



Current State of Woody Vegetation Encroachment on Dry Grasslands on Ćićarija and Učka

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DINALPCONNECT



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1. Introduction

This report has been compiled as part of the preparation for the activity “T2.4 Development and implementation of Pilot region Action plans for improved transboundary ecological connectivity”. The Pilot region Slovenia-Croatia encompasses several Natura 2000 sites (Fig. 1), two in Slovenia (SPA - SI5000023 Kras; SCI - SI3000276 Kras) and three in Croatia (SPA - HR1000018 Učka i Ćićarija; SCI - HR2000601 Park prirode Učka, HR2001304 Žbevnica). In all SCI sites, the habitat type 62A0 Eastern sub-mediterranean dry grasslands (*Scorzoneretalia vilosae*) is a target habitat type and a favourable conservation status is required in each SCI Natura 2000 site, according to the Article 6. of the Habitats directive. The favourable status is based on the habitat’s representativity, relative surface to the national territory, degree of conservation of its structure and function, as well as its restoration possibilities (most of these parameters are based on the interpretation of available data through expert judgement).

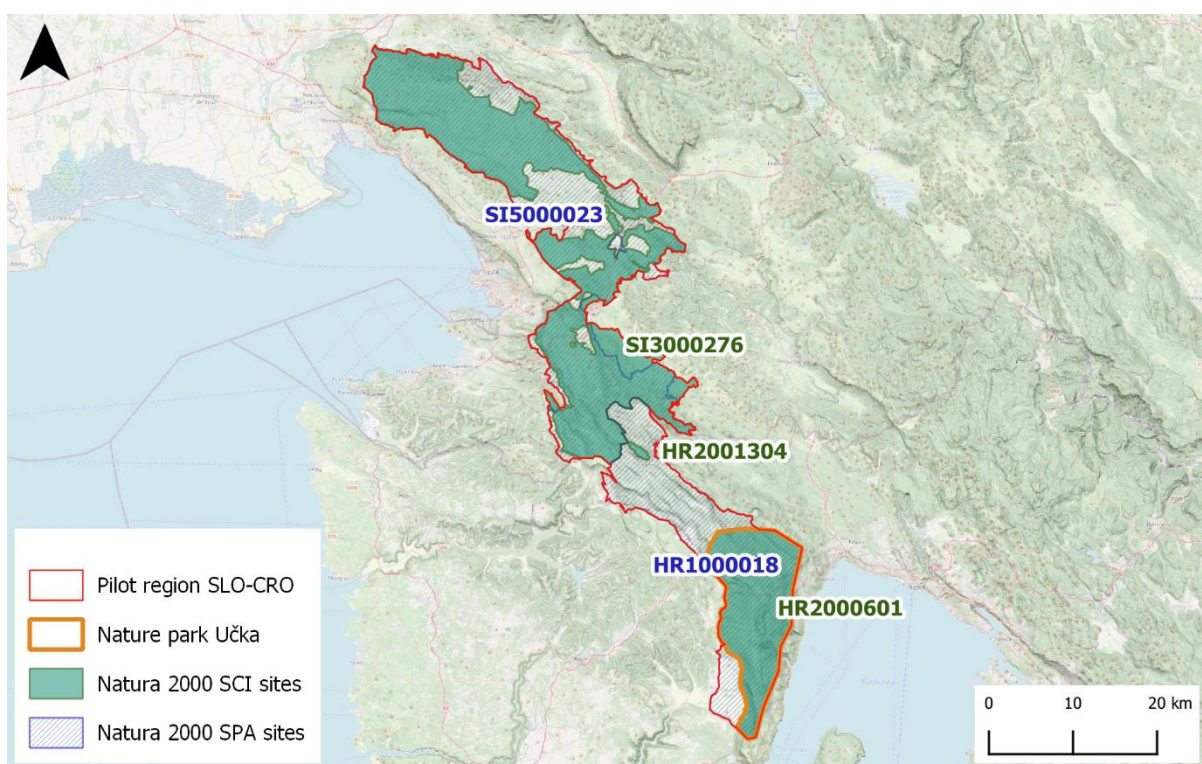


Figure 1: Natura 2000 sites in the Pilot region Slovenia-Croatia (basemap: OSM 2021, Hillshade based on EU-DEM (Copernicus Land 2021))

Since the Pilot region is facing problems of depopulation in rural areas, land abandonment and lack of interest in sustainable agriculture, the once widespread grasslands, used extensively for livestock, are being reclaimed by the surrounding forest (Kaligarič et al. 2006, Vitasović Kosić et al. 2011, Vitasović Kosić et al. 2012, Vitasović Kosić and Britvec 2014, Surina and Modrić-Surina 2019), which is a common problem in rural mountain areas throughout Europe (Willems 1990, Luick 1998, Zervas 1998, Macdonald et al. 2000, Dullinger et al. 2003, Sebastià et al. 2008).

So, the current conservations status of this habitat type is favourable only in sites SI3000276 Kras and HR2001304 Žbevnica, but in time it will decrease as the sites are likely to lose large areas of the target habitat due to succession, as a result of negative socio-economic trends in the Pilot region. Habitat loss consequently will lead to fragmentation, which will speed up the habitat loss on the grasslands and lower the overall biodiversity of the area, impacting a large number of species, many of which are target species of these 5 Natura 2000 sites.

By looking at the vegetation structure of dry grassland, the population and livestock trends in the area, and relevant landscape features (ruggedness of the terrain, water availability, presence of settlements), we can identify areas which represent the highest value for preservation of the ecological connectivity of dry grasslands, thus enabling the conservation of its biological diversity in the long term. Most of these data will be collected and analysed as part of the activity “*T1.2 Collection of data and development of GIS model for EC analysis*”, except for the data about vegetation. The floristic and vegetation composition of the grasslands in the Croatian part of the Pilot region is well known and has been extensively studied (Vitasović Kosić 2011, Vitasović Kosić et al. 2011, Surina and Modrić-Surina 2019), but structure of the vegetation and the condition of grasslands on Ćićarija and Učka has not been systematically analysed in detail and there is yet no measurable indication of the degree of the problem.

The aim of this survey was to assess the current condition of dry grasslands in the Croatian part of the Pilot area (Učka and Ćićarija), by mapping the extent of encroachment of dry grasslands, and to collect data about the density of woody vegetation in two different habitat classes. The collected data can be used during the development of the Action plan and for prioritizing grassland polygons in respect to the effort needed for restoration, enabling an objective assessment of the actions that can be carried out during the duration of the project.

2. Methodology

The survey area encompasses only the Croatian part of the Pilot area (Ćićarija and Učka), and its borders are the same as the borders of Natura 2000 site HR1000018 Učka i Ćićarija. In order to assess the **condition of dry grasslands regarding succession**, we first selected all the dry grasslands present in the survey area, according to the Map of non-forest terrestrial habitats of Republic of Croatia (Bardi et al. 2016). We used only polygons where the only or dominant habitat type represents Natura 2000 habitat Eastern sub-mediterranean dry grasslands (*Scorzoneratalia villosae*). Merging together polygons that shared a border, we created grassland patches from which we removed areas with permanent infrastructure elements (roads, railroads, settlements), as well as permanent agricultural areas, with the aid of a Digital ortho-photo form 2018 (Geoportal 2021). After removing patches with a size less than 0,4ha (arbitrary threshold), we reviewed all the patches and removed those that had no grassland in it, as they are probably a result of a mapping error in the original map (contained either forest or agricultural habitats). The remaining patches represent the extent of dry grasslands in the survey area in 2016 (**Fig.2**). We divided the survey area in two parts - Ćićarija and Učka, as both areas have a slightly different physical characteristics and history of land use and management. But the division does not follow the geographical boundaries of both mountain ranges (Ćićarija encompasses geographically the upper third of the Nature park Učka) as we decided to group the grasslands around the highest peak of Ćićarija (Veli Planik) with the grassland patches of Učka, because of their similarity and proximity (both are above 1000m a.s.l. and inside the Nature park).

Using a Digital ortho-photo form 2018 (Geoportal 2021), we created a map of grassland encroachment for every patch by delineating three habitat classes (**Fig. 3**):

- [Grasslands \(1\)](#) - no or a small amount of woody vegetation is visible in the polygon which is dominated by grasses (open habitats);
- [Transition \(2\)](#) - on at least 15% of the polygon area there is a visible cover of woody vegetation. These polygons are in between classes (1) and (3) and comprise a very broad category that covers areas with a variable degree of openness in respect to the woody vegetation;
- [Woodland \(3\)](#) - the polygon is dominated by a dense cover of woody vegetation or mature trees with a sparse understory (closed habitats).

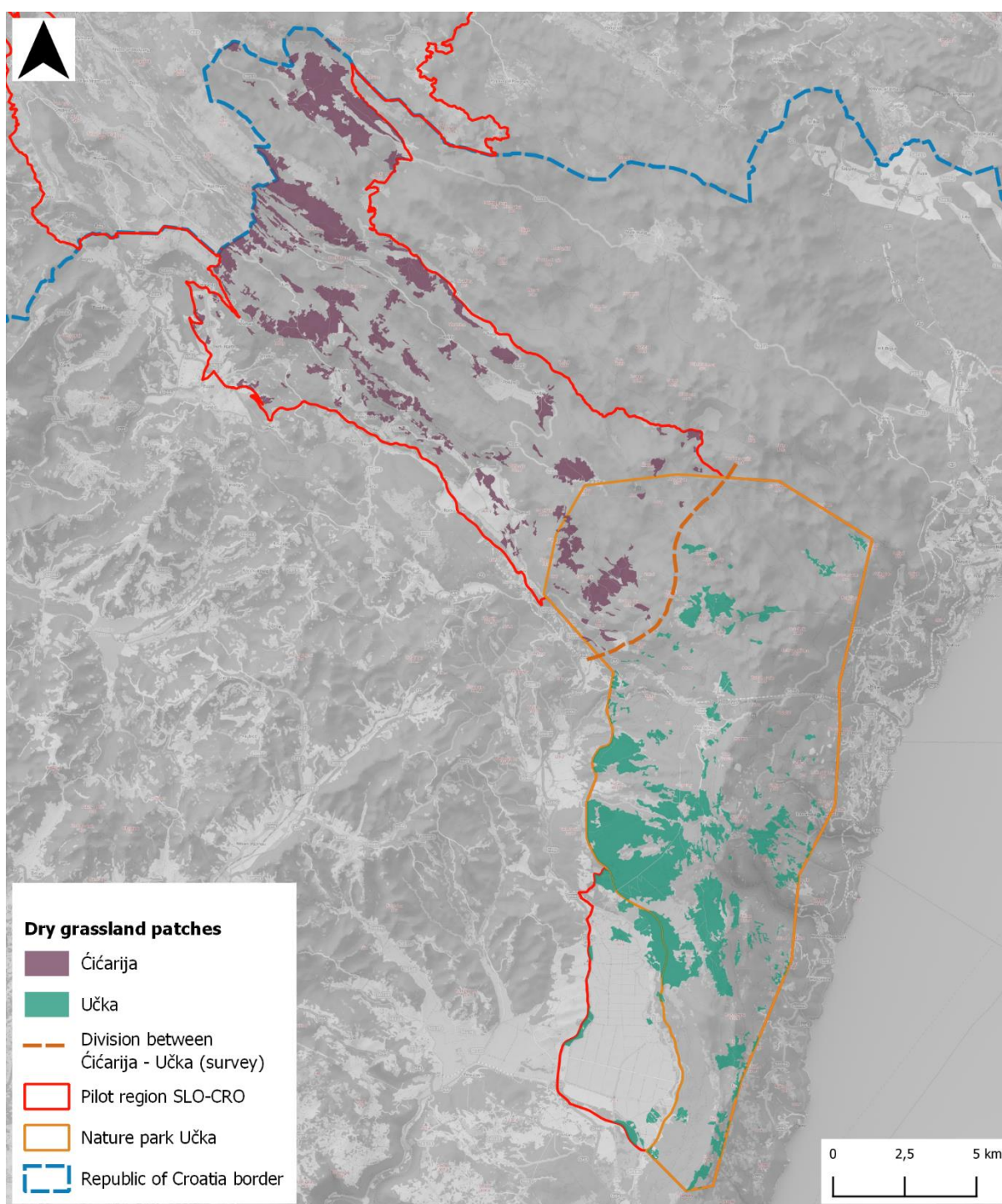


Figure 2: Dry grassland patches present in the survey area of the Pilot region Slovenia-Croatia (basemap: OSM 2021, Hillshade based on EU-DEM (Copernicus Land 2021))

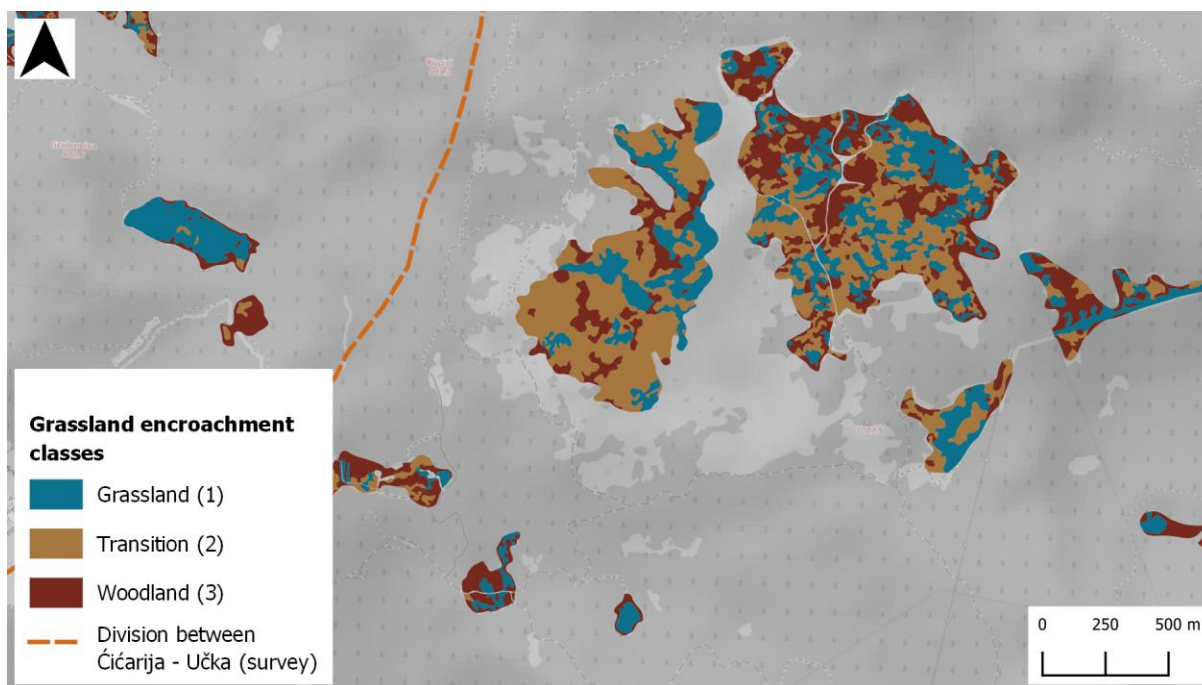


Figure 3: Grassland encroachment classes in the area of Kupice, northern part of Nature park Učka (basemap: OSM 2021, Hillshade based on EU-DEM (Copernicus Land 2021))

The amount of grassland class in the patch indicates the current status of the grasslands in the survey area. Patches with 80% or more grassland are in a good condition, while patches with less than 50% are not grasslands anymore. These thresholds are arbitrary and are based on the logic that in whatever way we map grasslands, we'll always have a small amount of space in the patch covered by something else other than grasslands, and having more than 2/3 of the patch actually covered by grasslands can be considered a naturally good result. In the same way, if 50% or more of the mapped space is used by something else than grassland, this patch represents a bad result and should not be interpreted as grassland. It should either be interpreted as a mosaic, or divided into smaller patches of homogenous structure if possible (but that goes beyond the scope of this report).

The encroachment of woody vegetation on grasslands is a result of a lack of management, and the proportion of woody vegetation in a patch can be used as an indicator of the relative longevity of neglect for a specific patch. Based on that idea, we divided the patches into 3 neglect categories, patches that have less than 15% of woodland are still being managed in some way, for those that have between 15-50% of

woodlands, the neglect is relatively recent, and patches that have more than 50% of their area covered by woodlands, we suppose they have been neglected for the longest time.

The amount of transition class in a patch can be used as proxy for grassland restoration prioritization, by categorising patches into 4 categories that indicate low and high priority patches. Patches with more than 50% of transition class represent the highest priority while patches with 0,01 - 20% represent low priority. Patches with no transition class have no priority as they are either actively managed or completely overgrown, so they were given their own class. The threshold for the classes are arbitrary and based on the logic that patches with a high degree of transition class are on the verge of being permanently lost to woodland, and thus should be restored before it is too late.

In order to assess the **density of woody vegetation** present in the each of the delineated grassland classes, we arbitrarily selected 20 patches of different sizes, distributed across the survey area (11 on Čićarija and 9 on Učka), as our sampling area. The sampling sites within the patches, 10x5m (50m²) plots, were located only in the first two classes, as the areas classified as '*Woodland (3)*' had an obviously high density of woody vegetation, that was easily observable on the orthophoto. We sampled a total of 49 plots (22 on Čićarija, 37 on Učka), with 36 plots in the class '*Grassland (1)*' and 23 plots in '*Transition (2)*'. The plots were distributed so as to cover the all patches equally. In the field the data was collected using a GPS handheld device, with which we would find the lower left corner of the plot and then mark the area using a rope and some tent poles. Then we would count all specimens of woody species in three categories:

- 1) seedlings;
- 2) height <1m;
- 3) height >1m.

The collected data will enable us to calculate the total density of woody vegetation per class (the number of recorded specimens per 50m²), as well as the number of different woody species per class, indicating which species dominate the encroachment in different stages of succession, or if there are differences in the composition of woody species in grasslands (early stage of succession) and the transition areas (late stages of succession).

3. Results

Prior to the fieldwork, we identified a total of 227 grassland patches, 116 patches on Ćićarija and 111 patches on Učka (**Fig. 2**). The average size of the grassland patch is 22,96ha, with the patches being slightly bigger on Učka than on Ćićarija (24,25ha and 21,73ha respectively). Učka has also the largest patch of grasslands in the survey area by far (UCK80 - 805,16ha), almost as twice as large as the next one (CIC1 - 460,96ha). But most patches have a size less than 5ha (125 patches), so the grassland patches in the survey area are generally small. Also, we can say that the dry grasslands are relatively rare in this area, considering that the total area covered by dry grasslands in 2016 is estimated to 5211,96ha, which is only 16,8% of the survey area (and that is an optimistic estimate, in reality the area is even smaller due to the ongoing succession).

3.1. Condition of grasslands regarding succession

The average proportion of grasslands in the patches, in the whole survey area, is 33,13%, which is not great considering that the patches should have had at least 85% of grasslands in 2016 (Bardi et al. 2016). But these values should be interpreted with care, since the minimal mapping unit (MMU) in Bardi et al. (2016) was 1,56ha, while our minimal mapping unit was 25m² (0,0025ha), so 96% of our polygons has an area lower than the MMU used by Bardi et al. (2016). Despite the differences in the methodology, it still gives us an indication of the change in the grassland area in the last 5 years.

Moreover, the average proportion of woodlands in the patches is 47,78%, which indicates a high degree of encroachment on grasslands in the survey area. But the results are dissimilar for Ćićarija and Učka (**Appendix 1**), as the average proportion of grasslands on Ćićarija is 40,01%, which is significantly higher than Učka (24,25%). And the average proportion of transition class (16,53%) on Ćićarija is lower than the proportion of woodlands (43,46%), while on Učka these averages are slightly higher (**Fig. 4**). These results indicate, that on average, the grasslands of the survey area are highly overgrown with woody vegetation, as less than 50% of the patch area was classified as grasslands. Even if we decide to consider the transition class as grassland, the average proportion of woodland is still very high.

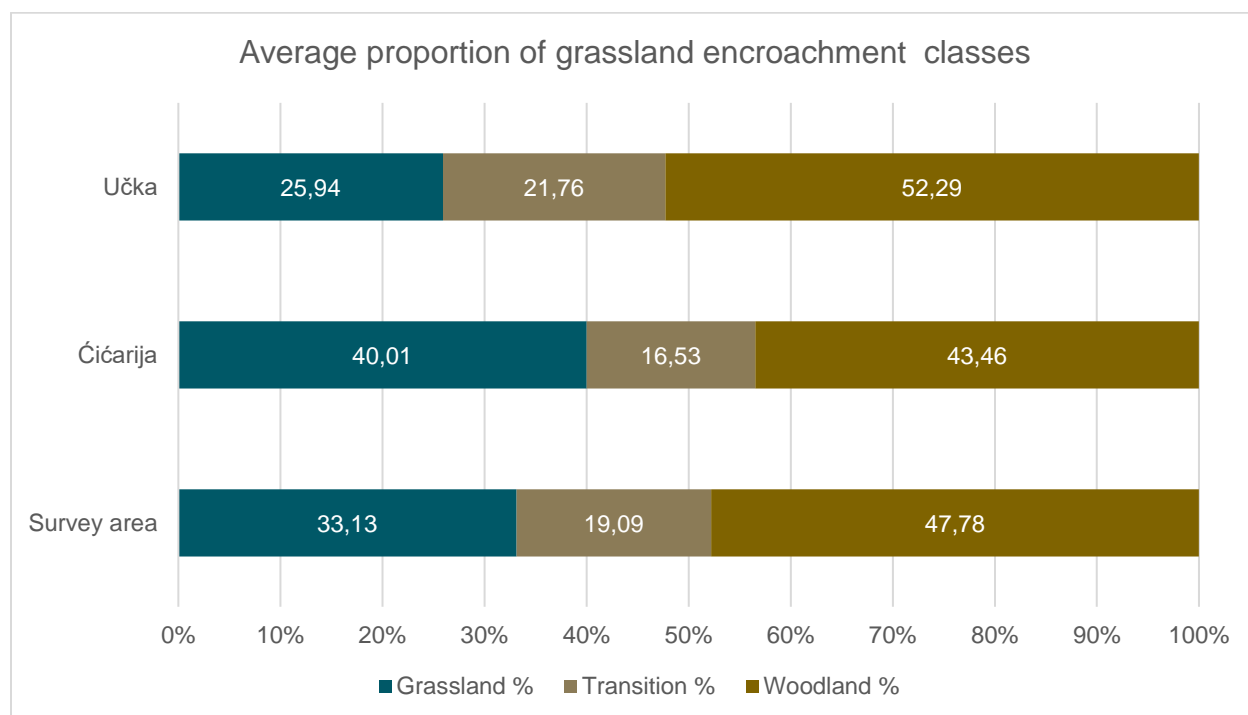


Figure 4: Comparison of average proportion of grassland encroachment classes in different parts of the survey area.

In general, the status of grasslands regarding succession is better on Čićarija than on Učka, as we recorded a total of 971,35ha of grassland on Čićarija compared to the total of 767,92ha on Učka. Also, on Učka there are 14 grassland patches with no grassland class, while Čićarija has only 3 patches, but all patches without grassland class are inside borders of the Nature park Učka (Fig. 5). The highest proportion of grassland in a patch on Čićarija was recorded for the patch CIC97 (92,81%), while the highest proportion on Učka was recorded for the patch UCK103 (78,478%).

In order to get a better understanding of the current status of the grasslands in survey area, we grouped the grassland patches in 7 categories, according to the proportion of grassland class present in the patch (Fig. 5, Fig. 6):

Category 1: 0% grassland	Category 5: 50,01 - 70% grassland
Category 2: 0,1 - 10% grassland	Category 6: 70,01 - 80% grassland
Category 3: 10,01 - 30% grassland	Category 7: 80,01 - 100% grassland
Category 4: 30,01 - 50% grassland	

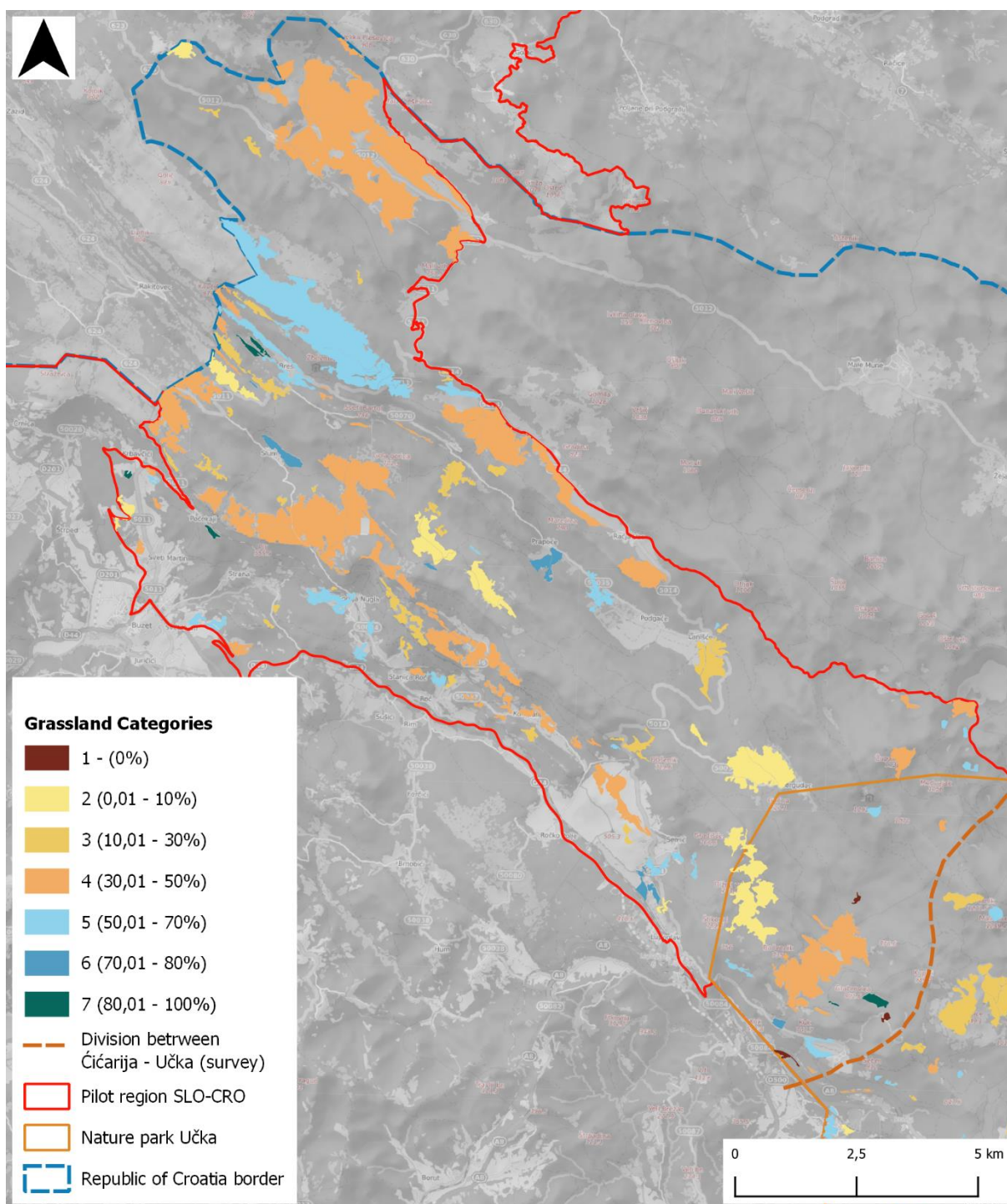


Figure 5: Grassland patches divided into 7 grassland categories on Čičarija (basemap: OSM 2021, Hillshade based on EU-DEM (Copernicus Land 2021))

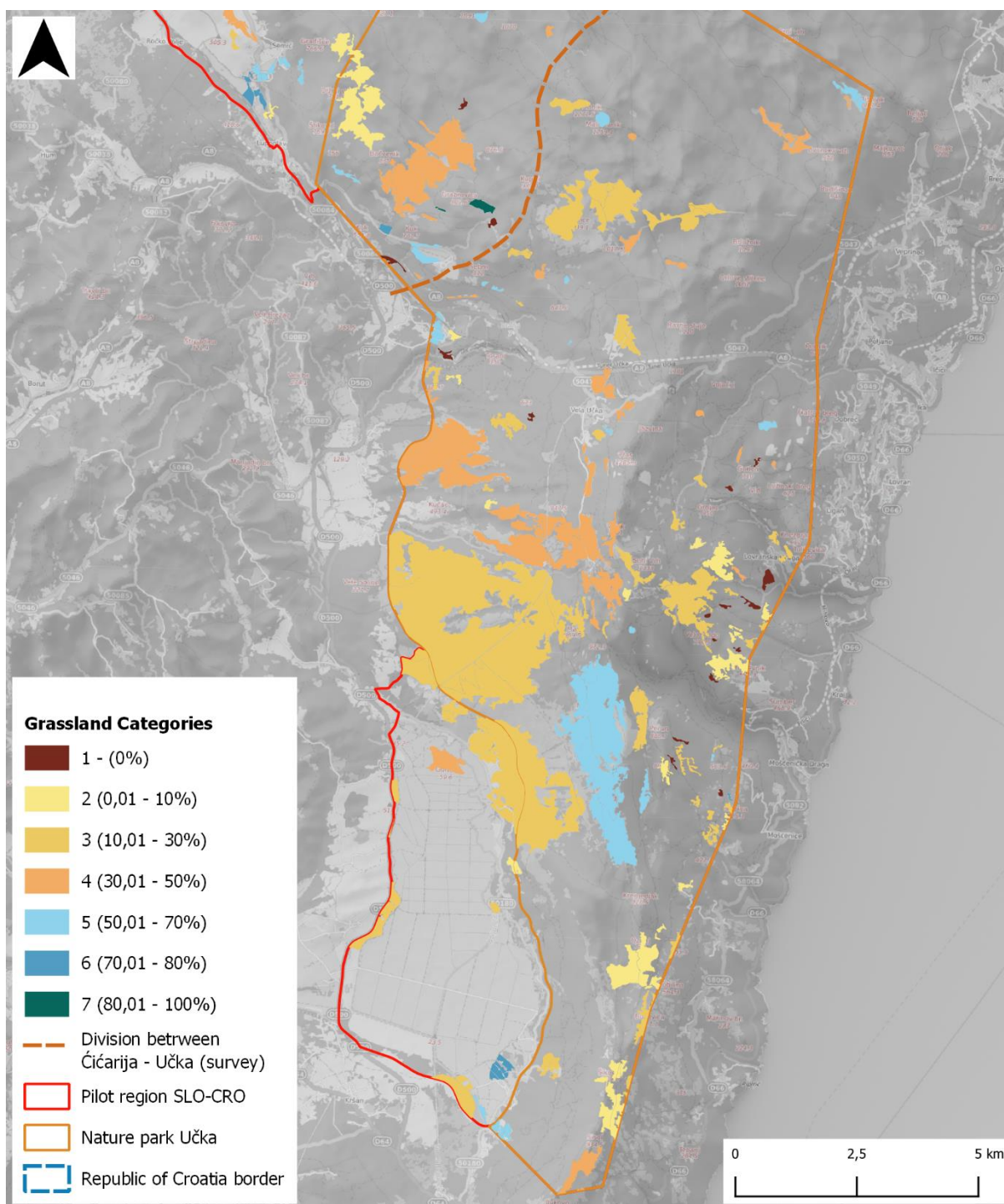


Figure 6: Grassland patches divided into 7 grassland categories on Učka (basemap: OSM 2021, Hillshade based on EU-DEM (Copernicus Land 2021))

The choice to divide patches into 7 categories was arbitrary, as well as the thresholds for the categories. These categories are meant to simplify the interpretation of our results and highlight the extremes (that is why the patches with no grasslands have their own category). So, categories 1 - 4 cannot be considered grasslands as less than 50% of the patch area is not covered by grasslands. And the patches that can be considered currently in good condition, would be only the ones in category 7.

Having the above in mind, we can see that, from the 227 grassland patches, 172 cannot be considered grasslands anymore, which is quite a bad result (it is 75% of all grassland patches). On Ćićarija, 38 patches of 116 can be currently considered as grasslands, and only 7 are in a good condition. Of these 7, only 2 are in the Nature park Učka, both located around Grabrovica peak, above Brest pod Učkom. The other 5 are located in the western part of the survey area, 3 near the town of Brest and 2 near the villages Počekaji and Rumjeni. On Učka, of the total of 111 patches, only 17 can be considered grasslands and none are in a good condition (no grassland patch on Učka was given the category 7). There are only 2 patches in category 6, one is located near the village of Kožljak, in Ćepić polje, and the other is located above Mošćenice, on the littoral slopes of Učka. Most of the bigger patches on both Ćićarija and Učka (more than 30ha), have a category 3 or 4, with the exception of Žbevnica (Ćićarija) and Senožetice (Učka), that have a category 5, having 63,65% and 55,37% of grasslands respectively. So, out of the 5211,96ha of grassland estimated for the survey area in 2016 (Bardi et al 2016), only 20,74ha are in a good condition, which represents 0,40%. If we would lower our threshold for the good condition to 70% of grasslands in a patch, the amount of grasslands in a good condition would raise to 1,6% of the total estimated area, which is still disappointing.

The encroachment of woody vegetation on grasslands results as a lack of management, in the form of mowing, grazing or a combination of the two. As the time passes, the area of the grassland gets smaller, but also the woody vegetation gets bigger and denser and the proportion of woodland in the patch can be used as an indicator of the relative longevity of neglect for a specific patch. Since we can expect a small amount of woody vegetation in a grassland patch, as it usually provides cattle some welcome shade in the summer, we considered a patch neglected if it had more than 15% of woodland in the patch (also an arbitrary threshold) (**Fig. 7**).

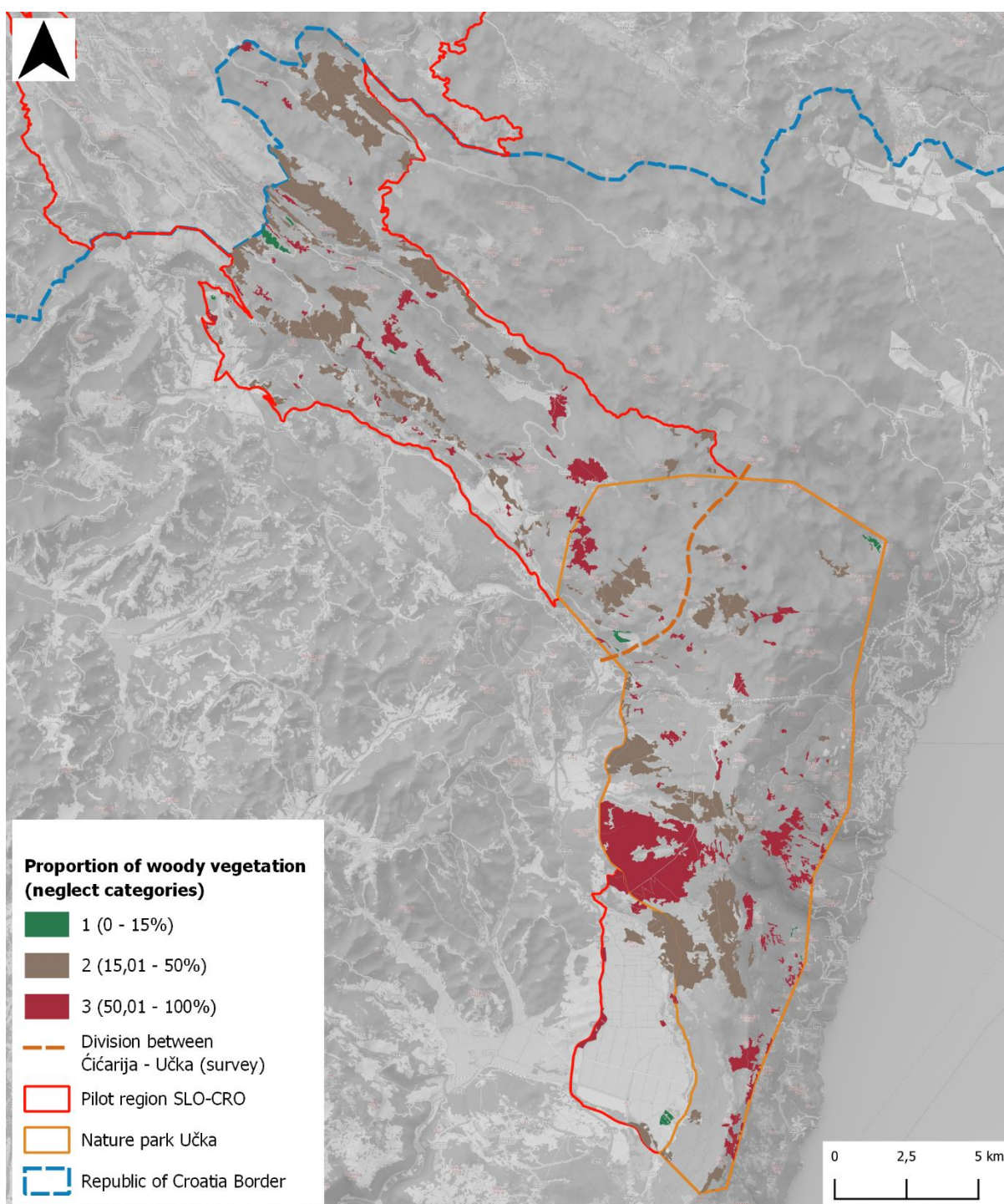


Figure 7: The longevity of neglect of grassland patches in the survey area (basemap: OSM 2021, Hillshade based on EU-DEM (Copernicus Land 2021))

So, this categorisation indicates patches that have recently been lacking management (category 2) and those that have been lacking management for a relatively long time (category 3). But this categorisation is a gross simplification of reality and should be used only as an indication of a possible current status of a patch regarding land use. This is most evident in the case of patches located close to the road between Vranja and Buzet, below 500m a.s.l., as most of these patches are still regularly machine mowed, but have still been categorized as neglected. What this categorization can tell us is that the grassland patches on Učka have been neglected for a longer time than those on Čićarija, and that on Učka mostly small patches are still being managed (most have an area less than 1ha).

When a grassland area ceases to be used, the woody vegetation slowly starts to spread along the edges, creating a transition area of a semi-open habitat. This change can be reversed by physically removing the shrubs and trees from the grassland, but if the transition area is too large or the woody vegetation is too dense, the restoration becomes too expensive and is less likely to be successful. So, we divided the grassland patches in our survey area, based on the proportion of transition class, in 4 categories that represent priority for restoration (**Fig. 8**). The patches that have more than 50% of their area covered by the transition class (category 4), have the highest priority for restoration, but can also be the ones where the restoration is less likely to succeed as most of the area need to be cleared. Patches with no transition class (category 1) have a low priority for restoration as there is basically nothing to restore, as these patches are either under active management or are dominated by woodland and should not be classified as grasslands anymore. Only six patches were given a highest priority for restoration, and most of them (4) are located on Učka. Also, Učka has far more patches in a higher priority (category 3) than Čićarija (52 compared to 36), which was expected, as the proportion of grassland on Učka is lower than on Čićarija and the grassland patches have been neglected for a relatively longer time.

The grassland patches can also be grouped based on the amount of area that can be restored, calculated according to the proportion of transition class in the patch (**Fig. 9**). Obviously, we can expect that bigger patches will have a higher amount of area to be restored, but since this value depends also on the proportion of the transition class, the relationship is not so simple. As we can see, there are only 3 patches with more than 100ha that can be restored, 2 on Učka and 1 on Čićarija. available So, this map can give us an indication of the time and effort is needed to restore a particular patch, and can provide a useful source of information for the stakeholders during the development of the action plan.

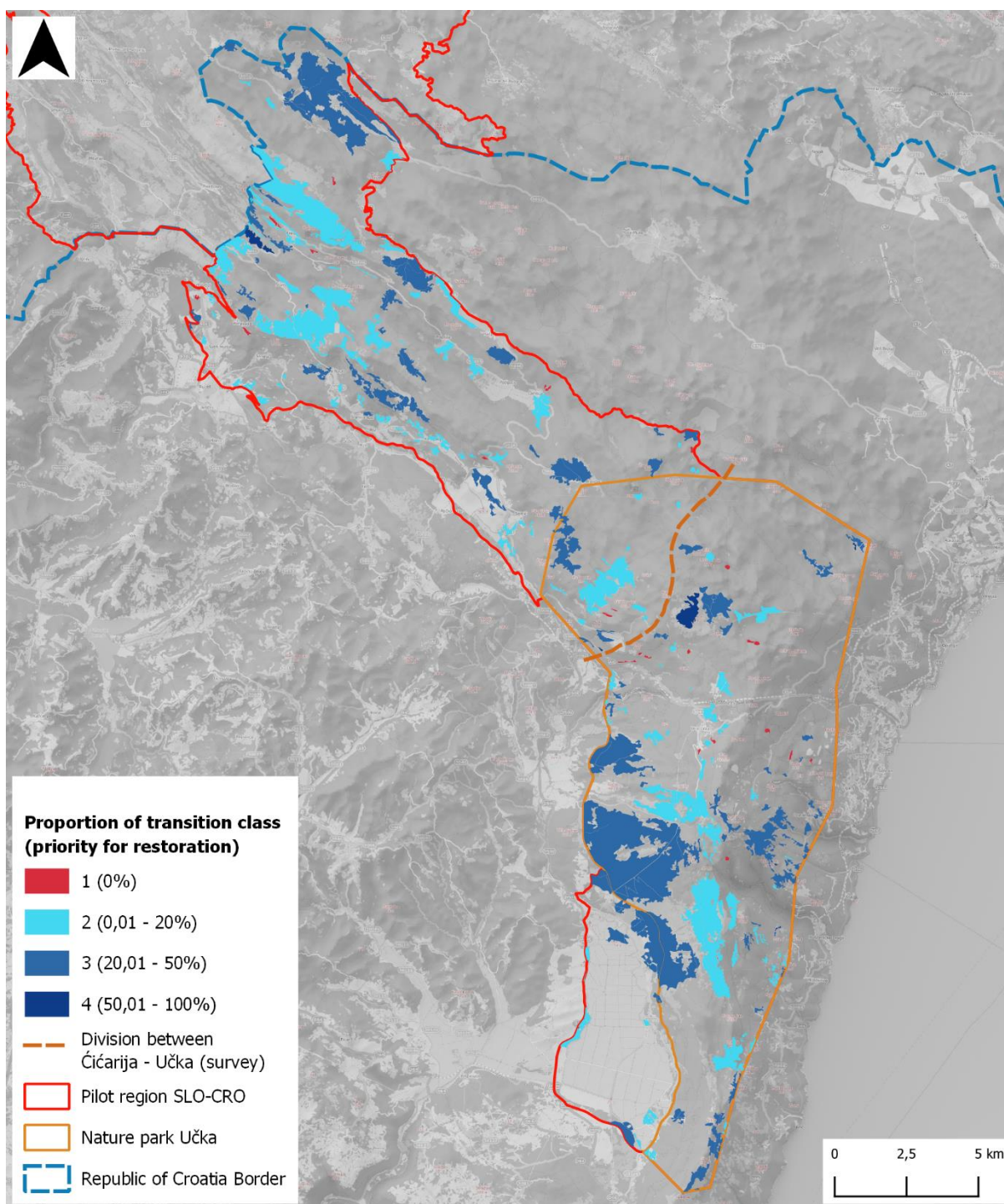


Figure 8: The priority for restoration of grassland patches in the survey area, with category 1 indicating the lowest priority (basemap: OSM 2021, Hillshade based on EU-DEM (Copernicus Land 2021))

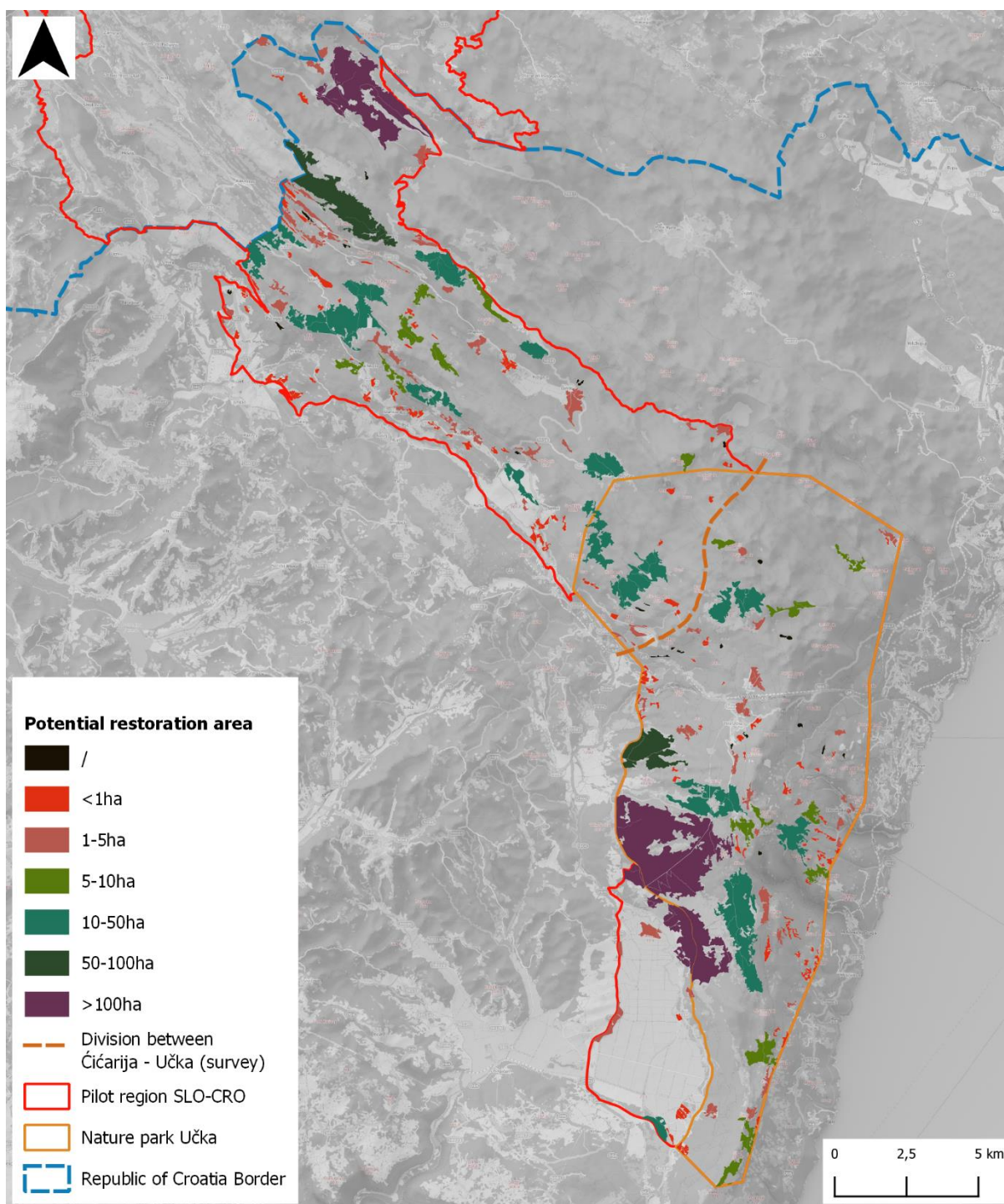


Figure 9: The potential restoration area for every grassland patch in the survey area, grouped according to the available amount (basemap: OSM 2021, Hillshade based on EU-DEM (Copernicus Land 2021))

3.2. Density of woody vegetation

Although the floristic and vegetation composition of the grasslands on Čićarija and Učka is well known (Vitasović Kosić and Britvec 2014, Surina and Modrić-Surina 2019), and the problem of the abandonment of grasslands and the encroaching of woody vegetation has been recognised more than 20 years ago (Čarni 1999), there is a lack of data about the density of woody vegetation present in the survey area, which would help stakeholders to assess the time and effort needed to restore the overgrown areas.

To collect the data about density of woody vegetation in the survey area, we visited 20 grassland patches in June (14-18/06/2021), where we counted all woody specimens present in a total of 49 plots (**Fig. 10, Fig. 11; Appendix 2.**). The plots encompass either the typical grassland vegetation or the vegetation of the transition zone, that can be divided into two distinct parts, mantle (close to the woodland, dominated by shrub species) and “saum” (close to the grassland, with the presence of tall herbaceous species) (Čarni 1999). Both mantle and saum represent the succession stage between grassland and woodland vegetation, but since we recorded only woody species, plots with a high density can be considered as mantle vegetation.

During the fieldwork, we recorded in total 26 woody species for the survey area (**Appendix 3.**), with the most frequently recorded species being *Frangula rupestris*, *Fraxinus ornus*, *Juniperus oxycedrus* and *Rosa Canina*. The most abundant species by far was *Rosa pimpinellifolia*, with a total of 1246 specimens recorded only for Učka. The next most abundant species were *Fraxinus ornus* (311), *Frangula rupestris* (232) and *Prunus spinosa* (114), which were recorded both on Čićarija and Učka.

The floristic composition recorded for the transition class is diverse and more abundant than the composition for the grassland class, which was expected. Also, the floristic composition differs between Čićarija and Učka, with Učka having far more species recorded for the grassland class (14) than Čićarija (4). Učka has also more species recorded in the transition class, 22 compared to 17 recorded on Čićarija. These differences in the floristic diversity of the mantle vegetation indicates that Učka is more affected by the encroachment than Čićarija, which was also evident from the analysis of the condition of grasslands (**Chapter 3.1.**).

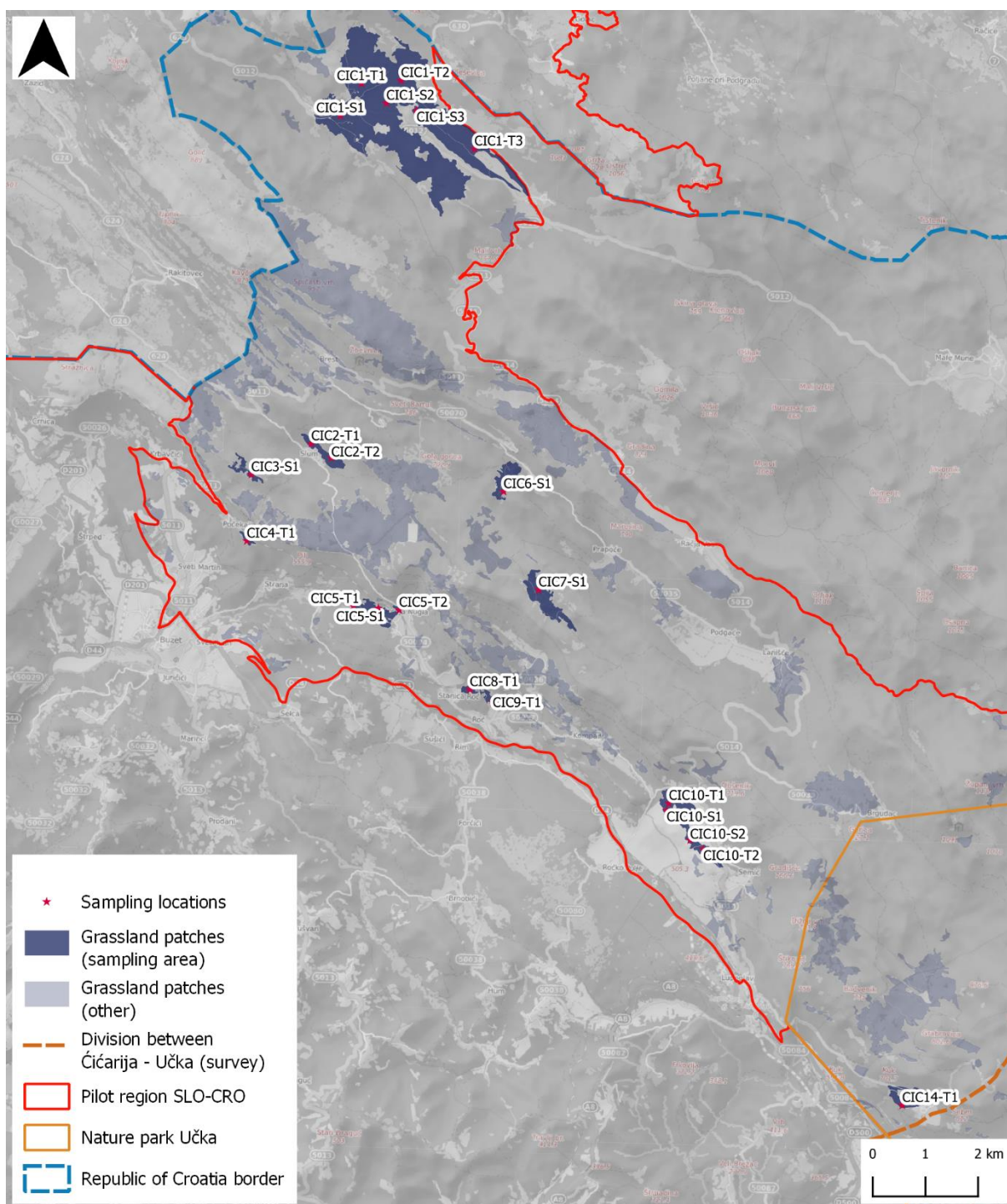


Figure 10: Sampling locations on Čičarija. Locations with a T in the name indicate grassland class while S indicates Transition class (basemap: OSM 2021, Hillshade based on EU-DEM (Copernicus Land 2021))

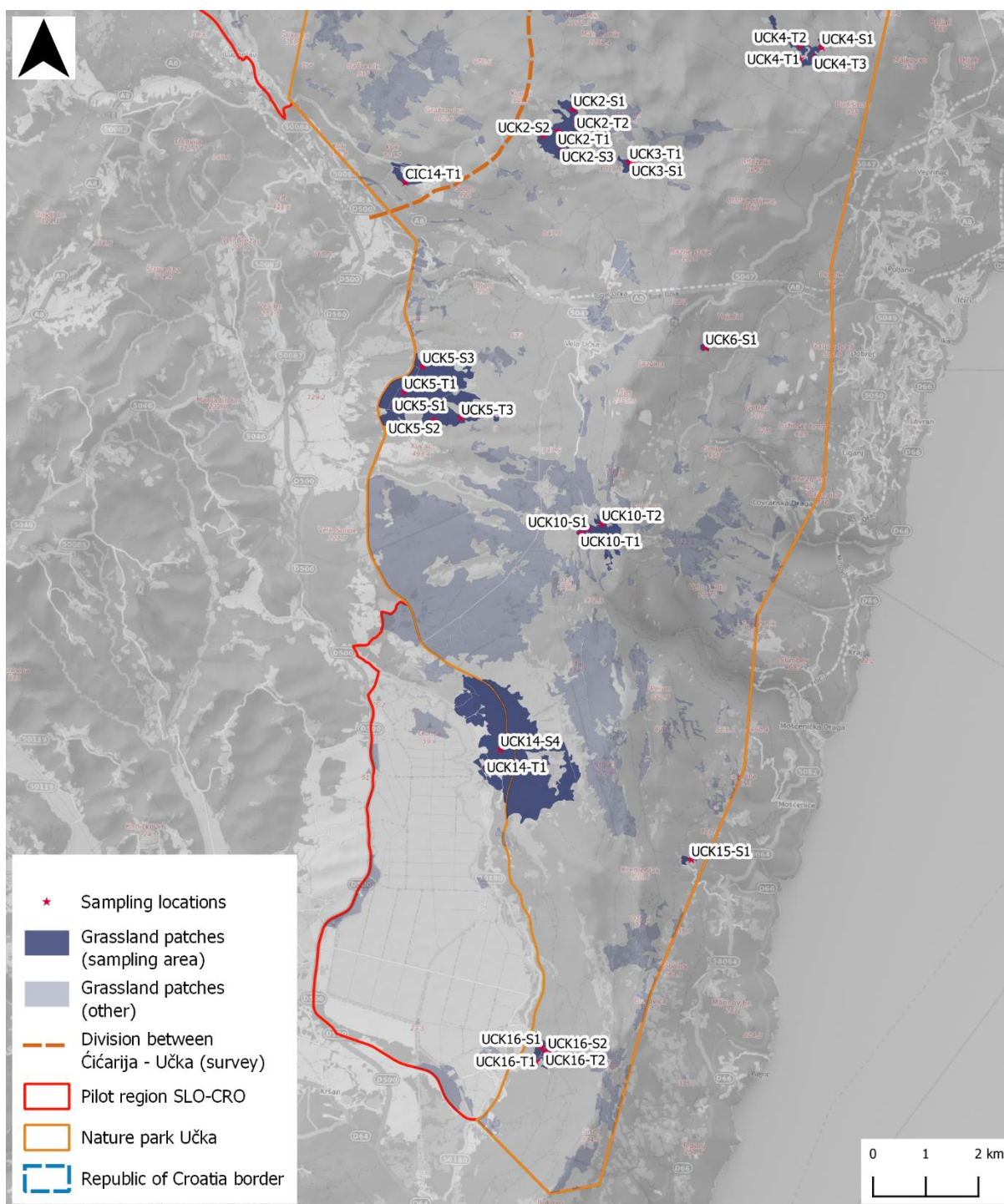


Figure 10: Sampling locations on Učka. Locations with a T in the name indicate grassland class while S indicates Transition class (basemap: OSM 2021, Hillshade based on EU-DEM (Copernicus Land 2021))

When we compare the structure of the recorded woody vegetation between transition and grassland classes, on both Čićarija and Učka the structure is similar, with the highest number of specimens recorded in the middle category (<1m) (**Fig. 12, Fig. 13**), which is expected for a transition area whose vegetation is in the process of change. Although their structure is similar, there is a difference between the Čićarija and Učka, with Čićarija having twice the amount of seedlings recorded for both classes (**Fig. 14**) then older specimens (>1m), while Učka has a higher amount of older specimens than seedlings, at least in the grassland class. And on Učka, the high proportion of middle height category is extremely high, which can be attributed to *Rosa pimpinellifolia*, that was recorded only on Učka. Also, for the whole survey area far more specimens in total numbers, are present in the transition class than in the grassland class, a result that was expected as both classes can be usually easily recognized through orthophoto imagery. But the degree of dissimilarity can mostly be guessed, as some species are not visible in orthophoto imagery, nor is possible to count the specimens under the canopies (and a lot of seedlings are usually found there).

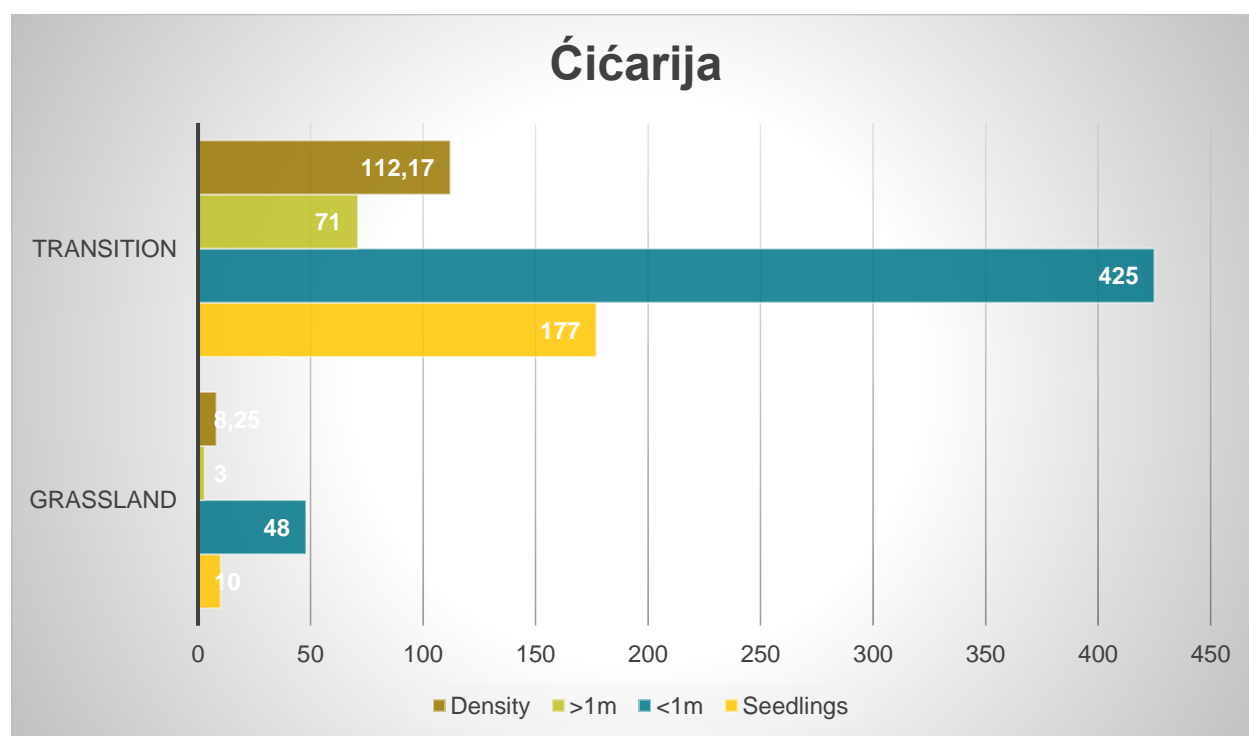


Figure 12: Comparison of the total number of recorded specimens of woody species between grassland and transition class on Čićarija. Density is given as the average number of all specimens in the plots.

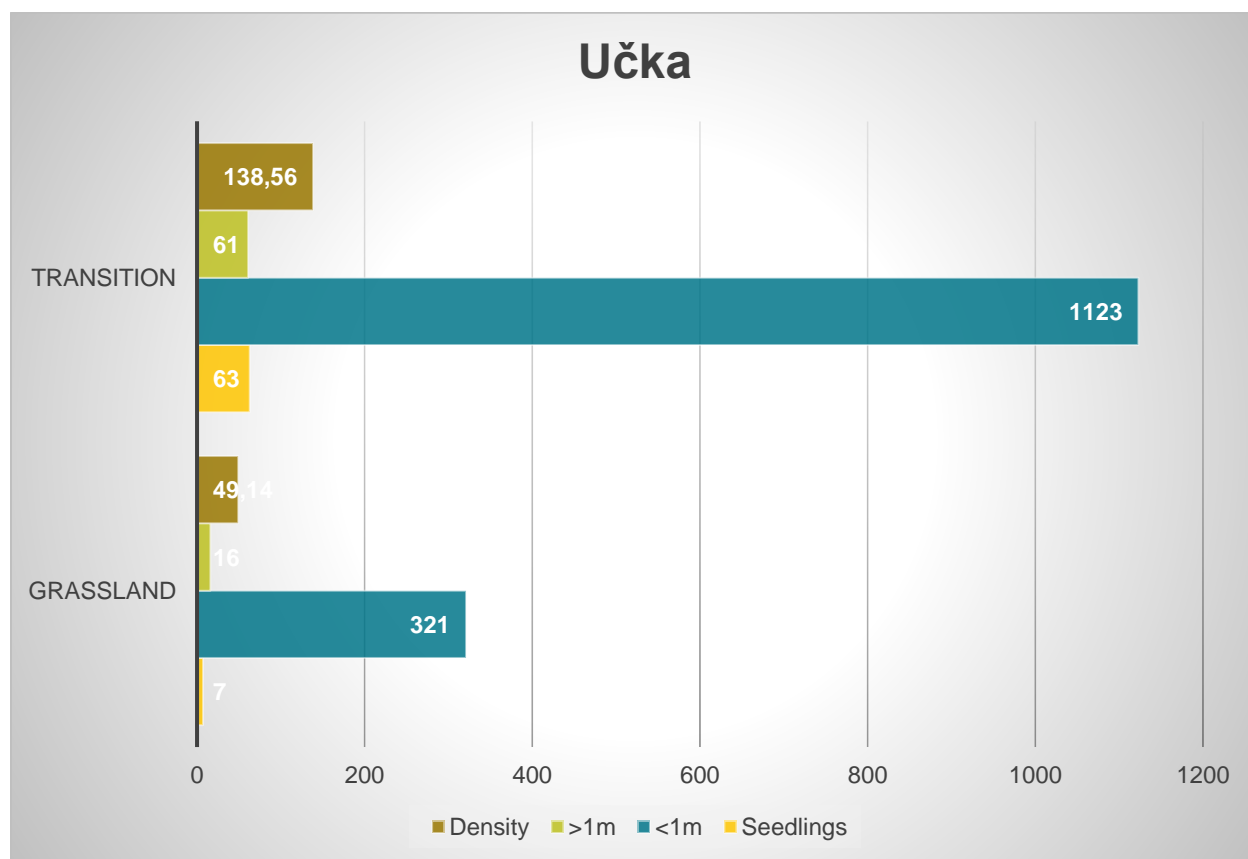


Figure 13: Comparison of the total number of recorded specimens of woody species between grassland and transition class on Učka. Density is given as the average number of all specimens in the plots.

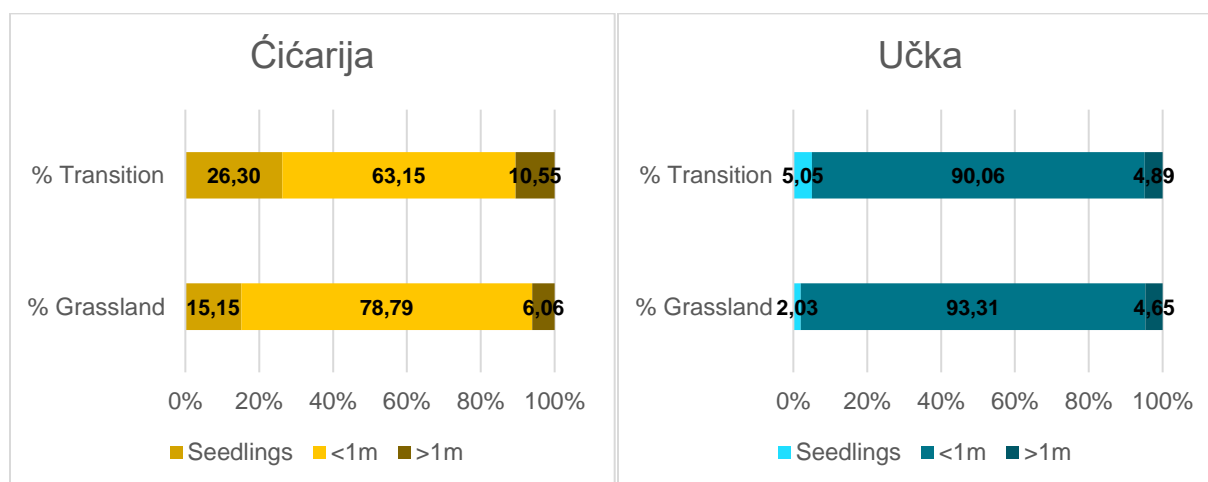


Figure 14: The amount of specimens of woody species recorded per height class, on Ćićarija and Učka.

The differences in woody vegetation structure are more pronounced on Ćićarija, as the difference in density between grassland and transition class is tenfold, while on Učka the density in the transition class is almost 3 times higher than in the grassland class. As the abandonment of grasslands leads to an increase in number and abundance of generalist species living mostly in open woods or fringe habitats (Catorci et al. 2011), but in time we can expect their total number to decrease as the stand becomes older and develops a more closed canopy. So, the recorded differences in the density of woody vegetation could be a result of sampling on relatively recently abandoned grassland (Ćićarija), in contrast to sampling on grasslands abandoned long time ago (Učka). But the survey we conducted does not allow more than speculation on this subject, as the methodology we employed may not be adequate for making this kind of inferences and we do not have data about the exact time of abandonment for grasslands in the survey area.

The density gives us the average amount of woody species specimens per 50m², which was the size of our survey plot. So, we can see that, on average, a 1ha of grassland on Ćićarija has 1650 specimens of woody species (8,25 x 200), while the same area of grassland on Učka has 9828 specimens, which indicates that the grasslands of Učka are, on average, more overgrown by woody vegetation than those of Ćićarija. Also, this indicates that it would require a lot of effort to restore these grasslands, as the number of specimens per 1ha in the transition class on Učka is 27711, which is similar to the value for Ćićarija (22433). Although around 10-26% of these numbers comprises seedlings, the resulting number is still high (16533 for Ćićarija and 26311 for Učka), and as the time passes it will probably get even higher.

The high total number of specimens recorded on Učka is mostly due to the presence of *Rosa pimpinellifolia* on seven plots (UCK2-T1, UCK2-T2, UCK2-S1, UCK2-S2, UCK2-S3, UCK3-T1 and UCK3-S1), where it was the dominant species that covered most of the ground (**Fig. 15**). These plots are located in the area of Kupice, in the northern part of Nature park Učka. This area geographically belongs to Ćićarija, but as it has a similar management as the rest of the Nature park, it was grouped with the plots of Učka. This species spreads by root suckers and rhizomes, forming dense populations, and is usually avoided by herbivores (Mayland-Quellhorst et al. 2012). In Central Europe it is a characteristic species of *Geranion sanguinei* alliance, a vegetation common to transition areas between dry grasslands and oak woodland, that can result from grassland abandonment (Pladias 2021). The succession of this species as a threat to grasslands on Učka was already mentioned by Surina and Modrić-Surina (2019).



Figure 15: A high cover of *Rosa pimpinellifolia* in the ground layer (area of Kupice, Učka), making it a dominant species which outcompetes the grass species in the absence of management (plot UCK2-S1).

Each of the grassland patches that we survey on Učka had some distinguishing attributes and they encompass most of the diversity present on the mountain. One of the grassland patches (UCK16) that is close to the settlements (Katun) and is relatively flat, and was already mowed by the time we did the survey (**Fig. 16**). The other patch with similar attributes (UCK14) had clear signs of encroachment, with the far more woody specimens in the transition class than the grassland class (**Fig. 17**). The succession towards woodland has gone far more ahead on the slopes that surround the remains of the grassland in the lowlands, as the slopes are far more rocky and less accessible. A similar situation was recorded in the area of Vela Sapca (UCK4), characterized by very steep sinkholes, where the grassland is still present in most of the sinkholes as the encroachment is probably slowed down by the low temperatures and the wet conditions that favour the development of patches of mesophilous vegetation (**Fig. 18**). On the other hand, on Mala Učka (UCK10) we have an overgrazed grassland (**Fig. 19**), a problem that was already mentioned by Surina and Modrić-Surina (2019).



Figure 16: Machine mowed grassland, near the village of Katun (plot UCK16-T2).



Figure 17: The encroachment of *Paliurus spina-christi* on the grassland in the area of Jesenovik, near the village Šurjani. On the left is the plot in the grassland class (UCK14-T1) and on the right is the plot in the transition class (UCK14-S1).

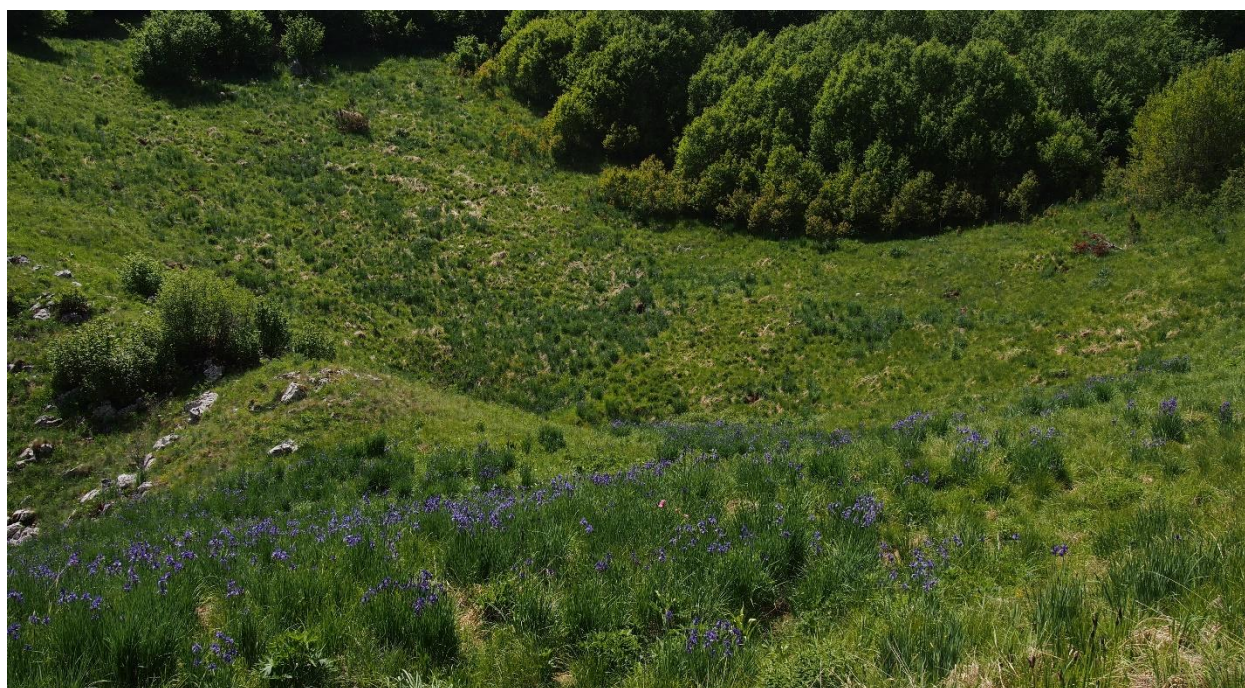


Figure 18: Patches of wet grassland dominated by *Iris sibirica*, on Vela Sapca. The extreme climatic conditions slow the progression of succession (plot UCK4-T1).

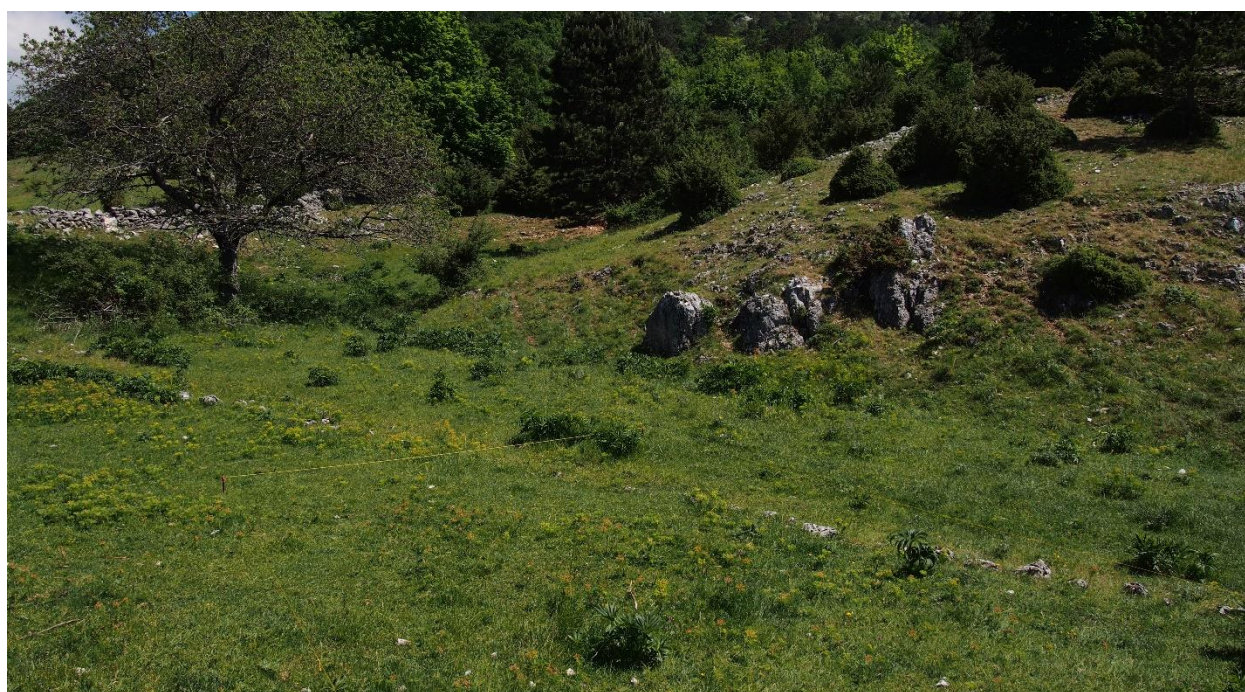


Figure 19: An overgrazed grassland on Mala Učka (plot UCK10-T1).

On Čićarija, there are much more similarities between grassland patches and most of the patches that area bellow 500m a.s.l., and close to the road Vranja-Buzet, are still actively managed, either by machine mowing (CIC2, CIC4, CIC5, CIC8, CIC9, CIC14; **Fig. 20**) or grazing (CIC10; **Fig. 21**).



Figure 20: Machine mowed grassland near the village Počekaji, representative of the lowland grassland patches along Čićarija (plot CIC4-T1).



Figure 21: Actively grazed grassland patch in the area of Podbrus (plot CIC10-T1).

On the other hand, grassland patches on the hills in the middle part of Ćićarija, between Lanišće and Slum (CIC6 and CIC7), are already overgrown by *Pinus nigra* woodland with *Fraxinus ornus*, *Frangula alnus* and *Prunus spinosa* dominating in the shrub layer (Fig. 22).



Figure 22: The remains of grassland overgrown by *Pinus nigra* woodland (plot CIC6-S1).

In the north-western part of Ćićarija, between villages Vodice and Jelovice, there are extensive areas of grasslands that are still being grazed (CIC1), but the grazing pressure is not enough to stop the encroachment by *Pinus nigra* (Fig. 23). Most of the grasslands in the area are affected by the succession (Fig. 24), with the slopes overgrown by the *Pinus nigra* woodland and the bottom of the valley by shrubland dominated by *Cornus sanguinea*, *Fraxinus ornus* and *Juniperus oxycedrus* (Fig. 25).

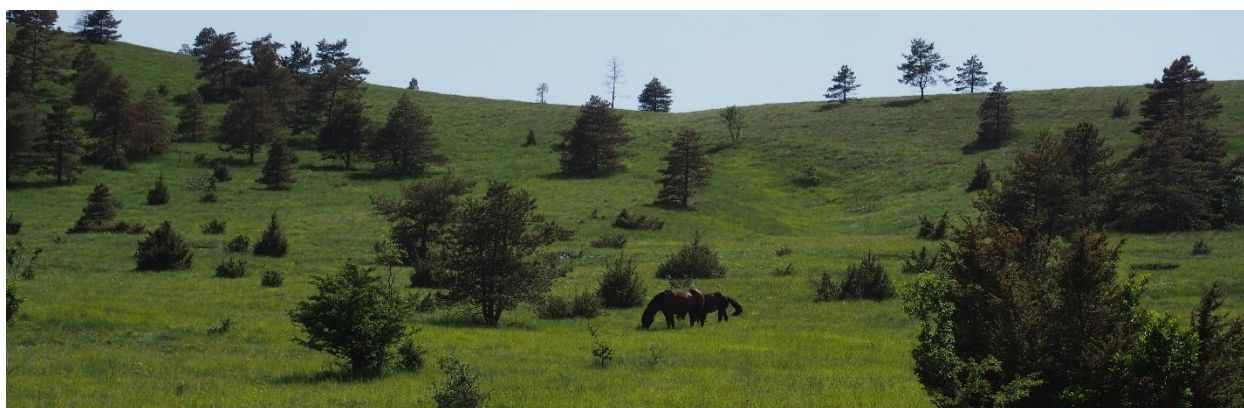


Figure 23: In the distance feral horses are grazing on a grassland under succession towards *Pinus nigra* woodland, that is more pronounced on the slopes (plot CIC1-T2).

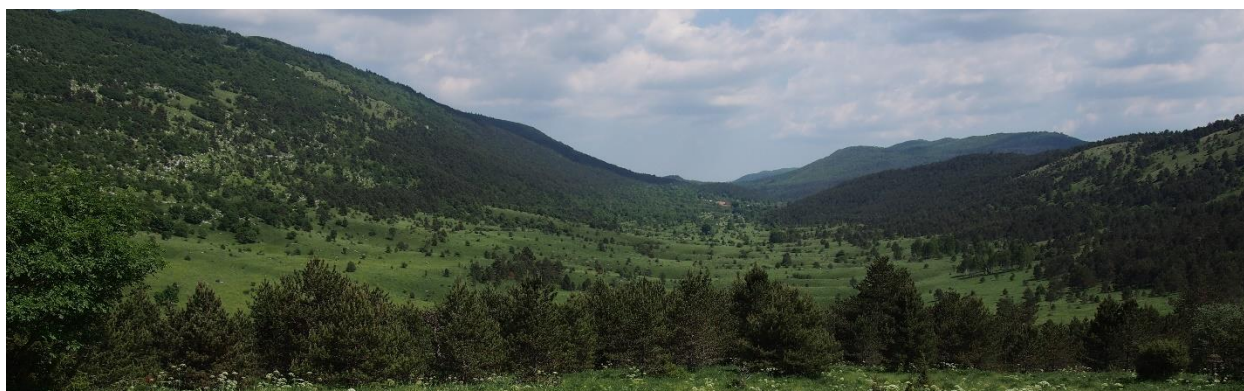


Figure 24: The view of the valley Brežine, towards the village Vodice (far end of the picture). In the past, the valley was almost completely without woody vegetation (plot CIC1-S1).



Figure 25: Shrubland encroaching on the grasslands at the bottom of the valley Brežine (plot CIC1-T3).

4. Conclusion

Based on data from 2016, we identified a total of 227 grassland patches present in the survey area, that encompasses Čićarija and Učka, with the average size of the grassland patch being 22,96ha.

After a detailed classification of the patch area into grassland encroachment classes, we conclude that the average proportion of grasslands in the patches is 33,13%, which indicates a high degree of encroachment on grasslands in the survey area, with the status of grasslands regarding succession generally being better on Čićarija then on Učka.

Also, 172 patches out of 227 cannot be considered grasslands anymore as they have more than 50% of the patch area classified as non-grassland. On Čićarija, 38 patches out of 116 can be currently considered as grasslands, and only 7 are in a good condition (more than 80% of the patch area is grassland), while on Učka only 17 patches out of 111 can be considered grasslands, and none are in a good condition. Of the total grassland area estimated in 2016, only 0,4% can be considered in a good condition, which comes to 20,74ha. If the threshold was lowered to 70% of grasslands in the patch, 1,6% of the grassland area estimated in 2016 would be considered in good condition today.

Data about the density of woody vegetation in the survey area was collected on a total of 49 plots scattered in 20 grassland patches, where we recorded a total of 26 woody species. Most frequently recorded species are *Frangula rupestris*, *Fraxinus ornus*, *Juniperus oxycedrus* and *Rosa Canina*, while the most abundant species is *Rosa pimpinellifolia*, recorded only for Učka. The floristic composition of grassland and transition classes differ between Čićarija and Učka, with Učka having more species than Čićarija, indicating that Učka is more affected by the encroachment.

Vegetation structure on both Čićarija and Učka show the highest number of specimens in the middle category (<1m), but Čićarija has more seedlings recorded then older specimens (>1m), while the opposite was recorded for Učka. Density of woody vegetation is higher on Učka for both classes and the differences in density between classes is lower than on Čićarija, indicating that the grassland abandonment on Učka could have a longer history than on Čićarija.

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6. Appendix 1. Proportion of Grassland classes per patch

Patch Id	Area (ha)	Grassland (%)	Grassland Category	Transition (%)	Priority Category	Woodland (%)	Neglect Category	Area for restoration (ha)	Restoration Group
Uck50	17,07	13,94	3	12,71	2	73,35	3	2,17	3 (1-5ha)
Cic22	1,92	43,75	4	0	1	56,25	3	0	1 (/)
Cic105	314,22	63,65	5	19,2	2	17,15	2	60,33	6 (50-100ha)
Cic106	1,87	21,39	3	0	1	78,61	3	0	1 (/)
Uck51	1,45	0,00	1	12,41	2	87,59	3	0,18	2 (<1ha)
Cic23	3,59	77,16	6	2,23	2	20,61	2	0,08	2 (<1ha)
Uck52	1,64	10,98	3	40,85	3	48,17	2	0,67	2 (<1ha)
Cic100	0,54	50,00	4	5,56	2	44,44	2	0,03	2 (<1ha)
Cic101	1,64	40,24	4	0	1	59,76	3	0	1 (/)
Cic102	7,88	49,37	4	9,39	2	41,24	2	0,74	2 (<1ha)
Uck8	2,93	11,95	3	20,82	3	67,24	3	0,61	2 (<1ha)
Uck9	1,06	0,00	1	20,75	3	79,25	3	0,22	2 (<1ha)
Uck4	22,48	47,73	4	34,39	3	17,88	2	7,73	4 (5-10ha)
Uck5	164,15	38,59	4	38,88	3	22,53	2	63,82	6 (50-100ha)
Uck6	1,91	46,07	4	0	1	53,93	3	0	1 (/)
Uck7	5,34	53,56	5	23,03	3	23,41	2	1,23	3 (1-5ha)
Uck1	15,27	15,78	3	45,97	3	38,24	2	7,02	4 (5-10ha)
Uck2	50,93	25,98	3	57,79	4	16,24	2	29,43	5 (10-50ha)
Uck3	7,59	40,18	4	44,4	3	15,42	2	3,37	3 (1-5ha)
Cic17	7,84	80,10	7	3,06	2	16,84	2	0,24	2 (<1ha)
Uck46	1,21	47,11	4	3,31	2	49,59	2	0,04	2 (<1ha)
Cic18	2,57	36,58	4	19,46	2	43,97	2	0,5	2 (<1ha)
Cic19	4,37	67,51	5	12,81	2	19,68	2	0,56	2 (<1ha)
Uck47	5,96	27,68	3	26,17	3	46,14	2	1,56	3 (1-5ha)
Uck48	2,54	5,51	2	16,93	2	77,56	3	0,43	2 (<1ha)
Cic13	16,5	35,39	4	49,15	3	15,45	2	8,11	4 (5-10ha)
Uck49	2,4	47,08	4	8,33	2	44,58	2	0,2	2 (<1ha)
Uck42	1,37	45,26	4	15,33	2	39,42	2	0,21	2 (<1ha)
Cic14	11,24	62,99	5	25,62	3	11,39	1	2,88	3 (1-5ha)
Uck43	1,8	44,44	4	0	1	55,56	3	0	1 (/)
Cic15	0,77	42,86	4	54,55	4	2,60	1	0,42	2 (<1ha)
Uck44	1,07	0,00	1	39,25	3	60,75	3	0,42	2 (<1ha)
Cic16	2,06	0,00	1	15,53	2	84,47	3	0,32	2 (<1ha)
Uck45	0,93	44,09	4	0	1	55,91	3	0	1 (/)
Cic10	38,16	34,09	4	43,71	3	22,20	2	16,68	5 (10-50ha)
Cic11	4,57	5,47	2	29,1	3	65,43	3	1,33	3 (1-5ha)
Cic12	98,77	6,06	2	29,24	3	64,70	3	28,88	5 (10-50ha)
Cic97	2,78	92,81	7	0	1	7,19	1	0	1 (/)
Uck40	1,04	45,19	4	0	1	54,81	3	0	1 (/)
Cic98	0,6	83,33	7	0	1	16,67	2	0	1 (/)
Uck41	9,11	35,02	4	11,09	2	53,90	3	1,01	3 (1-5ha)
Cic99	19,36	50,93	5	7,95	2	41,12	2	1,54	3 (1-5ha)
Cic93	12,43	28,24	3	32,98	3	38,78	2	4,1	3 (1-5ha)
Cic94	12,88	18,40	3	20,81	3	60,79	3	2,68	3 (1-5ha)
Cic95	13,3	61,50	5	9,32	2	29,17	2	1,24	3 (1-5ha)
Cic96	4,36	82,80	7	1,38	2	15,83	2	0,06	2 (<1ha)
Cic90	24,57	9,52	2	80,67	4	9,81	1	19,82	5 (10-50ha)
Cic91	3,26	38,65	4	8,59	2	52,76	3	0,28	2 (<1ha)
Cic92	0,61	70,49	6	8,2	2	21,31	2	0,05	2 (<1ha)

Patch Id	Area (ha)	Grassland (%)	Grassland Category	Transition (%)	Priority Category	Woodland (%)	Neglect Category	Area for restoration (ha)	Restoration Group
Uck39	3,67	21,53	3	18,26	2	60,22	3	0,67	2 (<1ha)
Uck35	21,23	28,50	3	14,18	2	57,32	3	3,01	3 (1-5ha)
Uck36	17,14	42,65	4	12,66	2	44,69	2	2,17	3 (1-5ha)
Cic8	3,29	44,68	4	30,4	3	24,92	2	1	3 (1-5ha)
Uck37	5,23	40,73	4	11,85	2	47,42	2	0,62	2 (<1ha)
Cic9	5,82	63,57	5	13,06	2	23,37	2	0,76	2 (<1ha)
Uck38	1,43	63,64	5	0	1	36,36	2	0	1 (/)
Uck31	9,47	58,39	5	6,34	2	35,27	2	0,6	2 (<1ha)
Uck32	2,72	9,93	2	36,03	3	54,04	3	0,98	2 (<1ha)
Cic4	2,79	84,95	7	0	1	15,05	2	0	1 (/)
Uck33	2,89	0,00	1	24,22	3	75,78	3	0,7	2 (<1ha)
Cic5	22,3	51,57	5	23	3	25,43	2	5,13	4 (5-10ha)
Uck34	0,44	54,55	5	18,18	2	27,27	2	0,08	2 (<1ha)
Cic6	22,83	13,89	3	27,55	3	58,56	3	6,29	4 (5-10ha)
Cic7	32,21	5,34	2	25,4	3	69,26	3	8,18	4 (5-10ha)
Cic86	1,89	41,80	4	7,41	2	50,79	3	0,14	2 (<1ha)
Cic87	3,21	23,68	3	25,23	3	51,09	3	0,81	2 (<1ha)
Cic1	460,96	32,41	4	41,33	3	26,26	2	190,51	7 (>100ha)
Uck30	0,78	24,36	3	6,41	2	69,23	3	0,05	2 (<1ha)
Cic2	14,74	76,87	6	3,93	2	19,20	2	0,58	2 (<1ha)
Cic88	78,6	42,53	4	15,74	2	41,73	2	12,37	5 (10-50ha)
Cic3	8,78	16,06	3	32,8	3	51,14	3	2,88	3 (1-5ha)
Cic89	1,84	10,33	3	28,8	3	60,87	3	0,53	2 (<1ha)
Cic82	8,73	1,60	2	32,19	3	66,21	3	2,81	3 (1-5ha)
Cic83	1,99	46,23	4	4,02	2	49,75	2	0,08	2 (<1ha)
Cic84	1,74	86,78	7	0	1	13,22	1	0	1 (/)
Cic85	2,13	50,23	5	6,57	2	43,19	2	0,14	2 (<1ha)
Cic80	0,66	16,67	3	27,27	3	56,06	3	0,18	2 (<1ha)
Cic81	3,67	40,87	4	17,71	2	41,42	2	0,65	2 (<1ha)
Uck28	0,81	59,26	5	0	1	40,74	2	0	1 (/)
Uck29	1,27	66,93	5	0	1	33,07	2	0	1 (/)
Uck24	1,22	62,30	5	0	1	37,70	2	0	1 (/)
Uck25	3,8	32,89	4	1,84	2	65,26	3	0,07	2 (<1ha)
Uck26	5,76	14,06	3	27,95	3	57,99	3	1,61	3 (1-5ha)
Uck27	1,77	49,15	4	0	1	50,85	3	0	1 (/)
Uck20	10,14	57,69	5	28,21	3	14,10	1	2,86	3 (1-5ha)
Cic79	11,02	63,88	5	10,8	2	25,32	2	1,19	3 (1-5ha)
Uck21	33,39	25,70	3	18,63	2	55,68	3	6,22	4 (5-10ha)
Uck22	71,9	29,30	3	36,04	3	34,66	2	25,91	5 (10-50ha)
Uck23	3,66	31,69	4	0	1	68,31	3	0	1 (/)
Cic75	0,92	11,96	3	32,61	3	55,43	3	0,3	2 (<1ha)
Cic76	14,48	38,81	4	30,32	3	30,87	2	4,39	3 (1-5ha)
Cic77	2,09	33,49	4	5,26	2	61,24	3	0,11	2 (<1ha)
Cic78	2,34	35,04	4	15,81	2	49,15	2	0,37	2 (<1ha)
Cic71	5,91	60,41	5	7,11	2	32,49	2	0,42	2 (<1ha)
Cic72	4,55	56,04	5	15,38	2	28,57	2	0,7	2 (<1ha)
Cic73	285,8	43,14	4	15,59	2	41,26	2	44,56	5 (10-50ha)
Cic74	2,29	18,34	3	18,78	2	62,88	3	0,43	2 (<1ha)
Cic70	1,59	27,67	3	11,32	2	61,01	3	0,18	2 (<1ha)
Uck110	26,09	38,06	4	34,42	3	27,52	2	8,98	4 (5-10ha)
Uck111	1,38	0,00	1	1	2	0,00	1	0,01	2 (<1ha)
Uck17	6,51	57,60	5	16,13	2	26,27	2	1,05	3 (1-5ha)
Uck18	1,95	40,00	4	0	1	60,00	3	0	1 (/)
Uck19	1,44	31,25	4	50,69	4	18,06	2	0,73	2 (<1ha)
Uck13	0,66	57,58	5	42,42	3	0,00	1	0,28	2 (<1ha)
Uck14	301,27	17,17	3	38,08	3	44,75	2	114,72	7 (>100ha)
Uck15	2,98	5,03	2	41,28	3	53,69	3	1,23	3 (1-5ha)
Uck16	13,08	23,47	3	27,14	3	49,39	2	3,55	3 (1-5ha)

Patch Id	Area (ha)	Grassland (%)	Grassland Category	Transition (%)	Priority Category	Woodland (%)	Neglect Category	Area for restoration (ha)	Restoration Group
Uck97	5,08	8,46	2	31,69	3	59,84	3	1,61	3 (1-5ha)
Uck98	3,1	28,71	3	5,16	2	66,13	3	0,16	2 (<1ha)
Cic68	7,82	41,05	4	10,36	2	48,59	2	0,81	2 (<1ha)
Uck10	34,48	39,56	4	17,14	2	43,30	2	5,91	4 (5-10ha)
Cic69	1,78	21,91	3	16,29	2	61,80	3	0,29	2 (<1ha)
Uck99	61,41	4,20	2	15,96	2	79,84	3	9,8	4 (5-10ha)
Uck11	24,11	9,33	2	38,45	3	52,22	3	9,27	4 (5-10ha)
Uck93	1,75	21,71	3	3,43	2	74,86	3	0,06	2 (<1ha)
Uck12	0,84	26,19	3	72,62	4	1,19	1	0,61	2 (<1ha)
Uck94	1,81	7,18	2	25,41	3	67,40	3	0,46	2 (<1ha)
Cic64	6,79	33,87	4	24,59	3	41,53	2	1,67	3 (1-5ha)
Uck95	2,02	18,81	3	10,4	2	70,79	3	0,21	2 (<1ha)
Cic65	24,07	24,64	3	26,63	3	48,73	2	6,41	4 (5-10ha)
Uck96	6,69	10,31	3	7,62	2	82,06	3	0,51	2 (<1ha)
Cic66	4,12	10,92	3	13,83	2	75,24	3	0,57	2 (<1ha)
Cic67	8,4	63,93	5	11,31	2	24,76	2	0,95	2 (<1ha)
Uck90	2,02	17,82	3	9,41	2	72,77	3	0,19	2 (<1ha)
Cic60	2,95	29,83	3	24,07	3	46,10	2	0,71	2 (<1ha)
Cic61	0,96	63,54	5	8,33	2	28,13	2	0,08	2 (<1ha)
Uck91	1,04	0,00	1	19,23	2	80,77	3	0,2	2 (<1ha)
Uck92	0,59	76,27	6	18,64	2	5,08	1	0,11	2 (<1ha)
Cic62	1,66	71,08	6	16,87	2	12,05	1	0,28	2 (<1ha)
Cic63	23,42	30,91	4	17,98	2	51,11	3	4,21	3 (1-5ha)
Uck107	8,69	5,87	2	35,56	3	58,57	3	3,09	3 (1-5ha)
Uck108	30,35	8,04	2	21,05	3	70,91	3	6,39	4 (5-10ha)
Uck109	2,65	10,57	3	3,4	2	86,04	3	0,09	2 (<1ha)
Uck103	13,7	78,47	6	7,23	2	14,31	1	0,99	2 (<1ha)
Uck104	28,39	23,32	3	38,64	3	38,04	2	10,97	5 (10-50ha)
Uck105	3,74	60,70	5	17,11	2	22,19	2	0,64	2 (<1ha)
Uck106	8,47	53,60	5	10,27	2	36,13	2	0,87	2 (<1ha)
Uck100	2,06	8,74	2	14,08	2	77,18	3	0,29	2 (<1ha)
Uck101	4,06	14,29	3	3,2	2	82,51	3	0,13	2 (<1ha)
Uck102	12,34	24,64	3	22,93	3	52,43	3	2,83	3 (1-5ha)
Cic57	6,07	25,37	3	18,12	2	56,51	3	1,1	3 (1-5ha)
Uck86	6,39	7,20	2	34,27	3	58,53	3	2,19	3 (1-5ha)
Cic58	3,76	25,80	3	19,68	2	54,52	3	0,74	2 (<1ha)
Uck87	1,35	0,00	1	43,7	3	56,30	3	0,59	2 (<1ha)
Cic59	39,41	5,18	2	18,19	2	76,63	3	7,17	4 (5-10ha)
Uck88	6,91	22,14	3	7,81	2	70,04	3	0,54	2 (<1ha)
Uck89	1,48	0,00	1	20,95	3	79,05	3	0,31	2 (<1ha)
Cic53	63,49	37,23	4	26,1	3	36,67	2	16,57	5 (10-50ha)
Cic54	17,13	73,09	6	6,19	2	20,72	2	1,06	3 (1-5ha)
Uck82	23,27	30,94	4	21,1	3	47,96	2	4,91	3 (1-5ha)
Uck83	298,59	55,37	5	14,24	2	30,39	2	42,52	5 (10-50ha)
Cic55	38,73	45,31	4	17,27	2	37,41	2	6,69	4 (5-10ha)
Cic56	106,02	46,07	4	23,86	3	30,07	2	25,3	5 (10-50ha)
Uck84	29,35	23,07	3	14,68	2	62,25	3	4,31	3 (1-5ha)
Uck85	9,54	52,83	5	3,67	2	43,50	2	0,35	2 (<1ha)
Cic50	1,61	37,27	4	11,18	2	51,55	3	0,18	2 (<1ha)
Cic51	2,96	39,53	4	5,07	2	55,41	3	0,15	2 (<1ha)
Uck80	805,16	24,11	3	21,69	3	54,20	3	174,64	7 (>100ha)
Cic52	3,1	28,71	3	6,13	2	65,16	3	0,19	2 (<1ha)
Uck81	31,44	29,39	3	13,33	2	57,28	3	4,19	3 (1-5ha)
Uck79	4,24	30,66	4	3,3	2	66,04	3	0,14	2 (<1ha)
Cic46	35,64	41,58	4	34,09	3	24,33	2	12,15	5 (10-50ha)
Uck75	0,89	0,00	1	32,58	3	67,42	3	0,29	2 (<1ha)
Cic47	16,48	65,96	5	3,58	2	30,46	2	0,59	2 (<1ha)
Uck76	0,43	0,00	1	74,42	4	25,58	2	0,32	2 (<1ha)

Patch Id	Area (ha)	Grassland (%)	Grassland Category	Transition (%)	Priority Category	Woodland (%)	Neglect Category	Area for restoration (ha)	Restoration Group
Cic48	22,26	48,92	4	8,31	2	42,77	2	1,85	3 (1-5ha)
Uck77	1,46	58,90	5	0	1	41,10	2	0	1 (/)
Cic49	5,19	24,28	3	10,4	2	65,32	3	0,54	2 (<1ha)
Uck78	1,91	17,28	3	17,28	2	65,45	3	0,33	2 (<1ha)
Cic42	2,96	38,18	4	12,84	2	48,99	2	0,38	2 (<1ha)
Uck71	1,23	0,00	1	26,83	3	73,17	3	0,33	2 (<1ha)
Cic43	42	28,26	3	11,9	2	59,83	3	5	3 (1-5ha)
Uck72	1,2	6,67	2	10,83	2	82,50	3	0,13	2 (<1ha)
Cic44	1,62	20,37	3	0	1	79,63	3	0	1 (/)
Uck73	2,87	1,05	2	20,21	3	78,75	3	0,58	2 (<1ha)
Cic45	0,66	56,06	5	0	1	43,94	2	0	1 (/)
Uck74	2,79	11,11	3	22,58	3	66,31	3	0,63	2 (<1ha)
Cic40	1,22	52,46	5	0	1	47,54	2	0	1 (/)
Cic41	1,67	32,93	4	10,78	2	56,29	3	0,18	2 (<1ha)
Uck70	0,89	0,00	1	30,34	3	69,66	3	0,27	2 (<1ha)
Cic39	12,76	27,82	3	13,48	2	58,70	3	1,72	3 (1-5ha)
Uck68	1,93	21,76	3	22,8	3	55,44	3	0,44	2 (<1ha)
Uck69	81,25	10,57	3	35,25	3	54,18	3	28,64	5 (10-50ha)
Cic35	7,73	55,37	5	5,95	2	38,68	2	0,46	2 (<1ha)
Cic36	3,26	8,90	2	16,87	2	74,23	3	0,55	2 (<1ha)
Uck64	5,96	0,00	1	29,19	3	70,81	3	1,74	3 (1-5ha)
Uck65	3,95	4,30	2	29,37	3	66,33	3	1,16	3 (1-5ha)
Cic37	10,87	79,21	6	3,5	2	17,30	2	0,38	2 (<1ha)
Uck66	1,74	14,37	3	27,59	3	58,05	3	0,48	2 (<1ha)
Cic38	3,94	13,20	3	29,19	3	57,61	3	1,15	3 (1-5ha)
Uck67	2,86	0,00	1	25,17	3	74,83	3	0,72	2 (<1ha)
Cic31	160,41	37,28	4	19,36	2	43,36	2	31,06	5 (10-50ha)
Cic32	83,83	7,56	2	24,44	3	67,99	3	20,49	5 (10-50ha)
Uck60	3,57	0,84	2	45,94	3	53,22	3	1,64	3 (1-5ha)
Cic114	0,62	19,35	3	3,23	2	77,42	3	0,02	2 (<1ha)
Uck61	23,63	2,62	2	41,01	3	56,37	3	9,69	4 (5-10ha)
Cic33	3,39	67,85	5	6,78	2	25,37	2	0,23	2 (<1ha)
Uck62	2,38	33,61	4	36,13	3	30,25	2	0,86	2 (<1ha)
Cic34	2,88	64,58	5	6,25	2	29,17	2	0,18	2 (<1ha)
Cic115	1,12	22,32	3	12,5	2	65,18	3	0,14	2 (<1ha)
Uck63	7,02	16,95	3	31,2	3,00	51,85	3	2,19	3 (1-5ha)
Cic116	4,72	33,90	4	20,13	3,00	45,97	2	0,95	2 (<1ha)
Cic110	10,97	5,93	2	24,7	3,00	69,37	3	2,71	3 (1-5ha)
Cic30	4,1	41,71	4	25,85	3,00	32,44	2	1,06	3 (1-5ha)
Cic111	12,24	35,38	4	30,56	3,00	34,07	2	3,74	3 (1-5ha)
Cic112	8,83	36,47	4	38,05	3	25,48	2	3,36	3 (1-5ha)
Cic113	5,42	30,63	4	43,17	3	26,20	2	2,34	3 (1-5ha)
Cic28	1,72	63,95	5	4,07	2	31,98	2	0,07	2 (<1ha)
Uck57	13,81	17,67	3	39,17	3	43,16	2	5,41	4 (5-10ha)
Cic29	13,21	37,77	4	36,26	3	25,97	2	4,79	3 (1-5ha)
Uck58	3,09	8,74	2	35,92	3	55,34	3	1,11	3 (1-5ha)
Uck59	5,37	10,80	3	14,34	2	74,86	3	0,77	2 (<1ha)
Cic107	21,66	35,92	4	18,1	2	45,98	2	3,92	3 (1-5ha)
Cic24	3,21	0,00	1	38,63	3	61,37	3	1,24	3 (1-5ha)
Uck53	2,57	8,56	2	27,24	3	64,20	3	0,7	2 (<1ha)
Cic25	4,01	53,12	5	4,99	2	41,90	2	0,2	2 (<1ha)
Cic108	5,9	16,95	3	11,19	2	71,86	3	0,66	2 (<1ha)
Uck54	157,16	37,14	4	19,6	2	43,26	2	30,8	5 (10-50ha)
Cic26	3,45	58,26	5	7,54	2	34,20	2	0,26	2 (<1ha)
Cic109	2,85	10,88	3	9,12	2	80,00	3	0,26	2 (<1ha)
Uck55	0,53	37,74	4	49,06	3	13,21	1	0,26	2 (<1ha)
Cic27	1,68	54,76	5	0	1	45,24	2	0	1 (/)
Cic103	0,62	56,45	5	6,45	2	37,10	2	0,04	2 (<1ha)



Patch Id	Area (ha)	Grassland (%)	Grassland Category	Transition (%)	Priority Category	Woodland (%)	Neglect Category	Area for restoration (ha)	Restoration Group
Uck56	10,27	37,10	4	40,8	3	22,10	2	4,19	3 (1-5ha)
Cic20	1,74	0,00	1	5,17	2	94,83	3	0,09	2 (<1ha)
Cic104	7,21	24,97	3	23,86	3	51,18	3	1,72	3 (1-5ha)
Cic21	0,63	84,13	7	0	1	15,87	2	0	1 (/)

7. Appendix 2. Plots for the Density of Woody Vegetation Data Collection

Patch Id	Date	Y HTRS	X HTRS	Photo
CIC10-S1	20210616	5029519,55	311290,46	P6162820-P6162834
CIC10-S2	20210616	5028961,18	311737,04	P6162798-P6162809
CIC10-T1	20210616	5029660,44	311332,54	P6162810-P6162819
CIC10-T2	20210616	5028782,90	311986,26	P6162785-P6162797
CIC14-T1	20210616	5023921,28	315767,70	P6162771-P6162784
CIC1-S1	20210617	5042720,76	305089,90	P6172944-P6172956
CIC1-S2	20210617	5042960,19	305964,07	P6172927-P6172936
CIC1-S3	20210617	5042813,23	306537,38	P6172887-P6172904
CIC1-T1	20210617	5043330,95	305486,04	P6172937-P6172943
CIC1-T2	20210617	5043392,10	306241,81	P6172905-P6172926
CIC1-T3	20210617	5042091,53	307637,79	P6172874-P6172886
CIC2-T1	20210617	5036491,52	304536,83	P6172957-P6172964
CIC2-T2	20210617	5036222,29	304917,89	P6172965-P6172973
CIC3-S1	20210617	5035902,27	303396,19	P6172835-P6172848
CIC4-T1	20210615	5034641,83	303311,66	P6152625-P6152630
CIC5-S1	20210615	5033361,53	305810,65	P6152640-P6152661
CIC5-T1	20210615	5033401,11	305336,17	P6152631-P6152639
CIC5-T2	20210615	5033329,68	306205,14	P6152662-P6152671
CIC6-S1	20210617	5035581,34	308190,85	P6172849-P6172858
CIC7-S1	20210617	5033713,85	308857,18	P6172859-P6172873
CIC8-T1	20210615	5031820,16	307550,13	P6152672-P6152680
CIC9-T1	20210615	5031574,96	307985,08	P6152681-P6152690
UCK10-S1	20210615	5017343,37	319229,29	P6152542-P6152551
UCK10-T1	20210615	5017243,84	319100,64	P6152552-P6152558
UCK10-T2	20210615	5017430,57	319501,76	P6152534-P6152541
UCK14-S4	20210618	5013141,20	317577,21	P6183008-P6183016
UCK14-T1	20210618	5012802,05	317316,36	P6182998-P6183007
UCK15-S1	20210618	5011052,90	321201,53	P6183053-P6183061
UCK16-S1	20210618	5007485,28	318345,19	P6183030-P6183038
UCK16-S2	20210618	5007403,88	318476,88	P6183045-P6183052
UCK16-T1	20210618	5007210,39	318246,87	P6183017-P6183029
UCK16-T2	20210618	5007390,94	318431,84	P6183039-P6183044
UCK2-S1	20210616	5025302,15	318962,19	P6162761-P6162770
UCK2-S2	20210616	5024803,29	318390,83	P6162724-P6162737
UCK2-S3	20210616	5024513,38	318741,73	P6162707-P6162723
UCK2-T1	20210616	5024882,74	318668,11	P6162738-P6162747
UCK2-T2	20210616	5025040,78	319020,65	P6162748-P6162760
UCK3-S1	20210616	5024282,71	320066,96	P6162691-P6162700
UCK3-T1	20210616	5024302,99	320026,75	P6162701-P6162706
UCK4-S1	20210615	5026482,85	323679,94	P6152581-P6152588
UCK4-T1	20210615	5026251,13	323256,94	P6152614-P6152624

Patch Id	Date	Y HTRS	X HTRS	Photo
UCK4-T2	20210615	5026512,22	323266,45	P6152559-P6152580
UCK4-T3	20210615	5026279,91	323535,79	P6152589-P6152613
UCK5-S1	20210614	5019671,84	315563,31	P6142520-P6142526
UCK5-S2	20210614	5019392,25	316307,55	P6142512-P6142519
UCK5-S3	20210618	5020424,40	316096,11	P6182986-P6182997
UCK5-T1	20210618	5019932,89	315745,67	P6182974-P6182985
UCK5-T3	20210614	5019441,61	316829,47	P6142505-P6142511
UCK6-S1	20210615	5020773,60	321466,99	P6152527-P6152533

8. Appendix 3. Woody Species Abundance per Plot

Plot ID	Species Name	No. seedlings	No. <1m	No. >1m
CIC1-S1	<i>Crataegus monogyna</i>	/	1	/
	<i>Frangula rupestris</i>	/	51	/
	<i>Prunus mahaleb</i>	/	1	1
	<i>Sorbus aria</i>	/	2	1
CIC1-S2	<i>Cornus sanguinea</i>	/	2	1
	<i>Frangula rupestris</i>	/	20	/
	<i>Juniperus oxycedrus</i>	/	1	1
	<i>Prunus mahaleb</i>	/	1	/
	<i>Sorbus aria</i>	/	1	1
CIC1-S3	<i>Crataegus monogyna</i>	/	1	/
	<i>Euonymus sp.</i>	/	1	/
	<i>Fraxinus ornus</i>	8	6	3
	<i>Juniperus oxycedrus</i>	/	/	1
	<i>Pinus nigra</i>	/	3	2
	<i>Prunus sp.</i>	3	4	/
	<i>Sorbus aria</i>	/	6	/
CIC1-T1	<i>Juniperus oxycedrus</i>	/	/	1
CIC1-T2	/	/	/	/
CIC1-T3	<i>Prunus spinosa</i>	/	1	/
CIC2-T1	/	/	/	/
CIC2-T2	<i>Prunus spinosa</i>	/	3	/
CIC3-S1	<i>Acer monspessulanum</i>	/	1	/
	<i>Cornus sanguinea</i>	3	3	/
	<i>Fraxinus ornus</i>	3	32	/
	<i>Juniperus oxycedrus</i>	/	1	/
	<i>Ostrya carpinifolia</i>	/	2	/
	<i>Pinus nigra</i>	/	2	/
	<i>Quercus pubescens</i>	4	14	4
	<i>Rosa canina</i>	/	1	4
	<i>Rubus sp.</i>	/	2	/
CIC4-T1	/	/	/	/
CIC5-S1	/	/	/	/
CIC5-T1	/	/	/	/
CIC5-T2	<i>Ononis sp.</i>	/	28	/
CIC6-S1	<i>Cornus sanguinea</i>	/	2	1
	<i>Frangula rupestris</i>	/	51	/
	<i>Fraxinus ornus</i>	40	47	8
	<i>Juniperus oxycedrus</i>	/	/	2
	<i>Ligustrum vulgare</i>	/	2	/
	<i>Ostrya carpinifolia</i>	1	/	/
	<i>Pinus nigra</i>	/	/	1

Plot ID	Species Name	No. seedlings	No. <1m	No. >1m
	<i>Prunus spinosa</i>	/	26	5
	<i>Quercus pubescens</i>	/	4	/
	<i>Rosa canina</i>	/	3	/
	<i>Sorbus aria</i>	1	/	/
CIC7-S1	<i>Crataegus monogyna</i>	/	/	3
	<i>Frangula rupestris</i>	/	1	/
	<i>Ligustrum vulgare</i>	/	10	5
	<i>Quercus pubescens</i>	2	/	/
	<i>Rosa canina</i>	/	1	/
	<i>Rubus</i> sp.	/	1	1
CIC8-T1	/	/	/	/
CIC9-T1	/	/	/	/
CIC10-S1	<i>Cornus sanguinea</i>	2	/	/
	<i>Frangula rupestris</i>	42	54	/
	<i>Fraxinus ornus</i>	51	55	21
	<i>Prunus mahaleb</i>	/	/	1
	<i>Quercus pubescens</i>	1	/	/
CIC10-S2	<i>Cornus sanguinea</i>	/	3	/
	<i>Crataegus monogyna</i>	/	/	1
	<i>Frangula rupestris</i>	/	7	/
	<i>Fraxinus ornus</i>	9	1	2
	<i>Juniperus oxycedrus</i>	/	/	1
	<i>Prunus mahaleb</i>	1	/	/
	<i>Prunus spinosa</i>	6	7	/
	<i>Rosa canina</i>	/	1	1
CIC10-T1	<i>Fraxinus ornus</i>	/	7	1
	<i>Juniperus oxycedrus</i>	10	4	2
CIC10-T2	<i>Prunus spinosa</i>	/	9	/
CIC14-T1	/	/	/	/
UCK2-S1	<i>Crataegus monogyna</i>	/	/	1
	<i>Juniperus oxycedrus</i>	/	5	2
	<i>Rosa pimpinellifolia</i>	/	309	/
	<i>Sorbus aria</i>	/	/	2
UCK2-S2	<i>Frangula rupestris</i>	/	3	/
	<i>Juniperus oxycedrus</i>	1	2	1
	<i>Prunus mahaleb</i>	/	1	/
	<i>Rosa pimpinellifolia</i>	34	142	/
	<i>Sorbus aria</i>	/	1	1
UCK2-S3	<i>Juniperus oxycedrus</i>	/	5	/
	<i>Prunus spinosa</i>	/	4	/
	<i>Rosa pimpinellifolia</i>	/	441	/
UCK2-T1	<i>Juniperus oxycedrus</i>	/	3	2
	<i>Rosa pimpinellifolia</i>	/	271	/
UCK2-T2	<i>Acer pseudoplatanus</i>	/	1	/
	<i>Juniperus oxycedrus</i>	/	5	3
	<i>Rhamnus alpine</i> ssp. <i>fallax</i>	/	2	/
	<i>Rosa pimpinellifolia</i>	/	2	/

Plot ID	Species Name	No. seedlings	No. <1m	No. >1m
	<i>Sorbus aria</i>	/	/	1
UCK3-S1	<i>Rosa pimpinellifolia</i>	2	37	/
UCK3-T1	<i>Rosa pimpinellifolia</i>	/	8	/
UCK4-S1	<i>Fraxinus ornus</i>	1	1	2
	<i>Juniperus oxycedrus</i>	/	1	3
	<i>Rhamnus alpine ssp. fallax</i>	/	/	2
UCK4-T1	/	/	/	/
UCK4-T2	/	/	/	/
UCK4-T3	/	/	/	/
UCK5-S1	<i>Frangula rupestris</i>	/	2	/
	<i>Paliurus spina-christi</i>	/	/	4
	<i>Pinus nigra</i>	/	/	1
	<i>Prunus spinosa</i>	/	4	/
	<i>Rosa canina</i>	/	/	7
	<i>Rubus sp.</i>	/	12	1
UCK5-S2	<i>Frangula rupestris</i>	/	1	/
	<i>Quercus pubescens</i>	/	2	1
UCK5-S3	<i>Fraxinus ornus</i>	/	1	/
	<i>Ostrya carpinifolia</i>	/	/	1
	<i>Quercus pubescens</i>	/	/	6
	<i>Rubus sp.</i>	/	16	6
UCK5-T1	/	/	/	/
UCK5-T3	<i>Fraxinus ornus</i>	/	1	1
UCK6-S1	<i>Prunus spinosa</i>	/	42	7
	<i>Rosa canina</i>	/	/	1
UCK10-S1	<i>Acer obtusatum</i>	5	/	1
	<i>Acer pseudoplatanus</i>	8	/	1
	<i>Fraxinus ornus</i>	3	1	/
	<i>Juniperus oxycedrus</i>	/	3	3
	<i>Ostrya carpinifolia</i>	/	1	/
	<i>Rosa canina</i>	4	9	1
	<i>Sorbus aria</i>	/	1	/
UCK10-T1	<i>Acer obtusatum</i>	1	/	/
	<i>Juniperus oxycedrus</i>	1	/	/
	<i>Rubus sp.</i>	/	1	/
UCK10-T2	<i>Rosa canina</i>	1	/	1
UCK14-S4	<i>Fraxinus ornus</i>	/	2	/
	<i>Paliurus spina-christi</i>	/	/	2
	<i>Prunus sp.</i>	/	1	2
	<i>Rubus sp.</i>	/	43	/
UCK14-T1	<i>Acer campestre</i>	/	4	/
	<i>Paliurus spina-christi</i>	/	8	/
UCK15-S1	/	/	/	/
UCK16-S1	<i>Cornus sanguinea</i>	/	9	/
	<i>Quercus cerris</i>	2	3	/
	<i>Quercus pubescens</i>	2	18	1
	<i>Viburnum tinus</i>	1	/	/

Plot ID	Species Name	No. seedlings	No. <1m	No. >1m
UCK16-S2	<i>Acer campestre</i>	/	/	1
UCK16-T1	<i>Acer campestre</i>	1	6	/
	<i>Acer monspessulanum</i>	3	5	3
	<i>Fraxinus ornus</i>	/	1	3
	<i>Prunus mahaleb</i>	/	/	1
	<i>Quercus pubescens</i>	/	3	/
	<i>Rosa canina</i>	/	/	1
UCK16-T2	/	/	/	/