Aerial broadcast of rodenticide on the island of Sa Dragonera (Balearic Islands, Spain). A promising rodent eradication experience on a Mediterranean island

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The Natural Park of Sa Dragonera is a small group of non-habited islands just off the coast of the summer holiday destination island of Mallorca. Sa Dragonera, which gives its name to the Natural Park, is a massive limestone island of 362 ha that protrudes out of the sea as the northwestern extension of the Tramuntana mountain range of Mallorca. The island is over 4 km long with a maximum peak altitude of 360 m. The north coast of sa Dragonera is dominated by abrupt cliffs that plunge vertically in the turquoise blue Mediterranean. Along the southern coast, much less abrupt, the visitor can find beautifully preserved natural coves and the only harbor and landing place to access the Park. Outstanding natural values of Sa Dragonera are the important breeding colonies of six Mediterranean seabirds: shag, yellow-legged gull, Audouin's gull, Scopoli's shearwater, European storm petrel and Balearic shearwater (a critically endangered shearwater that only breeds in the Balearic Islands).

The island is also an important breeding site in the Mediterranean for the rare Eleonora's falcon. Other important bird species that breed on the island are the Peregrine falcon and the Balearic warbler. The osprey doesn't breed on sa Dragonera, but they do regularly fish in the sea strait that separates the island from Mallorca. The non-avian fauna is no less important, among which is the Balearic wall lizard, a survivor of the pre-human fauna of the Balearic islands, and 25 endemic invertebrates (mostly land snails and beetles). The flora of sa Dragonera includes 372 species, of which 12 are endemic to the Balearic islands.

In the 1970's a devastating development plan was

Fig. 1 - The complet team involved in the project: the flags were used as signal to the helicopter for precise flyways (See also map in fig. 3). Photo: Martí Mayol.

stopped by the mobilization of people of Mallorca that favored the conservation of the natural values of sa Dragonera instead of a large tourist villa. The island was bought by the local council of Mallorca in 1987 and in 1995 the Natural Park of Sa Dragonera was created with the inclusion of two small neighboring islands (Pantaleu and Mitjana).
After legal protection, the main environmental problem of Sa Dragonera was the large population of ship rats. Rabbits and house mice were also present on the island. These species are not native to the Balearic Islands, and even in the 70's, the private owner of the island tried to control the rat population by using massive amounts of a first generation rodenticide. Previous experiences in other Balearic Islets has been applied by our team, but never using aerial management techniques (Aguilar and Cózar 1989, Orueta 2003).

Fig. 2 - A young black rat (*Rattus rattus*) the most important target for this project. Photo: Joan Mayol.

The Balearic shearwater action plan and the management plan of the Park of Sa Dragonera including rodent eradication has a high priority conservation objective. The negative effect of rats in the Balearic Islands has been documented (Traveset et al. 2008) on endemic invertebrates guilds and the productivity of nesting seabirds, such as the European storm petrel and the Balearic shearwater. Rodents also have a devastating effect on the flora, predating seeds, seedlings and even the bark of bushes and tress. Rat density on Sa Dragonera has reached up to 50 individuals/ha, but has fluctuated in response to yearly control campaigns with rodenticide. Baits with rodenticide were laid out in baiting stations designed to protect lizards and land birds. Between 2001 and 2008, several control campaigns were carried out on the island, covering the most accessible areas, but leaving a large surface of rugged terrain untreated.
The positive results of these control campaigns lasted only a few months, and the rat population quickly recovered high densities, probably due to a recolonization from non treated areas. The cost and effort of these campaigns was very high, and with very poor results, and a complete eradication using an air drop of rodenticide was considered as probably the best solution, due to the extreme orography. The initial plan was to rely on the experience and technology used in New Zealand, and in 2009 one of the authors visited New Zealand hosted by Landcare Research. In 2010 an airdrop eradication was done on the Mediterranean island of Molara, Sardinia, Italy. M. Mayol, director of the Natural Park of Sa Dragonera, contacted the team that did the Tavolara (Anonymous 2009) eradication, and proposed a cooperation to do a similar airdrop on sa Dragonera. Finally the Dragonera airdrop was organized with the aid and cooperation of the Italian team, which also kindly supplied the bucket for the operation.

Preparation of the air drop was laborious, due to the fact that the helicopter had to follow the flight paths using a reference grid marked with flags displayed by a coordinated ground team. Unfortunatly, no GPS aided control system for the airdrop was available.

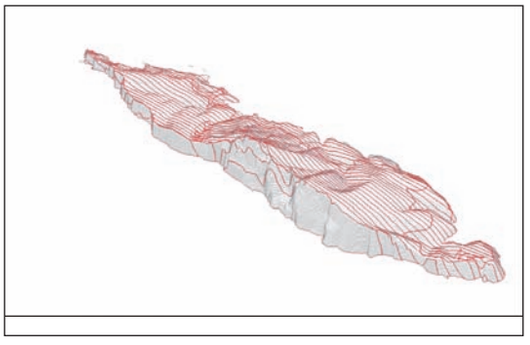

Fig. 3 - 3D model of Dragonera, with the flyways in read, every 40 m. Five perpendicular transects were marked in advance, and flags were located successively at each intersection by 3/5 men oving on the transect.

Two air drops with brodifacoum were done in January and February of 2011. The weather conditions were suitable for the dispersion of bait, and all minor incidents were promptly resolved. Although the dispersion of bait was controlled from the helicopter, a small amount of bait did fall into the sea during the flight paths of the northern cliffs. No mortality of sea life during the following weeks was detected. Additional bait was manually broadcast in buildings, caves, and other areas that could be a potential refuge for rodents.

The only negative side effect of the eradication was the death of yellow-legged gulls. Over 5000 gulls breed on Sa Dragonera, and the bait dispersion was carried out when the birds start to defend their territories, just before the laying period. During the weeks after the dispersion of rodenticide, an average of 13 gulls per day died of primary intoxication. This negative side effect was not considered of concern as the large populations of yellow-legged gulls has a negative impact on the biota of sa Dragonera, and the gulls are systematically culled on the main landfills of the large islands. No other mortality of birds or marine or terrestrial fauna was detected at all.

Post eradication monitoring using tracking tunnels and photographic trapping, has been carried out since the day after the last bait drop. The park staff have also been trained to identify any sign of the presence of rodents. After fifteen months of monitoring, no signs of rats or mice has been detected. Only a few rabbits have survived the bait drop, probably due to a winter baiting when the animals had more palatable food resources. We are still evaluating the results as a preliminary success, and the problem of the rabbits has to be correctly addressed in the near future.

Fig. 4 - This project is a very important victory for island biorestauration in the Mediterranean. Photo: Oriol Domenech.

It is very important to stop rodents colonizing again at Sa Dragonera, and a biosecurity protocol is a very important tool against a new infestation. The protocol has been implemented in the Park management, and all commercial boats visiting the island have been supplied with baiting stations. The local council of the nearest village on Mallorca has improved rodent control of the main harbors where supplies and visitors are ferried to sa Dragonera. Visitors are also informed of the project.

Fig. 5 - The bucked and the helicopter used in Dragonera, and Miguel Mcminn, one of the tecnical consultants in the operation. Photo: Joan Mayol.

Last spring (2011) Balearic shearwaters success-

fully fledged young birds near the main pier of sa Dragonera. During previous years with rats, all eggs were depredated very early during the breeding season. Other good news is the improved fruiting of bushes of the garrigue of Sa Dragonera, improving the amount of available food for terrestrial birds. In the near future we plan to continue monitoring the recuperation of the biota of sa Dragonera.

Sa Dragonera is now probably the largest island in the Mediterranean with no rats (Howald et al. 2007). We do hope that this project will serve as an example of what a restoration project can do for many other islands of the Mare Nostrum.

Technical aspects of the campaign

Product and dose used
Product: Brodifacoum pellets (0'005%)
Dose used: 14'02 kilos/ha
Timing of the operation: January-February. During the winter the public doesn't visit the park and coastal areas. The activity of endemic lizards is reduced and the Elonora's falcon are still in their wintering grounds in Africa. A summer drop would have compromised the breeding season of the falcon.
Dates: 13 de January and 8 de February 2011 (with a period of 26 days between treatments).
Duration of the flights: Two hours

Team involved
Marking of the flight grid on the ground: 17 people
Loading bucket: 6 people
Technical coordination: 6 people
Air team: Two pilots and a flight mechanic.
Control of island access during the operations: 3 people

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