UDK 630* 156
https:/doi.org/10.31298/sl.146.9-10.6

Prethodno priopćenje – Preliminary communication
Šumarski list, 9–10 (2022): ???–???

MONITORING OF REINTRODUCED RED DEER IN THE AREA OF TARA (WESTERN SERBIA): INCIDENCE OF BARK STRIPPING WITHIN AN ACCLIMATISATION ENCLOSURE AND POSTRELEASE MOVEMENTS

MONITORING REINTRODUCIRANOG JELENA OBIČNOG NA PODRUČJU TARE (ZAPADNA SRBIJA): OPSEG GULJENJA KORE U PRIHVATILIŠTU I KRETANJE POSLIJE ISPUŠTANJA

Slavko MLADENOVIĆ[1], Milan MALINIĆ[2], Boris RADIĆ[1], Dragica VILOTIĆ[1], Srđan STAMENKOVIĆ[3], Dragan GAČIĆ[1]

SUMMARY

The modern approach in the development of programs for the reintroduction of red deer was applied for the first time in Serbia. We compared the most important planned and implemented activities in the period 2018-2021, and assessed the results achieved in the Mt. Tara area. The plan was to hold the red deer (5♂ + 15♀) in the acclimatisation enclosure for several months and release them into the selected favourable area (150 km^2) during three consecutive years. Bark stripping occurred mainly on thinner common hazel stems of coppice origin (≤ 9.9 cm). Total mortality among the 72 red deer that were transported to the acclimatisation enclosure was 8.3%. The longest movement of a 4-year-old female (held for 15 weeks) was 24 km. During the study period, no bark stripping was observed outside the acclimatization enclosure, nor were any deaths of the released red deer registered. In the period 2019-2021, 74 red deer were released from the acclimatization enclosure into the Mt. Tara area, which is about 60% of the estimated capacity of the selected favourable area.

KEY WORDS: Cervus elaphus, reintroduction, population, management, GPS collar

INTRODUCTION
UVOD

In the past, red deer (*Cervus elaphus* L.), as an indigenous species was present in large numbers in many forest complexes in today's central Serbia, whose forest cover is about 37%, with mostly coppice forests occupying 66% or 1.38 million hectares (Gačić et al., 2020). According to the data from the statistical survey on hunting (Form LOV-11, municipal level, www.stat.gov.rs), in the spring of 2019 the estimated number of red deer was 6,268 individuals, of which 2,056 individuals or 32.8% were in Central Serbia: 1,593 individuals in the statistical region of Southern and Eastern Serbia, and 463 individuals in the statistical region of Šumadija and Western Serbia (Fig. 1). More precisely, the to-

[1] MSc Slavko Mladenović - e-mail: beograd11070@gmail.com, PhD Boris Radić, PhD Dragica Vilotić, PhD Dragan Gačić, University of Belgrade, Faculty of Forestry, Kneza Višeslava 1, Belgrade, Serbia
[2] Milan Malinić, Public Enterprise "Tara National Park", Milenka Topalovića 3, Bajina Bašta, Serbia
[3] PhD Srđan Stamenković, University of Belgrade, Faculty of Biology, Studentski trg 16, Belgrade, Serbia

tal recorded culling in 2019/2020 was 94 individuals in these statistical regions (78 and 16, respectively). This clearly indicates that the current status of red deer is not favourable in central Serbia, mainly due to overexploitation (legal and illegal), habitat loss and competition with domestic livestock, which were also the main causes of deer extinction in some parts of Europe (Burbaité and Csányi 2010; Valente et al., 2017).

In the period 2016-2018, a multidisciplinary research was successfully implemented within the SRBREDDEER project, which was initiated and funded by the Forest Administration of the Ministry of Agriculture, Forestry and Water Management. For the first time a modern approach and methodology were applied to determine areas suitable for the reintroduction of red deer in Serbia, as well as to determine the location of acclimatisation enclosure, risk assessment of extinction and minimum viable population after reintroduction, and develop a more efficient monitoring system for red deer populations and their habitats in Serbia (Gačić et al., 2020). One of the main project activities was the collection and analysis of data on previous reintroductions of red deer in Serbia and throughout Europe (e.g. Bojović, 1968; Tomić et al., 2010; Apollonio et al., 2014), with emphasis on errors and factors of the greatest significance for their success or failure. Thanks to that, measures were proposed to improve the ongoing reintroductions in Serbia, not only to improve the survival and reproduction of red deer, but also to make the reintroduction process as economical as possible.

The proposed program for the reintroduction of red deer to the Mt. Tara area (Gačić et al., 2018) was based on the guidelines prepared and adopted by the IUCN/SSC Re-introduction Specialist Group (1998, 2013), as well as on the conclusions from the expert workshop held in Kragujevac (May 26, 2018) within the SRBREDDEER project. Besides this, the spatial context of reintroduction was observed through the specific landscape pattern issues using a structural metric parameter (Kie et al., 2002; Plante et al., 2004). In addition, it is based on the interest and willingness of local hunters and relevant state hunting authorities to provide full and long-term support to this reintroduction in the selected favourable area of Mt. Tara. Therefore, it differs significantly from all previous programs implemented in central Serbia (Hadži-Pavlović, 1986; Novaković, 1999).

The aim of this paper was to compare the most important planned and implemented activities related to the proposed program during the period 2018-2021, and to evaluate the results achieved in the reintroduction of red deer in the Tara area with emphasis on the incidence of bark stripping within an acclimatization enclosure and postrelease movement of red deer.

MATERIAL AND METHODS
MATERIJAL I METODE

Research area – *Područje istraživanja*

The selected favourable area for reintroduction was central part of the Tara mountain massif (Fig. 1) on the area of 150 cels 1 km × 1 km squares. The altitude ranges from 424 to 1,544 m a.s.l., but the altitudinal belt of 900-1,300 m occupy about 119 km^2, or 79.3% of its total area.

The acclimatisation enclosure is located in the central part of the favourable area (Fig. 2), which mostly belongs to two hunting grounds. The acclimatisation enclosure occupies 3.63 ha (altitude about 1,100 m a.s.l.), of which most are forests (1.90 ha or 52.3%), followed by meadows and pastures (1.27 ha or 35.0%), forest land (0.18 ha), wetland (0.27 ha), while it also contains two wooden huts (0.01 ha). The parent rock is limestone, which forms smaller or larger ridges in some parts of the forest.

According to Gačić et al. (2018) 150 km^2 was the smallest possible area relevant for the assessment of red deer habitat, where the newly established red deer population has a realistic chance of remaining as a compact whole after reintroduction. In addition, we analyzed the position of the

Figure 1. Research area
Slika 1. Područje istraživanja

acclimatization enclosure in relation to the characteristics of the neighboring forests including state forests (managed by state forest company - approx. 7,550 ha and Tara National Park - approx. 4,180 ha) and Church forests (approx. 360 ha). Areas under high forests range from 40.2 to 97.8%, while non-overgrown areas are rare, mostly barren land (range 0.3-18.1%). The main tree species are common beech (*Fagus sylvatica* L.), sessile oak (*Quercus petraea* / Matt./ Liebl.), Austrian pine (*Pinus nigra* J. F. Arnold), Norway spruce (*Picea abies* /L./ H. Karst), Scots pine (*Pinus sylvestris* L.), silver fir (*Abies alba* Mill.) and European white birch (*Betula pendula* Roth.). Numerous rivers (Đetinja, Bratešina, Kamišina and Rača), as well as numerous streams that have water throughout the year pass through the area, so the hydrographic characteristics are favourable. It is estimated that the current state of the road network in these forest management units does not cause serious habitat fragmentation.

The vegetation period in the research area begins in mid-April and ends in late October. The average annual rainfall is about 1040 mm. A significant part of the annual precipitation is in the form of snow. The first snow appears in September, and the last one in April, sometimes even later. The season with the highest recorded precipitation is summer, followed by autumn, spring and winter. The main directions of wind blowing are northeast and southwest. For further information on the research area and acclimatisation enclosure, see Gačić et al. (2018, 2020).

Methodology – *Metodologija*

Our study is based on a newly established population of 74 red deer released in the Mt. Tara area during 2019 (n = 22), 2020 (n = 32) and 2021 (n = 20), from five localities: 1. Dubašnica, 2. Fruška gora National park, 3. Bukovik, 4. Plavna and 5. Kozara (Fig 1.). The data on the number and structure (sex and age) of released red deer were collected from the records of the Forest Directorate (Ministry of Agriculture, Forestry and Water Management) and PE "Vojvodinašume". Animals were from enclosures.

During the first year of red deer reintroduction, six females were translocated from eastern Serbia, a fenced part called Dubašnica within the hunting ground Zlotske šume - Crni vrh, three of which died during transport on March 17, 2019, and one after a few days, most likely due to the stress of capture and long transport. A month later, 17 individuals were translocated from Vojvodina (4 males, 7 females and 6 calves), which originate from Hungary but were temporarily kept in quarantine at the Ravne location within the hunting ground of Fruška Gora National Park.

During the second year (January 28, 2020), four females were translocated from a fenced area called Košuta inside the Bukovik hunting ground in southern Serbia, one of which died a few days after arrival. Then, six males from Vojvodina, originating from the Plavna hunting ground (February 15), as well as 18 individuals (2 males, 7 females and 9 calves) from Fruška gora National Park (March 23) were also translocated.

During the third year, six males were translocated from the hunting ground Plavna (February 10, 2021), one of which died a few days after arrival. A month after that, four females and two calves were translocated from the hunting ground Plavna (March 27) and one male, seven females and one calf from the famous hunting ground Kozara in Vojvodina (March 29).

Upon arrival, red deer were placed in an acclimatisation enclosure at Jezerine, a location 14.4 km away from the main road Užice - Višegrad, which also had the role of a temporary holding quarantine. The plan was to hold the red deer in the acclimatisation enclosure for several months to allow them to recover from the trip and to acclimatize to their new habitat, and release them into the selected favourable area (150 km^2) during three consecutive years between July 20 and August 15, depending on weather conditions and calf development. However, the length of the holding period varied due to an unplanned release in 2021 resulting from a damage to the fence caused by brown bear – *Ursus arctos* L. (from February 10 to the beginning of May) until the planned release after calving in 2019 (April 17 to July 29) and 2020 (January 28 to June 25). In both cases, the holding period lasted for several months, which is a technique defined by some authors as soft release (Rosatte et al., 2007; Ryckman et al., 2010). During captivity, as well as after release, red deer were provided with hay, maize and rock salt.

The reintroduced red deer were monitored in a way that does not interfere with its normal activities and does not lead to domestication. We used quality equipment for day and night observation (Swarovski SLC 10 × 42, Pulsar CORE FXQ 50, camera traps Ltl Acorn, Spromise and Seissiger), while five individuals (4♀ + 1♂) were equipped with GPS collars (Lotek LifeCycle 500 Pro Collar) during disease-testing protocol in quarantine of origin (Ravne - Fruška gora National Park) in April 2019. These individuals were then loaded into a livestock trailer and transported to the acclimatisation enclosure in the area of Tara.

Other participants in the monitoring were employees of local hunting association ("Aleksa Dejović", Užice) and Tara National Park (Bajina Bašta), who used camera traps and personally collected records of red deer in the field, or collected records from the local people. All records from the Đetinja hunting ground were without data on geographical coordinates, so they were not included in the statistical analysis. We had a total of 27 complete records, of which 26 were from the Tara National Park hunting ground and

one from the Soko hunting ground. Additionally, we had 14 records in the period from August 15 to November 9, 2019, which were obtained from a 4-year-old female equipped with GPS collar number 607. The straight-line dispersion distance from the acclimatisation enclosure was calculated. The difference between the mean dispersion distances in 2019, 2020 and 2021 was tested using one-way ANOVA and the Fisher's LSD test ($P < 0.05$) after log transformation (STATGRAPHICS 16.1). The collected data were mapped and all spatial analyses were performed using ArcGIS 10.3 Package.

Incidence and intensity of bark stripping caused by red deer within the acclimatisation enclosure were determined from 18 to 20 September, 2020. The definition of incidence is the percentage of damaged trees in an area, and the intensity is the severity of damage to an individual tree, such as the number or size of bark wounds (Gill, 1992). Trees of high and coppice origin were randomly selected on the entire surface of the forest, so we mostly moved along isohypses. The diameter at breast height was measured (cm) and the position of the tree in the acclimatization enclosure was determined using a Magellan Mobile Mapper 50 4G GPS receiver. The total number of measured trees of high origin (n = 479) was twice smaller than the trees of coppice origin (n = 999). Each individual tree was assessed for all visible bark stripping damage (recent and aged) and was quantified using a five point scale (Mountford, 1997): 0 = no damage (no bark removed); 1 = limited damage (<10% bark removed); 2 = moderate damage (10-50% bark removed); 3 = severe damage (>50% bark removed); and 4 = very severe damage (ring-barked). Utilization intensity (%) was calculated for trees of coppice origin and represents the ratio of debarked stems and all stems in the stump, e.g. some stumps of common hazel (*Corylus avellana* L.) had 30 stems. The median values for damaged and undamaged common hazel trees were compared by the Kruskal–Wallis test.

RESULTS AND DISCUSSION
REZULTATI I RASPRAVA

Bark stripping occurred mainly on thinner common hazel stems of coppice origin (≤ 9.9 cm), as well as on thinner aspen, European hornbeam and sycamore stems of high origin (Fig. 2). In total, 1478 stems within the acclimatization enclosure were examined and 301 of them were debarked (20%).

The mean stem girth of coppice and high trees was 5.1 ± 4.6 and 13.7 ± 12.1 cm, respectively. Bark stripped common hazel stems were not significantly thinner than undamaged common hazel stems (Kruskal–Wallis test: KW = 1.10, P = 0.29). We found that middle-aged and quality trees of the main species were not damaged: beech (*Fagus sylvatica*), sycamore (*Acer pseudoplatanus*), sessile oak (*Quercus petrae*), Scots pine (*Pinus sylvestris*), Norway spruce (*Picea abies*) and wild cherry (*Prunus avium*). These results indicated that, except properly supplemental feeding, an adequate methodology for the selection of acclimatisation enclosure had been applied, whose habitat quality mitigated the consequences of numerous mistakes made during the implementation of the reintroduction program. During the study period, no bark stripping was observed outside the acclimatization enclosure.

The highest incidence and intensity of bark stripping damage were found on the edge of the forest near the best meadow, where there are two old wooden huts and a feeding station with maize and hay. Utilization intensity was the highest in the part of the forest that is below the best meadow and feeding site, and above the moist soil where the only water source is located (Fig. 3).

Habitat quality at the release site has a high impact on the success of reintroduction, if the number and origin of the inhabited breeding stock are favourable, which includes the degree to which the animals are dispersed from the release

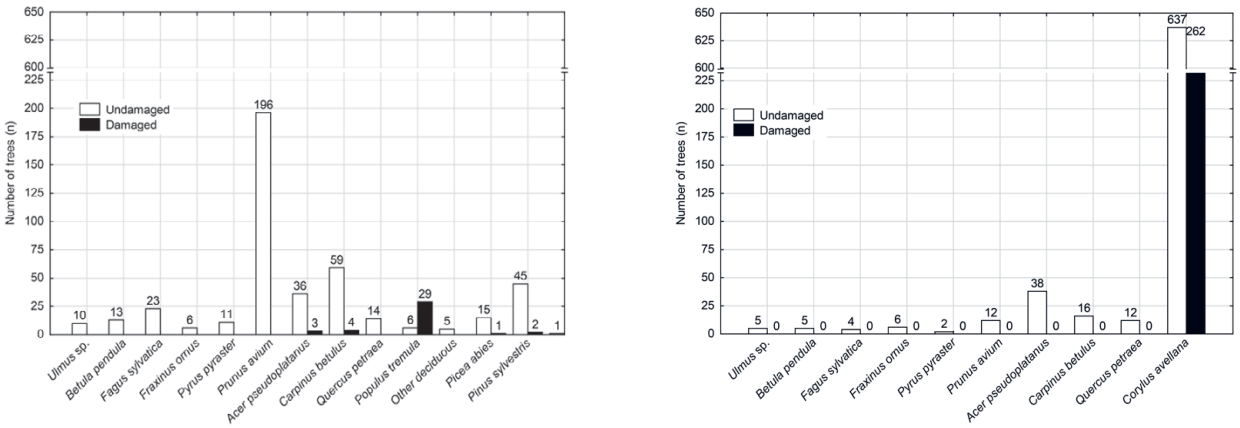

Figure 2. Number of trees per species - left (seed origin), right (coppice origin)
Slika 2. Broj stabala po vrstama drveća - lijevo (iz sjemena), desno (iz panja)

Table 1. Intensity of damage within acclimatisation enclosure in the area of Tara
Tablica 1. Intenzitet guljenja kore u prihvatilištu jelena običnog na području Tare

DBH class *Debljinski stupanj* (cm)	Category (damage score) *Kategorija oštećenja*					Total *Ukupno* (n)
	No *Nema*	Limited *Slab*	Moderate *Umjeren*	Severe *Jak*	Very severe *Vrlo jak*	
			Trees of high origin *Stabla visokog porijekla*			
≤ 9.9	206	8	11	5	11	241
10.0-19.9	139	1	2	1	-	143
20.0-29.9	44	-	-	-	-	44
30.0-39.9	23	-	-	-	-	23
40.0-49.9	13	-	-	-	-	13
50.0-59.9	11	-	-	-	-	11
60.0-69.9	4	-	-	-	-	4
Total *Ukupno*	440	9	13	6	11	479
			Trees of coppice origin *Stabla izdanačkog porijekla*			
≤ 9.9	678	260	-	-	-	938
10.0-19.9	39	2	-	-	-	41
20.0-29.9	12	-	-	-	-	12
30.0-39.9	3	-	-	-	-	3
40.0-49.9	4	-	-	-	-	4
50.0-59.9	1	-	-	-	-	1
Total *Ukupno*	737	262	-	-	-	999

site (Griffith et al., 1989; Yott et al., 2011; Apollonio et al., 2014). The location of the acclimatisation enclosure Jezerine in the Tara area was determined with the participation of numerous experts (from Serbia, Slovenia and Italy) using landscape structure analyses and the common phytocoenological methodology (Gačić et al., 2018). Based on these analyses, four hexagons (the area of each one is 50 ha), were selected, which are sunny during the winter with an average value of 1228 Wh per unit area of 25 m^2. Their landscape structure is complex with over 1120 elements on an area of 200 ha, while the length of the forest edge is about 54 km on an area of 200 ha.

There are pastures of good enough quality on natural meadows in the acclimatisation enclosure Jezerine. They were once mowed to feed livestock, and now various shrub species such as common hazel, blueberry (*Vaccinium myrtillus* L.), forest blackberry (*Rubus* spp.) and wild rose (*Rosa* spp.) appear on them. In addition, the scrub of common hazel is present, mostly as shrubs with several thin and several thicker stems from the stump. In the further surroundings, the share of areas under field crops and orchards was not large. The red deer released within the acclimatisation enclosure removed the bark of several tree species during spring and summer 2020 (Tab. 1). We believe that this can be explained by its significantly smaller total area than projected (3.63 vs 7.29 ha). In addition, in 2020, a higher number of individuals was released (n = 28) compared to the projected optimal number (5♂ + 15♀), which was then further increased in early June by five newborn calves. Unfortunately, there are no detailed data on supplementary feeding within the acclimatization enclosure, especially on the amount of maize suppled on a daily and/or monthly basis, so it was not possible to analyze the impact of this factor on the released red deer behavior.

From 29 July 2019 to 30 November 2021, we obtained 41 red deer locations for the 74 released individuals from the acclimatisation enclosure in the area of Tara (Tab. 2). Approximately 42% of all location estimates were obtained from direct observations, 34% from GPS collars, and the remaining 24% from camera traps, footprints and damage by red deer.

Mean straight-line dispersal distance differed between GPS points and other red deer records in 2019 ($F_{1,18}$ = 288.76, P < 0.05), but GPS points were not obtained in 2020 and 2021 (Fig. 4). The dispersal distance for GPS points (4-year-old female) ranged from 17.30 to 24.23 km (mean ± SD = 21.89 ± 2.47), while for the other pooled records it ranged from 3.09 to 18.44 km (8.97 ± 4.30). The mean straight-line dispersal distance from the acclimatisation enclosure differed between the three study years ($F_{2,24}$ = 5.55, P = 0.01). Red deer during 2020 (11.66 ± 4.61) dispersed farther than red

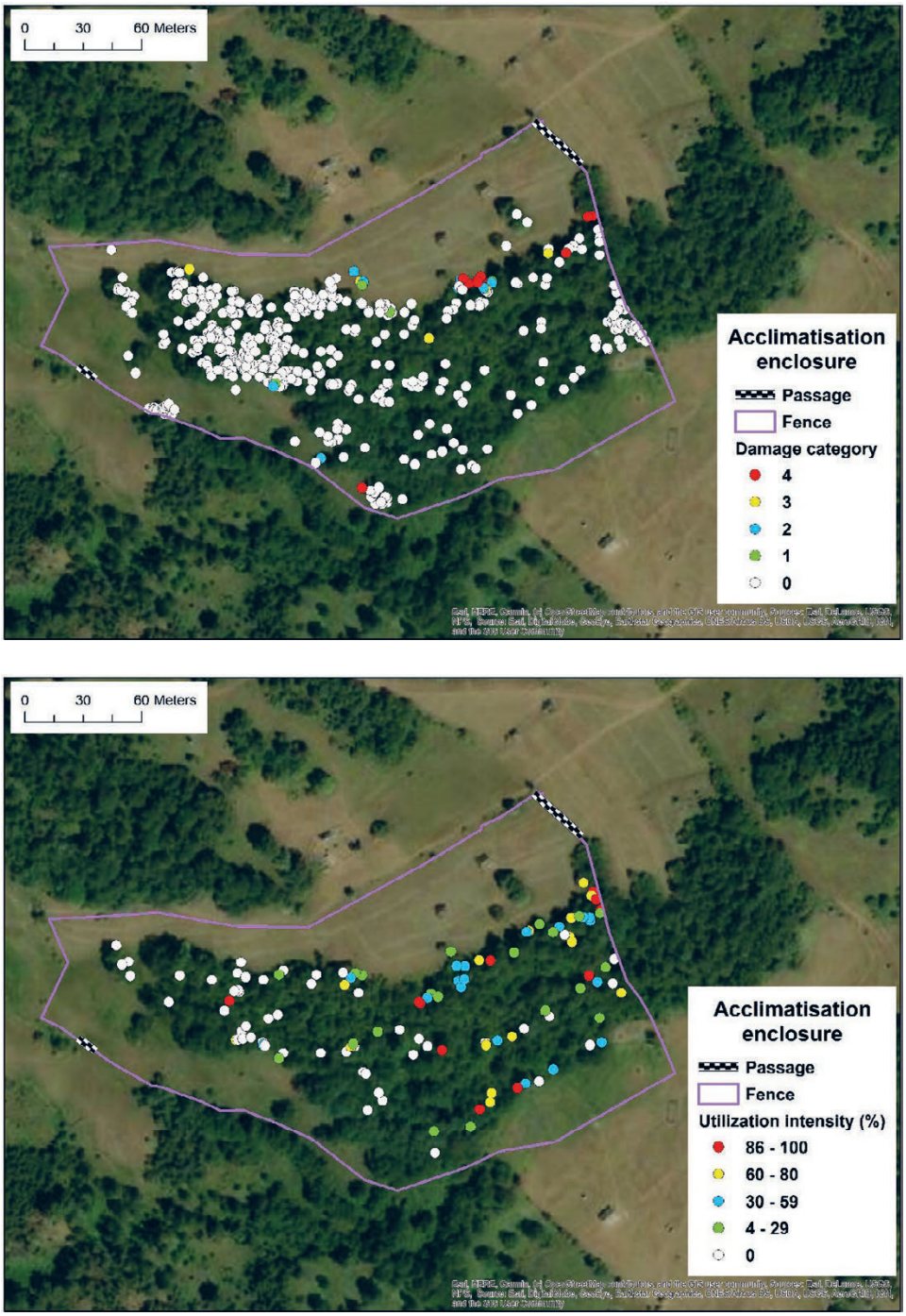

Figure 3. a - shares of trees per damage category (trees of high origin), b - utilization intensity in % (trees of coppice origin)
Slika 3. a - raspored stabala iz sjemena po kategoriji oštećenja, b - prosiječno korištenje (guljenje kore) stabala iz panja

deer in 2019 and 2021 (6.85 ± 1.26 and 7.29 ± 3.76, respectively).

Total mortality among the 72 red deer that were transported to the acclimatization enclosure was 8.3% between 2019 and 2021, of which three females died in the livestock trailer, and three individuals after a few days in the acclimatization enclosure (2♀ + 1♂). During the study period, there were no recorded deaths of released red deer outside the acclimatization enclosure. The fence around the acclimatization enclosure was much weaker than designed (Gačić et al., 2018), due to which free-ranging brown bears and wild boars could enter the enclosure and access the feeding station, even when new groups of red deer were inside and the fence was closed.

Red deer were released from the acclimatization enclosure through two openings in the fence whose length was 10 and 30 m (Fig. 3). Each year, these openings were closed a few days before the transport of the new group, until the day of

Table 2. Dispersal distance from the acclimatization enclosure for released red deer
Tablica 2. Udaljenost od prihvatilišta za jelena običnog naseljenog na području Tare

Record *Zapis* (n)	Date *Datum*	Record description *Opis zapisa*	Distance *Udaljenost* (km)
1	30 July 2019	Camera trap on a brown bear feeding place, 7 ♀ + 1 ♂	5.18
2	end of August 2019	Direct observation (gamekeeper), 2 ♀	6.21
3	3 September 2019	Camera trap on a feeding place, 1 ♂ (with GPS collar)	6.10
4	5 September 2019	Direct observation, 1 ♀	8.61
5	15 September 2019	Direct observation, 1 ♀	7.85
6	2 October 2019	Direct observation, 3 ♀	7.15
7	19 January 2020	Footprint on the ground	17.82
8	18 February 2020	Footprint on the ground	18.44
9	20 April 2020	Camera trap and direct observation (gamekeeper), 3 ♀	12.41
10	21 April 2020	Direct observation (gamekeeper), 1 ♀	8.36
11	24 June 2020	Direct observation (vegetable garden owner), 1 ♀	7.89
12	4 July 2020	Direct observation, 1 ♂	7.77
13	29 July 2020	Direct observation (vegetable garden owner), 1 ♀	10.45
14	end of August 2020	Direct observation, 1 ♀ + 1 ♂	7.59
15	10 September 2020	Browsing by red deer on beech trees	6.74
16	11 September 2020	Direct observation, 1 ♀ + 1 ♂	18.39
17	29 October 2020	Direct observation (hunting ground manager), 1 ♀	12.45
18	31 January 2021	Direct observation, 2 ♀	17.14
19	6 February 2021	Footprint on the ground	4.88
20	5 March 2021	Direct observation, 3 ♀ + 3 ♂	7.78
21	5 June 2021	Direct observation (gamekeeper), 1 ♀	8.21
22	15 July 2021	Damage by red deer on vegetable garden	6.96
23	24 August 2021	Camera trap, 1 ♂	5.69
24	end of August 2021	Direct observation, 1 ♂	7.04
25	end of August 2021	Direct observation, 2 ♀	6.21
26	20 September 2021	Direct observation, 2 ♀	5.95
27	November 2021	Camera trap and direct observation, 3 ♀ + 1 ♂	3.09

their release, so that previously released individuals into the wild (Đetinja hunting ground) could return to the acclimatization enclosure for most of the year. The exception was 2021, when a brown bear destroyed part of the fence, as a result of which the released red deer escaped from the acclimatization enclosure before calving.

Our results obtained in 2019, showed that red deer dispersal occured immediately after release from the acclimatization enclosure, which confirms the results obtained in Ontario, Canada (Yott et al., 2011). The release began in the afternoon of July 29, and on the same day, the first herd of one middle-aged male and 7 hinds left the acclimatization enclosure at around 10:30 pm. Then, this herd was recorded early in the morning of July 30 at 4:27 am on the camera trap in the hunting ground Tara National Park (record no. 1), which was at a 5.2 km distance (straight-line) from the acclimatization enclosure. After 3-4 days, another middle-aged male equipped with a GPS collar, a number of other hinds and three newborn calves came out. Two hinds from eastern Serbia returned to the feeding station in the acclimatization enclosure almost every day during the night, while hinds from Fruška gora National Park and newborn calves were recorded at a site located about 1.5 km from the acclimatization enclosure. The following month, on September 3, 2019 at 2:14 am, a middle-aged male equipped with a GPS collar was spotted on a camera trap at a distance of 6.1 km (record no. 3), but it was returning to the acclimatization enclosure for the next two years.

The distribution of red deer around the acclimatization enclosure was satisfactory, but there were no records with geographical coordinates from the hunting ground Đetinja (Fig. 4). Instead, there are many records obtained using camera traps, which showed that one middle-aged male and three females equipped with GPS collars remained very close to the acclimatization enclosure after release in 2019. In addition, there are some individuals, or smaller herds around the acclimatization enclosure, that have been continuously seen by the guard service, especially after the establishment of three new feeding stations surrounding the acclimatization enclosure.

Unfortunately, 4 GPS collars that were placed on one male and three females did not give the expected results during the study period. One collar did not function after being

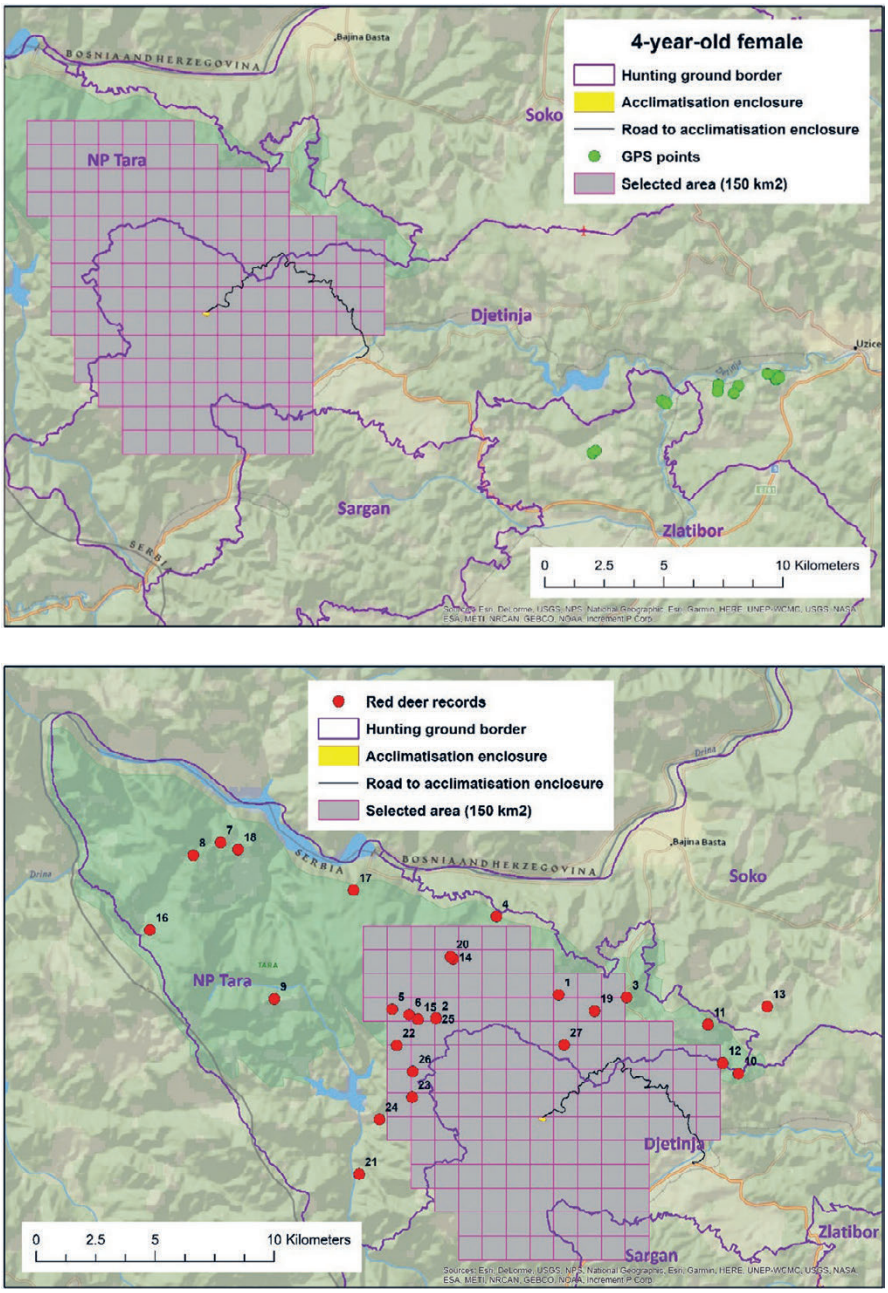

Figure 4. Dispersal distance: a - GPS collar points (n = 14), b - other red deer records (n = 27)
Slika 4. Udaljenost od prihvatilišta: a - točke od GPS ovratnika (n = 14), b - drugi zapisi (n = 27)

placed on the animal, while three collars collected GPS points only while the animals were in the acclimatization enclosure. This can be explained by the inadequate time lag in the dynamics of procurement of the GPS collars (January 2018) and the delay in the start of their application (April, 2019). In addition, there were problems in obtaining 3D locations from the GPS collars due to dense vegetation and steep terrain, which was also reported by many other researchers (e.g. Jung et al., 2018).

We believe that the fidelity of the release area can be explained by its high quality habitat and that the release stock was kept for several months in the acclimatization enclosure, as well as that all released red deer originate from a smaller fenced parts of the hunting ground. Since the released red deer have different origins, with most individuals originating from Hungary (17 in 2019 and 18 in 2020), Vojvodina (6 in 2020 and 20 in 2021), southern Serbia (3 in 2020) and eastern Serbia (2 in 2019), it is plausible to assume that this also influenced the establishment and growth of the population in the Tara area, especially the postrelease movements of individuals.

A large number of the red deer in the area of Tara released from 29 July 2019 to early May 2021 were moving within a 10 km-distance from the acclimatization enclosure (Fig. 4).

The longest movement of a 4-year-old female (held for 15 weeks) was 24 km, when she came very close to the town of Užice together with two other individuals. She stayed there from August 15 to November 9, 2019 (after that, GPS collar failed), which was a dispersal event contrary to all our predictions. The cause of this movement may be wolf harassment, as a few days after the opening of the fence near the acclimatization enclosure (≈ 2.5 km), one female from a pack of three wolves was culled by the guard service. There may also be a need for water and better food resources during the stay in the enclosure, because this new habitat near Užice is located at an altitude of 600 to 900 m a.s.l., along the Đetinja River and various agricultural crops in a deciduous forest setting.

Red deer uses space depending on the impacts of various factors, such as abiotic (topography and climate) and anthropogenic (forest characteristics, supplementary feeding, roads and hiking trails), but also historical events and management in the past (Stergar and Jerina, 2017). Reaserch in Slovakia (Kropil et al., 2015) showed two distinct spatial patterns in the same local population (residential and migratory), and residential annual home ranges were significantly smaller compared to migratory ones, but residents expanded their space use in winter compared to other seasons. In their research, the longest movements were determined in three young stags emigrating to neighbouring mountain ranges (30, 47 and 65 km), and they concluded that the smallest area for unified management should be at least 300 km^2.

Elk (*Cervus elaphus*) dispersion from the release site depends on the impacts of many factors such as the length of time they were held prior to release, large predators, prevailing winds, geographical features of the area, age of released individuals, road density, hydro-electric corridors and human disturbance (Rosatte et al., 2007; Ryckman et al., 2010; Yott et al., 2011). We believe that the released red deer in the Tara area dispersed further in 2020 due to the COVID-19 pandemic, when many families from Belgrade and other large cities came to this mountain during a period of strict lockdown (to their own or rented cottages), which was the cause of frequent human disturbance. Some authors suggest that areas dominated by a single cover type with little interspersion of other habitats should be avoided for elk reintroduction (Larkin et al., 2004). These authors recommended areas with high levels of open-forest edge (≈ 5 km/km^2), which will likely enhance release-site fidelity and promote reintroduction success.

Wolf and brown bear predation, especially poaching and illegal shooting could be an important factor affecting red deer recruitment and reintroduction success, similar to the situation in some other countries (Rosatte et al., 2007; Yott et al., 2011), while further study in the area of Mt. Tara is required. Our results obtained in the period 2019-2021 provided only a partial insight into the directions and distances of movement after the release of red deer, which are probably much larger than shown by the collected records and GPS points (Fig. 4). For example, unverified data indicate that one group of released red deer crossed the state border between Serbia and B&H, and that it is located near the town of Višegrad.

The proposed reintroduction program for red deer in the Tara area contains the necessary elements and measures (Gačić et al., 2018), but many of them were modified during implementation, while some were not implemented. The main goal of this reintroduction was to form a self-sustaining and vital population of red deer in the selected favourable area (150 km^2) within a 20-year period. The population should reach an estimated capacity of 120 individuals, and serve for new settlements and sustainable use through hunting tourism.

Some authors (Yott et al., 2011) argue that the degree of movement and dispersal of animals from a temporary acclimatization enclosure (soft release), or from a release site (hard release) has the highest impact on the success of reintroduction. In addition, the key goal of reintroduction should be to increase the size of the population as soon as possible (Ryckman et al., 2010).

Our analysis showed that the established acclimatisation enclosure (3.63 ha) had a significantly smaller area than planned (7.29 ha), so that very favourable parts of the forest and three natural streams were left out. Moreover, the disinfection barrier at the main gate was not built, while the fence around the acclimatization enclosure was much weaker than designed, e.g. there was no electric fence on the outside for protection against large predators (wolves and brown bears), and no barbed wire above the upper part of the wire mesh with flags in the middle of the space between the poles, etc.

CONCLUSIONS
ZAKLJUČCI

The modern approach and methodologies used in this project ("SRBREDDEER") were appropriate and can be applied in other projects trying to reintroduce red deer to areas that were once part of its natural range, both in central Serbia and neighboring countries (B&H, Montenegro and North Macedonia). In the period 2019-2021, 74 red deers were released from the acclimatization enclosure in the Tara area, which is about 60% of the estimated capacity of the selected favourable area (150 km^2). Total mortality among the 72 red deer that were transported to the acclimatisation enclosure was 8.3%. During the study period, no bark stripping was observed outside the acclimatization enclosure, nor were any deaths of the released red deer registered. A large

number of the released red deer were moving within a 10 km-distance from the acclimatization enclosure.

Some of the most important problems in the implementation of the red deer reintroduction program in the Tara area are: 1) inadequate supervision regarding the realization of the established deadlines and implementation of elements of the program; 2) poorly organized monitoring of released red deer and its habitats; 3) lack of education of hunters and the local population; 4) lack of a plan for the management of red deer populations and hunting grounds at the regional and national level (e.g. Action Plan); and 5) potential conflicts between red deer and humans.

ACKNOWLEDGMENTS
ZAHVALA

This study was financed by the Ministry of Education, Science and Technological Development of the Republic of Serbia [Agreement on financing the scientific research work of NIO in 2021, registration number 451-03-9/2021-14/200169 dated 05.02.2021], and the Forest Directorate of the Ministry of Agriculture, Forestry and Water Management [project SRBREDDEER].

REFERENCES
LITERATURA

- Apollonio, M., M. Scandura, N. Šprem, 2014: Reintroductions as a management tool for European ungulates. In Behaviour and management of European ungulates. Chapter 3. Edited by Putman R., M. Apollonio, Whittles Publishing, Scotland, UK. p. 46-77, Dunbeath
- Bojović, D., 1968: Composition, distribution and condition of macrofauna populations in the wider area of Đerdap "(in Serbian)", Šumarstvo, Vol. 7-8: 47-57, Beograd
- Burbaité, L., S. Csányi, 2010: Red deer population and harvest changes in Europe, Acta Zoologica Lituanica, Vol. 20 (4): 179-188, Vilnjus
- Gačić, D., (ed), (2018): Research on the causes and consequences of the disappearance of red deer in central Serbia, defining areas suitable for reintroduction (settlement) and measures to improve the reintroduction process - Phase II "(in Serbian)", Završni izveštaj, Univerzitet u Beogradu, Šumarski fakultet, 597 p., Beograd
- Gačić, D., (ed), 2020: Red deer in Serbia: a modern approach and methodology for the development of reintroduction programs "(in Serbian)", Faculty of Forestry, 336 p., Belgrade
- Gill, R.M.A., 1992: A Review of Damage by Mammals in North Temperate Forests: 1. Deer, Forestry, Vol. 65 (2): 145-169, Oxford
- Griffith, B., M. Scott, J. Carpenter, C. Reed, 1989: Translocation as a species conservation tool: status and strategy, Science, Vol. 245: 477-480, Washington
- Hadži-Pavlović, M., 1986: Status and characteristics of red deer populations in Northeastern Serbia "(in Serbian)", Magistarski rad, Šumarski fakultet, Univerzitet u Beogradu, Beograd
- IUCN, 1998: Guidelines for Re-introductions, IUCN/SSC Reintroduction Specialist Group, 10 p., Gland
- IUCN, 2013: Guidelines for Reintroductions and Other Conservation Translocations, Version 1.0, IUCN/SSC Species Survival Commission, 57 p., Gland
- Jung, T., T. Hegel, T. Bentzen, K. Egli, L. Jessup, M. Kienzler, K. Kuba, P. Kukka, K. Russell, M. Suitor, K. Tatsumi, 2018: Accuracy and performance of low-feature GPS collars deployed on bison Bison bison and caribou Rangifer tarandus, Wildlife Biology, Vol. 2018 (1): 1-11, Hornslet
- Kie, J., T. Bowyer, M. Nicholson, B. Boroski, E. Loft, 2002: Landscape heterogeneity at differing scales: Effects on spatial distribution of mule deer, Ecology, Vol. 83 (2): 530-544, Washington
- Kropil, R., P. Smolko, P. Garaj, 2015: Home range and migration patterns of male red deer Cervus elaphus in Western Carpathians, European Journal of Wildlife Research, Vol. 61 (1): 63-72, Berlin and Heidelberg
- Larkin, J., J. Cox, M. Wichrowski, M. Dzialak, D. Maehr, 2004: Influences on release-site fidelity of translocated elk, Restoration Ecology, Vol. 12 (1): 97-105, Hoboken
- Mountford, E., 1997: A decade of grey squirrel bark-stripping damage to beech in Lady Park Wood, UK, Forestry, Vol. 70 (1): 17-29, Oxford
- Novaković, V., 1999: Red deer (Cervus elaphus L.) "(in Serbian)", Ministarstvo poljoprivrede, šumarstva i vodoprivrede Republike Srbije, 316 p., Beograd
- Plante, M., K. Lowell, F. Potvin, B. Boots, M.-J. Fortin, 2004: Studying deer habitat on Anticosti Island, Québec: relating animal occurrences and forest map information, Ecological Modelling, Vol. 174 (4): 387-399, Amsterdam
- Rosatte, R., J. Hamr, J. Young, I. Filion, H. Smith, 2007: The restoration of elk (Cervus elaphus) in Ontario, Canada: 1998-2005, Restoration Ecology, Vol. 15 (1): 34-43, Hoboken
- Ryckman, M., R. Rosatte, T. McIntosh, J. Hamr, D. Jenkins, 2010: Postrelease dispersal of reintroduced elk (Cervus elaphus) in Ontario, Canada, Restoration Ecology, Vol. 18 (2): 173-180, Hoboken
- Stergar, M., K. Jerina, 2017: Wildlife and forest management measures significantly impact red deer population density, Šumarski list, Vol. 141 (3-4): 139-150, Zagreb
- Tomić, Z., Z. Bijelić, D. Vilotić, D. Gačić, 2010: Phytocenological research into the meadow associations on forest hunting grounds of Serbia, Archives of Biological Sciences, Vol. 62 (2): 363-372, Belgrade
- Valente, A., J. Valente, C. Fonseca, R. Torres, 2017: The success of species reitroductions: a case study of red deer in Portugal two decades after reintroduction, International Journal of Biodiversity Science, Ecosystem Services & Management, Vol. 13 (1): 134-138, London
- Yott, A., R. Rosatte, J. Schaefer, J. Hamr, J. Fryxell, 2011: Movement and spread of a founding population of reintroduced elk (Cervus elaphus) in Ontario, Canada, Restoration Ecology, Vol. 19 (101): 70-77, Hoboken

SAŽETAK

Suvremeni pristup u izradi programa za reintrodukciju jelena običnog bio je primijenjen po prvi put u Srbiji. U radu je dan prikaz planiranih i primijenjenih aktivnosti obnove populacije jelena običnog na lokalitetu Tara tijekom razdoblja 2018.-2021., kao i procjena ostvarena na području Tara. Plan je bio da se jelen obični (5♂ + 15♀) drži u prihvatilištu nekoliko mjeseci, a nakon toga ispusti u odabrano povoljno područje (150 km^2) tijekom tri uzastopne godine. Jelen obični je uglavnom gulio koru tanjih stabala obične lijeske (≤ 9.9 cm). Tijekom razdoblja transporta i boravka u prihvatilištu, od 72 jedinke jelena običnog uginulo ih je 6 (8.3%). Nakon ispuštanja iz prihvatilišta, četiri godine stara košuta (držana 15 sedmica u prihvatilištu) imala je najdulje pravocrtno kretanje od 24 km. Tijekom proučavanog razdoblja, izvan prihvatilišta nije evidentirano guljenje kore, niti su evidentirana uginuća ispuštenih jedinki jelena običnog. U razoblju 2019.-2021., 74 jedinke su ispuštene iz prihvatilišta u područje planine Tara, što iznosi oko 60% od procijenjenog kapaciteta odabranog povoljnog područja.