

Long term rodent control in Rđum tal-Madonna yelkouan shearwater colony

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Abstract Rodent predation on eggs and chicks is one of the main threats to procellariiform species in the Mediterranean, where the black rat (*Rattus rattus*) and brown rat (*R. norvegicus*) have been present on many islands for centuries. The yelkouan shearwater (*Puffinus yelkouan*) is an endemic Mediterranean seabird species classified as vulnerable. Malta holds up to 10% of the global population; the largest colony, Rđum tal-Madonna (RM), protected as a Natura 2000 site, hosts around 500 breeding pairs. This colony has been monitored since its discovery in 1969. A very low reproductive success due to rat predation was noticed in the late 1990s to early 2000s. In 2007 a seasonal rodent control programme was established during the breeding season of yelkouan shearwater to reduce rat predation on eggs and chicks. Rodent control took place between 2007 and 2010 and was reviewed and continued from 2012 to 2017. Breeding success since 2007 has been higher than 80%. In two other colonies with rat presence and where rodent control did not take place, the breeding success in 2016 and 2017 was substantially lower than in the colony with the rodent control programme. The European storm-petrel (*Hydrobates pelagicus melitensis*) only breeds in rat-free areas like remote sea caves or islets around the Maltese islands. In 2014, the first breeding attempt by European storm-petrel was recorded on the Maltese mainland at RM with a chick fledging successfully for the first time in 2016. The ongoing LIFE Arcipelagu Ġarnija project is assessing rat predation in all Maltese yelkouan shearwater colonies in order to establish predator control in the most important yelkouan shearwater breeding sites in 2018.

Keywords: breeding success, chicks, eggs, littering, rats, seabirds

INTRODUCTION

Malta is a southern European archipelago in the Mediterranean Sea with three main islands: Malta, Gozo and Comino; and other important islets: Filfla, Saint Paul, Fungus Rock and Cominotto. Each island and islet harbours important colonies of seabirds. The archipelago lies 80 km from the south of Sicily (Italy), 284 km from the east of Tunisia and 333 km from the north of Libya. The islands cover over 315 km². Malta hosts internationally important breeding populations of procellariiforms: yelkouan shearwater (*Puffinus yelkouan*) (estimated 1370–2000 pairs, constituting up to 10% of the global population) (Metzger, et al., 2015), Scopoli's shearwater (*Calonectris diomedea*) (estimated 4,500 pairs, up to 5 % of the global population) and European storm-petrel (*Hydrobates pelagicus melitensis*) (estimated 5,000–8,000 pairs, around 50% of the Mediterranean population) (Sultana, et al., 2011).

The invasion of ecosystems by introduced species is one of the most significant sources of ecosystem change (Howald, et al., 2007) and biodiversity loss on islands (Martin, et al., 2000; Courchamp, et al., 2003). Introduction of alien rodents has been shown to have devastating effects on insular ecosystems and some rodent species can be important predators of nesting seabirds (Traveset, et al., 2009), especially procellariiforms (Imber, 1978). Rodent predation on eggs and chicks is one of the main dangers to this group of seabirds across the world (Booth, et al., 1996; Hobson, et al., 1999; Gaze, 2000; Imber, et al., 2000). Rats are associated with extinctions or declines of burrowing seabirds (Seto & Conant, 1996; Towns, et al., 2006). Rats have a severe impact on breeding success and are a major cause of seabird mortality in the world (Jones, et al., 2008; Pascal, et al., 2008).

Rats were introduced into the Mediterranean over 2000 years ago and have been present on many islands for centuries (Atkinson, 1985; Audoin-Rouzeau & Vigne, 1994; Martin, et al., 2000). Black rat (*Rattus rattus*) is the most devastating predator of seabirds in the Mediterranean (Iguar, et al., 2006) and the main reason for breeding failure

on some islands, for example Corsica (Thibault, 1995). Therefore, the persistence of native long-lived seabirds in the Mediterranean basin, despite the long-standing introduction of black rat on most islands, constitutes an amazing conservation paradox (Ruffino, et al., 2009).

Yelkouan shearwater is an endemic Mediterranean seabird belonging to the family Procellariidae. It is a long-lived species that lays a single egg each season in deep burrows. It has been classified as vulnerable since 2012 according to the IUCN (BirdLife International, 2016). The Maltese population of yelkouan shearwater has declined in recent years, mainly due to predation by rats, loss of breeding habitat, illegal hunting, fishing bycatch, disturbance and light and sound pollution (Sultana, et al., 2011).

The main colony in Malta situated in Rđum tal-Madonna (RM) holds around 500 breeding pairs (2 or 3% of the global population). It is a Natura 2000 site – part of the European network of protected areas. This colony is situated along 1 km of coralline limestone sea cliff. It has been monitored since its discovery in 1969 and it was noticed that the breeding success in the late 1990s to early 2000s was very low, largely due to rat predation, with very few chicks fledging (Sultana, et al., 2011). The best response to such a situation is almost always to control the alien population, either by frequently reducing their numbers, or better still, by eradicating the whole population (Courchamp, et al., 2003).

As the colony is located on the Maltese main island, eradication of rats was not feasible because it is not possible to isolate the area from rat populations found across the rest of the island. The population of rats benefits from the persistent availability of food close to the colony. Litter from recreational users in the area making barbecues and camping is compounded by the inefficient and inadequate waste disposal and collection system. Actions to increase awareness about littering between site users and authorities were carried out but no substantial improvement in the situation was observed.

In 2007, a seasonal rodent control programme was established at the site to reduce rat predation. The control programme has now been active for 11 years from 2007 to 2017. In this paper we present the results of the rodent control programme on the breeding success of the yelkouan shearwater colony. We discuss the results and lessons learnt and their applicability to other locations.

MATERIALS AND METHODS

The colony site is surrounded by the ocean on three sides, making it an ideal site for rodent control. The methodology chosen for rodent control was seasonal control using rodenticide. The most frequent rodenticide distribution method used on small islands around the world is bait stations (Howald, et al., 2007) and other projects have shown that using a permanent bait-station system is an efficient methodology to control rats (Orueta, et al., 2005; Pascal, et al., 2008). Around 90 bait stations (PROTEXX TM) were distributed over 25 ha of RM on the top of the cliff plateau and the lower part of the cliffs where yelkouan shearwaters breed (Fig.1). The bait stations on top of the cliffs create a buffer to prevent rats accessing the colony. Bait stations were placed around areas of high rat presence, for example those areas subject to littering from campers. Rodent control took place around nesting sites between February and July during the yelkouan shearwater breeding season, when eggs and chicks are most vulnerable. The bait stations were baited one to three times per month, depending on rodent activity. Each bait station contained two blocks of anticoagulant rodenticide. Between 2007 and 2015 the rodenticide used was brodifacoum 0.005% and from 2016 it was bromadiolone 0.005% to reduce the risk of secondary poisoning. The bait blocks were threaded on to metal skewers that were clipped in place, to prevent them falling out of the stations even if they were shaken violently.

Every time the bait stations were checked, data were collected on the amount of rat sign (droppings and rat teeth marks in the wax bait blocks), non-target species sign like mice, shrews and insects taking the bait, and the number of bait blocks replaced. The area baited was checked for signs of dead rats and primary or secondary poisoning of non-target species. Rat presence was calculated as the number of bait stations with rat teeth marks on the bait divided by the total number of bait stations.

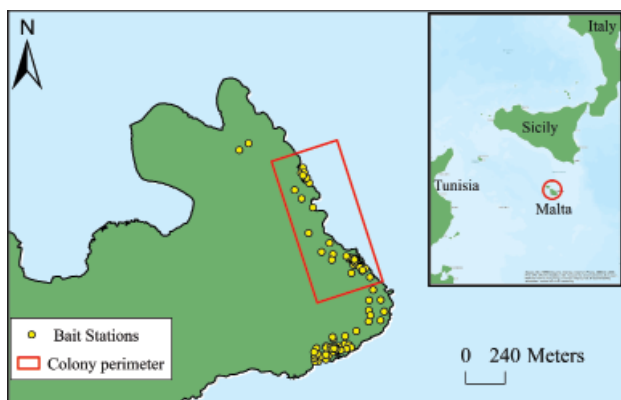


Fig. 1 Map of Rđum tal-Madonna colony in Malta where the Yelkouan shearwater colony is situated (rectangle) and the location of the bait stations (dots).

Table 1 Breeding success (% of chicks fledged per eggs laid) of yelkouan shearwater at Rđum tal-Madonna between 2007 and 2017.

Year	No. of nests	Breeding success
2007	6	83%
2008	12	92%
2009	11	91%
2012	16	94%
2013	32	88%
2014	25	88%
2016	24	88%
2017	38	84%

Table 2 Breeding success (% of chicks fledged per eggs laid) of yelkouan shearwater in 2016 and 2017 in Rđum tal-Madonna (rodent control) and St. Paul's Island and Majjistral (no rodent control).

Colony	Year	No. of nests	Breeding success
RM	2016	24	88%
St. Paul's Is	2016	9	67%
Majjistral	2016	12	33%
RM	2017	38	84%
St. Paul's Is	2017	9	11%
Majjistral	2017	11	55%

RESULTS

Rodent control took place between 2007 and 2010, after which it was reviewed and then continued from 2012 to 2017. After the first season of rodent control in 2007, the occurrence of eggs and chicks depredated by rats dropped dramatically and there have been few recorded signs of rat predation during the subsequent 11 years. Breeding success has been very high since rodent control started (Table 1), with a mean of 88 % (averaged over the eight years for which data are available).

In 2016 and 2017, the breeding success (chicks fledged per eggs laid) in RM (88% and 84%, respectively) was much higher than in two other colonies where rats were known to be present but no rat control took place, St. Paul's Island (67% and 11%, respectively) and Majjistral Park (33% and 55%, respectively) (Table 2).

In RM, rat activity varies throughout the yelkouan shearwater breeding season. Rats are regularly present from February until July. Rat activity is reduced after the first month of rat control in February, the peak of activity is in May and then a small upturn in June (Fig. 3). Rodent activity over the period 2012–2017 (data available for four years) shows a decrease in rat presence in recent years. No signs of secondary poisoning have been found in the study period.

After the first season of rat control in 2007, European storm-petrels were regularly seen in RM (Borg, et al., 2010). In 2014 the first breeding attempt was recorded and in 2016 and 2017 chicks fledged successfully. The data collected during 2014–2017 suggest European Storm-petrel is establishing a breeding colony in RM.

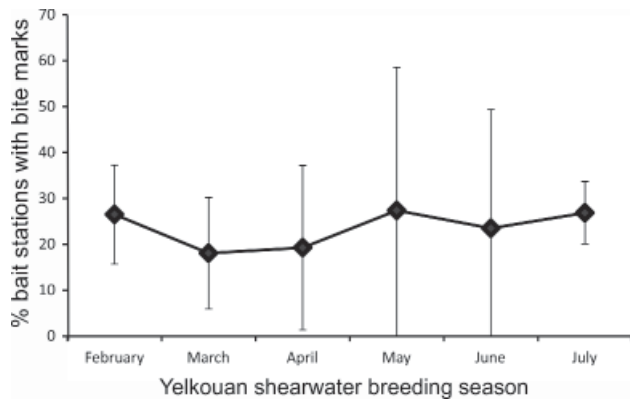


Fig. 2 Proportion (%; with mean and standard deviation) of bait stations with rodent bite marks throughout the Yelkouan shearwater breeding season from February to July (for years 2012, 2015, 2016, 2017 combined).

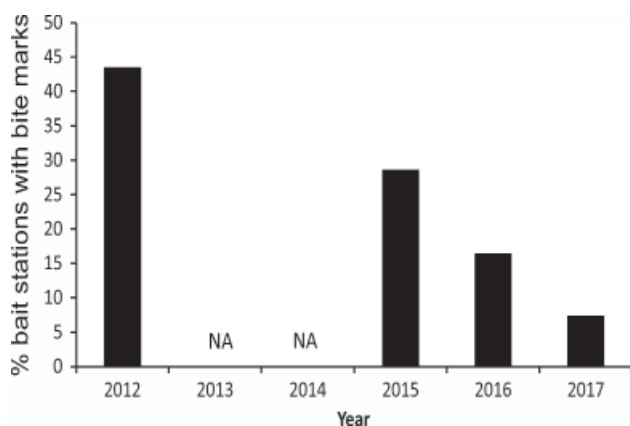


Fig.3 The percentage of bait stations with rodent bite marks by year; 2012, 2015, 2016 and 2017.

DISCUSSION

Seasonal rat control in seabird colonies where eradication is not feasible is an effective way to reduce rat predation and increase reproductive success (Imber, et al., 2000; Martin, et al., 2000; Jouventin, et al., 2003; Orueta, et al., 2005; Igual, et al., 2006; Pascal, et al., 2008). In many cases, the removal of the alien invasive species is followed by a fast and often great recovery of the damaged local populations (Courchamp, et al., 2003), even allowing new colonies of other species to become established, as has been seen at RM (Malta). However, only intensive and constant long-term poisoning will control rats satisfactorily (Jouventin, et al., 2003).

The increase in the reproductive success observed during recent years in the Yelkouan shearwater colony in RM is correlated with the lower rat activity as a result of rodent control programme. Rat activity varies throughout the Yelkouan shearwater breeding season. The peak of activity in May is related to the increase in ambient temperature and also to the start of camping activity in the area. The presence of campers increases littering (i.e. supplying food for rodents) which is the likely reason for the increase in the rat population around the colony. The general decrease of rat presence in 2016 and 2017 may be related to the very dry weather in these two years, but possibly also to increased public awareness about littering. On 30 April 2017, an intensive clean-up by more than 100 volunteers was organised in the area.

The rodent control programme showed its effectiveness at increasing the breeding success of Yelkouan shearwater and allowed the establishment of a new European storm-petrel population. The main Yelkouan shearwater colony locations are situated on the main islands of Malta and Gozo making the eradication of rats not possible. Rat eradication could only be feasible in the islands of Comino, Cominotto and Saint Paul that hold smaller colonies. Ongoing rodent control programmes are therefore needed in the main colonies to secure Yelkouan shearwater populations in the archipelago and to improve their situation. Building on the lessons learnt and the success of the rodent control programme in RM, the current EU-Life Arcipelagu Garnija project LIFE14 NAT/MT/991 is assessing predation by rats in all Maltese Yelkouan shearwater colonies in order to establish predator control in the most important sites in 2018 and secure the main colonies across Malta. During the study period, no evidence of secondary poisoning was found but, in any case, from 2016 the bait was changed from brodifacoum to bromadiolone that has less risk of secondary poisoning. Less toxic bait, such as first generation anticoagulants, are not available in Malta. In order to reduce the amount of anticoagulant used in the new rat control programmes, the current project is testing methodologies to replace or combine anticoagulant baiting with auto-reset mechanical traps and carrying out activities to increase awareness about littering among site users.

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