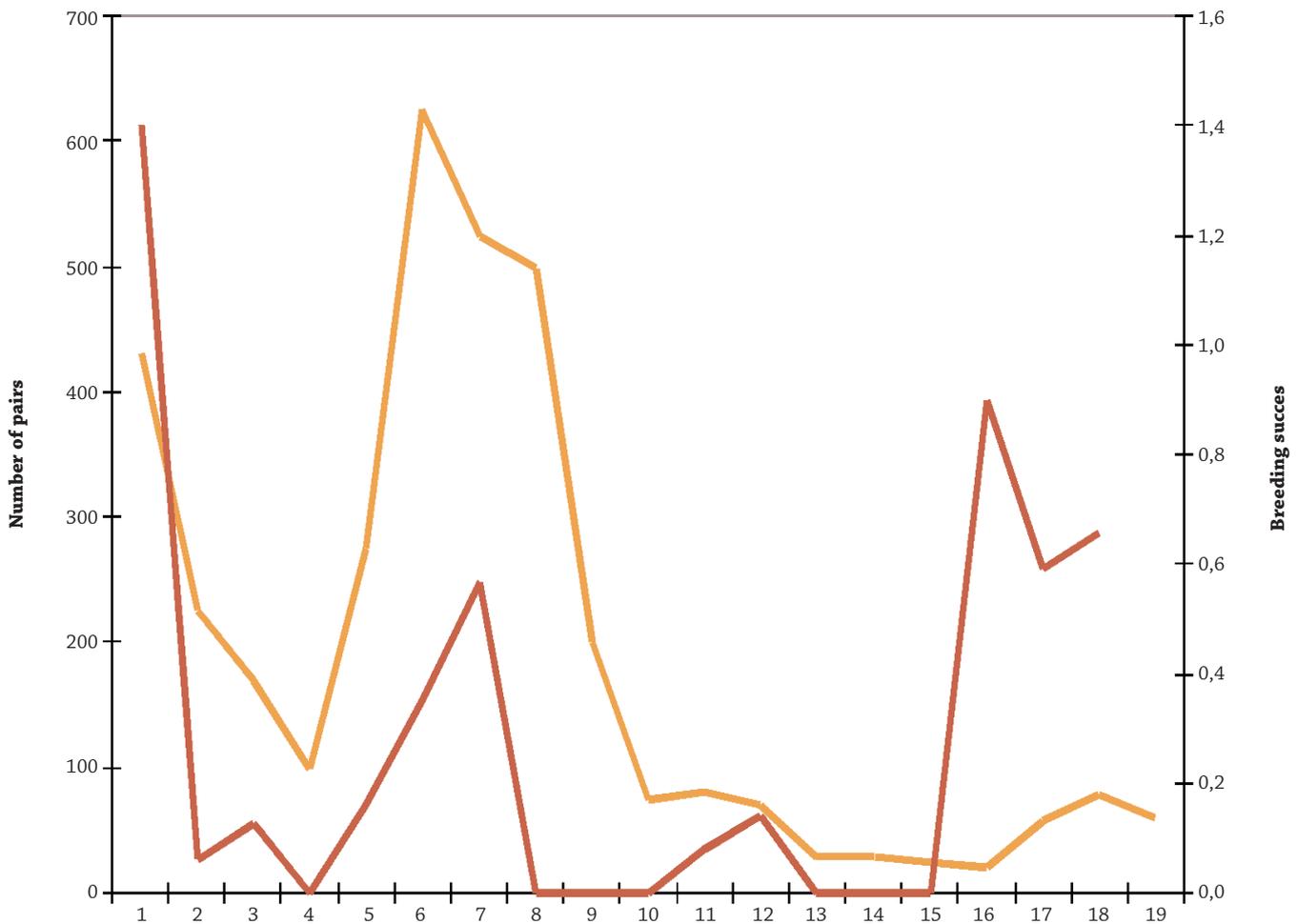


Figure 4: Evolution of Audouin’s Gulls in the colony on the Columbretes Archipelago (1990-2008). Green: Number of pairs; Grey: Reproduction success. (Source: Consellería de Medio Ambiente, Agua, Urbanismo y Vivienda).

2 JUSTIFICATION

Until the recovery of Audouin's Gulls as a result of the establishment of the Ebro Delta colony, the species was considered to be one of the most threatened gull species in the world. Currently, the species is protected on international, European, national and regional scopes (Table 3). The distribution of Audouin's Gulls is practically limited to the Mediterranean area, and most of the worldwide population is concentrated in only one colony (the colony of Punta de la Banya at the Ebro Delta Natural Park). Other than this colony, most colonies are relegated to islands and islets, basically in the Spanish Mediterranean. This habitat seems to be of a low quality for the species, but it is available given the significant alteration of beaches and other coastal habitats. The Audouin's Gull species has been considered a flagship species in different insular areas and it has been used as an emblem of protection for some areas, such as the Columbretes Archipelago. Nevertheless, the ecology of this gull is characteristic of a coastal bird.

Nowadays, although the population size is globally increasing, decreases have been noted in some colonies, such as the Columbretes Archipelago (Figure 4). This situation, and the localised distribution of the colonies, increases the risk of extinction owing to stochastic phenomena. Furthermore, the important urban development that is taking place along the Mediterranean

coast is reducing potential areas for this species to colonise.

Nonetheless, the Audouin's Gull population's main competitor, Yellow-legged Gulls, is presently undergoing a significant increase. Traditionally, interaction with species was considered to be one of the threatening factors for the conservation of both Audouin's Gulls and others seabird colonies (Oro & Martínez-Abraín 2007). For this reason, controlling the population size of Yellow-legged Gulls has been considered essential to avoid the desertion of colonies of Audouin's Gulls (for example, in Chafarinas and Balears Islands). The negative interactions between both species can be reflected in three ways (Oro & Martínez-Abraín 2007):

- Competition for nesting places. Yellow-legged Gulls start reproduction almost one month earlier than Audouin's Gulls. One consequence is a reduction in nesting places or lower quality nesting places being available.
- Trophic resources competence. Both species use trawler discards for feeding, and although Audouin's Gulls are more efficient in capturing discards (Arcos et al. 2001), kleptoparasitism is very intense when the number of Yellow-legged Gulls is considerably higher than the number of Audouin's Gulls. So, the key variable is not the amount of trophic resources, but the amount that individuals can obtain, and this depends on the amount of trophic resources, and also on intra- and interspecific competence (Oro & Martínez-Abraín 2005; Oro et al. 2006).
- Finally, Yellow-legged Gulls are a facultative predator of Audouin's Gulls, and they prey on eggs, chicks and adults (Oro & Martínez-Villalta 1994, Bradley 1986, Monbailliu & Torre 1986; Martínez-Abraín et al. 2003).

Table 3: Threatened categories of Audouin's Gulls.

Bonn Convention	Annexe I
Berna Convention	Annexe II
Birds Directive	Annexes I and II
SPAMI	Annexe II
IUCN	Near threatened
National catalogue	Of special interest
Valencian Region catalogue	Endangered



Image 1: The Benidorm Island. Photo: **A. Martínez-Abraín.**

The Benidorm Island

The Benidorm Island (Image 1) is a calcareous outcrop of 6.5ha located 3 km from the Benidorm coastline (38°30'N, 0°08'E). Its main vegetation is composed of nitrohalophic bush.

This island was declared a Natural Park by the local government as a Special Protection Area in accordance with European Directives 92/43/EEC and 79/409/EEC. Although Audouin's Gulls were not a breeding species on the Benidorm Island, some actions were initiated to establish a new colony for strategic questions in conservation matters.

Specifically, the Benidorm Island is located between colonies of Audouin's Gulls of the south (Chafarinas, Alborán and Grosa) and the Ebro Delta-Columbretes systems. On the one hand, this position means that the creation of a new colony on this island is of great interest since it could reinforce the metapopulation distribution

of this species as a large percentage of its worldwide population is currently concentrated in only one colony. On the other hand, habitat characteristics and food availability seem to be adequate for the establishment of a new colony (Conselleria de Medio Ambiente, Agua, Urbanismo y Vivienda 2001c).

The objectives were to:

- Initiate a pilot project to assess the validity of active management for the recovery and creation of new populations of coastal seabirds, such as Audouin's Gulls.
- Increase the number of breeding pairs in the Valencian Region given an important decrease of the historic colony of the Columbretes Archipelago.
- Establish a new colony to decrease the risk of global extinction due to stochastic processes.

The Columbretes Archipelago

The Columbretes Islands form a small volcanic archipelago located 35 nautical miles from the coast (39°51'N, 0°40'E) and with approximately 19 ha of emerged land. The islets form four groups: the Grossa, Ferrera, Foradada and Carallot Islands. This archipelago was declared a Nature Reserve by the local government as a Special Protection Area of European Directives 92/43/EEC and 79/409/EEC. Since 1990, the marine area is a Marine Reserve and includes 4400 ha.

This archipelago has an Audouin's Gulls breeding colony since, at least, 1973, and it became one of the biggest colonies in the western Mediterranean. In the last few years however, this colony has significantly declined (Figure 4). It has reached a number of breeding pairs that could be considered of critical size since below this number, the colony is neither socially attractive to recruit new indivi-

duals which attempt reproduction, nor effective in its defence mechanisms to face Yellow-legged Gulls. In other words, Audouin's Gulls are at significantly risk of local extinction. For this reason, a series of measures was initiated in 2003 to manage this colony. The objectives of these actions were to:

- Recover the colony of Audouin's Gulls in the Columbretes Archipelago
- Increase the number of breeding pairs in the Valencian Region
- Maintain the metapopulation structure of the colonies of Audouin's Gulls in order to decrease the global risk of extinction through stochastic processes
- Assess the validity of this kind of measures for the conservation of coastal seabirds such as Audouin's Gulls



Image 2: Grosse Island of the Columbretes Archipelago. Photo: F. Guzman

3 DESCRIPTION AND RESULTS OF THE MANAGEMENT

The measures carried out between 1999-2008 to favour the reproduction of Audouin's Gulls in the Columbretes Archipelago and on the Benidorm Island were: artificial decoys, decoys with irrecoverable individuals from WRC, hacking, and a series of actions to control the Yellow-legged Gulls population.

In addition to these measures, 8 artificial decoys were centred on the Cantera Island in 2005 (Tabarca Archipelago; 38°10'N, 0°28'W) to favour the settlement of Audouin's Gulls because this area is frequently visited by this species in spring. This measure did not produce positive results and the decoys were broken by visitors. The management of Audouin's Gulls in this area was not continued over

the following years because it is not an optimal habitat for the species given the high number of visitors and the fact that there are predators (e.g. cats).

The different measures carried out in each area and the period of each measure are shown in Tables 4 and 5, respectively.

3.1 Location of the measures

On the Benidorm Island, the different measures (artificial decoys, cage with irrecoverable individuals, and hacking) were located in an area away from the visitors infrastructure, but somewhere which was accessible for the guards (Figure 5).

Table 4: Measures carried out on the Benidorm Island (B) and in the Columbretes Archipelago (C) to favour the reproduction of Audouin's Gulls.

	1999		2000		2001		2002		2003		2004		2005		2006		2007		2008	
	B	C	B	C	B	C	B	C	B	C	B	C	B	C	B	C	B	C	B	C
Artificial decoys																				
Cage with irrecoverable individuals																				
Hacking																				
Competence with Yellow-legged Gulls																				
Nest culling																				
Eggs culling																				
Chicks culling																				
Adults culling																				
Dissuasive measures																				
Balloons																				
Nylon grids																				
Firecrackers																				
Shuts																				

Table 5: Temporal periods of the different measures carried out to favour the reproduction of Audouin’s Gulls.

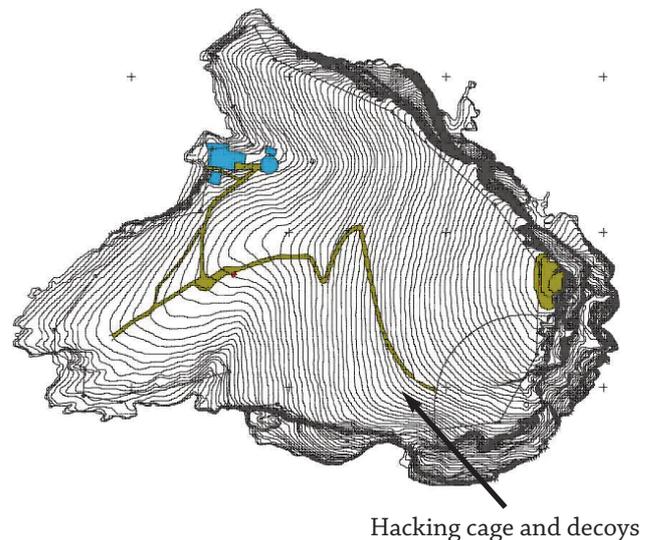
	Jan	Feb	Ma	Apr	Ma	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Artificial decoys												
Cage with irrecoverable individuals												
Hacking												
Collecting eggs												
Collecting chicks												
Transport to the islands												
Release												
Competence with Yellow-legged Gulls												
Nest culling												
Eggs culling												
Chicks culling												
Adults culling												
Dissuasive measures												
Balloons												
Nylon grids												
Firecrackers												
Lasers												
Shuts												

Although the selected area did not seem to be an optimal habitat for the Audouin’s Gull, as it had more Yellow-legged Gulls’s nests than other areas of the island and is rocky, tranquillity (no human nuisance) was the key reason to select this area of management.

In the Columbretes Archipelago, the measures were carried out on the Grossa and Ferrera Islands (Figure 6). Specifically, the cage to maintain the irrecoverable individuals and the chicks of the hacking actions was located on the Grossa Island, the biggest island of the archipelago where there are guards all year round and where the biggest and the most profitable colony was placed until the colony decrease. The artificial decoys were located on the Grossa Island in 2003 to help the birds to settle on this island rather than on the Foradada Island which did not seem to be an adequate habitat and where Audouin’s Gulls had settled the previous

year. In 2004 and 2005, the artificial decoys were located on the Ferrera Island.

Figure 5: Location of the management measures on the Benidorm Island. Blue: public use infrastructures, Green: path, Red: information stand.



3.2 Monitoring

The presence and behaviour of Audouin's Gulls individuals were monitored to assess the results of the social facilitation measures carried out on the Benidorm Island and in the Columbretes Archipelago.

Monitoring consisted in the guards making daily visits from February until the desertion of individuals from the island. During the monitoring period, the guards noted the number of individuals, if they were ringed and their behaviour (movements, singing, reproduction, etc.). Furthermore, once a week, two people stayed on the island during nightfall and daybreak to read the individuals' rings.

3.3 Artificial decoys

One of the measures taken to promote the nidification of Audouin's Gulls on the Benidorm and Columbretes Archipelago was to place some figures that simulated adult individuals of the species (Images 3 and 4). Artificial decoys were set up in early spring in places which were considered optimal for the colonisation of Audouin's Gulls (see Section 3.1). Firstly, the material employed for artificial decoys was foam rubber, but this material was substituted for fibreglass, and finally for concrete.

On the Benidorm island, between 25 and 37 artificial decoys were placed each year in the period 2002-2006 to attract those individuals released in the

Figure 6: Location of the Audouin's Gulls colony in the Columbretes Archipelago and the location of the management measures.



hacking programme (Table 6). On the Columbretes Archipelago, some 11-31 artificial decoys were placed each year between 2003 and 2005 (Table 6).

Table 6: Artificial decoys placed on the Benidorm and Columbretes Archipelago.

	2002	2003	2004	2005	2006
BENIDORM					
Number	25	41	37	31	24
Placing date	-	Mar	24 Apr	11 Mar	Mar
COLUMBRETES					
Number	0	40	31	11	0
Placing date	-	5 Mar	21 Apr	9 Feb	-



Image 3: Artificial Audouin's Gull decoys. Photo: A. Martínez-Abraín.

Measure assessment

On the Benidorm and Columbretes Archipelago, artificial decoys did not seem to favour the nidification of Audouin's Gulls; indeed no gull alighted in the area. However, artificial decoys served to facilitate the adaptation of the chicks of the hacking programme to the new cage conditions in the release area because the chicks recognised them and they did a feeding display to obtain food. So, artificial decoys were placed near food trays in order to facilitate the chicks feeding.

One of the key questions in this kind of measures is the material used. On islands, a commitment exists between transport and durability. Artificial decoys made from foam rubber were easily transported but because of their lightness and fragility, they blew away, and Yellow-legged Gulls wrecked them. Artificial decoys made out of fibreglass were also too light and it was difficult to anchor them onto the land. Finally, concrete artificial decoys were more resistant and durable but their transport, especially on the Columbretes Archipelago, made placing difficult.

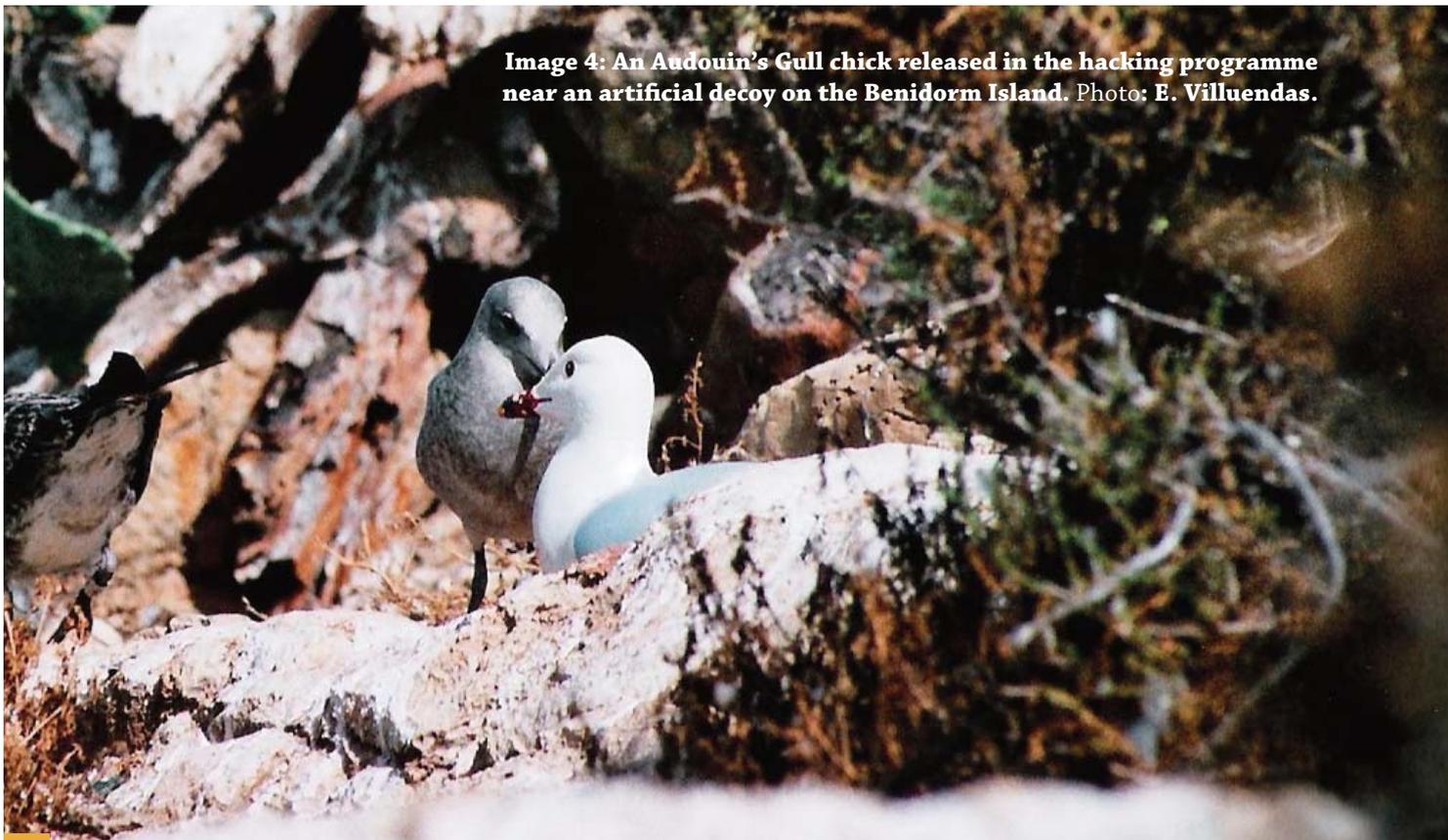


Image 4: An Audouin's Gull chick released in the hacking programme near an artificial decoy on the Benidorm Island. Photo: E. Villuendas.

3.4 Decoys with live individuals

On the Benidorm (2002-2007) and Columbretes Archipelago (2003), cages with irrecoverable Audouin's Gulls individuals from the WRC were put into cages. This measure aimed to attract wild individuals and to encourage nidification. Live decoys have the advantage over artificial decoys in that social facilitation does not only use visual but also auditory tracks.

To carry out this measure, four cages were constructed on the Benidorm Island. These were replaced with a bigger cage (10x6 m floor) in 2004, and also with another small detachable cage (3x2 m floor). As Table 7 shows, decoys remained on the island for a mean of 61.22 days between March and June.

In the Columbretes Archipelago, this measure was adopted in 2003. It consisted in installing a cage on the Grossa Island with two individuals. In 2004 and 2005, this measure was not adopted due to the difficulty of placing the cage on the Ferrera Island, where the Audouin's Gulls colony had already settled in 2003. Again in 2006, this measure was not taken because the decoys did not seem to unfailingly encourage the nidification of the species.

The live individuals used returned to the WRC when the chicks of the hacking programme arri-

ved. While the individuals remained, the cages were maintained (repair of the mesh, parasol, etc.). Caring for individuals consisted in feeding and watering once a day. Besides, a veterinary inspection on what appeared to be unhealthy individuals was performed; a probe was used to force feed those individuals that did not feed. Finally, individuals were returned to the WRF if they lost too much weight.

Measure assessment

One of the difficulties of using this kind of measure was that the inaccessibility of many of the colonies made placing cages difficult. Furthermore, it is important to take into account that this measure requires a daily presence of guards to feed the individuals used as decoys. On small islands, where the presence of guards or accessibility on days with bad weather conditions is difficult, as with the Ferrera Island of the Columbretes Archipelago, the use of such a measure is unfeasible. Thus, the use of live individuals as decoys as a social facilitation measure is only feasible on islands or in other areas with good accessibility and where the presence of guards is continuous, as in Benidorm island. Furthermore, the presence of infrastructures for the preservation of fish is also required on islands where the daily replacement of guards is not feasible.

Table 7: Number and periods of utilisation of live decoys on the Benidorm and Columbretes Archipelago.

	2002	2003	2004	2005	2006	2007
BENIDORM						
Number	6	3	6	5	4	2
Arrival date	15 Feb	22 Apr	2 Apr	3 ind, 14 Mar		
2 ind, 21 Apr	11 Apr	14 Jun				
Leaving date	1 Apr	10 Jun	2 ind, 8 Apr			
4 ind, 1 Jul	14 Jun	23 Jun	-			
COLUMBRETES						
Number	0	2	0	0	0	0
Arrival date	-	23 Apr	-	-	-	-
Leaving date	-	Jun	-	-	-	-

In relation to the adaptability of the decoy individuals, they were seen to respond well to the transport and maintenance of cages on the Benidorm and Columbretes Archipelago. In 2002 however, decoys lost considerable weight on the Benidorm Island, and three died while the rest had to return to the WRC (Table 8). Weight loss and the presence of bleeding ulcers (C. Gerique pers. com.) were associated with the absence of fresh water. In subsequent years, jars of fresh water and seawater were placed in the cages. This problem was analysed in detail by Martínez-Abraín et al. (2007).

During the first year in which this measure was applied, some individuals were hurt owing to the small dimensions of the cages on the Benidorm Island, which did not occur when a bigger cage was constructed.

In relation to the results obtained, the use of live decoys as a social facilitation measure to encourage the nidification of the species provided positive results on the Benidorm Island because, in conjunction with the Yellow-legged Gulls' culling and hacking, it facilitates the settlement of some Audouin's Gull pairs, although they did breed successfully (see the section of the final assessment of the social facilitation measures). Although this measure was only adopted during one year at Columbretes, it apparently did not yield positive results. It has to take into account that a colony of Audouin's Gulls had already settled at Columbretes (Grossa Island), so wild individuals acted as a social facilitation measure, thus rendering this measure unnecessary.

3.5 Rivalry with Yellow-legged Gulls

Benidorm Island

Measures commenced in 2003 to prevent breeding pairs of Yellow-legged Gulls from settling on the Benidorm Island, specifically in the area where colonisation of Audouin's Gulls was expected. During this year, empty nest culling was carried out, but no laying control measure was taken to reduce any nuisance for Audouin's Gulls to settle.

From 2004 to 2006, this kind of measures was intensified. Specifically, the measures adopted were the elimination of empty nests early in the reproduction period, and eggs culling (Image 6). This second measure consisted in collecting, pricking or waterproofing of eggs. In the last case, eggs were immersed in a container with a waterproof liquid. However, the establishment of nests as a control showed that this measure was not successful, thus this method did not continue. Chicks and adults culling was another measure taken. Traps were used for these individuals (Image 7), and Pentothal was used as a sedative. Chick and adult culling was undertaken principally in the place where the hacking cage was placed.

Nonetheless, deterrent measures were developed to avoid Yellow-legged Gulls from nesting. These measures consisted in large balloons with faces painted on them, nylon grids (Image 8), firecrackers and shuts. Table 9 shows the period when these measures were applied on the Benidorm Island.

Table 8: Weight loss of live decoys during their stay on the Benidorm Island in 2002.

	15 Feb	08 Mar	18 Mar	19 Mar	20 Mar	24 Mar
JNR (♀)	523	451	368	344	Died	
JHN (♀)	532	369	368	359	338	Died
J7X (♂)	641	604	598	581		
JWV (♂)	575	544	545	510		
JW0	606	530	530	516		
Y77	-	-	-	-	-	-

Table 9: Measures adopted to decrease the number of breeding pairs and to avoid the reproduction of Yellow-legged Gulls on the Benidorm Island.

	2003	2004	2005	2006
Nest culling	119	209	479	1084
Period of nest culling	-	2 Jan – 18 Mar	13 Jan – 6 Apr	12 Apr – 10 Jun
Eggs culling	0	933	2420	1894
Period of eggs culling	-	18 Mar – 29 Jun	9 Mar – 9 Jun	Apr-Jun
Chicks culling	0	132	138	41
Adults culling	0	44 (12 pairs)	80	22 (11 pairs)
Deterrent measures	0	X	X	X
Balloons	-	X	0	0
Application period of balloons	-	5 Feb	-	-
Nylon grids (m2)	-	1400	2100	3000
Application period of nylon grids	-	12 Feb – 5 Apr	Mar	Dec 2005 – 31 Ago
Firecrackers	-	X	X	0
Application period of firecrackers	-	9, 18, 22, 24 Mar and 28, 29 Apr	Mar	-
Shuts	-	X	X	0
Application period of shuts	-	Jan-Mar	Jan-Mar	-

Columbretes

In the Columbretes Archipelago, the measures to avoid Yellow-legged Gulls from nesting were taken in 2003 and 2004 on the Grossa Island.

These measures consisted in nest, eggs and chicks culling, although with less intensity than those on the Benidorm Island (Table 10).

Table 10: Measures adopted to decrease the number of breeding pairs and to avoid the reproduction of Yellow-legged Gulls on the Columbretes Archipelago.

	2003	2004
Nest culling	68 (without eggs)	12 (18 eggs)
Period of nest culling	20 – 31 Mar	28 Apr
Eggs culling	-	93
Period of eggs culling	-	28 Apr
Chicks culling	-	23
Period of chicks culling	-	26 May



Image 6: The eggs culling measure for Yellow-legged Gulls on the Benidorm Island. Left: pricking of eggs, Right: collecting eggs. Photo: A. Martínez-Abraín.



Measure assessment

In general terms, culling and deterrent measures did not help Audouin's Gulls to settle and had no significant repercussion on the reproduction of Yellow-legged Gulls. In the final assessment section, a general assessment of this kind of measures is made.

On the Benidorm Island, the measures taken to avoid Yellow-legged Gulls from settling were not successful because this species was accustomed to such measures. Although nylon grids had a tempo-

rally effect on the Yellow-legged Gulls colony, it also avoided the establishment of colonies of Audouin's Gulls, and once the nylon grids were removed, Yellow-legged Gulls rapidly occupied this space.

Nest culling was ineffective because Yellow-legged Gulls were able to replace them rapidly. Only the creation of a gap of Yellow-legged Gulls in the area where the hacking cage was placed on the Benidorm Island by chicks and adults culling, as well as by the social facilitation measures adopted, actually facilitated the nesting of Audouin's Gulls (see the hacking assessment section).



Image 7: The culling of Yellow-legged Gull adults on the Benidorm Island. Photo: A. Martínez-Abraín.

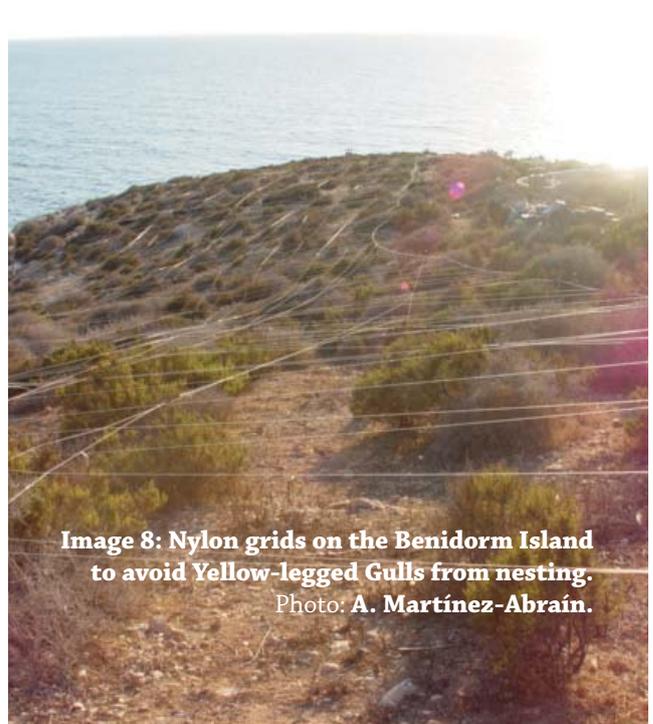


Image 8: Nylon grids on the Benidorm Island to avoid Yellow-legged Gulls from nesting. Photo: A. Martínez-Abraín.

3.6 Hacking

This technique is one of the most important tools for the recovery of endangered species in places where they are extinct. It has been frequently used for raptors and also for seabirds such as Atlantic puffins (*Fratercula arctica*) and Leach's Storm-petrel (*Oceanodroma leucorhoa*) (Kress 1997). This method consists in the translocation of chicks to cages placed in the area where species would ideally be recovered and where chicks are fed until they become independent since chicks of filopatric species are expected to return to the place where they became independent in order to breed. On the Benidorm Island, the hacking programme was underway from 1999 to 2006. The hacking programme at Columbretes started in 2003 and continued until recently (2008).

Phase I: Collecting and maintaining eggs and chicks in captivity

Table 11 summarises the information of this first phase of the hacking programme. As this table shows, in the first two years of the programme,

eggs were collected from the Columbretes Archipelago and were hatched in the WRC. In 2001, eggs were collected from Punta la Banya (the Ebro Delta) to minimise the impacts on the decadent colony of the Columbretes Archipelago. During these years, hatch success was high. In the following years, chicks, but no eggs, were collected from Punta la Banya and maintained in the WRC until their translocation to Benidorm or Columbretes (Table 11). The collection of chicks rather than eggs offers two main advantages: the risk of human impregnation decreases and the effort in breeding decreases.

Once the chicks were born in the WRC, they remained in an incubator for 24 hours (Image 9), after which they were moved to circular cages of 1m in diameter. Chicks were monitored during their stay at the WRC (Image 10). When chicks were two weeks old, they stayed in a larger outside cage (2x1.5m) during the day. When chicks were one month old, they were moved to an even bigger cage (3x5m) (Image 11) until their translocation to the Benidorm or Columbretes Archipelago (Lerma 1999) (Images 12 and 13).

Table 11: Main data of the collection and release of chicks in the Benidorm and Columbretes Archipelago. Colum = Columbretes; DEbro = Punta de la Banya (Ebro Delta); Mata = Mata-Torre Vieja Natural Park

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Collection place	Colum	Colum	DEbro	DEbro	DEbro	DEbro	DEbro	DEbro	DEbro	Mata
Collection date	5 and 21 May	19 May	15 May	11 Jun	13 Jun	14 and 15 Jun	16 Jun	13 Jun	26 Jun	26 Jun
Number of eggs	17 and 33	63	60	0	0	0	0	0	0	0
Number of chicks	0	0	0	42	54	61	31	19	30	22
Chicks age (days)	-	-	-	20-27	20-27	20-27	20-27	20-27	20-27	-
Stay at the WRC (days)	42-60	42-60	40-50	3-21	10-20	10-20	10-20	10-20	10-20	14-20
Age of chicks released (days)	49-52	55	55	51-58	40-60	40-60	40-60	40-60	40-60	-
Number of chicks released	31	44	40	38	32	61	28	45	30	22



Image 9: Captive breeding in the WRC of eggs collected in the Ebro Delta. Photo: E. Villuendas.

In relation to feeding, chicks were fed with small fish, *Osmerus eperlanus* since the second day of life. After 10 days, they were fed with anchovies (*Engraulis engraulis*). At the beginning they were fed once an hour, but the number of feeds decreased until three times a day.

A vitamin complex (B1, B2, B6 and nicotinamide) and a supplement of calcium were added (Lerma 1999) to the fish diet. In order to facilitate feeding, artificial decoys were placed near the feeding tray (Image 10).

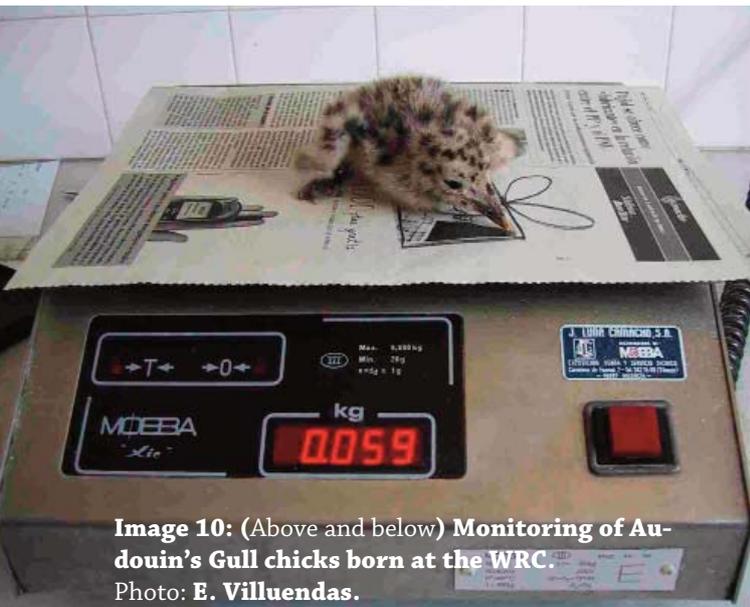


Image 10: (Above and below) Monitoring of Audouin's Gull chicks born at the WRC. Photo: E. Villuendas.

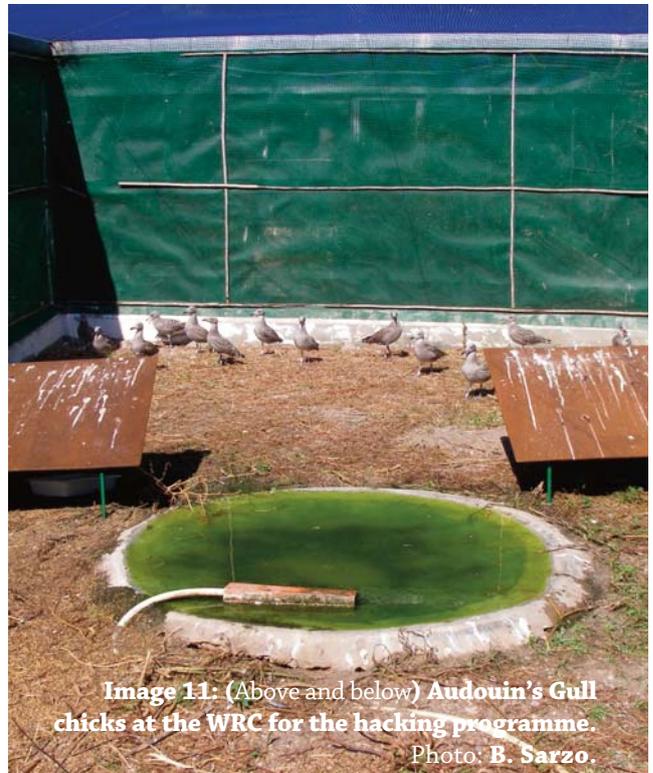


Image 11: (Above and below) Audouin's Gull chicks at the WRC for the hacking programme. Photo: B. Sarzo.



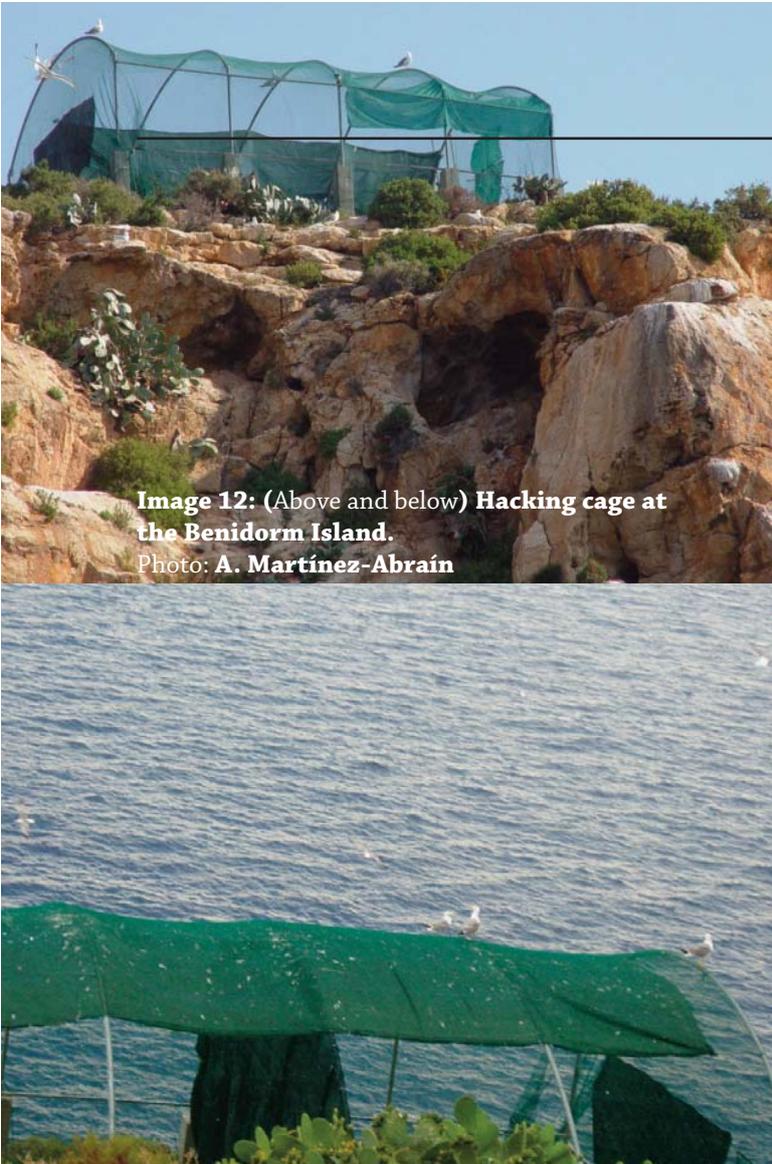


Image 12: (Above and below) Hacking cage at the Benidorm Island.

Photo: A. Martínez-Abraín

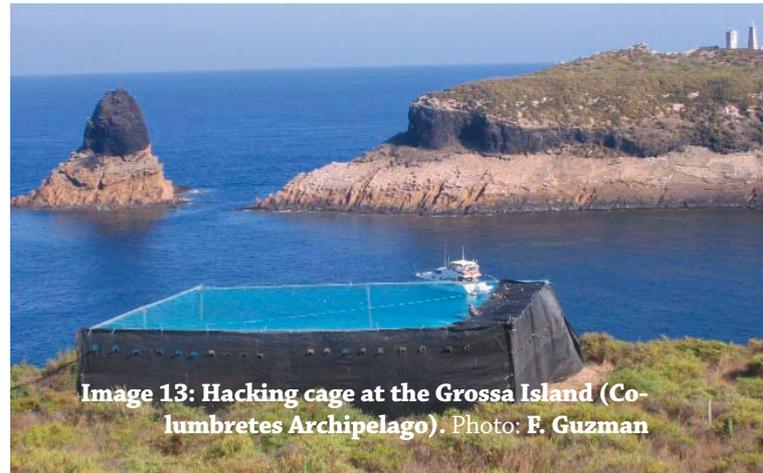


Image 13: Hacking cage at the Grossa Island (Columbretes Archipelago). Photo: F. Guzman

Phase II: Translocation, hacking and release

When the chicks at the WRC were of sufficient body size (approximately one month of age), they were translocated to the Benidorm and Columbretes Archipelago and remained in large cages. The translocation of the chicks was spread out over intervals according to age and size. Once the first group of bigger chicks was translocated to the island, they stayed in the cages for 3-4 days and were fed twice a day. After this period, the doors of the cages were left open and feeding continued for a further two days. After this period, another group of chicks was translocated from the WRC. At the most, 15 chicks in the large cage and 10 chicks in the small cage were translocated in each group.

On the Benidorm Island, 255 chicks were released from 1999 to 2006, a mean of 32 ± 10.38 chicks per year. In 2003 and 2008 in the Columbretes Archipelago, and particularly on the Grossa Island, 127 chicks were released, that is, a mean of 21 ± 7.28 chicks per year. Tables 13 and 14 summarise the information of the release of chicks and the main hacking parameters on the Benidorm and Columbretes Archipelago.

Table 12: Hatching success of the eggs collected for the hacking programme.

	Hatching success (%)
1999	68,0
2000	70,3
2001	76,7

Measure assessment

As Table 12 shows, hatchling success increased during the first three years. Although a better quality of the eggs in the last year of the eggs collection cannot be ruled out, this increased success is probably due to an improvement of the tools and methods employed in the transport and management of the eggs. During 1999 and 2000, eggs were collected from the Columbretes Archipelago and were transported to the WRC by ship. In 2001, eggs were collected from the Ebro Delta and were transported by road. This change in transport may positively affect hatchling success rates.

In the case of chick collections, in general, they seemed to respond well to transport and they stayed at the WRC. However in 2003, a high rate of mortality was registered (13 of the 54 chicks collected died) due to an infection caused by *Aspergillus*. This infection originated from the use of rice straw on the floor of the cages that absorbs and retains humidity. In subsequent years, paper and cardboard were used instead.

Table 13: Main parameters of the hacking programme on the Benidorm Island.

	1999	2000	2001	2002	2003	2004	2005	2006	TOTAL/MEAN
Date	17 and 23 Jun								
1, 8, 15 and 22 Jul	22 and 29 Jun								
6 and 13 Jul	21 and 28 Jun								
5 Jul	14, 18 and 25 Jun								
2 Jul	24 Jun								
1,3 and 21 Jul	28 and 30 Jun								
12 Jul	14 Jun	23 and 29 Jun	-						
No. of chicks translocated	31	44	40	38	32	33	10	27	255
Stay (days)	17	21	21	22	17	11-12	4	15	18 ± 6.01
Flight success (%)	86.1	93.3	87.0	90.5	72.2	100	100	96.0	90.6 ± 9.14
Age	52	55	55	51-58	44-60	-	-	-	54 ± 1.57
Mean weight (g)	567	570	557	521	497	526	521	575	542 ± 29.00

Measure assessment

In general terms, the chicks adapted well to transport and to their stay on the islands. They did not show human impregnation and, although they grew used to the presence of humans, they did not change their behaviour. This was due to the fact that they were collected at an age when the imprinting from their ancestors had already occurred.

In relation to the results obtained with the hacking programme, on the one hand these could be assessed by the effects that it had on the island where the programme was carried out and, on the other hand, by the effects that it had produced on other colonies.

Assessment of the Benidorm hacking programme

The hacking programme did not lead to the creation of a new colony of Audouin's Gulls on the Benidorm Island although, since 2005, some pairs attempted to breed on the island, especially in 2006 when five pairs tried to breed on the island and four of them laid eggs (in 2005 two pairs tried to breed and one in 2007). The low breeding success and recruitment rates, and the high spare rate noted, indicated the failure of this measure on the Benidorm Island (Table 15). However, the years in which social facilitation measures were more intense, the breeding intent and recruitment rates were higher. So, hacking is a social facilitation tool which provides good results for Audouin's Gulls, but the Benidorm Island

Table 14: Main parameters of the hacking programme on the Columbretes Archipelago.

	2003	2004	2005	2006	2007	2008	TOTAL/MEAN
Date	16 Jul	7, 14 and 21 Jul	13 Jul	5 and 12 Jul	11 and 18 Jul	10 and 16 Jul	-
No. of chicks translocated	10	28 (8, 10, 10)	18	19	30 (15, 15)	22	127
Stay (days)	7	3	4	4	4	3	4.17 ± 1.47
Flight success (%)	70	100	100	84.21	100	100	92.37 ± 12.64
Weight	503.25 ± 54.66	532.64 ± 55.53	581.89 ± 50.28	572.47 ± 73.01	539.97 ± 70.71	572 ± 38.73	546.04 ± 31.75

Table 15: Results of the hacking programme on the Benidorm Island. % of spares = birds seen that were not seen the year before in the place of release; Death = chicks that died during their stay in cages on the Benidorm Island.

	1999	2000	2001	2002	2003	2004	2005	2006	2007	TOTAL/MEDIA
Released chicks	31	44	40	38	42	33	10	23	0	261
Death	2	1	1	0	0	2	1	1	-	8
% of spares	-	-	-	-	100	99.98	99.98	99.99	100	99.99
Number of eggs laid	-	-	-	0	0	2	4	1	1	7
Breeding success	-	-	-	0	0	0	0	0	0	0

seems to be an unsuitable place for this species to establish given the high density of Yellow-legged Gulls presented and the physical characteristics of this island; that is, the species select flat surfaces and coastal areas with dunes and beaches as breeding places, and they reject cliff surfaces, which are characteristic of the Benidorm Island.

The low death rate indicates the chicks' good adaptation to their stay in cages on the Benidorm Island (only 3.07% of translocated chicks ($n=8$) died of starvation or were sent back to the WRC), and a high flight success rate was observed (97%). Of those individuals released at Benidorm, and given sightings at other places and in different years, 10 died, so al-

most 3.83% of the birds released had died.

Of the 261 individuals released in Benidorm, 97 (37.16%) have been sighted on 233 occasions. As Table 15 and Figure 7 show, the species presented a low recruitment rate and those birds that returned to the island presented a high spare rate. These results highlight the low homing instinct of the individuals released on the island. This low recruitment rate must be affected by the gender of the individuals released because more females were released, and they had a lower homing instinct than males (Table 17). As Figure 8 shows, places such as Lagunas de La Mata-Torre Vieja and the Grosa Island (Murcia) served as centres of attraction for the chicks released.

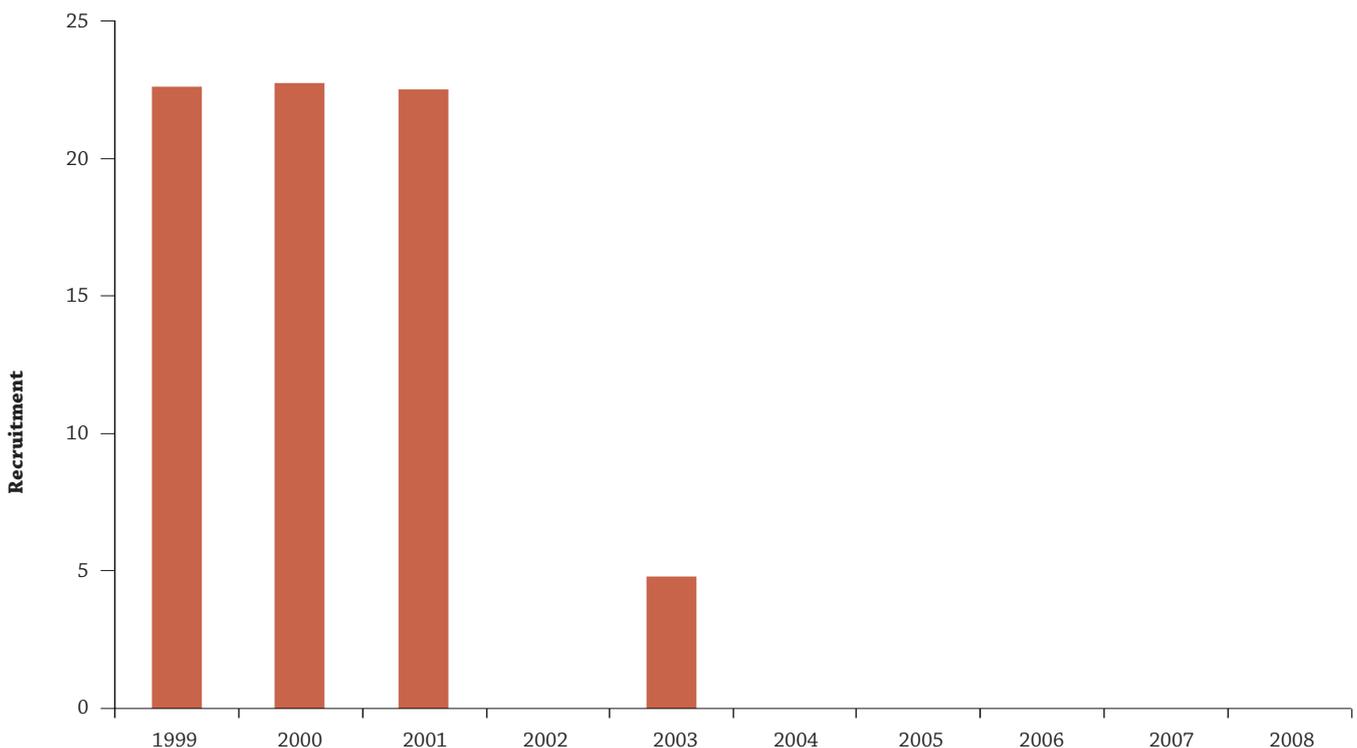


Figure 7: Cohort recruitment of individuals released in the hacking programme on the Benidorm Island. Since 2005, recruitment rates are null because less than three years have passed since the chicks were released.

Table 16: Mortality information of the Audouin's Gull individuals released on the Benidorm Island.

Ring	Release date	Date of death	Place	Cause of death
6129524	2002	May 2006	Grosa Island (Murcia)	Unknown
6108246	2000	May 2005	Benidorm Island	Unknown
6103326	1999	Abr 2004	Albufereta (Alicante)	Unknown
6111751	2000	May 2004	Benidorm Island	Unknown
6111766	2000	Nov 2001	Campello	Must be slaughtered after a year in the WRC
6103319	1999	Dec 1999	Senegal	Accidental capture in fishing nets
6103325	1999	Sep 1999	Morocco	Accidental capture in fishing nets
6111755	2000	-	-	Unknown
6135835	2003	-	-	Unknown
6130648	2003	-	-	Unknown

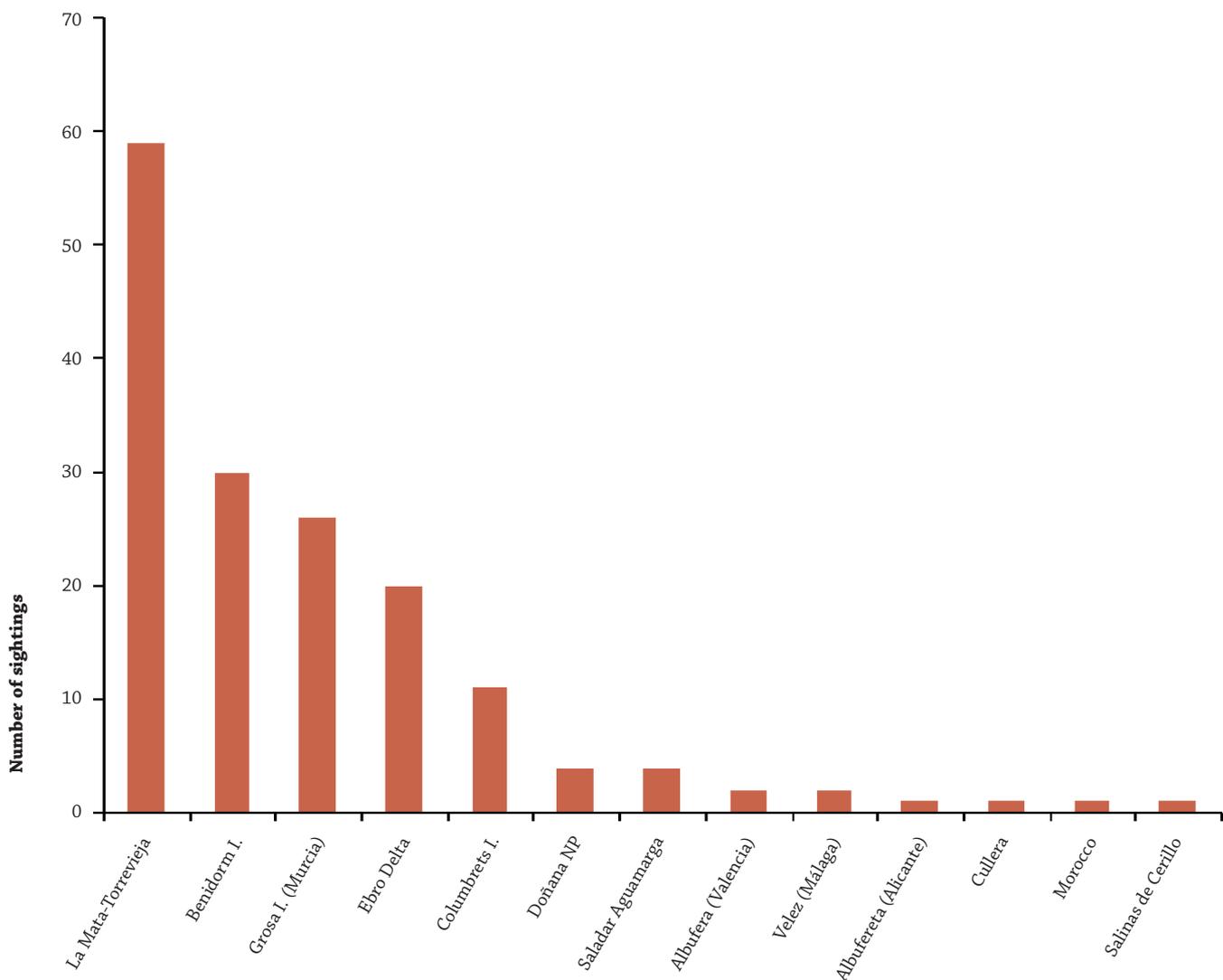
**Figure 8:** Location of sightings during the breeding season (from March to July) of the Audouin's Gulls released on the Benidorm Island.

Table 17: Gender of the individuals released and sightings on the Benidorm Island during 1999 and 2001.

	Released (R)	Sightings (S)	Ratio (S/R)
Male	22	11	0.5
Female	61	18	0.3

The hacking programme, as well as other social facilitation measures (decoys), seemed to encourage Audouin's Gulls to nest in Benidorm. In 2005, 2006 and 2007, two pairs, five pairs and one pair attempted to breed on the Island, respectively. However, breeding success was null for all the years.

Assessment of the Columbretes hacking programme

The low death rate indicates the chicks' good adaptation to their stay in cages on the Grossa Island (only 3.15% of translocated chicks died; two in 2003 and two in 2006), and a high flight success rate was observed (94.91%).

The colony at Columbretes Archipelago had increased considerably since 2005, with a maximum of 79 pairs in 2007 (Figure 4). On the other hand, Audouin's Gulls have changed their nesting places (from small islands to the biggest one, the Grossa Island), and the species is currently located in better areas which provide a better defence from Yellow-legged Gulls, thus allowing denser colonies to form. The hacking programme seems to have contributed considerably to both processes and thus to the recovery of this colony. However, the recruitment of individuals had been low since the starting of the hacking programme. In 2006 an individual released in 2004 was seen and in 2007,

seven individuals (one released in 2003, two in 2005 and four in 2004). Also, nesting attempt of released individuals has been low. In 2006 and 2007 one released individual attempted to breed on the Island.

Assessment of the hacking programme in the Valencian Region

Lagunas de la Mata-Torre Vieja Natural Park. In this Natural Park, a new colony of Audouin's Gulls was established in 2004, which rapidly increased in subsequent years (Table 18) with increase rates of up to 943% from 2005 to 2006. The breeding pairs of this colony mainly came from the Ebro Delta, the Grossa Island (Murcia) and the Benidorm Island (Table 19). The contribution of this last locality increases considerably if the values shown in Table 19 were standardised to the number of ringed individuals in each locality.

The high breeding success that this new colony presented seems to indicate a good status for this colony with no feeding or predation problems. Firstly, there was a fishing port near the colony, so the Gulls could feed on fishing discards. Secondly, the Yellow-legged Gulls in this area did not breed, and the Yellow-legged Gulls individuals which came near the colony were easily repelled by Audouin's Gulls.

Table 18: Evolution of the colony of Audouin's Gulls at the Lagunas de La Mata-Torre Vieja Natural Park.

	Number of pairs	Breeding success	Mean size of laid eggs
2004	20	-	-
2005	30	0.83	2.40
2006	300-310	0.66	2.61
2007	510	0.58	2.55
2008	700	0.85	-

Table 19: Origin of the Audouin's Gulls individuals sighted at the Lagunas de La Mata-Torreveija during 2007 and 2008. NA = Not available. *Individuals were not released during the hacking programme at the Columbretes Archipelago.

Origin	Number of individuals	%
Ebro Delta	119	43.91
Grosa Island	110	40.59
Benidorm Island	28	10.33
Columbretes*	8	2.95
La Mata-Torreveija	2	0.74
Balearic Islands	1	0.37
Italy	1	0.37
NA	2	0.74

Estany del Pujol (Devesa de l'Albufera). A new colony of Audouin's Gulls was established in this area in 2005. This colony presented an important rate of increase in subsequent years and had had a high breeding success (Table 20). The individuals of this colony mainly came from the Ebro Delta (Table 21). Five individuals were released in the hacking programme of Columbretes Archipelago. The suc-

cess rate of this colony seemed to be related with the consumption of *Procambarus clarkii*, an introduced species of crab that is highly abundant in the rice crops of this area. The increase of Audouin's Gulls might have a positive effect on the rice crops in this area as it could act as a control of this arthropod population which causes extensive damage to irrigation channels.

Table 20: Evolution of the colony of Audouin's Gulls at Estany del Pujol (Devesa de l'Albufera). (*) This low breeding success was probably due to an intense rainfall occurred in June.

	Number of pairs	Breeding success	Mean size of laid eggs
2005	8	1.0±0.76	-
2006	55	0.75	2.25±0.60
2007	88	0.92	2.28±0.80
2008	140	0.18*	1.94±0.71

Table 21: Origin of the Audouin's Gulls individuals sighted at Estany del Pujol (Devesa de l'Albufera) (2004-2008).

Origin	Number of individuals	%
Ebro Delta	89	87.25
Benidorm Island	8	7.84
Grosa Island	5	4.90

4 SOCIAL AND MEDIA IMPACTS

In order to analyse the social and media impacts of the Audouin's Gulls management project, an analysis of the news items published from 2003 to 2007 in relation to seabirds conservation in the Valencian Region, and from 2006 and 2007 regarding the Sierra Helada Natural Park, in which the Benidorm Island is located, was carried out. As Table 22 indicates, the news items related to Audouin's Gulls and their management were scarce in relation to other environmental subjects. Any news items encountered on Audouin's Gulls were of a local and regional scope, but not nationwide.

In addition to the mass media, during the LIFE projects, a communication programme which focused on the fishing sector and on other stakeholders implicated in the conservation of the species was undertaken. Some of the measures adopted were the edition of some informative and formative material (informative exhibits,

tales, T-shirts, posters, brochures, caps and stickers, cuddly toy and story about the species). Besides, many meetings had been organised for the purpose of the coordination of different local and regional governments.

Despite the efforts made towards the social diffusion of the measures taken and the high social and media impacts that these active management measures (captive breeding, species reintroduction, etc.) tend to have, the social impacts did not seem to be significant in the case of Audouin's Gulls. This situation is probably due to the fact that Audouin's Gulls species is not charismatic and is not easily distinguished by the general public (Lerma et al. 2004). In addition, the fact that most of the news items encountered were of a local scope may reflect a low interest in the measures taken given the current status of this species, whose major threatened status is presented in the Valencian Region (Table 3).

Table 21: Information of the Sierra Helada Park appeared in the media during 2006 and 2007.

Subject	Year	Distribution			TOTAL
		Local	Regional	Digital	
Audouin's Gulls	2003		3		26 (15.20%)
	2004	2	8		
	2005	1	2		
	2006	1	5		
	2007	2	2		
Other species	2003		22		58 (33.92%)
	2004		15		
	2005		2		
	2006	1	4		
	2007	12	1	1	
Habitat protection	2003	2			6 (3.51%)
	2004	4			
Park management	2006	19	3	7	81 (47.37)

5 FINAL ASSESSMENT

In this section, a final assessment of the measures carried out towards the recovery of Audouin's Gulls in the Valencian Region is made (summarised in Tables 23, 24 and 25), and a series of technical recommendations are established for the utilisation of the social facilitation measures developed.

Current status of Audouin's Gulls and the need for social facilitation measures

Currently, Audouin's Gulls present an adequate conservation status on a global level, and the different colonies have undergone considerable population growth since the mid 20th century when the Ebro Delta was colonised. This recovery has promoted discussion about considering this species to be a threatened species.

In the Valencian Region, the 900 pairs estimated in 2008 seem to indicate that the species is currently recovering (the 625 pairs estimated in 1995 decreased to 21 in 2005) due to the incipient growth of the Columbretes colony and the establishment of two new colonies at the Albufera Valenciana and the Lagunas de la Mata-Torrevieja Natural Park, with 140 and 700 pairs, respectively, in 2008. Even though a low number of pairs remained in the colony at the Columbretes Archipelago, and despite the decline noted in the early nineties, the breeding success of 2005 has been the highest since 1990, and the colony seems to be going through a recovery phase. The reason for this breeding success may have two components. On the one hand, there has been a more regular presence of seine fishing around the Columbretes in recent years which has facilitated the feeding of Audouin's Gulls. On the other hand, Audouin's Gulls have changed their nesting places (from small islands to the biggest one, the Grossa Island), and the species is currently located in better areas which provide a better defence from Yellow-

legged Gulls, thus allowing denser colonies to form (Oro & Martínez-Abraín in Consellería de Medio Ambiente, Agua, Urbanismo y Vivienda 2005a, 2006a).

The positive evolution of Audouin's Gulls worldwide means that, nowadays, social facilitation measures are no longer necessary, at least in western populations. Furthermore, if we take into account the metapopulation character and the important nomadism factor of this species (e.g. Tavecchia et al. 2007), any measure developed must consider a general vision of the whole distribution area and must maintain the metapopulation structure; that is, the local extinction of a colony does not imply a population decline but an emigration of individuals.

Assessment of social facilitation measures

The social facilitation measures developed in the Valencian Region constitute one of the few experiences of reintroduction and active management of colonial seabirds in general, and of Audouin's Gulls in particular.

After 10 years, the results obtained help us to conclude that hacking is an effective tool for seabirds since the chicks released presented a low death rate, did not show human imprinting, and they adapted well to the wild. However, the use of this and other social facilitation measures (decoys) did not achieve the establishment of a new colony in Benidorm Island; the individuals released presented a low recruitment rate and a high spare rate. This highlights the important nomadism factor of this species and how other areas of better quality (food availability, the higher conspecific presence and a low density of Yellow-legged Gulls) serve as a centre of attraction for the species. Thus, the individuals released on the Benidorm Island were

sighted on the Grosa Island (Murcia), and also at the Lagunas de La Mata-Torrevieja. On the Benidorm Island, the high density of Yellow-legged Gulls determines that the hacking measure cannot be effective because the ratio between Audouin's Gulls and Yellow-legged Gulls will always be unfavourable for the former species (Oro et al. 2006).

Even though the social facilitation measures did not enable the creation of a colony on the Benidorm Island, they seem to play an important role in the creation of new colonies in the Valencian Region, as well as to reinforce other Mediterra-

nean colonies. Therefore, the hacking programme could have contributed to decrease the risk of extinction of the species through the creation of new colonies such as that at La Mata-Torrevieja which links the colonies in the South (Chafarinas, Alborán and Grosa-Murcia) with the Ebro Delta-Columbretes system.

One indirect advantage of the hacking programme is that while the chicks remained in the cage, wild adults perceived them as their "own production"; that is, they perceived that the colony had produced chicks due to the important social factor of

Table 23: Assessment of the social facilitation measures developed to facilitate the colonisation and reproduction of Audouin's Gulls in the Valencian Region.

	Result	Assessment
Artificial decoys	-	Artificial decoys did not attract Audouin's Gull individuals. Type of material used: transport versus durability. Artificial decoys used for the adaptation of chicks to the cage in the hacking programme.
Live decoys	+/-	Positive results in Benidorm and negative results in Columbretes. Measure recommended in areas where any Audouin's Gull colony exists, and where decoys are necessary to attract wild individuals. On islands where this species is present, this measure is not necessary and does not offer positive results since wild individuals act as a natural decoy. Measures recommended in areas which are easily accessible and with the daily presence of guards.
Hacking	+/-	Positive results in relation to the adaptation of the chicks released (low death rate and absence of imprinting). Negative results for the establishment of a new colony on the Benidorm Island (low recruitment and high spare rates). Other higher quality areas act as a centre of attraction for the individuals released. In Columbretes, hacking programme had contributed to the recovery of this colony, encouraging adults to establish in the biggest island (Grossa Island) and to return in subsequent years. The presence of chicks means that the places where the cages were situated are perceived as high quality areas, which could encourage the return of adults in subsequent years. This measure could attract individuals to low-quality habitats and may lead to low breeding success rates.

this species (Oro & Martínez-Abraín in Consellería de Medio Ambiente, Agua, Urbanismo y Vivienda 2004b). Without doubt, in Columbretes this encourages adults to return in subsequent years (public information hypothesis, Doligez et al. 2002). At any rate, while the colony had a low number of individuals, these measures act as a kind of trap because these measures provide false information about the quality of the colony, so the individuals return year after year for their reproduction (Oro & Martínez-Abraín in Consellería de Medio Ambiente, Agua, Urbanismo y Vivienda 2005, 2006); for example, on the Benidorm Island, one pair and five pairs settled in 2005 and 2006, respectively, but none of them suc-

cessfully bred. In any case, and due to the important nomadism factor of this species, most individuals were able to recognise and select high quality areas for reproduction purposes.

Nonetheless, the utilisation of decoys was inefficient to attract wild Audouin's Gulls individuals, even though the live decoys on the Benidorm Island encouraged settlement and motivated the reproduction of some wild individuals. At Columbretes, the presence of an existing colony of Audouin's Gulls determined the inefficiency of this measure because wild individuals acted as a natural decoy to attract other reproductive individuals.

Table 24: Recommendations for the development of social facilitation measures towards the management of Audouin's Gulls.

Technical recommendations	
Artificial decoys	<p>Foam rubber and fibreglass used to construct decoys offered short durability and difficult mooring charges. Concrete was more durable but proved difficult to transport to areas with poor accessibility.</p> <p>Artificial decoys facilitated the adaptation and feeding of the Audouin's Gull chicks during the hacking programme.</p>
Alive decoys	<p>This measure is only recommended in islands or areas of easy accessibility and in which a daily presence of guards is feasible for the maintenance of individuals.</p> <p>Maintaining individuals may become a nuisance for the wild individuals attracted. Once the first wild individuals arrive, finalising this measure is recommended, or the search for other maintenance methods of individuals that are not a nuisance for the individuals attracted.</p> <p>The size of the cage must be large enough to avoid individuals from harm.</p> <p>It is necessary to provide individuals with fresh water while they are in the cages.</p>
Hacking	<p>This measure is only recommended in islands or areas of easy accessibility and in which a daily presence of guards is feasible for the maintenance of individuals.</p> <p>The size of the cage must be large enough to avoid individuals from harm.</p> <p>It is necessary to provide individuals with fresh water while they are in the cages.</p> <p>It is useful to include artificial decoys in the cages for the adaptation and feeding purposes of the chicks.</p> <p>Success depends on the quality of the habitat. The hacking programme may prove more successful in extensive coastal areas with dunes and in areas and with a low density of Yellow-legged Gulls.</p>

One of the difficulties of developing social facilitation measures on islands is that many of them are inaccessible. This makes the transport of cages or decoys and the maintenance of live individuals difficult. Islands where the daily presence of guards is not possible means that the use of hacking and live decoys is not feasible. Furthermore, one of the drawbacks with the use of live decoys is that the presence of humans to maintain individuals has to be continuous. This human presence acts as a dissuasion factor as it acts as a nuisance when attracting wild individuals.

Assessment of the management of Yellow-legged Gulls

Although the culling and the deterrent measures developed, in conjunction with the social facilitation

measures, seem to have favoured the settlement of some Audouin's Gulls pairs on the Benidorm Island, a recent analysis of the effect of culling measures on Yellow-legged Gulls for the purposes of recovering Audouin's Gulls and other species, presented a low success rate of this kind of measures in the long term (Oro & Martínez-Abraín 2007). Thus, culling measures do not originate a long-term decrease of Yellow-legged Gulls and an increase of sympatric species. Furthermore, culling measures could have a negative effect on other nearby colonies since the metapopulation character of seabirds may mean that Yellow-legged Gulls could disperse to other areas (Aguilar & Mayol 1994; Bosch et al. 2000; Oro & Muntaner 2000; Oro 2003). All these reasons lead us to conclude that the use of culling and deterrent measures of Yellow-legged Gulls to promote the recovery of Audouin's Gulls is not recommended.

Table 25: Assessment of the Yellow-legged Gulls management undertaken to facilitate the colonisation and reproduction of Audouin's Gulls in the Valencian Region.

Result	Assessment
Culling	<p>-</p> <p>Culling had no important effect on Yellow-legged Gulls.</p> <p>Culling measures adopted with Yellow-legged Gulls did not favour the nesting of Audouin's Gulls in the Columbretes Archipelago. However, establishing an area without Yellow-legged Gulls on the Benidorm Island encouraged some Audouin's Gulls pairs to nest.</p> <p>Culling and deterrent measures could have a negative effect on nearby colonies due to the emigration of individuals.</p> <p>Culling has a negative social impact (van Vuren et al. 1997; Gill 2000; Jones & Neelson 2003).</p>
Deterrent measures	<p>-</p> <p>The deterrent measures developed to frighten individuals that are attempting to settle in a given area (shuts, balloons, firecrackers) had no effect on colonies of Yellow-legged Gulls since their individuals finally became used to all these measures.</p> <p>The effectiveness of using nylon nests to avoid Yellow-legged Gulls from nesting is assessed as being negative because it does not favour the settlement of either Yellow-legged or Audouin's Gulls. Furthermore, when the nest was removed, Yellow-legged Gulls rapidly recolonized the area.</p>

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