

PREDATOR MANAGEMENT AND BIOSECURITY FINAL REPORT

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Seabird Conservation Network in the Adriatic

Action C.2: Implement effective predator management and/ or biosecurity across all targeted sites with seabird colonies where this management is necessary and feasible.



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Front cover illustration: Black rat trapped in classic snap trap. Biljana Ječmenica

This report is part of Action C.2: Implement effective predator management and/ or biosecurity across all targeted sites with seabird colonies where this management is necessary and feasible

Contents

1. INTRODUCTION	1
2. METHODS	2
3. RESULTS AND DISCUSSION.....	5
3.1. Permanent rat removal via rodenticide baiting.....	5
3.1.1. Vlašnici & Obrovac	5
3.1.2. Lukovci	8
3.2. Rat population control via rodenticide baiting	10
3.2.1. Maslovnjaci	10
3.2.2. Rutvenjaci.....	13
3.3. Localized rat population control via rodenticide baiting	16
3.3.1. Sušac	16
3.3.2. Kručica.....	16
3.4. Unsuccessful eradication attempts via rodenticide baiting.....	17
3.4.1. Pod Kopište	17
3.4.2. Petrovac	20
3.4.3. Bratin.....	22
3.5. Rat population control via live trapping/ cage trapping.....	24
3.5.1. Zaklopatica	24
4. CONCLUSION.....	26
5. ACKNOWLEDGEMENTS	27
6. LITERATURE CITED	28
7. APPENDICES	29

1. INTRODUCTION

Islands are known to be great places for evolutionary studies, just as for the general lack of predatory mammals. Species evolving in such places usually develop, island tameness, where they lose the anti-predator behavior due to the island insolation. Introduced, invasive mammalian predators such as brown (*Rattus norvegicus*) and black rats (*Rattus rattus*), mongooses (*Herpestidae*) and feral cats (*Felis catus*) can have serious impact on many such species, among them small to medium-sized seabirds (Towns et al. 2006). In the Mediterranean, black rats are known to be the major invasive species associated with seabird declines (Martin et al. 2000) and both Yelkouan (*Puffinus yelkouan*) and Scopoli's shearwater (*Calonectris diomedea*) are known to be affected by them (Bourgeois & Vidal 2008). Rats are known to readily predate on seabird eggs, chicks and even the adults of smaller species (Jones et al. 2008). Therefore, one of the methods of improving the status of burrow-nesting seabirds is through complete rat eradication from islands on which they nest. This has proven to improve the survival rates of seabird nestlings. Previous projects in the Mediterranean showed that small islands can be eradicated and kept rat free for extended periods of time (Canale et al. 2019). Besides increasing the breeding success rat eradication can also have a significant beneficial impact on shearwater breeding populations, for instance in Zembra archipelago in Tunisia, a tenfold increase in Yelkouan shearwater breeding pairs was recorded only three years after successful eradication (Bourgeois et al. 2013).

One of the main objectives of the LIFE Artina project was to eradicate invasive mammals, primarily black rats, from parts of the Lastovo Archipelago in order to improve breeding conditions for populations of Yelkouan shearwater, Scopoli's shearwater and Audouin's gull. As part of action A3, the LIFE Artina project carried out a predator assessment in 2019 and 2020 on all seabird colonies in the Lastovo Archipelago and confirmed the presence of rats for all islands except Crnac, Pod Mrčaru, Veli Tajan and Obrovac (Engelen et al. 2020a; Ječmenica et al. 2020). Their presence was recorded by observations of bones, faeces and evidence of feeding events (such as punctured olive seeds with specific bitemarks). Rats were also observed with camera traps, including their disturbance of seabird nests, and the predation of seabird eggs and chicks. A rat eradication/ control plan for SPA Lastovo otočje was created (Engelen et al. 2020b) and the implementation of predator management at important sites for Yelkouan and Scopoli's shearwater, as well as Audouin's gull was carried out in the following years. A report on the first preliminary results was produced at the end of 2020 (Kapelj et al. 2020).

Since then, rat populations have been successfully eradicated or controlled on several seabird colonies, additional islands have been surveyed for rat presence (as Audouin's gull regularly changed its breeding locations during the project – Jurinović & Engelen, 2022) and priority sites for (ongoing) future eradication work have been identified. This report shows the results of the rat eradication work carried out during for the LIFE Artina project from 2019 to 2023. The eradication work on some of the islands was made possible through additional funding from Fondation Segre under the Adriatic Seabird Guardians project (2019-2022). During the final year of the LIFE Artina project (2023), the eradication work on priority sites in the Lastovo Archipelago was mostly carried out by the Public Institution of the Lastovo Islands Nature Park.

2. METHODS

The initial plan for the LIFE Artina project was to do the rat control/ eradication on all islands by using mechanical traps only, thus without the use of rodenticides. Therefore in 2019, rat eradication work was conducted using cage traps, snap traps and automatic, self-resetting A24 Goodnature traps (Figure 1A & Figure 1B). In doing so, rat populations on Zaklopatica were controlled and complete rat eradication was attempted on the island of Donji Vlačnik (Smokvica). This approach, however, proved to be unfeasible, because it was highly labour-intensive and particularly difficult to conduct on remote islands that are difficult to reach (for instance, due to bad weather conditions). Also, as we wanted to eradicate rats from as many islands with seabird colonies as possible, thus maximizing our conservation efforts, we changed this approach after the first year and switched to using rodenticide in 2020 (Figure 1C), except for the island of Zaklopatica where cage trapping was preferred due to its vicinity to a settlement (Kapelj et al. 2020).

Islands where rat eradication work was to be carried out, were selected according to their importance for breeding shearwaters and Audouin's gull, as well as their accessibility and feasibility considering available human resources and budget. Additionally, a few minor islands without breeding seabirds were included in the eradication work, due to their vicinity to important islands in which case they could serve as a source or stepping stone for rat reinvasions. Islands were further divided into 4 groups depending on the method required. These different methods are 1) full eradication attempt via rodenticide baiting, 2) seasonal rat control via rodenticide baiting, 3) seasonal rat control via cage trapping, 4) monitoring of rat-free status, and are each described in detail in the A3 deliverable report 'Rat eradication/ control plan for SPA Lastovsko otočje' (Engelen et al. 2020).

Full eradication attempts via rodenticide baiting were conducted on a total of 14 islands in the Lastovo Archipelago, namely: Donji, Srednji and Gornji Vlačnik (Vlačnici) and Obrovac; Veli and Mali Maslovnjak (Maslovnjaci); Veli and Mali Rutvenjak (Rutvenjaci); Srednji, Gornji and Mali Lukovac (Lukovci); Pod Kopište; Petrovac; Bratin. The eradication work on islands with breeding Yelkouan shearwaters, as well as breeding Audouin's gull was started in February, while eradication work on islands with only Scopoli's shearwater commenced later, between March and June. Furthermore, localized seasonal rat control via rodenticide baiting was carried out around known Yelkouan shearwater colonies on Sušac in 2020 and around Scopoli's shearwater colonies on Kručica in 2021 and 2022. Finally, rat control via live trapping was conducted on Zaklopatica, from 2019 to 2023, prior to and during the breeding period for Yelkouan shearwater, covering also the incubation stage of Scopoli's shearwater. At first a combination of cage traps and snap traps was used, but later only cage traps were set up, because of the possibility of killing or injuring other species than rats. Figure 2 shows the locations of all these islands in the Lastovo Archipelago. Figures A1 to A10 in the Appendix of this report show the exact locations of the baiting stations or cage traps on each of the islands.

For the rodenticide baiting, a second-generation anticoagulant bait was used (based on the availability in Croatia): 20 g paraffin blocks with 0.005% concentration of bromadiolone. These rodenticide blocks were placed in special bait stations (Figure 1C), which were installed on each of the islands according to a 40x50 grid. If needed, baiting trails were created by cutting paths through the macchia to allow for full island coverage. After the initial bait placement, rebaiting visits were attempted on day 3 or 4, day 7, day 10 and day 14 (as described in the A3 rat eradication/ control plan), but this was not always possible due to bad weather conditions. During each rebaiting visit, we carefully monitored for fresh

rat signs (such as faeces or toothmarks) and replaced stale, mouldy, wet or otherwise unattractive bait, as well as rodenticide blocks that were only partially eaten. Afterwards bait consumption was calculated using the following formula:

*Bait consumption = previously placed # bait blocks * 20 g – non-replaced bait blocks * 20 g - what was replaced in exact grams*

non-replaced bait blocks = present bait blocks - replaced bait blocks

what was replaced in exact grams = the exact remaining weight of the replaced block(s)

When no bait was consumed and no fresh rat signs had been observed for at least 2 weeks, the bait was removed from the islands and replaced by wax blocks (a mixture of candle wax and cacao, Figure 1D). These wax blocks were monitored for bitemarks once per month on average to see if rats had survived or reinvaded the islands. Additionally, footage of camera traps installed on the islands, was checked for rat presence. In case rats returned during the breeding season, the rodenticide set-up was put back in place on the islands and the same procedure was repeated.

After the breeding season, between October and the middle of February, A24 Goodnature traps were installed on islands where rats had been successfully eradicated, as means of biosecurity for rat reinvasions. Although these 'smart' traps will not keep an island rat-free, they could prevent reinvasions occasionally or slow down population growth after reinvasions take place. As rats can be weary to eat bait from these traps and because the number on the counter does not always reflect the true number of rats killed (Kapelj et al. 2020), cameras were installed next to some of them to check for the presence of rats and their interactions with the smart traps. Figures A1 to A10 in the Appendix of this report show the exact locations of the A24 Goodnature traps on each of the islands.



Figure 1. Different tools used during the rat eradication work: 1A cage trap; 1B A24 Goodnature trap; 1C rodenticide blocks; 1D non-toxic wax blocks. Photos by Biljana Ječmenica.

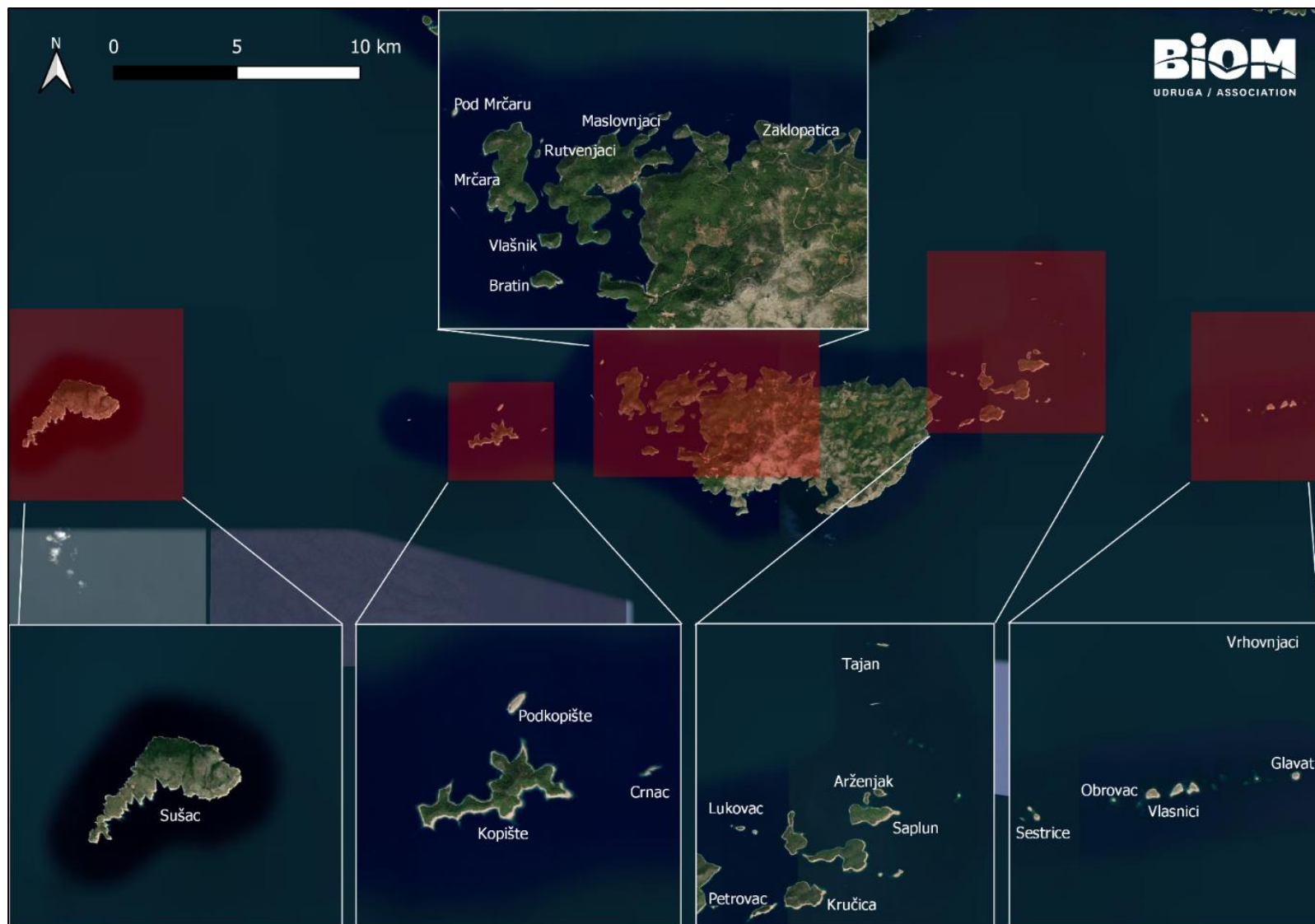


Figure 2. Overview of the Lastovo Archipelago with smaller island groups highlighted.

3. RESULTS AND DISCUSSION

During the 2020 to 2023 fieldwork seasons, eradication or control of rat populations via rodenticide baiting was attempted on 16 islands. Across these 16 islands 293 bait stations were placed and a total of 207.5 kg of rodenticide was consumed (Table 1). Initial bait consumption was typically high for each site as existing rat populations quickly consumed the bait deployed. Bait consumption usually started declining after 2 to 3 weeks and reached 0 after a month more or less, as the rat population was knocked down. After the eradication was deemed successful the islands continue to be monitored for surviving or reinvading rats by means of wax blocks and A24 Goodnature traps.

Table 1. Total bait consumption per island during the rat eradication work around Lastovo from 2020 to 2023.

Island name	Bait consumed/g per year			
	2020	2021	2022	2023
Donji Vlačnik	12108	0	0	0
Srednji Vlačnik	8116	0	0	0
Gornji Vlačnik	6636	0	0	0
Obrovac	0	0	0	0
Veli Maslovnjak	3800	1112	520	1280
Mali Maslovnjak	1100	560	1180	620
Veli Rutvenjak	1496	980	2120	2480
Mali Rutvenjak	360	0	140	100
Srednji Lukovac	1540	0	0	0
Gornji Lukovac	1360	0	0	0
Mali Lukovac	160	0	0	0
Pod Kopište	9451	4635	-	-
Petrovac	13577	-	-	-
Sušac	19200	0	0	0
Bratin	-	88048	-	-
Kručica	-	15200	9600	-
Total	78904	110535	13560	4480

A detailed overview of the progress and current state of the eradication work on each of the islands is presented in the next chapters. Overall, permanent rat removal was achieved on 7 islands, and 5 more islands have ongoing rat population control since 2020. Three eradications on relatively larger islands were attempted, and while initially successful, rats ultimately returned to these places.

3.1. Permanent rat removal via rodenticide baiting

3.1.1. Vlačnici & Obrovac

Rat removal from the three Vlačnici via rodenticide baiting was started in February 2020. The island of Obrovac was included in this effort, as the islands lies within rat swimming distance of the Vlačnici

(<750m). The rodenticide blocks on Obrovac never showed any signs of consumption (Figure 3), and wax blocks remained untouched (Figure 4), indicating that the island probably never had any rats. However, Donji, Srednji, and Gornji Vlašnik continued to display fresh signs of rat activity (faeces, bite marks) even though the consumption of rodenticide blocks initially dropped in a pattern similar to other islands (Figure 3). On Srednji Vlašnik, bait consumption even shortly picked up again after a month of being left untouched (Figure 4). While it's not clear why rats began avoiding the bait on some of these islands, it's possible that our limited ability to frequently visit the islands for rebaiting during the crucial first weeks of eradication prevented some rats from ingesting enough bait, making them wary of it.

After more than three months of eradication work, rat signs were still present while no bait was consumed, and the decision was made to abort the effort and try again in 2021. To our surprise, during the first three visits in 2021 to Donji, Srednji, and Gornji Vlašnik, no bait was taken, and also during subsequent visits all wax blocks remained untouched and cameras did not record any rats on the islands. It seems that the one/ few survivor(s) of the 2020 eradication attempt had died in the meantime. To be sure, all three islands were monitored for rat presence again in 2022, and also this time no rats were observed. Therefore, it was concluded that the eradication was successful after all and that the islands were now officially free from rats.

The nearest islands to the Vlašnici are Bratac, Vela, and Mala Sestrica to the west and Mrkljenta and Glavat to east (Figure 2), all of which have been assessed to be rat-free. Collectively the nine islands are known as the Vrhovnjaci, and they are approximately 6 kilometres away from the nearest other islands in the Lastovo Archipelago. The remoteness of the Vrhovnjaci from other islands should generally mean that they will remain rat-free in the future, unless rats are (un)intentionally brought back by people.

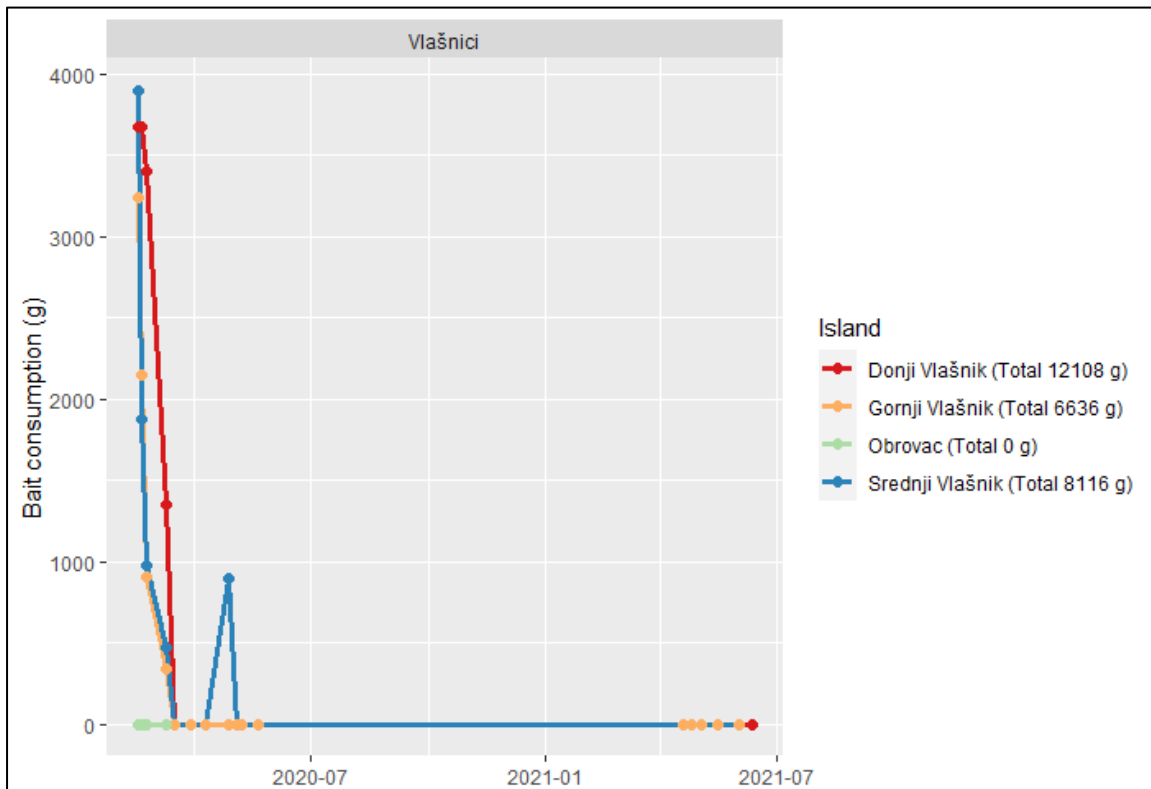


Figure 3. Bait consumption on the three Vlašnici and Obrovac during the 2020 - 2021 rat eradication effort.

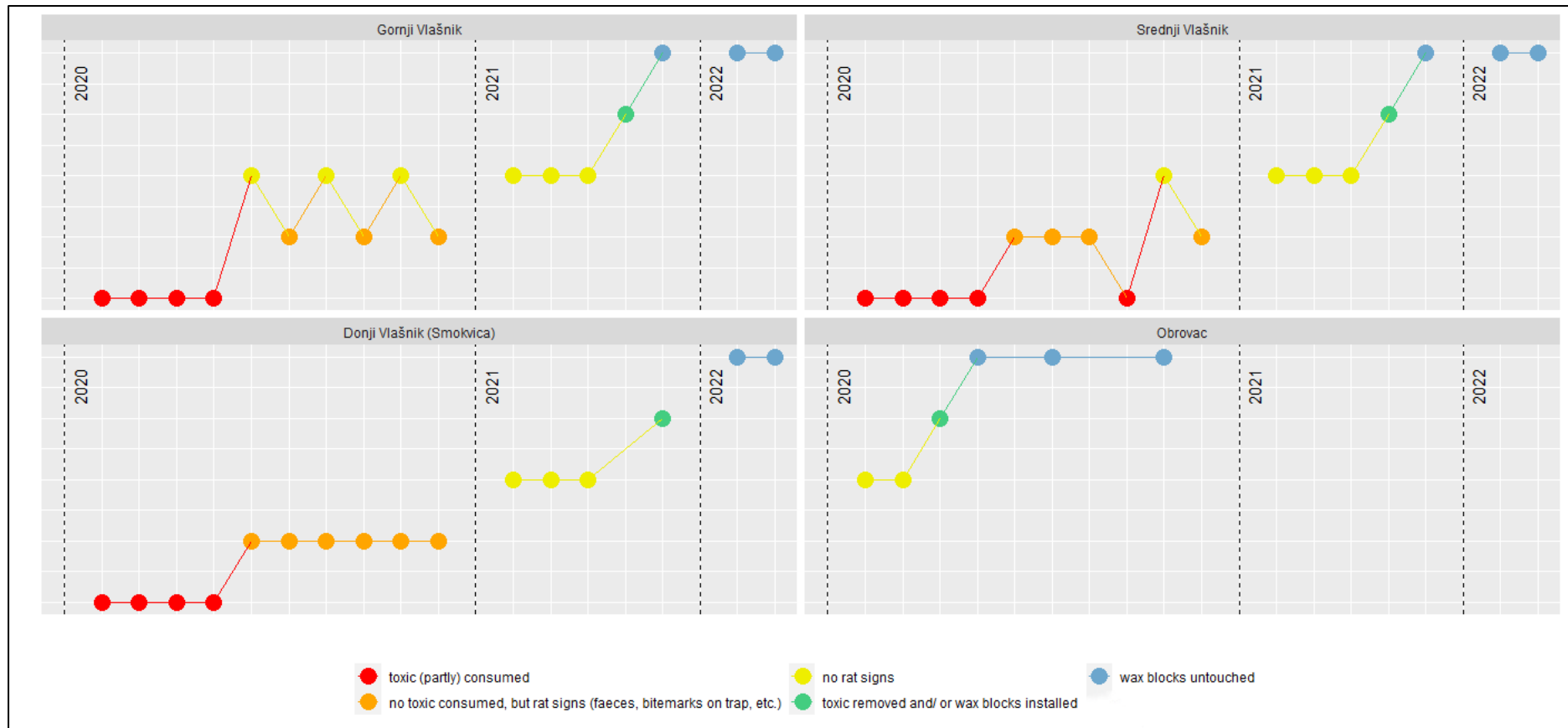


Figure 4. Detailed overview of visits per island showing the state of the eradication work on the three Vlašnici and Obrovac.

3.1.2. Lukovci

Rat eradication work on the three Lukovci started in March 2020. The consumption of bait on these islands decreased to zero within a month (Figure 5) and after no signs of rats were observed for another 2 to 3 weeks wax blocks were installed in all bait boxes. These wax blocks were monitored for bite marks each month until October, after which one A24 Goodnature trap was installed on Gornji Lukovac and three on Srednji Lukovac, accompanied by cameras. As no rats were observed during the winter, the following year wax blocks were installed and monitored again from April onwards (Figure 6). This cycle has been repeated each year and up until now no rats have been observed on the islands since their eradication in 2020.

The Lukovci are situated approximately 1 kilometre away from the main land of Lastovo island, making the reinvasion of rats from there highly improbable. However, the island of Stomorina is approximately 575 meters to the east of Gornji Lukovac and could serve as a route for rat reinvasion to the Lukovci in the future (Figure 2). It is therefore important that annual checks for rat presence keep happening, and to perhaps install A24 Goodnature traps on Stomorina as a first line of defence.

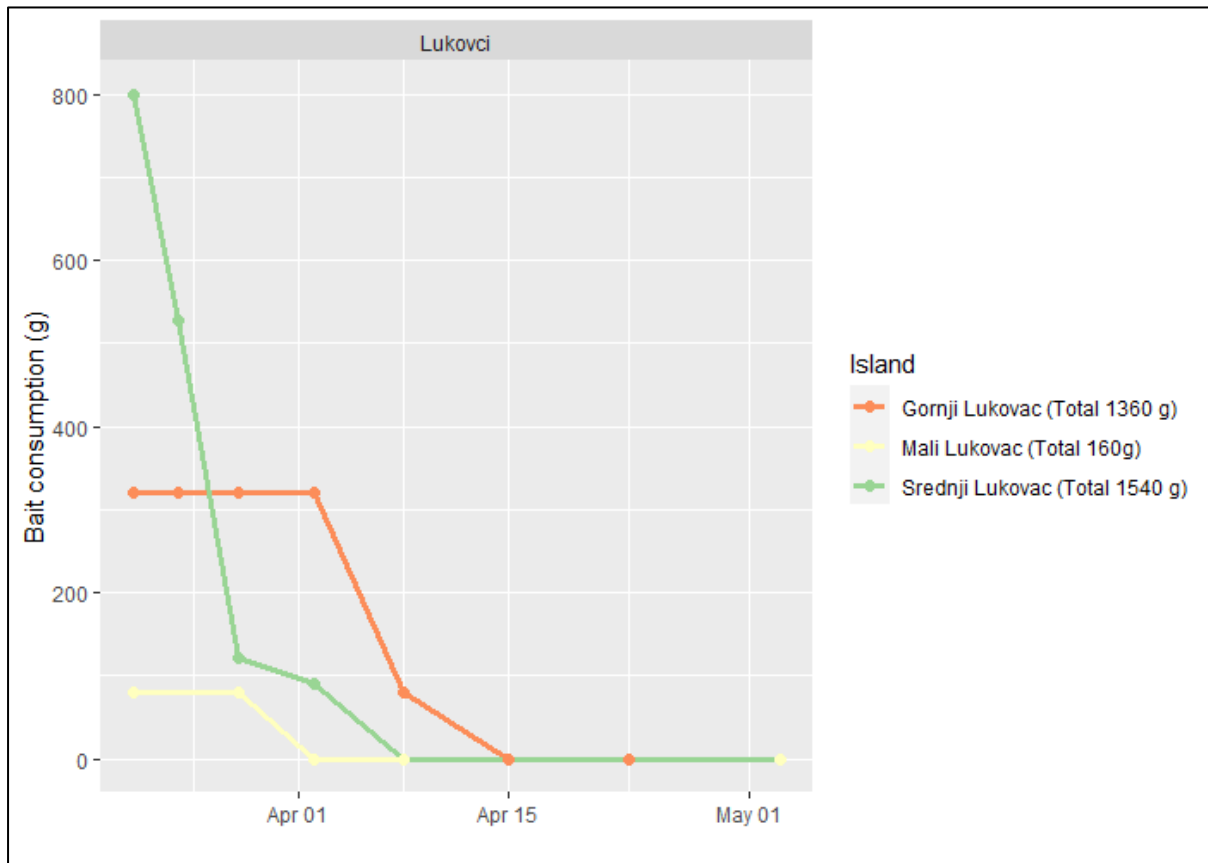


Figure 5. Bait consumption on the three Lukovci during the 2020 rat eradication effort.

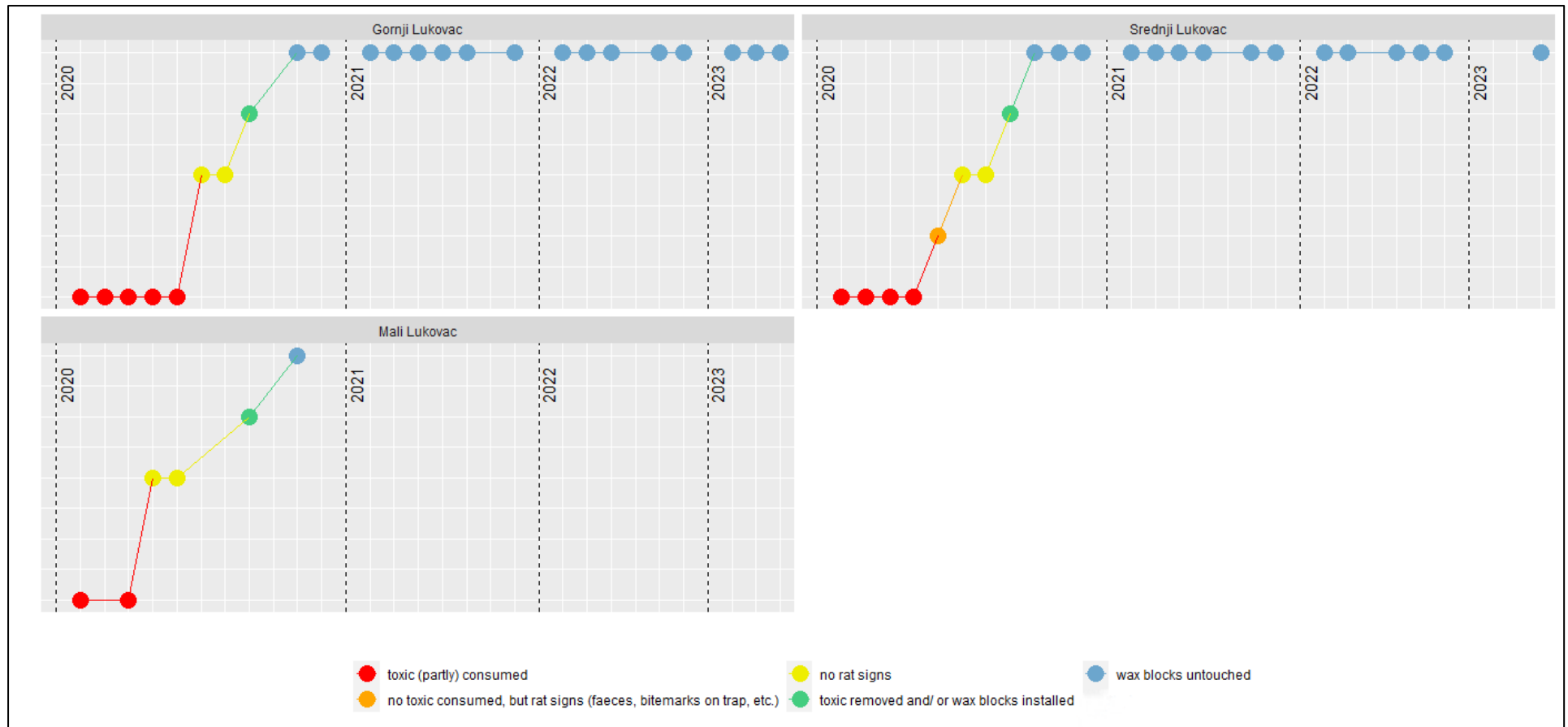


Figure 6. Detailed overview of visits per island showing the state of the eradication work on the three Lukovci.

3.2. Rat population control via rodenticide baiting

3.2.1. Maslovnjaci

The rat eradication work on the Maslovnjaci started in February 2020. Since then the effort has been repeated annually as rats reinvade the island each winter. During all years, bait consumption dropped to zero within a month (Figure 8; Figure 9). Once the bait consumption drops to zero and no rat signs are observed for at least two additional weeks, all rodenticide cubes are replaced with wax blocks for reinvasion monitoring (Figure 7; Figure 10). Whereas Veli Maslovnjak usually stays rat-free for a period of up to half a year (Figure 8; Figure 10), Mali Maslovnjak has more frequent rat reincursions (Figure 9; Figure 10). At the beginning of every year the cycle is repeated. Furthermore, during winter, and in parallel with the eradication work, two A24 Goodnature traps are installed on Mali Maslovnjak and five on Veli Maslovnjak as a first line of defence for rat reincursions.

The Maslovnjaci islands are in close proximity to the main island of Lastovo, with Mali Maslovnjak being approximately 80 meters away and Veli Maslovnjak around 200 meters away (Figure 2). Due to their closeness to the main island of Lastovo, rats reinvade the islands annually, which makes continuous eradication efforts necessary to keep the rat population at low numbers during the breeding season for shearwaters.



Figure 7. Wax blocks installed on Veli Maslovnjak in 2022. Despite the wear and tear or partial melting, none of the blocks have bite marks of rats on them. Photo by Dries Engelen.

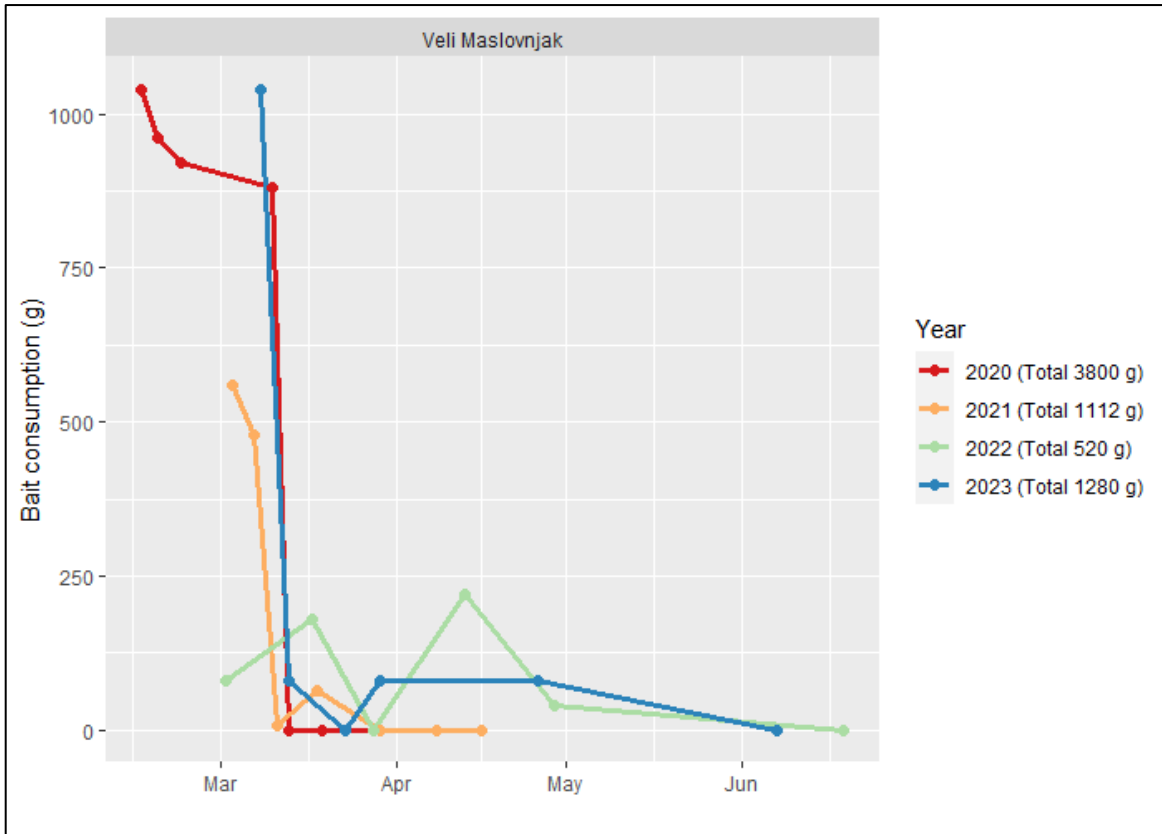


Figure 8. Bait consumption on Veli Maslovnjak during the 2020 - 2023 rat population control efforts.

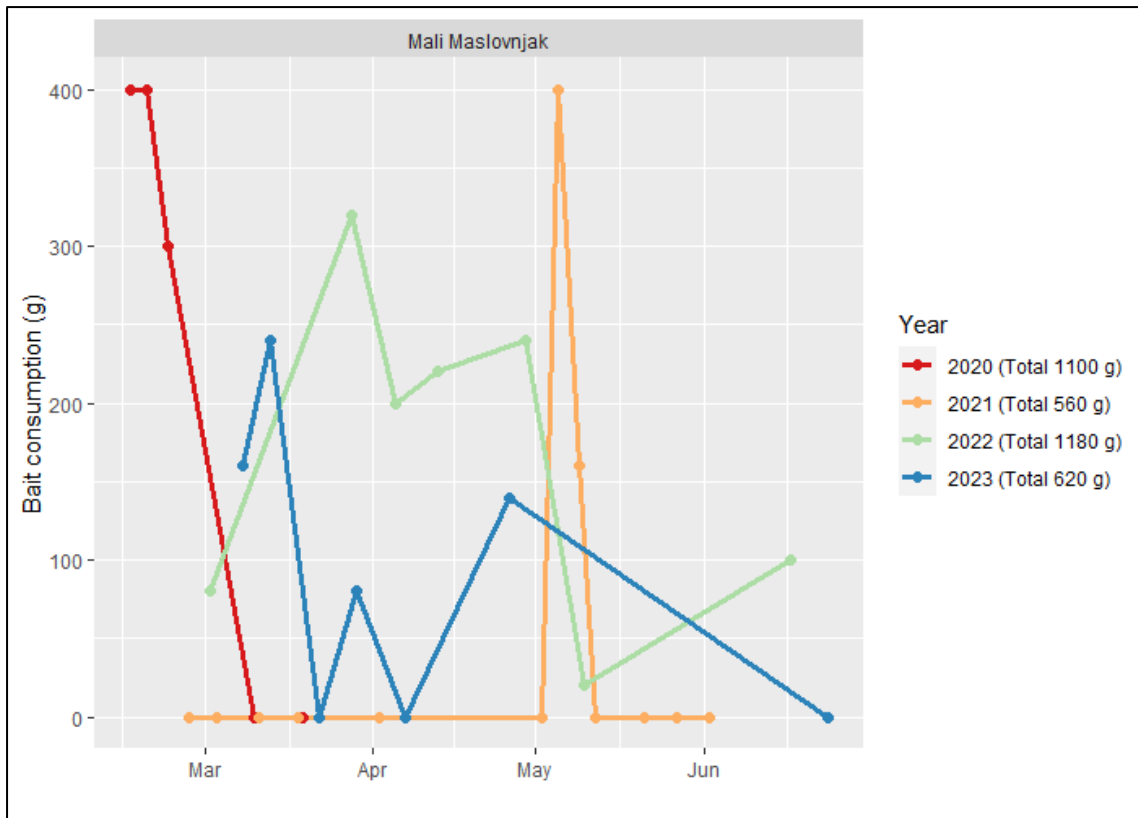


Figure 9. Bait consumption on Mali Maslovnjak during the 2020 - 2023 rat population control efforts.

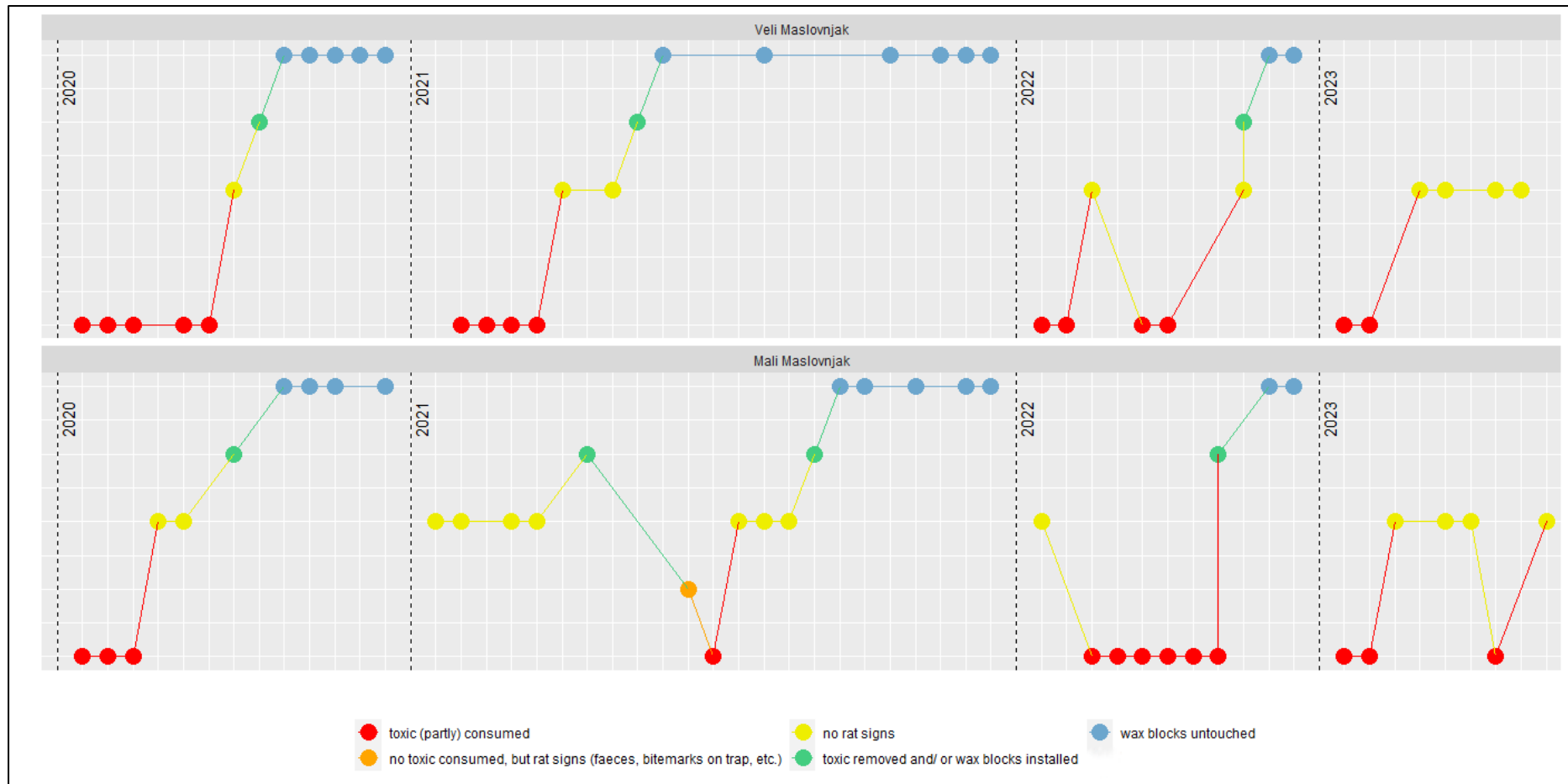


Figure 10. Detailed overview of visits per island showing the state of the eradication work on the Maslovnjaci.

3.2.2. Rutvenjaci

The eradication of rats on the Rutvenjaci was conducted in parallel with the Maslovnjaci islands, and started in February 2020. On the Rutvenjaci islands, the consumption of rodenticide blocks initially followed a pattern similar to that of other islands during 2020 (Figure 12; Figure 13). Since then Mali Rutvenjak has had few rat reincursions, less than annually, which were controlled in a straight forwarded manner during 2022 and 2023 (Figure 13; Figure 14). Veli Rutvenjak, on the other hand, had unusual toxic bait consumption between 2021 to 2023 (Figure 12; Figure 13). Possibly rats reinvaded from neighbouring islands continuously during the baiting process. However, particularly high consumption of toxic bait was recorded throughout the year in both 2022 and 2023 raising suspicion as to what was happening exactly. In June 2022, rodenticide cubes were replaced with wax blocks to determine if rats were eating the bait or if something else was consuming it. The wax blocks indeed confirmed the presence of rats (Figure 11), but cameras also showed that Hooded crows (*Corvus cornix*) were consuming the bait. In parallel to the ongoing eradication efforts, and during the winter months, one A24 Goodnature traps was installed on Mali Rutvenjak and three on Veli Maslovnjak as a means of biosecurity and support in keeping rat populations in low numbers.

The Rutvenjaci islands are in close vicinity to the island of Mrčara, with both islands being less than 200 meters away, and to the main island of Lastovo, which is less than 600 meters away (Figure 2). Due to their closeness to the islands of Mrčara and Lastovo, rats reinvade the islands annually, which makes continuous eradication efforts necessary to keep the rat population at low numbers during the breeding season for shearwaters. However, the set-up of bait boxes should be improved to exclude the consumption of bait by Hooded crows.



Figure 11. Wax blocks installed on Veli Rutvenjak in 2022 with clear rat bite marks on them. Photo by Dries Engelen.

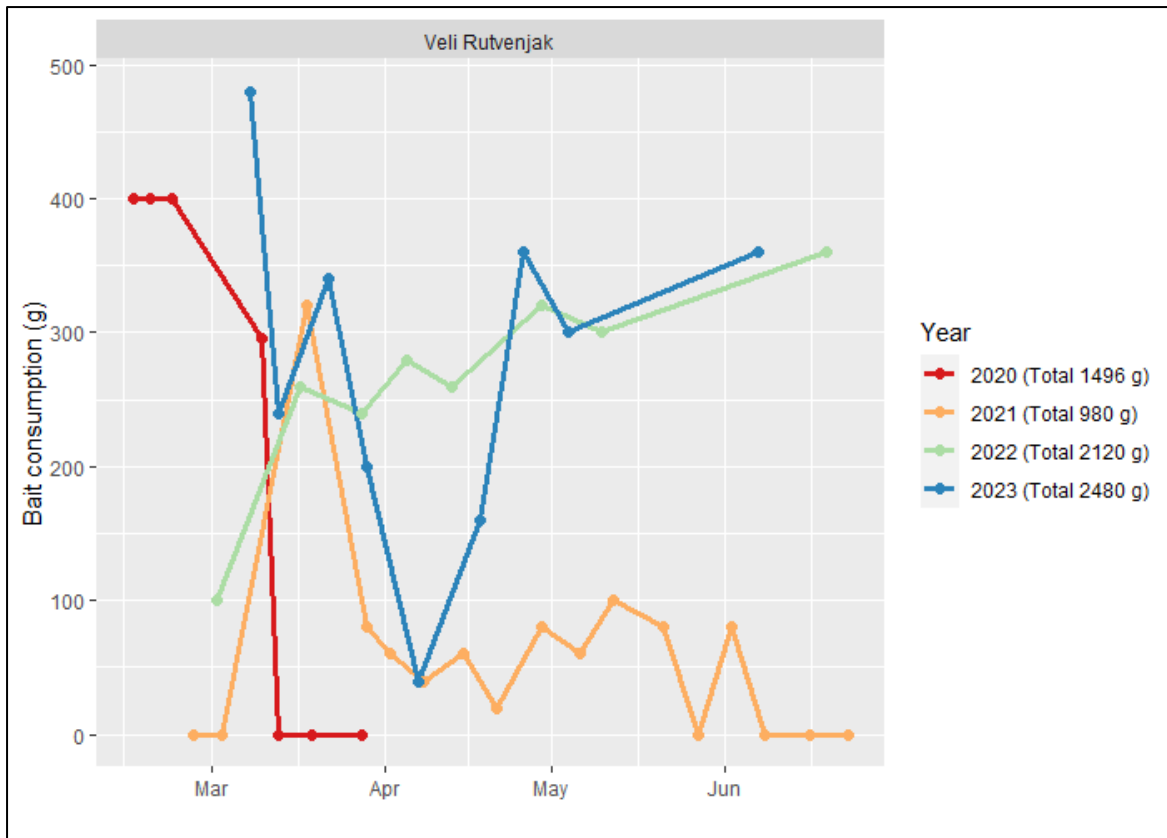


Figure 12. Bait consumption on Veli Rutvenjak during the 2020 - 2023 rat population control efforts.

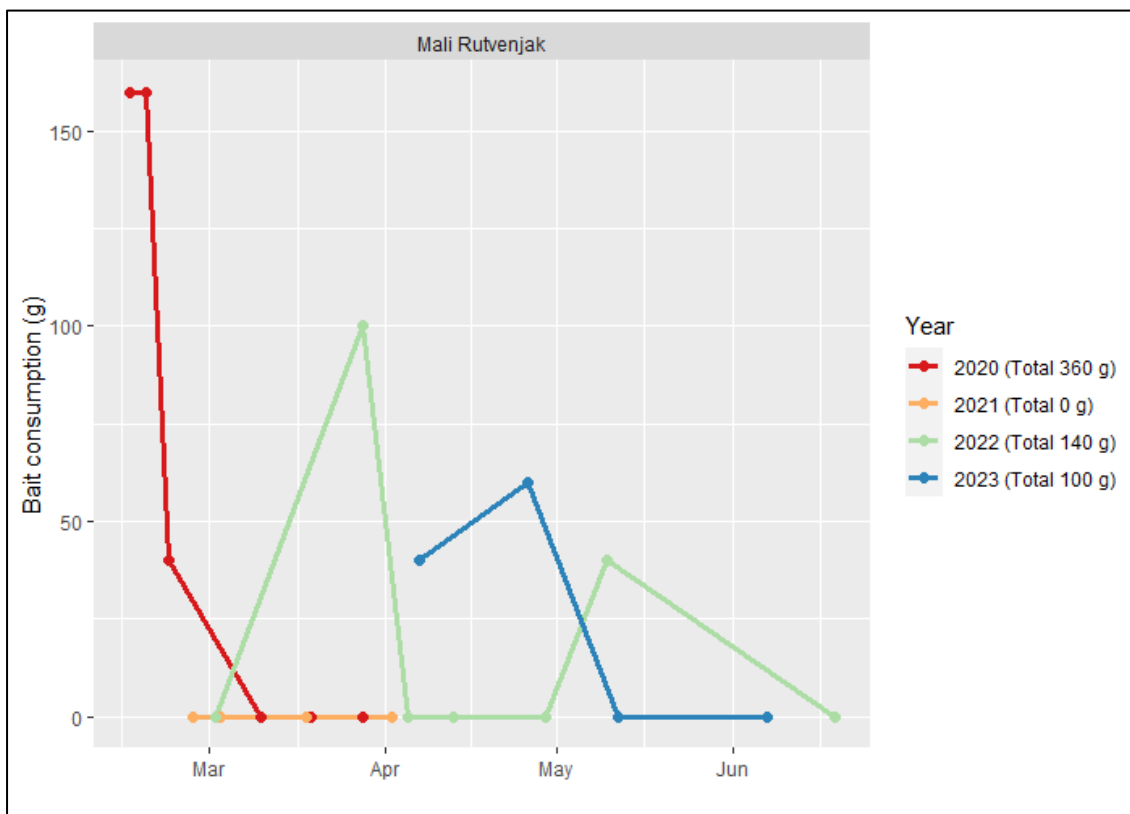


Figure 13. Bait consumption on Mali Rutvenjak during the 2020 - 2023 rat population control efforts.

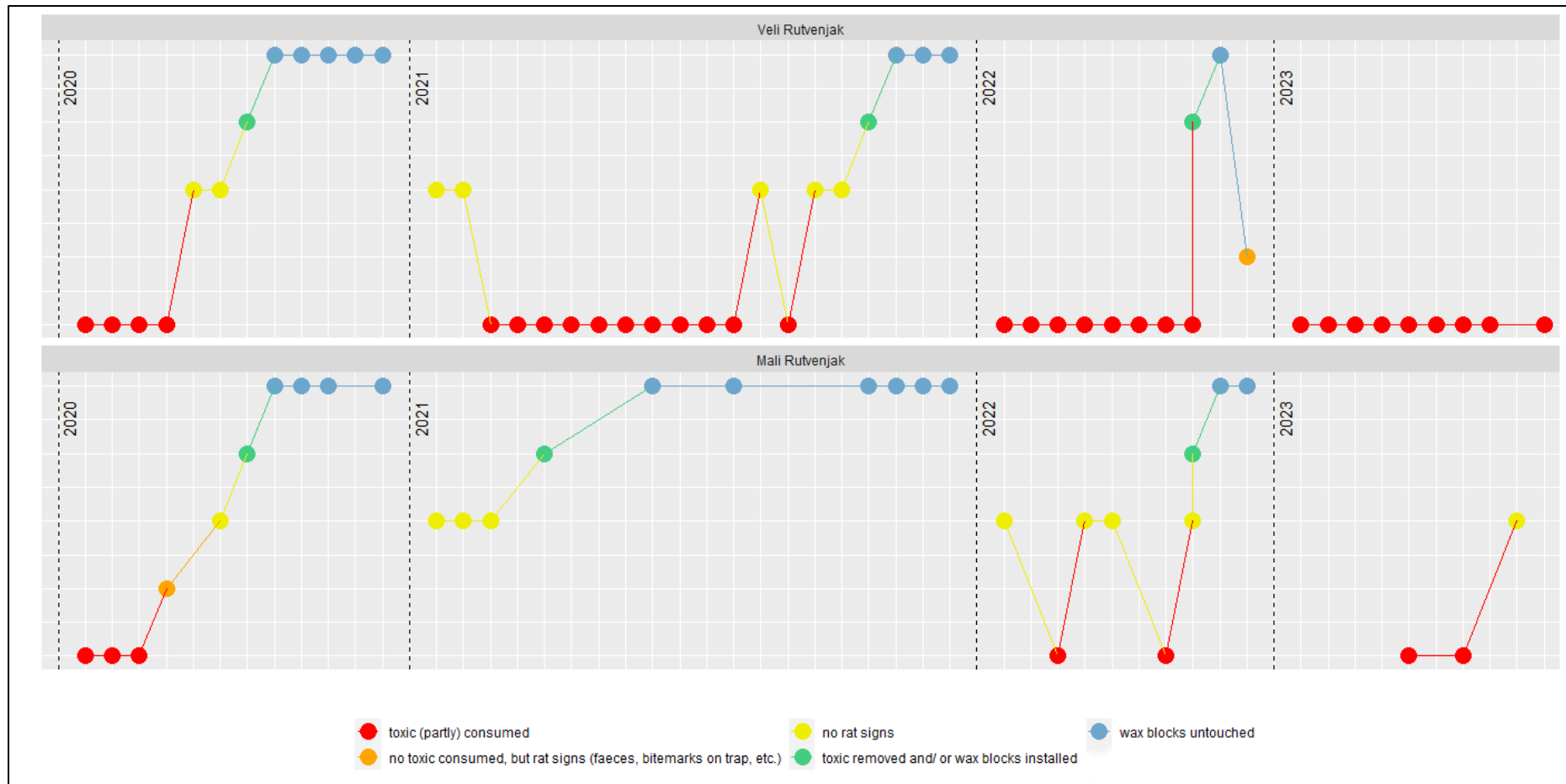


Figure 14. Detailed overview of visits per island showing the state of the eradication work on the Rutvenjaci.

3.3. Localized rat population control via rodenticide baiting

3.3.1. Sušac

On the island of Sušac a total of 20 bait stations was placed around known Yelkouan shearwater nests on the 24th of February 2020. Throughout the breeding season, bait boxes were checked six times, roughly once every three weeks, with the last visit being on 13th of June 2020. All 20 boxes had to be rebaited entirely during each visit and a total of 19.2 kg of rodenticide was consumed (Figure 15). As Sušac is also home to wood mice *Apodemus sylvaticus*, it could be that the bait was not exclusively ingested by rats. Although the breeding success of Yelkouan shearwater was high in 2020 (72%), the effort was not repeated in the following years due to the remoteness of Sušac (Figure 2). It is exactly for this reason, however, as well as for the fact that it is uninhabited and has a large availability of suitable breeding habitat for shearwaters, that the island should be prioritized for a first future large-scale complete rat removal project in Croatia (Austad et al. 2020).

3.3.2. Kručica

On the island of Kručica a total of 12 bait stations was placed around known Scopoli's shearwater nests at the end of March 2021 and beginning of April 2022. Throughout the breeding season, bait boxes were checked 8 times during 2021 and 5 times during 2022, roughly once every two to three weeks, with the last visit being at the end of September to collect the boxes. All 12 boxes had to be rebaited entirely during each visit and a total of 24.8 kg of rodenticide was consumed (Figure 15). The breeding success of the Scopoli's shearwaters increased dramatically during the seasons that rat control was carried out (0% in 2019 and 2020 vs. 85% and 76% in 2021 and 2022 respectively), so this relatively low effort should surely be considered in future years as well.

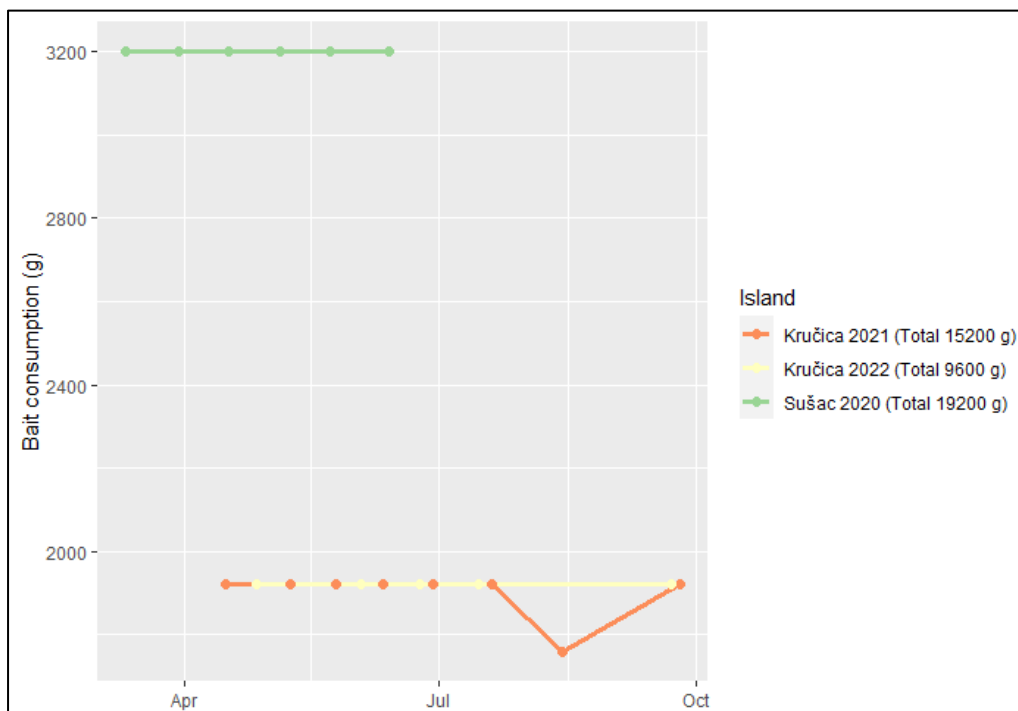


Figure 15. Bait consumption on the islands Sušac and Kručica during localized rat control in 2020 and 2021-2022 respectively.

3.4. Unsuccessful eradication attempts via rodenticide baiting

3.4.1. Pod Kopište

Rat eradication work was started on Pod Kopište in 2020, and again in 2021. Bait consumption on the island dropped to zero within a month in 2020 (Figure 16). After no signs of rats were observed for another 2 to 3 weeks, wax blocks were installed in the bait boxes (Figure 18). There were no rat signs observed from mid-July to mid-October, after which two A24 Goodnature traps were installed on the island for winter. Upon returning to the island the following year, we were surprised to find both smart traps, as well as one of the cameras heavily chewed on by rats (Figure 17).

The eradication effort was repeated in 2021, but this time it lasted longer for the bait consumption to reach zero (Figure 16). During following visits rat signs were still observed even though the bait remained untouched (Figure 18). There were also regular encounters between the bait boxes and Hooded crows (*Corvus cornix*) and Yellow-legged gulls (*Larus michahellis*), which ultimately lead to the decision to stop the eradication attempt in July.

Pod Kopište is in close vicinity to the island of Kopište, with it being approximately 400 meters away (Figure 2). Due to its closeness to the island of Kopište rats could reinvade the island, making permanent eradication impossible. As both islands are fairly exposed to the waves, rat reinvasions might not happen each year, but continuous eradication efforts and monitoring for rat presence would be necessary to keep the rat population at low numbers.

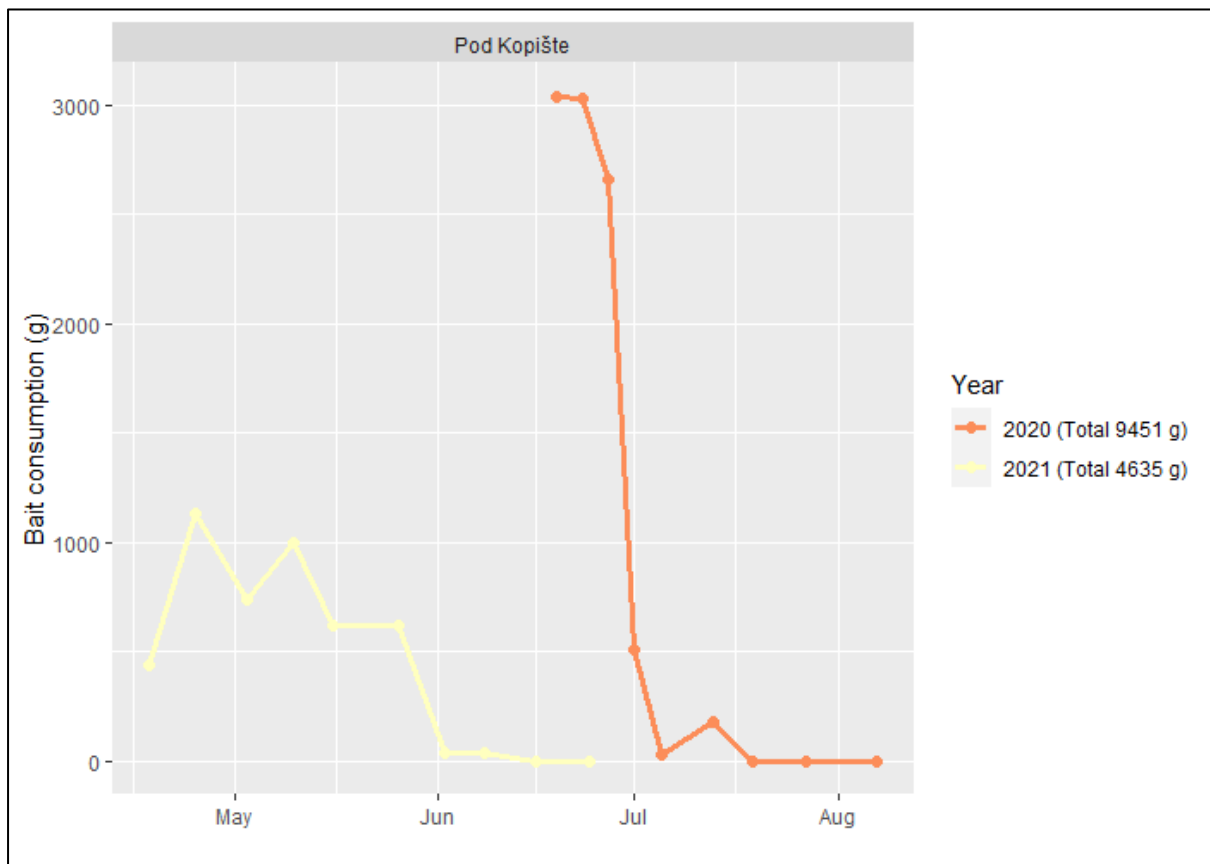


Figure 16. Bait consumption on Pod Kopište during the 2020 - 2021 rat eradication efforts.



Figure 17. A24 Goodnature traps eaten by rats on Pod Kopište. Photo by Dries Engelen.

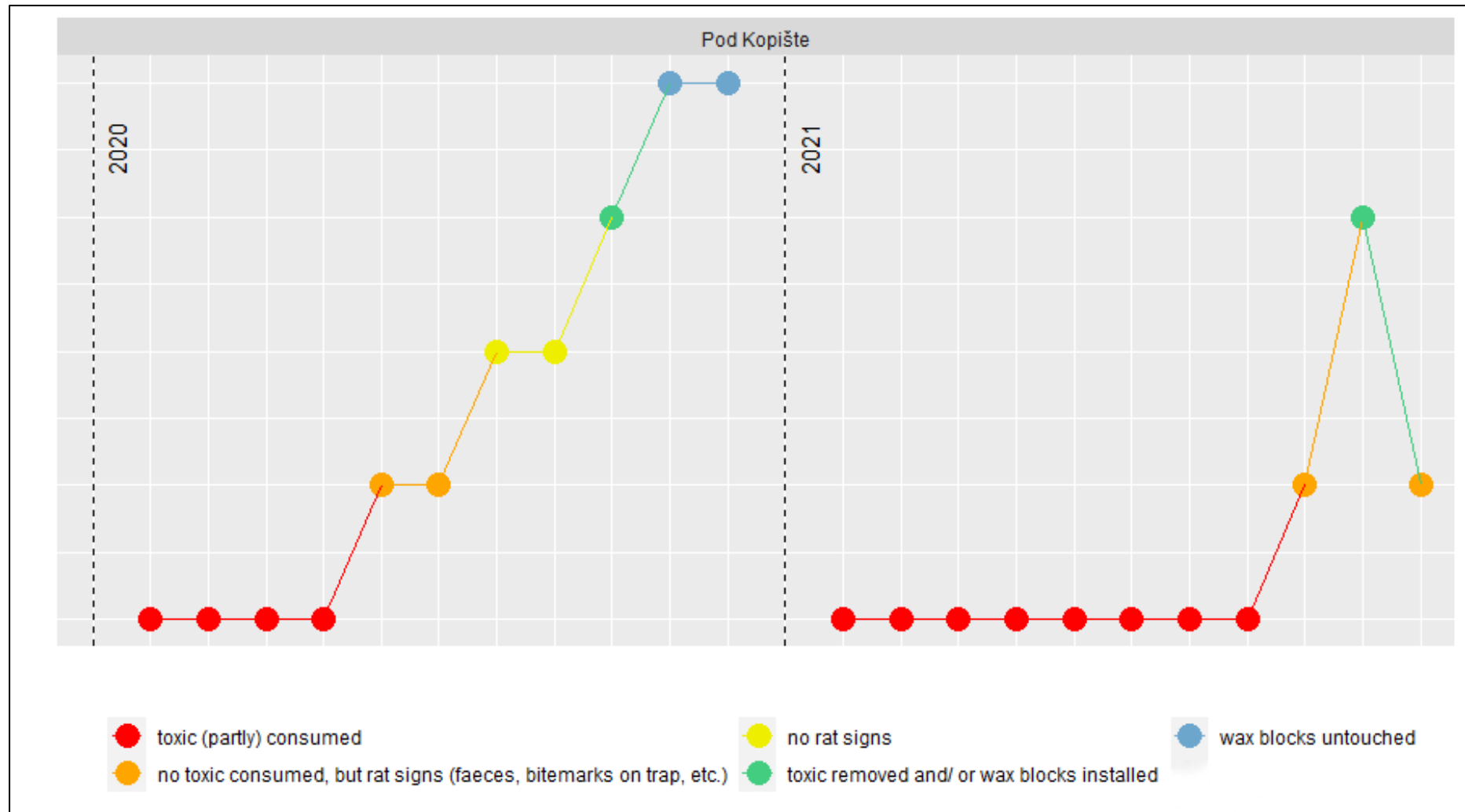


Figure 18. Detailed overview of visits showing the state of the eradication work on Pod Kopište.

3.4.2. Petrovac

A complete rat eradication effort on Petrovac was attempted in June 2020. To allow for full island bait station coverage, firstly, a baiting grid was created by cutting trails through certain sections of dense vegetation. Once the 45 bait boxes were installed, the consumption of bait decreased to zero within a month (Figure 19) and after no signs of rats were observed for another 2 to 3 weeks, wax blocks were installed and monitored (Figure 20). No rat signs were observed from the end of July to the end of October, after which five A24 Goodnature traps and camera traps were installed. They smart traps were set-up in a north-south orientation on the east side of the island, as that is where re-invading rats would be expected to arrive. In November, the camera traps recorded the first rat, indicating that the eradication had mostly likely not succeeded.

Petrovac is in close vicinity to the island of Kručica, with it being approximately 200 meters away (Figure 2). Due to its closeness to the island of Kručica rats could reinvade the island, making permanent eradication impossible. Even the westside of Petrovac is not entirely free from possible reinvasions, as the island is 800 meters separated from the rocky island of Barje which could serve as a stepping stone from rats from the main island of Lastovo. Thus, continuous eradication efforts would be necessary to keep the rat population on Petrovac at low numbers.

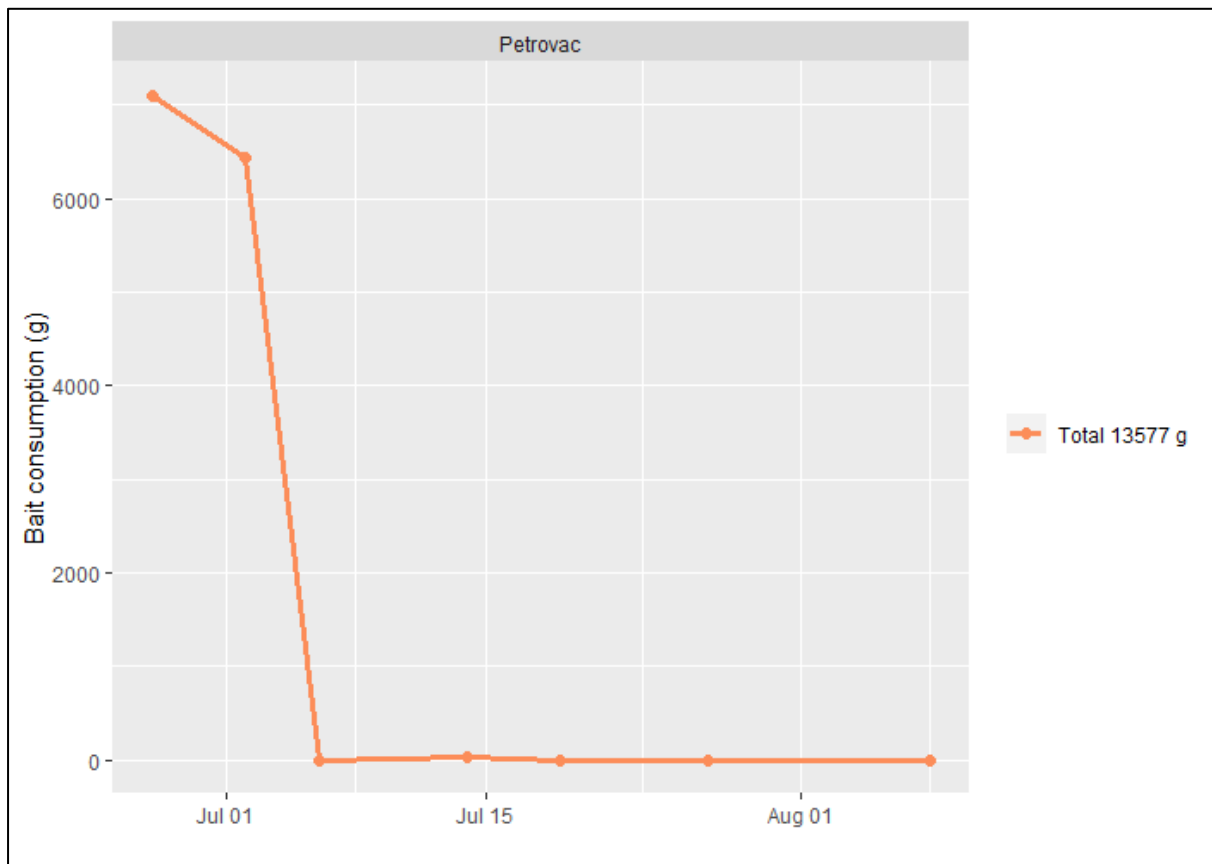


Figure 19. Bait consumption on Petrovac during the 2020 rat eradication attempt.

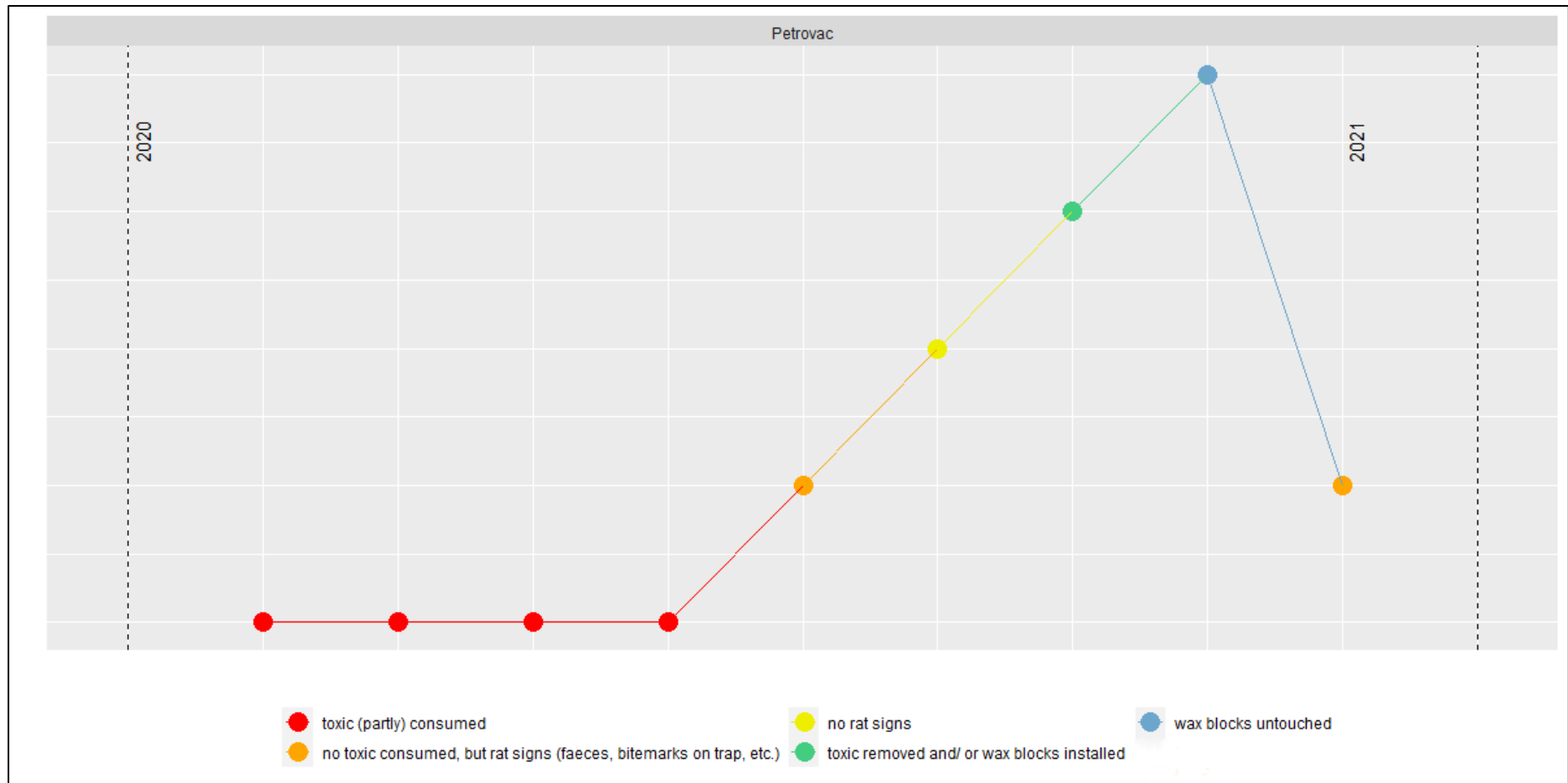


Figure 20. Detailed overview of visits showing the state of the eradication work on Petrovac.

3.4.3. Bratin

Rat eradication work was started on Bratin in February 2021. To ensure the full island coverage with bait boxes, 85 in total, a network of baiting trails had to be created by cutting paths through the dense macchia vegetation. Around 40kg of bait was consumed in the first month of the eradication. However, as consumption lasted longer than normal (Figure 21), camera traps were installed to monitor several bait boxes and they revealed that Hooded crows (*Corvus cornix*) had found a way to take bait from the boxes. After this the set-up of the bait boxes was changed to make it harder for crows to extract the bait, and immediately a major drop in bait consumption was noticed (Figure 14).

Although bait consumption on Bratin never dropped entirely to zero, at the end of June baiting was stopped because none of the cameras showed any rats. After this three A24 Goodnature traps were installed on the northside of Bratin, accompanied by cameras to check for rat presence. Additionally, the following year, wax blocks were placed across the island in 15 locations and monitored for several months (Figure 22). Ultimately no rat signs were observed for 16 months, until September 2022, when rat fur was found near an A24 Goodnature trap.

It is hard to say whether rats reinvaded the island or a very small number survived the eradication attempt. As Bratin is in close vicinity to the island of Vlašnik, with it being approximately 500 meters away, and to the main island of Lastovo, which is less than 800 meters away (Figure 2), rats could reinvade the island even if rats get completely eradicated from the island. Permanent rat removal seems therefore unlikely, although the island could remain rat-free for some period of time (as also seen on the Lukovci, see chapter 3.1.2). The effort is needed, however, and will need a new try in the near future, as the island hosts the largest colony of Scopoli's shearwater in the Lastovo Archipelago.

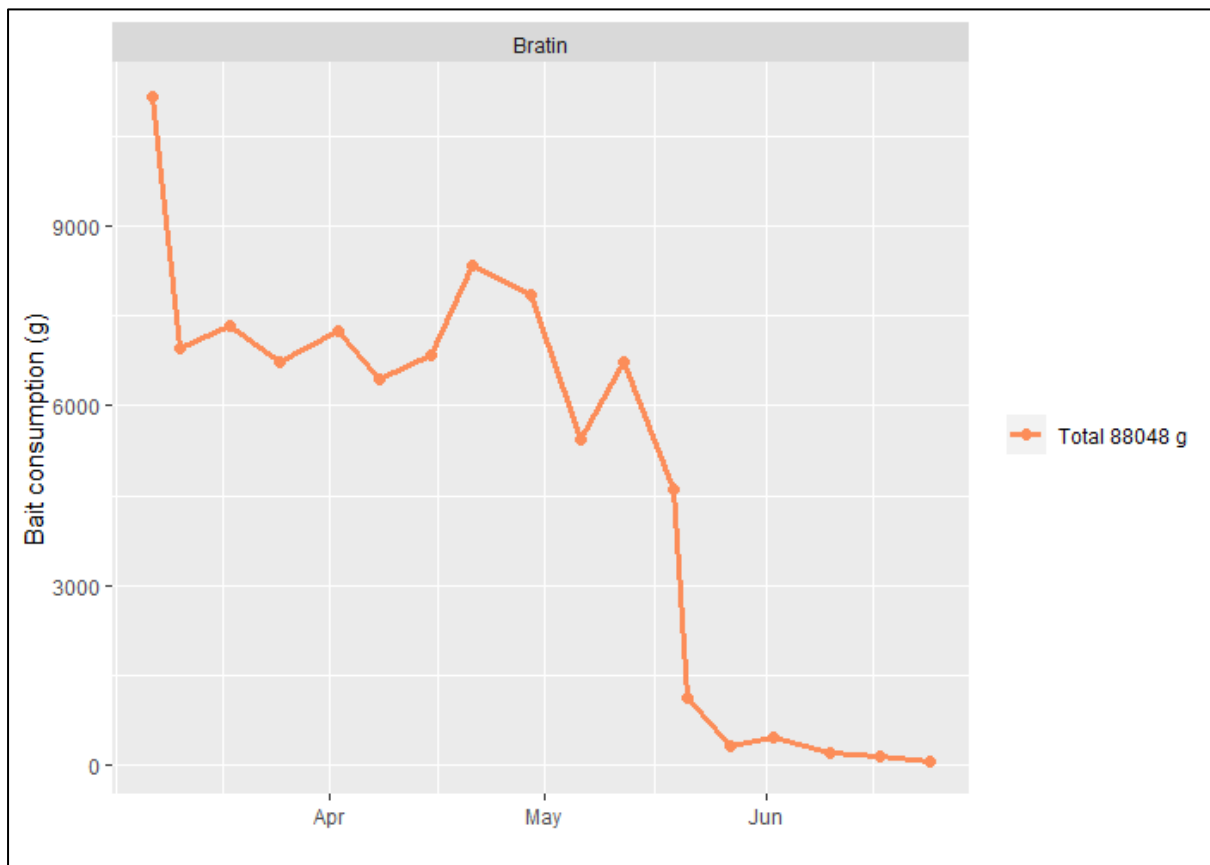


Figure 21. Bait consumption on Bratin during the 2021 rat eradication attempt.

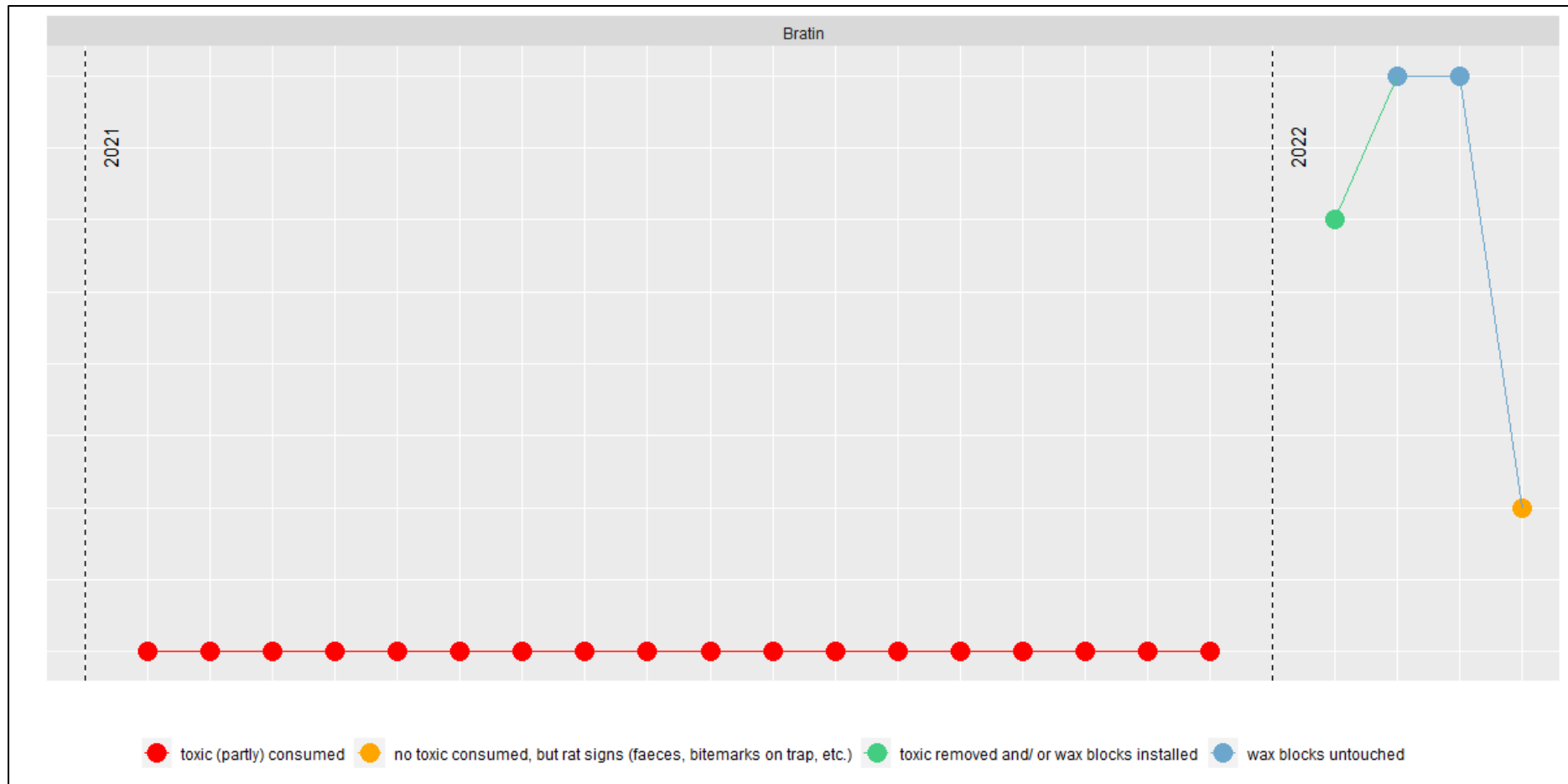


Figure 22. Detailed overview of visits showing the state of the eradication work on Bratin.

3.5. Rat population control via live trapping/ cage trapping

3.5.1. Zaklopatica

Rat control via cage trapping was implemented during all project years on the island of Zaklopatica, between February and June, with an average of 30 to 40 traps set up per night. All years combined, a total of 51 trapping nights were conducted and a total of 108 rats were trapped and euthanized (Figure 23). Every year, the highest number of rats is usually trapped during the first night, after which the number drops rapidly (Figure 23). The 6th of February 2019 saw most rats trapped during a single night, 23 in total (Figure 24). On three occasions wood mice (*Apodemus sylvaticus*) were caught, which were subsequently released on the main island. In parallel to cage trapping, five A24 Goodnature traps were installed on Zaklopatica from 2019 until 2023. These traps were also left on the island during winter as a means of biosecurity. Two of five A24 Goodnature traps had cameras installed next to them, which confirmed the killing of at least 25 rats during the project period.

During the winter of 2022/2023, a Beech marten (*Martes foina*) was observed on the camera traps, and five large cage traps were set up across the island to trap it. On the 18th of March, it was successfully trapped (Figure 25) and transported off the island. Although no complete shearwater breeding census was carried out that year, a total of 43 dead Yelkouan shearwaters were found on the island during several spring visits, of which most had fallen victim to the marten.

With the island of Zaklopatica being a mere 20 m away from the main island of Lastovo and the town of Zaklopatica (Figure 2), reinvasions of rats and occasionally martens will continue to happen. It is therefore of utmost importance that continuous monitoring and eradication efforts keep in place to make sure that the rat population remains at a low number, especially during the breeding period of both shearwater species.



Figure 23. Number of trapping nights and number of rats killed per month on Zaklopatica between 2019 and 2023.



Figure 24. Rats killed after the first night of live trapping on Zaklopatica on the 6th of February 2019. Photo by Sven Kapelj.



Figure 25. Beech Marten (*Martes foina*) caught in a cage trap on Zaklopatica on the 18th of March 2023.

4. CONCLUSION

As rat predation was identified as a major threat to breeding seabirds, particularly for both shearwater species, in the Lastovo Archipelago, the implementation of predator management at important sites for Yelkouan shearwater, Scopoli's shearwater and Audouin's gull was carried out under Action C.2: Implement effective predator management and/or biosecurity across all targeted sites with seabird colonies where this management is necessary and feasible.

During the fieldwork of the project, control and eradication of rat populations was carried out on 14 islands in the Lastovo Archipelago. Overall, the eradication work was successful in reducing the rat populations on all these islands, sometimes even permanently. With the removal of rats from the Vlašnici (Donji, Srednji and Gornji Vlašnik) in 2020, the entire Vrhovnjaci Archipelago is currently rat-free and they have a high chance of remaining as such, because the nearest rat-infested island is almost 6 kms away from them.

Also free from rats since 2020 are the Lukovci (Srednji, Gornji and Mali Lukovac). Although a rat reinvasion is expected to happen at some point, monitoring for rat presence (and re-eradicating rats if needed) is a relatively small effort and should be continued annually. Setting up some A24 Goodnature traps on the neighbouring island of Stomorina could help in preventing a reinvasion.

Other islands where annual control and removal of rats should be carried out are Veli and Mali Maslovnjak, Veli and Mali Rutvenjak and Zaklopatica, which all hold important colonies of both shearwater species. The islands are relatively small and easy to reach, as they are close to Lastovo. This last point is also the reason that annual rat eradication is needed as rats regularly (and occasionally even martens) swim across and invade these islands. The rat control programme on the island of Zaklopatica showed that it is possible to keep rat populations low without the use of rodenticides, but only if the island is small enough and easily accessible (under all weather conditions). The use of A24 Goodnature traps can be a nice addition to rodenticide baiting and cage trapping to keep rat numbers low or to occasionally halt rat reinvasions.

Although the rat eradications on the islands of Pod Kopište, Petrovac and Bratin failed, the case of the Lukovci shows that even islands within the known swimming distance for black rats (<750m) can stay rat-free for several years. At least in the case of Bratin it is strongly recommended to retry a full eradication in the future as the island holds the largest Scopoli's shearwater colony around Lastovo. In case islands are too big, it can also be considered to restrict the rat eradication work to the seabird colony specifically, as shown by the positive effects achieved by localized eradication efforts done on Sušac and Kručica.

Regarding Sušac specifically, the island should be seriously considered for a full rat eradication in the future. The fact that it is uninhabited, its remoteness and the large areas of suitable breeding habitat for shearwaters make this island a perfect site for the long-term conservation of shearwaters in the Adriatic. A feasibility study carried out on Sušac during the LIFE Artina project has shown that permanent rat removal can be achieved, both via ground-based baiting as well as via aerial means (Austad et al. 2020; Sposimo, 2022).

Lastly, it is important to note that on several occasions during the implementation of rat eradication activities on the islands around Lastovo, Hooded crows were recorded to take rodenticide blocks from

the bait boxes. Future efforts should seriously consider this and adjust the set-up in such a way that crows are prevented from extracting bait. Not only does the toxic target the wrong species in this case, but the removal of rats will be much more difficult as they may not ingest enough of the rodenticide before becoming weary of it.

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