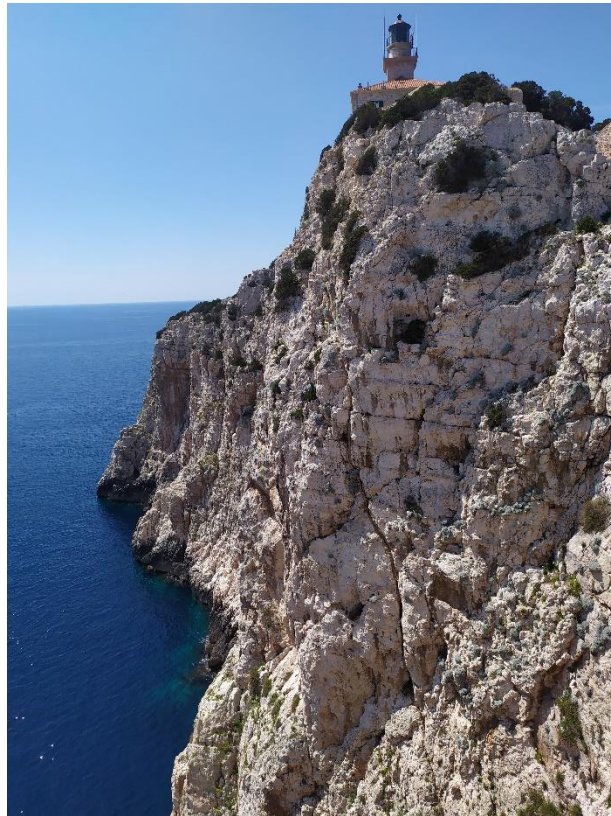


Trip Report

Sušac Island, Croatia: Feasibility of black rat (*Rattus rattus*) eradication by means of aerial baiting

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Trip Objectives:

Assess the physical geography, biological features, human presence and activities influencing the development of a Black Rat (*Rattus rattus*) eradication project, with a comparison between different methods of bait broadcasting, on Sušac Island, Lastovo Archipelago, Croatia.

This report is not a comprehensive assessment, and is only intended to provide general observations and a summary of recommendations for consideration on pro and cons of different bait delivery methods based on the site visit and the discussions held with and between site visit participants before and after the visit.

Date of visit:

April 30th – May 4th, 2022 (May 1st on Sušac)

Island Description

Island Name: Sušac Island

Location: Adriatic Sea, off the coast of Croatia in the Lastovo Archipelago, 23km from Lastovo and around 50km from the Croatian mainland.

Area: 403 ha

Access: Only private and touristic boats, wharf with facilities to land materials (not cars or other vehicles) close to the lighthouse.

Human Use: Inhabited only by the lighthouse warden and, during summer months, by one or two shepherds. In the lighthouse few people can be accommodated, there are no other buildings in good condition except the shepherd's house. There are several hundreds of sheep that stay on the island throughout the year (also when the shepherd is absent). They seem easily startled by humans. Although they use the entire surface of the island, they seem to be concentrated in coastal areas, where scattered individuals or small groups can be observed. There are also some goats and rabbits, the latter perhaps partially feral. Furthermore, around the lighthouse there are chickens and cats, the latter perhaps also present with feral individuals all over the island.

Physical Geography and Habitat Overview: Hilly landscape, with some steep cliffs and slopes along the coastline, hosting typical Mediterranean habitat and species. The vegetation is more complex, with mosaics of high macchia and forests of several tree species (*Olea europaea*, *Quercus ilex*, *Euphorbia dendroides*, *Rhamnus alaternus*, etc.) on northern expositions and low formations of macchia and of garrigue on the warmer slopes (including a.o. *Juniperus phoenicea*, *Rosmarinus officinalis*). Notably exotic plant species seem almost absent, except that in the immediate vicinities of the lighthouse and of the shepherd's house, but no invasive species have been observed during the short visit. The island appears to be characterized by very high levels of naturalness, which is very rare for Mediterranean islands of comparable size.

Proposed Project:

Black Rat eradication, firstly aimed at the protection of breeding populations of Yelkouan Shearwater (*Puffinus yelkouan*), Scopoli's Shearwater (*Calonectris diomedea*) and Eleonora's Falcon (*Falco eleonora*).

Site Visit Summary:

- Circumnavigation of the island by boat, stopping in different points for short visits, notably the lighthouse area with cliffs, the shepherd's house and facilities, a wooded area along the northern coast with a dense colony of Yelkouan Shearwater. During the visit of the island and throughout the whole period on Lastovo, discussions were held on rat eradication strategies, tools, capacity and regulatory constraints, including social conditions, as well as technical and ecological considerations on the presence of sheep and non-target species (notably *Apodemus sylvaticus*). An evident and apparently increasing impact of sheep on the island vegetation, worst in the coastal areas.
- Signs of rats (fresh olive seeds gnawed and pellets) are widespread but in the Yelkouan shearwater colony all the nest checked on 1st of May had the adult incubating and/or the chick (however, the final visit by BIOM staff on the 24th of June to assess the breeding success before fledging, found only 9 surviving chicks in a total of 76 monitored nests).
- During the study trip, several other smaller islands were visited as well. Most of them with rodent control activities ongoing and two rat-infested island (besides Lastovo main island) without any rodent control. On all the islands with rodent control there were no signs of rat activities, as if they were rodent-free for several years, whereas on the islands without control activities had many piles of gnawed pine-cones, as well as rat pellets.

First considerations

- The aerial baiting (i.e. two baitings with pellet spread by helicopter on the whole island) seems feasible and apparently without technical difficulties due to physical and biological features of the island, but some critical aspects must be carefully evaluated.
- To maximize probability of successful eradication, a ground-based operation will need to utilize tools that will allow access to cliff faces.
- The presence of sheep seems to be a critical issue for their impact on island ecosystem and for an eventual implementation of the aerial (i.e. with pellet) baiting.
- Rat control activities on the smaller islands are very effective.
- Genetic studies of the population of *R. rattus* and *Apodemus sylvaticus* on the archipelago and on potential rat sources on other large islands and mainland harbour are suggested.

Short description and comparison of the application of the two different baiting techniques on Sušac

Aerial baiting

The aerial baiting seems feasible and apparently without technical difficulties due to physical and biological features of the island, but some critical aspects must be carefully evaluated.

General description

Broadcast by helicopter of pellet of about 2 g on the whole island surface, according with the most updated guidelines.

Two launches 10-15 days apart; quantity of bait approximately equal to 12 kg / ha in the first baiting and 8 kg/ha in the second. As a first approximation, the preferable period seems to be late summer, from the end of August if this is compatible with tourist presences, otherwise postpone for the shortest possible time.

Each baiting can easily be completed in one day. Presumably the organization of the operation could include the transport of the bait to the island by boat, and the bucket reloading operations could be carried out with the helicopter hovering directly on the boat, or on the island in the immediate vicinity of the landing site, near the lighthouse. Refueling, on the other hand, requires a helicopter trip to Lastovo or to another island. These aspects of logistics must still be examined and confirmed by an aerial work company/pilot and after the identification of the support vessel.

Propedeutic activities

The preliminary investigations listed in Austad *et al.* 2020 (Austad, M., Varnham, K., Engelen, D., Ječmenica, B., Kapelj, S. (2020). *Feasibility study for the removal of black rats *Rattus rattus* from the island of Sušac, Croatia. LIFE Artina (LIFE17 NAT/HR/000594): Action A5 report. BirdLife Malta. 66 pp.*) are valid also for an aerial baiting, with the addition of some field-tests concerning the specific bait that will be used.

The planning of the operation must be carried out with the utmost detail, in accordance with the most up-to-date protocols.

The main problems are those related to obtaining the necessary derogation according with the art. 55 of the EU Regulation n. 736/2013 and subsequent integrations, for the use of bait outside of safety containers, which must be issued by the competent national body (presumably the Ministry of Health) and accepted by the public; another absolutely relevant problem is the presence of sheep.

It is necessary to have complete certainty, before submission (LIFE or non-LIFE funds), of the effective possibility of having the derogation on the method of use of rodenticides, and of having the full support of the bodies involved, the Ministry of the Environment, the Ministry of Health (if necessary), municipalities, parks etc.

The activities of communication and the involvement of local communities and stakeholders are crucial: the allocation of adequate funds and the involvement of communication experts are therefore necessary. It is also very important to evaluate the socio-economic benefits from such a project, for

instance deriving from the advertising of an archipelago which is rat-free and where nature is protected by means of innovative operations. This process, that could hopefully lead toward local developments based on sustainability and green tourism, can be promoted by the improvement of awareness of the local community on conservation issues, and particularly on the importance and uniqueness of the natural value of their archipelago. E.g., during the first LIFE project on Tuscan Archipelago (LIFE97 NAT/IT/004153), the inhabitants of Capraia Island were surprised to discover the importance of some habitats and species on their island (such as the riparian forest with *Nerium oleander* which in Central Italy can only be found on Capraia), which has increased their willingness and interest in aiming for a sustainable development. Now Capraia is very popular with hikers and there are projects to restore some traditional agricultural activities, archaeological sites, whereas previous development ideas based only on massive summer tourism have been abandoned.

In the case of aerial baiting, the choice of sheep management appears crucial. Two possible options are identified:

1) Keeping the sheep on the island: capture all or most of them, fencing of at least one area where they have to be maintained, providing them food, water and shelter, for the period of presence of palatable pellet on the ground (dependent on the amount of rain, probably 2-4 months) and then release them.

2) Eradication: capture all or most of them, translocation to larger inhabited islands or the mainland, shooting of the last surviving individuals. Possibly the eradication can be completed through captures, by creating several feeding and trapping fences in different parts of the island, with food and water in the summer. Preliminary surveys and capture tests are necessary to evaluate the approach and techniques that must be adopted to complete the operation (Campbell and Donlan 2005).

Economic cost

The cost of the aerial baiting can be very roughly estimated in around 110-120k euros plus VAT, including helicopter work, bait, logistic and technical coordination. Costs for preliminary activities, general planning, monitoring and sheep management have to be added, as well as costs for the general management and communication and the eventual activities concerning other non-target species (goats, cats, rabbits, wood mouse).

Mixed baiting (ground-based with aerial launch of biodegradable tools in the steepest areas)

General description

Use of biodegradable bait-boxes (made of bamboo) in the steepest areas where it is dangerous or too expensive to carry out a ground-based baiting. This appears useful and necessary in some sectors, of a limited extent, of steep coast. It is, however, not feasible in some vertical cliffs; 1) either those where there are no potential rat habitats anyway, 2) or in those sections directly below the lighthouse. Although caves located here are potentially suitable for rats, it is not possible to launch bamboos or traps in them by helicopter. However, these areas have a very limited extend, and intensive baiting at

the top of the cliffs will be sufficient, next to some simple additions carried out with different methods.

Launching of boxes in a high number compared to that of dispensers in ground-based areas (at least 16 per ha), with at least 4 – 5 repetitions. These details have to be better defined once the areas subject to this type of baiting and the tools available at the date of the operation will be known. Generally, the first three baiting rounds have two weeks between them, while the 4th and possibly 5th can be separated by a 3-week period.

Logistics – Similar to that described for a proper aerial baiting, but the reloading of the helicopter requests the landing, consequently the bait-boxes must be on the island (at the jetty near to the lighthouse). The best period for this needs to be decided and depends on several factors, such as rat phenology, risks for non-target species and interferences by tourists.

Economic cost

The cost of the activity, if carried out using bamboo-trunks, can be very roughly estimated in around 60-90k euros plus VAT, depending of the surface baited and the number of launches. Costs for preliminary activities, general planning, monitoring, general management and communication and the eventual activities concerning other non-target species (sheep, goats, cats, rabbits, wood mouse), the latter not strictly necessary as for the proper aerial baiting, have to be added.

Helicopter pilot – The availability of a pilot experienced in agricultural work (i.e. flying with suspended load, at constant speed, following GPS tracks) or if possible experienced in aerial baiting aimed at rat eradication is very important for both the activities described above, even mandatory for the proper aerial baiting. At least in Italy there are 2 very experienced pilots.

General recommendation for a **hybrid operation**: it is suggested to limit as much as possible the extension of the areas treated exclusively with the aerial baiting technique (it could be used more widely as an addition to ground baiting in areas partially accessible). Hybrid operations are currently only tested in few Italian islands (3 Pontine Islands of > 100 ha + small satellite islands -> 2 success and one failure; Tremiti Islands -> ongoing). Given that a possible problem with this technique is linked to the fact that in ground-based eradications there may be rats surviving because they are difficult to intercept, and consequently in the final stages of operations (at least on large islands) it is strongly suggested to use different baits or lures, traps and several monitoring tools. It is therefore suggested to use different types of bait-boxes (bamboo trunks and another to be defined, coherent with the EU and Croatian legislations) or, if possible, the use of biodegradable traps being developed in New Zealand within the project 'Predator Free 2050'.

Also, the use of a drone for the baiting, instead of a helicopter, will have to be evaluated, considering that there are development programs and tests at global level on this new technique.

Comparison and conclusions

Comparison of negative effects of an operation carried out entirely by aerial baiting and one with bait-boxes

Indirect mortality, due to the consumption by predators of intoxicated rodents (diurnal and nocturnal birds of prey, corvids, gulls), similar with the two methods or maybe lower with aerial baiting, thanks

to the much shorter period of risk (maximum 1-2 months) and the expected lower bait ingestion by each individual of the target species.

Direct and indirect mortality of other rodent species - For the local population of *Apodemus sylvaticus*, the risk cannot be eliminated or reduced; presumably with aerial baiting the population would become extinct, while with a ground-based intervention the risk of extinction exists, but should be low. In both cases, however, it is definitely preferable to provide a preliminary analysis of the population, with genetic characterization and comparison with neighboring populations, and if its conservation is evaluated as positive, carry out an ex situ conservation program and subsequent reintroduction.

Indirect mortality from the consumption of insects and other invertebrates by reptiles and birds - very low risk. There has never been evidence of even minor impacts due to this on Mediterranean islands (and only exceptionally in other parts of the world), with both distribution methods (Booth et al. 2001, Fisher 2010, Fisher et al. 2011, Brooke et al. 2011, Witmer & Mauldin 2012, Capizzi et al. 2016, Weir et al. 2016).

Direct mortality from consumption of bait in case of aerial baiting - Significant risk for seagulls and corvids. Both the Yellow-legged gull and the corvid species that frequent the island are at risk of secondary and primary poisoning, the latter much higher than the first for gulls. For corvids, at least in the Mediterranean, the actual consumption of pellets has not been confirmed but it seems very probable: several cases of mortality have been detected during eradications carried out with aerial or ground-based baiting, without clear differences between baiting methods (Capizzi et al. 2016, Sposimo et al. 2019, P. Sposimo unpubl.). In the case of seagulls, mortality from direct consumption of bait can be very high (Gotti et al. 2014). The monitoring of flora and fauna on Montecristo (from the report of the LIFE+ project "Montecristo 2010"., with possible negative consequences with respect to public opinion and increased risks of secondary poisoning of necrophagous species (raven, migrating birds of prey). By carrying out the aerial baiting during late summer, the mortality of seagulls is greatly reduced or avoided. On Tavolara (P. Sposimo unpubl.), with baiting carried out between the third week of October and the first of November, the loss of 100 - 200 individuals was estimated (on a total of at least 2000 breeding pairs). There appears to be no risk to other wild species.

Contamination risks for fish and the marine environment have been studied around the world and always rated as very low (e.g. Primus et al. 2005, Masuda et al. 2015). On Tavolara, where the cliffs are incomparably more extended and higher than on Sušac, we made preliminary surveys of non-toxic pellet consumption by fish, an estimation of pellet dropped into the sea during the baitings, and analyses of brodifacoum residues in coastal fish after the baiting. The quantities dropped into the sea were modest, and we did not find residual in the fish (Final Report of project LIFE12 NAT/IT/000416, annexes unpubl.).

Conclusions

An operation conducted by aerial baiting, properly planned, preceded by all the necessary analyzes and with the implementation of all the appropriate mitigations, has no risks that are excessively higher than those of a ground-based eradication. The greatest risk is that of a negative reaction from public opinion. For this method it is mandatory to obtain a derogation concerning the baiting method. The options concerning the sheep management must be evaluated and defined with the owner(s) and with local authorities. The risks and difficulties described above should not be underestimated because

they can jeopardize the completion of the operation and create a negative climate towards this type of conservation intervention, making it difficult to continue and expand them in the future. Considering all eradication projects carried out in Italy, there have been a lot of criticisms only during the rat eradication on 1) Montecristo, maybe due to a very scarce preliminary communication activity and an inadequate involvement of the local community and stakeholders (i.e. of Elba Island), and in 2) the mouflon eradication on Giglio island (LIFE18 NAT/IT/000828), which is currently ongoing. As mouflon is a charismatic species, the implementation of this project has been severely affected by public attack that reached national media, competent authorities, and even all the way up to the EU Commission. This resulted in a forced revision of the work plan, which not only created enormous waste of time for the project staff, but also an increase of the project costs and increased chance of overall risk for project failure.

An important advantage of an aerial operation, compared to one carried out on land or to a hybrid one, is the much lower economic cost. This would allow an intervention to be carried out with an overall cost adequate to that of the LIFE Nature Projects but with objectives much more ambitious (e.g. baiting several. With a cost presumably of the same order of magnitude as that necessary for the ground-based eradication of rats on Sušac (Austad *et al.* 2020), an aerial operation could be carried out not only on Sušac, but also including the island of Svetac (Sveti Andrija) and some smaller islands of in the area, as well as the eradication of the sheep from Sušac.

Another important advantage is represented by the greater probability of success in the eradication of rats guaranteed by the aerial baiting. It should be noted that a ground-based eradication carried out according to the indications of Austad *et al.* (2020), and integrated with the launch of biodegradable dispensers in some of the steepest areas, has a very high probability of success, maybe no less than that of an aerial baiting, but its implementation is extremely complex and difficult, very expensive and challenging for the staff.

The presence of sheep (and possibly goats) seems to pose a threat to the island ecosystem no less than that due to the Black rat. Although they do not pose a threat to seabirds, they are a risk for the conservation of the vegetation, and therefore of the entire ecosystem. This is particularly important in the case of Sušac as the island is characterized by high levels of naturalness, which is very rare in the Mediterranean, and which certainly requires the greatest possible protection.

The technically preferable solution for the conservation of the island appears to be the simultaneous eradication of rats and sheep, which would also make it possible to avoid the risk of surprise effects resulting from the eradication of only one of these species. This multiple eradication could be done through:

- 1) Capture and removal of as many sheep as possible (probably most of these could be captured by creating some feeding and trapping fences in different parts of the island, with food and water in the summer)
- 2) Aerial baiting, which could predictably cause the mortality of 25-50% of the sheep still present, hopefully a very small number by then.
- 3) Conclusion of sheep eradication by shooting of any survivors (for details see Campbell & Donlan 2005; Faulkner & Kessler 2011).

The rat eradication on Sušac island has undoubtedly a great importance for the conservation of seabirds in the Adriatic Sea. In the long term, the availability of a large rat-free island, that already hosts breeding populations of both shearwaters species is crucial. At ecosystem level, the eradication of

sheep seems to be of no less importance, considering a possible or probable increase of their impact on the island due to a future eventual (but apparently ongoing) processes of feralization and numerical increase of the population.

The rat eradication is a very challenging operation, both with ground-based technique (difficult logistics, amount of fieldwork requested, high costs) and aerial baiting (authorization requested, potential opposition by animal-right groups). Whatever baiting method will be selected, the operation must be carefully prepared and some preliminary technical and administrative activities have to be carried out prior to the project drafting.

The recommendation of Austad et al. (2020), “The written consent, or partnership, of the park management (Public Institution Nature Park Lastovo Islands), Croatian government (as land owners), Plovput, shepherd(s) and Lastovo community represented by the Municipality of Lastovo should be obtained before funding applications”, is obviously also valid for an eradication carried out through aerial baiting, with the addition of the national authorities in charge of the application of EU and national legislation concerning biocides, and of the authority in charge of the fishing activities¹.

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¹ During aerial baiting an amount of bait can roll into the sea along the cliffs, and even though contamination risk for fish is considered to be low, a temporary ban of fishing (1 or 2 months within 500 m from the coast) could be thoroughly evaluated and discussed with relevant stakeholders, if the fishing is allowed and actually practiced around the island.

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