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Population dynamics of cushion plant *Silene acaulis* in the High Tatras

Populační dynamika polštářovité rostliny silenky bezlodyžné ve Vysokých Tatrách

Diploma thesis

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V Prahe, 22. 4. 2021

Bc. Emma Krchová

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Abstract

This diploma thesis is studying population dynamics of endangered species *Silene acaulis* in the High Tatra Mountains in Slovakia. *Silene acaulis* is a species of extreme alpine habitats creating cushions that provide a microclimate acting as a facilitator of establishment of other species in the alpine communities. This dome-like structure has one woody taproot making it easier to distinguish each individual. It is thus a perfect model species for determining the population dynamics drivers. The findings help in understanding future behaviour of the species and whole alpine ecosystems. Population data have been collected since 2013 or 2014 in two valleys in the High Tatras providing a database suitable to study various effects on species performance. Data collection includes marking, measuring, counting of flowers and capsules, viability and new seedlings recording, gender identification and comparison of vegetation structure within and in close proximity of a cushion. The data on vegetation were analysed using CCA ordination and the population data were analysed using Integral Projection Models. The results show that the breeding system of Slovak *S. acaulis* is gynodioecious and the gender affects the size of cushions, individuals with both female and hermaphrodite flowers being the biggest. The vegetation composition is richer within the cushion in comparison with open space, therefore *Silene acaulis* growing in the High Tatras is acting as a facilitator in this environment. The effect of various predictors on vital rates was tested and the most informative models were found considering BIC values. Size of the cushion is affecting all vital rates. The cushion compactness seems to have prevalent impact on growth and fecundity. The effect of climate conditions is also included in the models, however its influence on the population dynamics of the plant is seemingly negligible. The performance of Slovak *Silene acaulis* populations is affected by compactness of the cushions, which is protecting it and other plant species growing within the branches from the harsh environment. The populations are slowly shrinking, therefore continuous observations are necessary to prevent additional decline of the number of individuals.

Key words: population biology, life cycle, moss campion, Integral Projection Models, climate, vegetation composition, gender analysis, facilitation

Abstrakt

Tato diplomová práce studuje populační dynamiku ohroženého druhu *Silene acaulis* ve Vysokých Tatrách na Slovensku. *Silene acaulis* je druh extrémních alpských stanovišť, který vytváří polštářovité porosty poskytující mikroklima a také podporující uchycování jiných druhů v alpínských společenstvech. Tato polštářovitá struktura má jeden dřevnatý kořen, který usnadňuje rozlišení každého jednotlivce. Je to tedy dokonalý modelový druh pro určení vlivu na populační dynamiku. Tato zjištění mohou pomoci pochopit budoucí chování druhu a celých alpínských ekosystémů. Údaje o populační dynamice se sbírají od roku 2013 nebo 2014 ve dvou údolích Vysokých Tater, což poskytuje databázi vhodnou ke studiu vlivu různých efektů na chování druhu. Sběr dat zahrnuje označení, měření, počítaní květů a tobolek, zaznamenávání přežíváni a nových semenáčků, určování pohlaví a studium struktury vegetace uvnitř a v těsné blízkosti polštářovité struktury. Data o vegetaci se analyzovali pomocí CCA ordinace a populační data byla analyzována použitím Integral Projection Models. Rozmnožovací systém slovenských jedinců *S. acaulis* je gynodioecický a pohlaví ovlivňuje velikost polštářů, přičemž největší jsou jedinci se samičími i hermafroditickými květy. Vegetační složení polštáře je ve srovnání s otevřeným prostorem bohatší, proto *Silene acaulis* rostoucí ve Vysokých Tatrách působí v tomto prostředí jako facilitátor. Byl testován vliv různých prediktorů na vitální funkce a byly nalezeny nejinformativnější modely podle hodnot BIC. Velikost polštáře ovlivňuje všechny vitální funkce. Zdá se, že kompaktnost polštáře má převládající efekt na růst a plodnost. Vliv klimatických podmínek je v modelech také zahrnutý, avšak jeho vliv na populační dynamiku rostliny je zřejmě zanedbatelný. Vývoj slovenských populací *Silene acaulis* je ovlivněn kompaktností polštářů, které chrání samotnou silenku a další druhy rostlin rostoucí v polštářovité struktuře před nehostinným prostředím. Populace se pomalu zmenšují, proto je nutné jejich neustálé pozorování, aby se zabránilo dalšímu poklesu počtu jedinců.

Klíčová slova: populační biologie, životní cyklus, polštářovitá rostlina, Integral Projection Models, klima, vegetační složení, analýza pohlaví, facilitace

1 Introduction

Population dynamics is a discipline about why and how sizes of populations change over time (Bierzychudek 2014). Natural populations observations present that when there is enough available resources and conditions are suitable, every population has a potential to exponentially expand (Watkinson 2009). The knowledge about population dynamics of endangered plant species is crucial as the main driver that is keeping the individuals alive and spreading can be established and we can potentially predict the future development and create conservation plans accordingly. There is a lot of complex external factors influencing the plant populations. Therefore, long-term observations and individuals' measurements along with analyses of plant communities, positive or negative interactions, other organisms across trophic levels present or of environmental conditions need to be conducted.

Climate change is affecting most of the living organisms across the globe by influencing their reproduction or growth possibly leading to changes in species distribution (Villellas et al., 2019). Over recent decades many species shifted their geographical range (Doak and Morris, 2010). Arctic and sub-arctic locations are expected to be especially threatened due to predictable strong temperature increase (Alatalo and Little 2014). It is expected that low to moderate climate warming will be resulting in population stability or even an expansion, supporting plants' vital rates, while higher temperature increase over time will finally diminish population growth and abrupt vital rates (Doak and Morris, 2010). However, it is possible that climate has no effect on species performance and that other factors are rather influential (Canelles et al., 2018) or than only some specific climatic variables are affecting the plant species. Thus, it is very important to examine changes of the climate and try to understand its impact on the flora, if there is any, by connecting it to the species vital rates.

There are various traits used by arctic flora to withstand the cold tough climate and temperatures slightly above zero occurring only during short growing season. Some plants are able to help the co-occurring species across trophic levels by having a facilitator (nurse) effect (Alatalo and Little 2014), which is a relationship in which interactions are either beneficial or neutral (Bruno et al., 2003). Facilitation is predominantly important in stressful and disturbed conditions, very often occurring in arctic environments (Antonsson et al., 2009). On the other hand, 'beneficiaries' are species growing within a facilitator, profiting from this positive interaction and these can also outcompete the facilitator which would lead to change in communities (Cranston et al., 2012). Many species benefit from creating cushions; circular dome-like structures. Cushion plants can be identified as ecosystem engineers; organisms, that modify environmental conditions consequently altering habitats of other species (Badano and Cavieres 2006). Cushion plants are able to cope with extreme environmental conditions and are dominating in alpine and polar ecosystems (Reid et al., 2010). Cushion was titled being a heat-trap (Bonanomi et al. 2016), by maintaining higher temperature compressing the single ramets close to one another, yet cushions only buffer heat and low humidity, therefore are acting more like "air conditioners" (Molenda et al., 2012). This form also traps water and as it has the lowest surface-to-volume ratio the loss of it is maximally reduced (Aubert et al., 2014). Cushion plants are also able to store more nutrients and protect from wind, so they modify the microclimate which is facilitating other organisms by reducing abiotic stress. Not only their own pollinators but also pollinators of other non-cushion vegetation are supported by more suitable conditions for their development within the tight branches (Reid and Lortie, 2012). Therefore, disturbing the facilitation effect of cushion plants may create a negative cascading effect for not only many species across trophic levels (Alatalo and Little, 2014), but also the whole environment.

A plant of the harsh alpine and Arctic tundra, *Silene acaulis* (L.) Jacq., is an excellent model species for studying population dynamics of cushion facilitator plant, as it is an umbrella species for conservation and ecosystem function. *Silene* has high level of plasticity and adaptability growing in harsh fluctuating conditions, where short-term changes in hardening are crucial in plant response (Neuner et al., 2000). It is facilitating other species of plants and arthropods increasing species richness of the areas (Molenda et al. 2012) in comparison to open space. But it is not supporting all the species in the same way and does interact with some taxa stronger than others (Antonsson et al., 2009). Reportedly, *S. acaulis* is usually shifting from competitiveness in lower altitudes towards facilitation in medium altitudes, but the frequency of positive interactions is again decreasing with higher elevation (Bonanomi et al., 2016). Its beneficial effects may be overshadowed by increased competitiveness with growing temperature in higher altitude (Klanderud and Totland 2007) or simply by greater stem density appearing with extreme stress restricting the plant-plant interactions (Bonanomi et al., 2016). Exploring the facilitation abilities of this particular Slovak populations could bring a lot of useful information about the pattern of positive plant interactions in the High Tatra Mountains and disclose if this species is also such an important environmental unit in this area.

Plant populations perform differently throughout species' ranges distribution and as the climate is warming, we expect the species to change their geographical ranges towards poles or higher elevations. Demographic compensation is a phenomenon of conditions closer to distribution edges negatively affecting some plant traits while supporting others (Doak and Morris, 2010), which is the reason why central and peripheral populations differ. Peripheral populations are isolated and adapted to various environments in comparison with populations in centre of species' range. These are less successful in reproduction, have high demographic vulnerability and are demographically more variable (Villellas et al., 2016). Even though *S. acaulis* has become a common subject of research in recent years and many southern and northern populations have been studied, central Europe haven't been explored except for disturbance studies of human trampling on species' populations growing in Switzerland (Chardon et al., 2018) and environmental stress effect report on three populations in Swiss Alps (Canelles et al., 2018). Slovak populations are therefore perfect for studying their population dynamics to determine moss campion population performance in another European country and they are also located on the edge of the distribution range. The fact that every cushion has its own woody taproot simplifying the identification of an individual (Jones and Richards, 1962), makes it easier to monitor individual's changes.

S. acaulis is reportedly creating around 35 populations in Slovakia (Goliášová et al., 2012). The information may be incorrect, as there are two main problems – in book of Slovak flora by Goliášová et al. (2012), with *Silene* chapter managed by Professor Daniel Dítě, is Slovak *S. acaulis* divided into two subspecies (subsp. *excapa* (All.) Killias and subsp. *longiscapa* A. Kern. Ex Vierh.) which are not distinguished in other regions outside Slovakia, sometimes co-occur in a locality and are in fact very difficult to differentiate. These subspecies might not even exist, or they are distinctive only by growing on different soil substrates – either silicate or limestone (D. Dítě, personal communication). The second reason for possible inaccuracy of the population number could be the fact, that the localities list was processed only using revised herbarium documents, some of them even from 19th century (Goliášová et al., 2012). *S. acaulis* is widely distributed across Tatra National Park, therefore it is quite challenging to define a population there (D. Dítě, pers. comm.). Two of the populations located in valleys of the High Tatras (Mengusovská valley, Mlynická valley) are studied demographically in detail. Another population in Furkotská valley is undergoing a gender observation only. Comparing the year-to-year development brings us a lot of information about its population dynamics.

Gender of *S. acaulis* individuals is rather labile and can change throughout years on its own (Alatalo, 1997) or by fungus (Hermanutz and Innes, 1994), when the presence of anther smut *Microbotryum violaceum* can sterilize the sex of a plant. Sex ratio varies with elevation (Alatalo and Molau, 1995) and stress (Delph and Carroll, 2001) towards higher occurrence of females with higher elevation but intermediate stressful conditions (Bonanomi et al., 2016). Population breeding system can be gynodioecious (Shykoff, 1988), gynomonoecious, subdioecious (Chen et al., 2017) and trioecious (Alatalo, 1997; Fosaa et al., 2011). The gender of Slovak individuals was not studied in detail yet, even though populations are supposed to be gynodioecious, which is the most common breeding system of this species (Shykoff, 1988; Shykoff et al., 1992; Alatalo and Molau, 1995). Females and hermaphrodites vary not only by specific flower structure, but also other anatomical modifications which differentiate their abilities in facilitation and reproduction success (Reid and Lortie, 2012). Females are usually smaller individuals with smaller flowers and larger reproductive organs. Hermaphrodites are creating bigger cushions and larger flowers with wider corolla and longer (Canelles et al., 2018) but narrower (Alatalo and Molau, 1995) petals in comparison with females. The variation in female total seed set ranges from 2.9 – 3.8 (Shykoff, 1988) to 4.4 (Morris and Doak, 1998) times more than for hermaphrodites. The study of Canelles et al. (2018) shows that the important strategy in maintaining gynodioecy is rather higher fruiting success, not seeds number. Female seeds have higher longevity but are not heavier than those produced by outcrossed or selfed hermaphrodites. That probably happens because the nitrogen saved by not producing pollen might be allocated to seeds (Shykoff, 1988), while hermaphrodites allocate more to pollen production, therefore reducing competition and enhancing their facilitation effect (Cranston et al., 2012). Higher female fecundity and differences in viability of female and hermaphrodite progeny is maintaining gynodioecy (Shykoff, 1988). Studying flowers of *S. acaulis* individuals in Tatra National Park was crucial to determine the sex ratio in the populations and if different genders are significantly influencing species richness, number of capsules, vegetation cover within the cushion or in its close proximity and the size of the cushion.

The main aim of the work is to study population dynamics of *S. acaulis* individuals in Slovakia and to determine the main driver of their survival, growth and fecundity. This thesis is focusing on population changes throughout the years by measuring size parameters, occurrence of flowers or capsules, reviewing viability, gender and vegetation composition. Climate data are included to evaluate the effect of temperature and moisture on plant performance with implications for species ability to respond to future climate change.

I aim to answer the following questions:

i. What is the gender of *S. acaulis* individuals in Tatra National Park and does it affect vital rates?
ii. What type of vegetation is growing within and outside the cushions and do Slovak *S. acaulis* cushions facilitate other plant species more in comparison with open space?
iii. How is temperature and moisture affecting performance of the Slovak populations?
iv. What is the main driver of High Tatra Mountains' plant population dynamics?

My hypotheses are:

i. Breeding system of *S. acaulis* individuals is mostly described being gynodioecious or trioecious. However, due to gender instability, there is a chance that sex of the populations may change throughout the years (Alatalo, 1997), or some individuals' gender is impossible to classify. We expect to find the most common breeding system – gynodioecy, a population consisting of females and hermaphrodites, which differ in their population dynamics. Females are usually more represented in higher altitudes (Alatalo and Molau, 1995) and harsh conditions, where the environment causes higher germination success in seeds (Canelles et al., 2018), improving their performance. This could be proved with greater number of female cushions represented in Furkotská valley which has the highest elevation of the three study sites. I hypothesise, that hermaphrodite cushions will be superior in size in comparison with females as insisted by Canelles et al. (2018) and also that they will facilitate more plant species than females.

ii. Cushions of *S. acaulis* are increasing species richness (Molenda et al., 2012) and usually consist of various plant species, however, species composition was found to be both comparable inside and outside the structure (Bonanomi et al., 2016) and different within the cushion and in the open ground (Molenda et al., 2012). The vegetation composition within the cushion was studied in detail in the USA (Cranston et al., 2012), Canada (Reid and Lortie, 2012) or Sweden (Villellas at al., 2018). We hypothesize that the cushion could consist of species similar to Swedish Lapland – boreo-alpine vascular plants, mosses and lichens (Villelas et al., 2018). There is a possibility that vegetation growing within and in close proximity of a cushion is positively affecting moss campion’s growth.

iii. Temperature or precipitation extremes occurring during reproduction or flowering period could be the most influential. However, sometimes even small divergence, like sudden frost during germination time, can cause a serious injury. Short-term climate warming should be positively affecting the species performance but could have a strongly negative effect over longer period (Alatalo and Little, 2014). I hypothesise that specific climate extremes will affect the number of dead seedlings and that specifically a number of growing degree-days and a mean temperature of the warmest month will have an influence on the species performance, in reference to findings of Ferrarini et al. (2019b).

iv. My hypothesis is that climate could be the main driver of *S. acaulis* population dynamics and that the increasing temperature will cause a significant damage on the cushion plant populations. The vegetation within the cushion could also affect the population performance of the individuals along the gender. The compactness of a *S. acaulis* cushion is supposedly increasing with elevation (Bonanomi et al., 2016) so this could be also one of the effects on the population dynamics, more compact cushion being more susceptible to extreme conditions.

2 Materials and Methods

2.1. *Silene acaulis* L. (Jacq.)

Silene acaulis (moss campion) is herbaceous perennial species from *Caryophyllaceae* family. It is a diploid mostly gynodioecious (Shykoff, 1988) plant creating dense moss-like cushion individuals possessing central woody taproot which is up to 130 cm long. Stems are erect, 1 – 5 cm tall, not sticky, with densely located leaves. Leaves are opposite, 6 – 12 mm long, with 1 to 3 veins, glabrous. Flowers are terminal, solitary, 9 – 12 mm in diameter. Calyx is campanulate, light green to dark red, 3.5 – 8 mm long. Petals 6 – 14 mm long, deep rose pink to reddish purple. Usually 3 styles. Capsules are 6 – 14 mm long, dehiscence by 6 teeth. Seeds are kidney-shaped, 1.2 – 1.5 mm long (Jones and Richards, 1962; Goliášová et al., 2012). Branches are not growing adventitiously, therefore precluding clonal reproduction (Morris and Doak, 1998).

Silene acaulis is an Arcto-alpine species with circumpolar distribution except for a division across Siberia (Gussarova et al., 2015) inhabiting uncovered rocky areas and ridges exposed to wind. It is found in North America, Greenland, Europe and Asia. In Europe the range reaches Alps, Balkans, British Isles, Carpathian Mountains, Cantabrian Mountains and Pyrenees (Global Biodiversity Information Facility atlas - GBIF).

S. acaulis in Slovakia is a taxon that requires taxonomic revision. Populations on limestone and silicate are considered different taxa (Goliášová et al., 2012). Jurcev (1971) distinguished 4 subspecies in its distribution range, due to colour and shape of corolla and calyx and calyx to corolla length ratio – subsp. *acaulis*, subsp. *arctica,* subsp. *excapa* and subsp. *longiscapa*. Subsp. *excapa* and subsp. *longiscapa* occur in Slovakia sometimes with only transitional types in the highest spots in the Low, High, West and Belianske Tatras. The map of distribution in Slovakia (*Fig. 1, 2*) and the list of localities (*Tab. 14* in *Attachment 2*) are processed only based on revised herbarium samples. The species is labelled nearly threatened and protected by the law (Goliášová et al., 2012), although, subsp. *excapa* and *longiscapa* are identified as LC – "least concern" in Turis et al. (2014). Subspecies are problematic and difficult to distinguish in the field and there is a chance that they are non-existent (D. Dítě, pers. comm.). Despite the uncertainty and need to study the potential subspecies in detail, it is not a topic of this thesis.

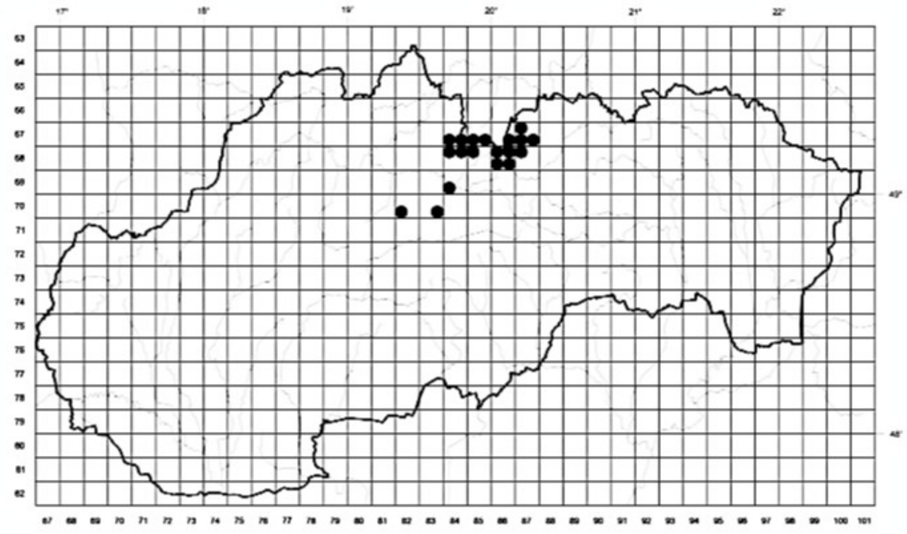


Figure 1 - Distribution of *Silene acaulis* subsp. *excapa* (All.) Killias (Goliášová et al., 2012)

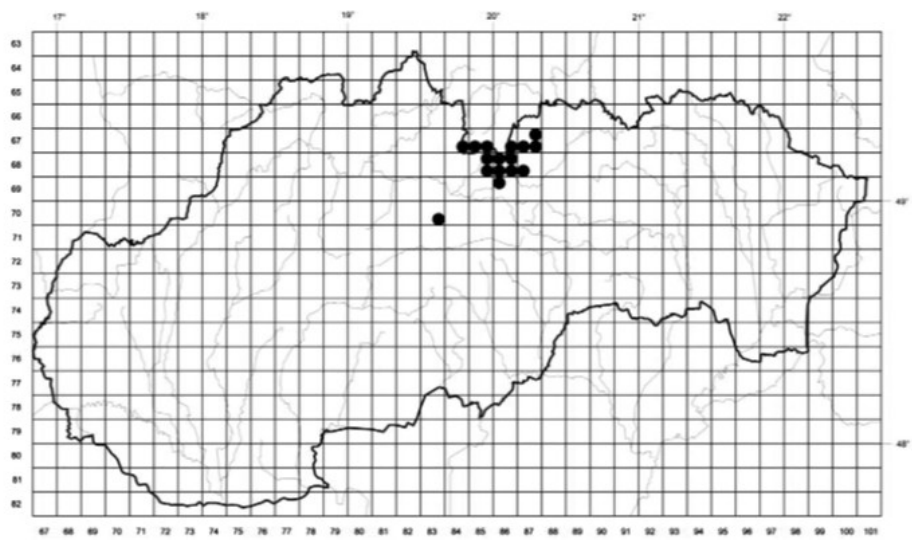


Figure 2 - Distribution of *Silene acaulis* subsp. *longiscapa* A. Kern. ex Vierh. (Goliášová et al., 2012)

2.2. Study area

Study sites are located in two valleys in Slovakia, above the tree line in the High Tatras, that being Mengusovská valley and Mlynická valley where annual measurements take place. Breeding system was compared with individuals located in Furkotská valley studied in 2020. This location was chosen after personal communication with botanist of Tatra National Park, Ing. Katarína Žlkovanová, PhD., who is familiar with the area. All locations are shown on the map of Slovakia (*Fig. 3*) and their details are listed (*Tab. 1*). A manipulation permission (*Attachment 3*) was necessary to be able to enter the localities and perform our study as they are located in Tatra National Park in 3 – 5. level protection area, *S. acaulis* being a nearly threatened species (Goliášová et al., 2012).

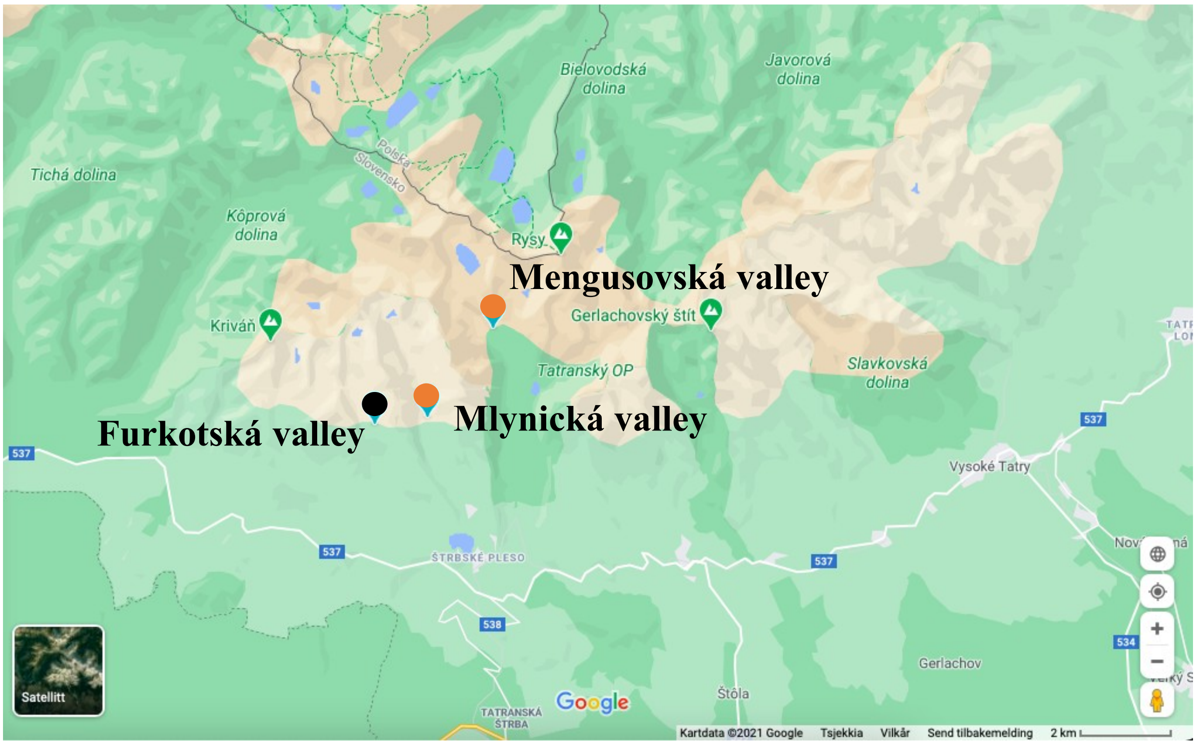


Figure 3 – A map of the study sites in High Tatra Mountains (Google Maps)

Table 1 - Overview of all study sites; elevation, latitude and longitude of study populations

locality	elevation	latitude	longitude
Mengusovská valley	1945 m a.s.l.	49°10’20’’	20°3’44’’
Mlynická valley	1927 m a.s.l.	49°9’24’’	20°2’40’’
Furkotská valley	2080 m a.s.l.	49°9’33’’	20°1’41’’

2.3. Population sampling

Populations of *Silene acaulis* occurring in two Slovak valleys located in the High Tatras (Mengusovská valley, Mlynická valley) have been under annual surveillance during summer periods. Mengusovská valley was monitored since 2013 and examining of Mlynická valley started in 2014. Altogether 680 individuals have been measured, 500 in Mengusovská valley and 180 in Mlynická valley. I joined the research in summer 2019 when I collaborated on the population data collection. In 2020 I did all the population data sampling on my own or with the help of my supervisor. This thesis is a part of a research led by Professor William Morris from Duke University in North Carolina, USA, focused on studying the impact of climate variability on this species’ dynamics. Therefore, our methods are following the ones applied on all other study sites located in Spain, Sweden and Switzerland.

The basis of population marking is creating a permanent transect prompted on both ends with deep nails, which are recorded by GPS and drawn into the map. All plant individuals located within approximately 1 meter from both sides of the transect are examined and afterwards individually marked by wire with plastic or metal tag with a number. Parameters are measured – size of the cushion (length, width); presence/absence of flowers, galls and capsules, their number if present; the number of rosettes (if the cushion is small) and viability. We recorded the percentage of *S. acaulis* and the percentage of other vegetation present within the ellipse.

As only length and width parameters of individuals were measured, I had to count the area of a cushion with a formula for ellipses, where a and b are the length and width of a cushion.

$$size = \frac{\pi \, . \, a \, . \, b}{4}$$

2.4. Vegetation composition

Plant species within and outside the marked cushion individuals of Mengusovská and Mlynická valley were recorded during summer period in June and July 2020. We evaluated the composition of vegetation inside the cushion and then outside the cushion right next to it, along the transect always in the same direction. If there was a stone, another *S. acaulis* individual, or unusually disturbed patch with significantly differing vegetation from its surrounding, we chose the most representative area that was the closest. Vegetation composition was recorded in the whole area of each tussock. Size of the sample next to the tussock always corresponded to the size of the adjacent tussocks. Plant species were sampled using a visual estimation of percentage cover.

2.5. Gender identification

Gender recognition of *S. acaulis* cushions was performed during summer period in June and July 2020 on both marked and some unmarked flowering individuals. We identified the individuals' gender in Mengusovská and Mlynická valley on marked cushions, and in close small area of Mengusovská valley but on the other side of the river and in Furkotská valley on unmarked individuals. The gender was identified according to blooming flowers. An individual was stated as a female if it had pistils only and stated as a hermaphrodite if it had pistils and stamens. The number of blooming and soon-to-be blooming flowers was counted.

2.6. Climate data and climate variables

We have extracted the climate data from 2 close climatological stations in different elevations from each month of each year from July 2013 until June 2020. Data from closer climatological station Štrbské Pleso (*Tab. 2*) were used and afterwards calculated for the exact locations of our study sites. This was done with the help of Nathalie Isabelle Chardon, PhD., who provided a script for this calculation by adding moist adiabatic lapse rate to the existing climate data taking into account the actual elevation of the study site. The number of growing degree-days was calculated from daily temperature data recorded by Štrbské Pleso station directly provided by Slovak Hydrometeorological Institute.

Table 2 - Overview of location information of Štrbské Pleso climatological station used for climate data extraction (Slovak Hydrometeorological Institute, Climatological service: www.shmu.sk/en)

climatological station location (name)	**elevation**	**latitude**	**longitude**
Štrbské Pleso	1360 m a.s.l.	49°7‘10‘‘	20°3‘48‘‘

Slovak Hydrometeorological Institute provides Bulletin of Meteorology and Climatology for each month of each year since 2008 in pdf format from certain climatological stations spread around Slovakia. Data from tables of the document were extracted using Tabula (https://tabula.technology/) to simplify digitalizing it.

The climate data calculated for our study sites between 2013 and 2020 are showing that the absolute minimums and maximums varied from -27.95°C to 25.05°C. The mean monthly precipitation varied between 82.7 and 103.2 mm. The warmest month was usually August, and the mean temperature of the warmest month was between 10.25°C and 12.75 °C. The number of growing degree days above 5°C was between 101 and 129 per year (year is defined from July to June – the time between measurements). The mean monthly temperature was varying between 0.9°C and 1.66°C.

There have been many studies trying to specify the most influential climate variables and all of them found out that temperature has the most significant effect on *S. acaulis* performance. Peterson et al. (2018) used mean July temperature and mean soil moisture in their study. Canelles et al. (2018) examined variables extracted from WorldClim and 4 of them were found to have high impact – annual mean temperature, annual temperature range, mean temperature of wettest season and annual precipitation. Ferrarini et al. (2019a) tested the impact of more than 80 climatic variables from which they downsized to 10 most important ones, out of which 7 were temperature related. The strongest effect that changed species performance was caused by mean spring and autumn maximum temperature, evaporation, and growing degree-days above 5°C. Ferrarini et al. (2019b) reduced climate variables to 20 and then to 3 most influential: degree-days above 5°C, mean warmest month temperature and extreme month temperature over 30 years.

A year is defined as the time between annual measurements of the individuals, therefore starting in July, ending in June. In selection of climatic variables, I was inspired by the variables that are being used for climate effect examination at other European sites studying populations of *Silene acaulis* that are not yet published. Following climatic variables are used:

- mean monthly precipitation
- mean monthly temperature
- mean temperature in the warmest month
- the number of growing degree-days above 5°C in a year

2.7. Data exploration

Finding a statistical model which is most explanatory is necessary to obtain the most reliable Integral Projection Models. Therefore, a thorough data formatting and exploration was conducted.

2.7.1. Data formatting

The data consisted of some individuals with only size parameters, some with size parameters along with the number of rosettes and some with the number of rosettes only. Therefore, I extracted the data from individuals with number of rosettes along with size parameters and counted mean size occupied by one rosette. Afterwards, I calculated the sizes of individuals with only rosettes numbers. One size calculation took into account only the size of the cushion (ellipse), while the other calculation included the percentage of *S. acaulis* within the ellipse to see if the amount of *S. acaulis* taking up the whole ellipse has any impact on individual's vital rates.

Data formatting was made in Excel manually. The data have to follow specific format for IPM analysis (*Tab. 3*), consisting of columns as follows:

- **transect number** for simplifying valleys distinction
- **ID** of the plant individual
- **year** of measuring
- **size** (size of the individual at time *t*)
- **sizeNext** (size of the individual at time *t+1*)
- **surv** (if the individual survived to time *t+1* (1) or did not (0))
- **stage** (what stage is the individual in at time *t* – continuous / not available (NA))
- **stageNext** (what stage is the individual in at time *t+1*– continuous / not available (NA) / dead)
- **flow** (if the individual was flowering at time *t* (1) or was not (0))
- **caps** (the number of produced capsules at time *t*)
- **veg** (the percentage of other vegetation within the cushion at time *t*)
- **PM** (the percentage of *S.acaulis* within the ellipse at time *t*)
- **gender** of the individual – hermaphrodite (0) / female (1) / indeterminate (2) / not analysed (NA)

Data from various years need to be formatted beneath each other so the information about each individual's development gets lost in the analysis taking into account only transitions of individuals from time *t* to time *t+1*. Yet, ID of the individual is always noted in the data, therefore it is possible to trace it back manually.

Data were separated into two datasets – one with only the smallest individuals and seedlings with the size up to 0.6 cm^2 (a seedling size is 0.46 cm^2) and the other one with individuals bigger than 0.6 cm^2. These datasets were only explored separately, but afterwards analysed together.

Table 3 – An example of data formatting used for IPM analysis

transect	ID	year	size	sizeNext	surv	stage	stageNext	flow	caps	veg	PM	gender
1e	387b	2013	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1e	1	2013	361.283	394.466	1	continuous	continuous	1	41	10	90	0
1e	318	2013	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1e	311	2013	36.262	16.211	1	continuous	continuous	0	NA	5	95	NA
1e	312	2013	312.717	118.752	1	continuous	continuous	1	4	20	80	0

2.8. Data analysis

2.8.1. Modelling of the best predictors for vital rates

Firstly, I added formatted data into R Studio 3.6.1 and did a logarithmic transformation of individuals' sizes and a square root transformation of the vegetation percentages to achieve a gaussian distribution. Using generic function calculating Schwarz's 'Bayesian Information Criterion' (BIC) (Schwarz 1978) I fitted different variables combinations for each vital rate using generalized mixed-effect models. BIC was used to evaluate the best model from a finite set of models with the best informative value – the lowest number. I used year of data collection and location (two valleys) as random factors in all the models. I tested the effect of *size*, $size + size^2$ and $size + size^2 + size^3$ as predictors on each of the vital rates – for growth where size of the next year was the dependent variable, for survival where the binary information about survival was the dependent variable and for fecundity where the number of capsules was the dependent variable. Then, after testing only the size of cushions, I added more predictors interacting with *size*, $size + size^2$ and $size + size^2$

+ $size^3$ - all 4 above-mentioned climate variables, percentage of *S. acaulis* within the ellipse and percentage of other vegetation within the cushion (*Tab. 4*).

Table 4 – An overview of variables combinations tested using BIC

<table>
<tr><th>vital rates</th><th></th><th>size predictors</th><th></th><th>other predictors</th></tr>
<tr><td rowspan="6">growth
or
survival
or
fecundity</td><td rowspan="6">~</td><td rowspan="6">size
or
size + size^2
or
size + size^2 + size^3</td><td rowspan="6">*</td><td>mean warmest month</td></tr>
<tr><td>mean monthly temperature</td></tr>
<tr><td>mean monthly precipitation</td></tr>
<tr><td>number of growing degree-days above 5°C in a year</td></tr>
<tr><td>Silene percentage</td></tr>
<tr><td>vegetation percentage</td></tr>
</table>

2.8.2. Vegetation composition inside and outside the cushion

2.8.2.1. Environmental optima

Ordination analysis was used as the data of plant species' percentages within and outside the cushion are multidimensional. Extra columns were added including additional information needed for the analyses (*Tab. 5*). Using Detrended Correspondence Analysis (DCA) I found out that the vegetation data is unimodal and Canonical Correspondence Analysis (CCA) was used to analyze the habitat preference of the other plant species, where percentages of other vegetation present were dependent variables, information about the area (inside or outside the cushion) was the predictor and the pair code was used as a covariate. The significance of the ordination was evaluated by Monte Carlo permutation test and split-plot randomization.

Supplementary data formatting was made in Excel manually consisting of columns as follows:

- **transect number** for simplifying valleys distinction
- **ID** of the plant individual

- **code** (pair code for vegetation composition inside and outside the same cushion)
- **female_flowers** (if the individual has female flowers (1), does not (0) or is not available (NA) – in case the individual is not flowering or not analysed)
- **cushion** (it the vegetation data is of inside the cushion (1) or outside the cushion (0))
- **Salix_sp** (percentage of plant individual *Salix sp.*)
- **other plant species**
- **species_richness** (the number of plant species observed in one area – either cushion or open space related to one individual)

Table 5 – An example of data formatting used for vegetation and gender analysis of marked individuals

transect	ID	code	fem_fl	cushion	Sal_sp	Ane_alp	Bis_maj	Cam_alp	sp_rich
1e	1	1	NA	1	0	0	0	5	5
1e	1	1	NA	0	0	0	0	2	5
1e	2	2	NA	1	0	0	0	2	4
1e	2	2	NA	0	0	0	0	2	5
1e	3	3	0	1	0	0	0	5	6

2.8.2.1. Species richness

The number of plant species present within and outside was firstly transformed with square root and then plotted with area as the predictor (within the cushion or in open space) and pair code as covariate and this was tested with analysis of variance. Dataset used for analysis of environmental optima was used (*Tab. 5*).

2.8.3. Vegetation analysis of cushions with different genders

Ordination analysis was used as the data of plant species' percentages within and outside the cushion are multidimensional. The same data from analysis of environmental optima was used (*Tab. 5*), however only rows with vegetation composition in the cushions with the information about gender were analyzed. Using Detrended Correspondence Analysis (DCA) I found out that the vegetation data is unimodal and Canonical Correspondence Analysis (CCA) was used to analyze if there is a preference of other plant species in gender of the cushion. Percentages of other vegetation present within the cushion were dependent variables and the gender (occurrence of female flowers 0/1) was the predictor. The significance of the ordination was evaluated by Monte Carlo permutation test.

2.8.3.1. Species richness

The number of plant species present was firstly transformed with square root and then plotted with the gender as the predictor, and this was tested with analysis of variance. Dataset used for analysis of environmental optima was used (*Tab. 5*).

2.8.4. Gender analysis

2.8.4.1. Gender composition of marked and unmarked individuals

Data about gender of cushion individuals in three valleys (Mengusovská, Mlynická and Furkotská valley) was recorded as the presence of female or hermaphrodite flowers and the number of blooming or soon-to-be blooming flowers (*Tab. 6*). The number of flowers was logarithmically transformed to achieve gaussian distribution and afterwards as a dependent variable compared between genders of all individuals as a predictor in one analysis and between transect as predictor in another analysis. This was tested with analysis of variance. Data for gender analysis consist of columns as follows:

- **transect** (the name of the location)
- **ID** of the plant individual
- **female** (if the individual has female flowers (1), does not (0) or is not available (NA))
- **hermaphrodite** (if the individual has hermaphrodite flowers (1), does not (0) or is not available (NA))
- **number of flowers**
- **gender** of the individual – hermaphrodite (0) / female (1) / indeterminate (2)

Table 6 – An example of data formatting used for gender analysis of both marked and unmarked individuals

transect	ID	female	hermaphrodite	number of flowers	gender
meng	4	0	1	330	0
meng	5	0	1	10	0
meng	8	0	1	20	0
meng	10	0	1	20	0
meng	14	1	0	1	1

2.8.4.1. Gender composition of marked individuals

Data about gender of marked cushion individuals in two valleys (Mengusovská and Mlynická valley) was recorded as the presence of female or hermaphrodite flowers and this was added as a parameter to dataset used for creating IPMs (*Tab. 3*) which was also used for this gender analysis. The occurrence of female or hermaphrodite or both flowers on marked individuals was plotted with size of the cushion, number of capsules, percentage of other vegetation within the cushion and percentage of *S. acaulis* within the ellipse. Gender was used as a predictor and then size or number of capsules or percentage of other vegetation or percentage of *Silene* was used as a dependent variable – these were tested with analysis of variance.

2.8.5. Integral projection models (IPMs)

Marked and measured plant individuals were separated into simple life stages every year – continuous (if the individual was alive), dead or not available (NA). This species is not clonal and does not have a seedbank. “Integral Projection Models” – IPMs were used for data analysis (Easterling et al., 2000). IPMs are using precise sizes of the cushion individuals, therefore bringing more exact results. These models can help to calculate and graphically display survival and population growth rate, create growth, survival and fecundity matrix, from which we can obtain IPM matrices together with elasticity and sensitivity matrices of every population from each year or all the years together. Mainly, I created IPM for all the individuals from both populations. Then I created separate IPMs for both valleys to see if there is a difference in population dynamics in isolated locations.

2.8.5.1. Integral projection models construction

Once population data was formatted and the most informative models were found growth, survival and fecundity objects were constructed followed by creating IPM matrices in R Studio 3.6.1.

Basic vital rates were created - growth, survival and fecundity objects - using the most informative variables combinations, which generated P and F matrices - the basis of IPM matrix. P matrix is showing the probability of growing, shrinking or stasis to a certain size at time $t+1$ for any size at time t. F matrix is showing the probability of reproduction (creating seedlings) to a certain size at time $t+1$ for any size at time t. Full IPM matrix consists of both P and F matrices, showing the probabilities of changing size and reproduction abilities together (Metcalf et al., 2013). Sensitivity and elasticity figures forecast the effect of hypothetical modifications in parameters on population growth rate. Elasticity figure shows the proportional change in the parameters while sensitivity shows absolute change in the parameter (de Kroon et al., 1986). Population growth rate (λ; dominant eigenvalue) is referred to as the 'finite rate of increase of the population' and can be calculated from the IPM matrix (Watkinson, 2009). If λ value exceeds 1 the population size will increase if transition matrix's demographic rates remain unchanged, while λ values between 0 and 1 indicate population decrease (Jongejans and de Kroon, 2012). We stated the overall population growth rate for both valleys in all years, but also the population growth rate of each valley separately. Packages *IPMpack*, *rgbif*, *raster*, *rgdal* and *fields* were required.

3 Results

3.1. Vegetation structure

3.1.1. Vegetation composition in the cushion and open space

Monte Carlo permutation test of CCA ordination analysis of vegetation composition inside and outside the cushion is significant (*F* value = 5.063, *p*-value = 0.005 **). The first axis captured 11.62 % of variation and the second one 9.89 %. More plant species have their environmental optimum inside the cushion in comparison with open space. *Silene acaulis* individuals located in the High Tatras are facilitating the occurrence of other plants within their branches. The optima of *Luzula sp., Cerastium alpinum* and *Crepis sp.* are associated with the cushion structure the most, whereas optima of *Saussurea alpina,* mosses and *Ranunculus alpinus* are associated with open space the most (*Fig. 4*).

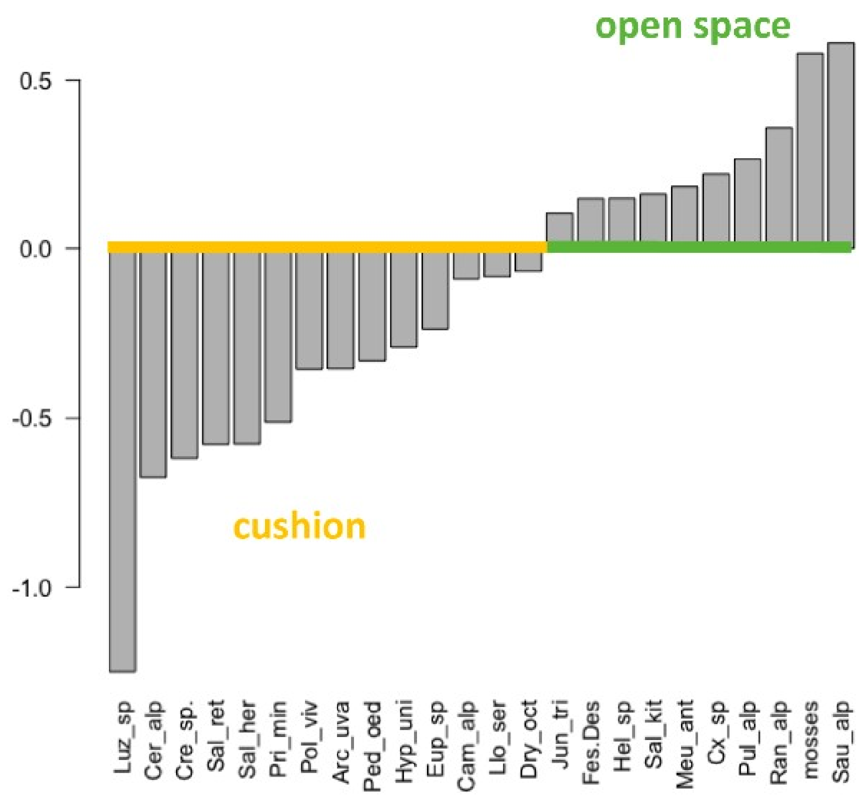


Figure 4 – Graphically displayed environmental optima of various species on X axis; inside the cushion on the left in orange and outside the cushion on the right in green; the position on first CCA ordination axis on Y axis

3.1.2. Species richness

The species richness is affected by the cushion as the number of plant species within the cushion is higher than in the open ground. This was tested with ANOVA (F = 9.1601, p = 0.002708 **) (*Fig. 5*).

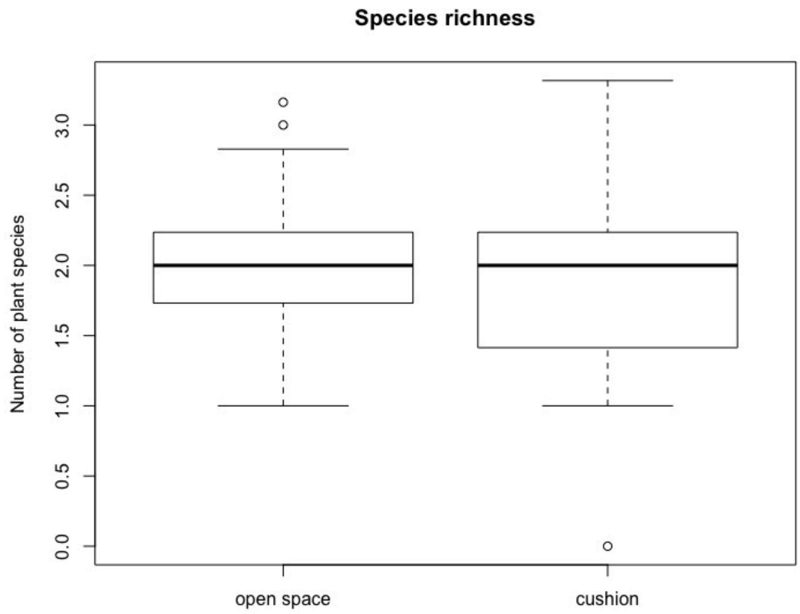


Figure 5 – Boxplot displaying species richness inside the cushion and in open space; areas on X axis, number of plant species (square root) on Y axis

3.2. Vegetation composition in female and hermaphrodite cushions

The permutation test for CCA ordination analysis of vegetation composition in female and hermaphrodite individuals is not significant (p = 0.46). No difference in plant species occurrence within two genders of *S. acaulis* cushions was found.

The species richness is not affected by the gender of the cushion and the number of plant species are comparable in cushions with female and hermaphrodite flowers. Analysis of variance test was not significant (p = 0.5256).

3.3. Gender of *Silene acaulis* individuals

The breeding system of populations in High Tatra Mountains studied on 185 individuals is gynodioecious, therefore consists of cushions with female and hermaphrodite flowers. There were 94 female and 80 hermaphrodite cushions identified within our study sites. There were no male flowers found and there were 11 individuals with both female and hermaphrodite flowers. Female individuals were dominant in three localities while hermaphrodites were dominant in one – Mengusovská valley (*Tab. 7*).

Table 7 – The number of individuals with female, hermaphrodite, or both flowers in studied valleys

location	♀	⚥	♀+⚥	**sum**
Mengusovská valley	17	44	3	= 64
Mengusovská valley (other side of river)	42	23	2	= 67
Mlynická valley	10	5	4	= 19
Furkotská valley	25	8	2	= 35
sum	= 94	= 80	= 11	**185**

3.3.1. Gender effect on all studied individuals

The ANOVA test exploring the effect of cushion genders on number of flowers of both marked and unmarked individuals is not significant (p = 0.2642). There is no difference in flowers number between females, hermaphrodites and individuals with both flowers present (*Tab. 8*). However, there is a difference between the number of flowers on study sites being the lowest in Mlynická valley, tested with analysis of variance (F = 2.9405, p = 0.03453 *) (*Fig. 6*).

Table 8 – The average number of flowers of individuals with female, hermaphrodite, or both flowers in studied valleys

location	♀	⚥	♀+⚥
Mengusovská valley	71	37.2	65
Mengusovská valley (other side of river)	63.3	50.9	115
Mlynická valley	90.6	69.6	14.8
Furkotská valley	48.4	38.8	20
average	**68.3**	**49.1**	**53.7**

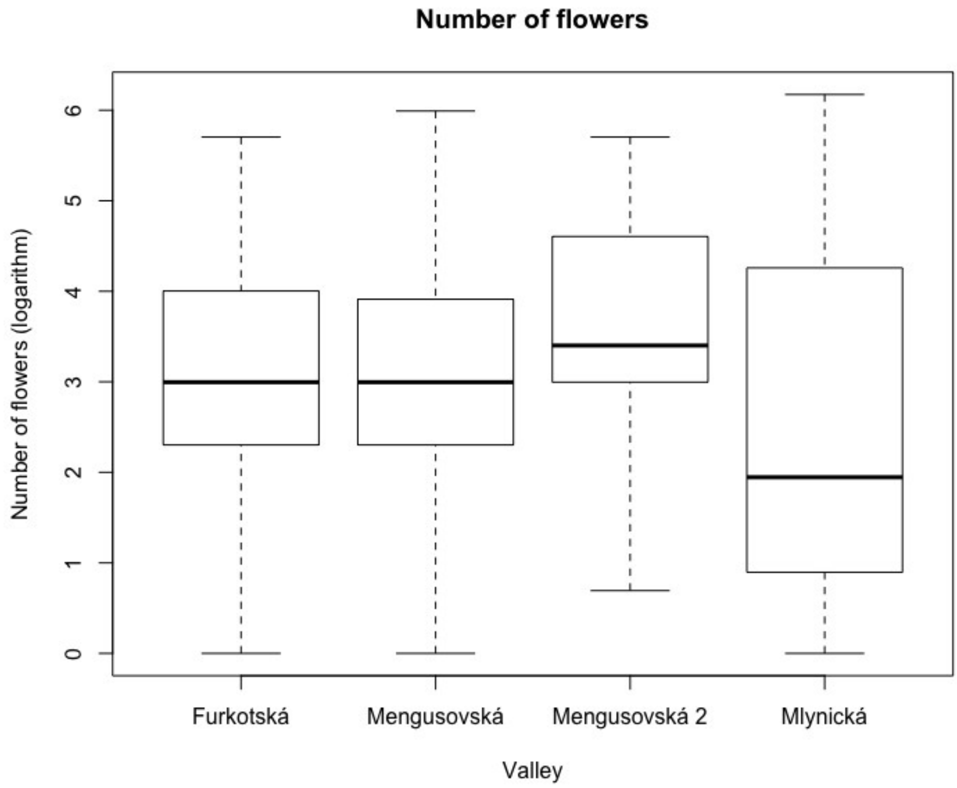


Figure 6 – Boxplot showing the number of flowers (logarithmic) per cushion on Y axis and location on X axis; Mengusovská 2 is Mengusovská valley but on the other side of the river

3.3.2. Gender effect on marked individuals

Gender information about marked individuals was tested with the size of the cushion, number of capsules (p = 0.1204), percentage of other vegetation within the cushion (p = 0.2084) and percentage of *S. acaulis* within the ellipse (p = 0.9985) using analysis of variance. Only the cushion sizes are significantly different among genders (F = 6.7084, p = 0.01164 *) with indeterminate gender being the biggest (*Fig. 7*).

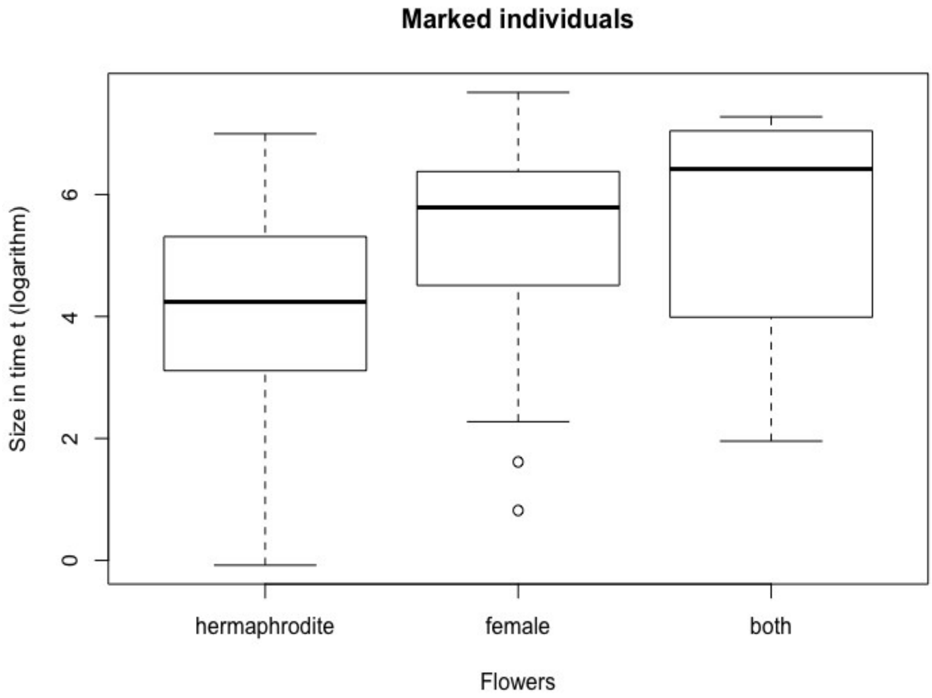


Figure 7 – Boxplot showing divergent cushion sizes in time *t* among individuals with hermaphrodite, female or both flowers; logarithmic size in time *t* on Y axis

3.4. Climate effects

Obtained and calculated climate values for the exact populations' locations were used for a comparison with population dynamics of *S. acaulis* in the High Tatras (*Tab. 9*). Using BIC function none of the climate variables showed to have a significant effect on any of the vital rates (*Tab. 10, 11, 12*).

Table 9 – The overview of used climatic variables' values for each year

year	mean monthly temperature (°C)	mean monthly precipitation (mm)	mean temperature of the warmest month (°C)	number of degree days above 5°C (per year)
2013	1.56	85.31	10.45	113
2014	0.91	103.23	10.25	129
2015	1.66	82.68	12.75	126
2016	0.43	93.78	10.35	128
2017	0.54	95.15	11.15	129
2018	1.20	87.20	11.25	122
2019	1.43	99.63	11.25	101

3.5. The best predictor of vital rates

Since 2013, 680 individuals of *S. acaulis* were analysed in the High Tatras. Individuals were separated into two datasets, smaller and larger plants, which were tested separately. The number of smallest individuals was too large to achieve a gaussian distribution.

There was no variability found in the dataset of small individuals and seedlings. Null models were the most informative for both growth and survival. On average, the smallest individuals are dying more frequently than the bigger ones, but those which survive are increasing their size successfully.

3.5.1 Adult individuals

Using BIC function, the best predictors (with the lowest BIC value (*Tab. 10, 11, 12*)) for vital rates of individuals larger than 0.6 cm^2 are:

- growth – $sizeNext \sim (size+size^2) * PM$
- survival – $surv \sim (size+size^2+size^3)$
- fecundity – $caps \sim (size+size^2+size^3) * PM$

Table 10 – The overview of calculated BIC values for growth – the best predictors obtained 0, while their BIC value was subtracted from all the other BIC values of other predictors, acquiring a scale where the most informative predictors for tested parameters for growth have the lowest values (shades of orange); the predictors in the first column are interacting with the predictors of size and their BIC values are in the corresponding cells

	growth		
predictors	size	size + $size^2$	size + $size^2$ + $size^3$
-	36.497	19.195	20.773
mean warmest month	47.905	35.636	42.896
mean monthly temperature	49.514	39.613	48.642
mean monthly precipitation	50.598	40.745	49.999
number of GDD above 5°C in a year	34.599	23.551	32.136
Silene percentage	30.127	0	9.822
vegetation percentage	47.539	40.846	42.065

Table 11 – The overview of calculated BIC values for survival – the best predictors obtained 0, while their BIC value was subtracted from all the other BIC values of other predictors, acquiring a scale where the most informative predictors for tested parameters for survival have the lowest values (shades of orange); the predictors in the first column are interacting with the predictors of size and their BIC values are in the corresponding cells

	survival		
predictors	size	size + $size^2$	size + $size^2$ + $size^3$
-	53.491	5.03	0
mean warmest month	66.873	26.255	28.692
mean monthly temperature	67.244	23.688	24.966
mean monthly precipitation	67.677	26.16	28.498
number of GDD above 5°C in a year	67.694	25.057	27.075
Silene percentage	46.757	24.889	30.999
vegetation percentage	37.585	19.286	27.839

Table 12 – The overview of calculated BIC values for fecundity – the best predictors obtained 0, while their BIC value was subtracted from all the other BIC values of other predictors, acquiring a scale where the most informative predictors for tested parameters for fecundity have the lowest values (shades of orange); the predictors in the first column are interacting with the predictors of size and their BIC values are in the corresponding cells

	fecundity		
predictors	size	size + $size^2$	size + $size^2$ + $size^3$
-	86.573	42.877	8.954
mean warmest month	96.102	54.629	25.359
mean monthly temperature	98.714	57.769	28.619
mean monthly precipitation	98.99	61.058	31.979
number of GDD above 5°C in a year	97.214	54.152	21.955
Silene percentage	83.366	32.504	0
vegetation percentage	96.419	55.449	25.773

These were used in further data analyses. Both growth and fecundity are influenced by the percentage of *S. acaulis* within the ellipse (therefore a compactness of a cushion = PM) while growth is influenced by *size* + $size^2$ (*Fig. 8*) and fecundity is influenced by *size* + $size^2$ + $size^3$ (*Fig. 10*). Survival is affected by *size* + $size^2$ + $size^3$ of the cushion (*Fig. 9*). The graphs of vital rates of adult individuals with fitted models can be found in the *Attachment 1* (*Fig. 20*).

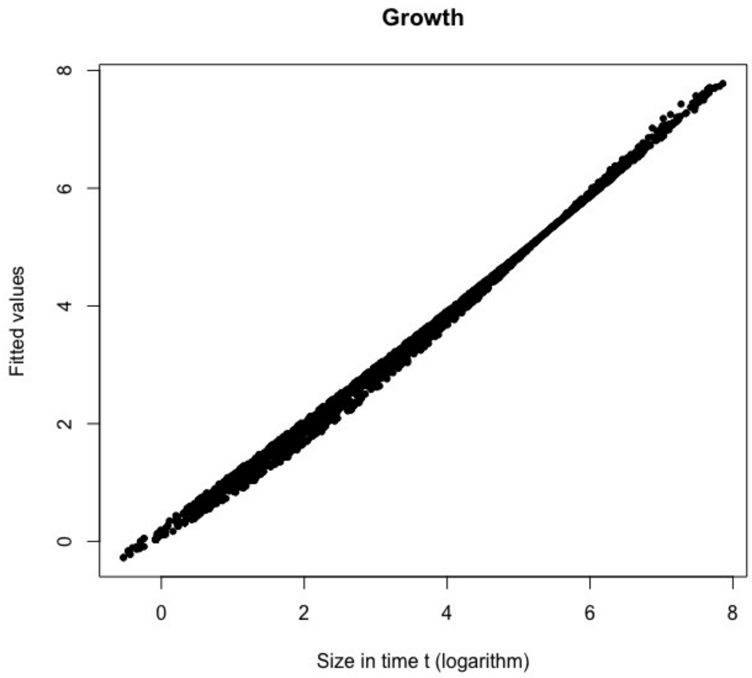


Figure 8 – The most informative model of growth displayed (*sizeNext ~ (size+size*^{2}*) * PM*); logarithmic size in time *t* on X axis; fitted values of the model on Y axis

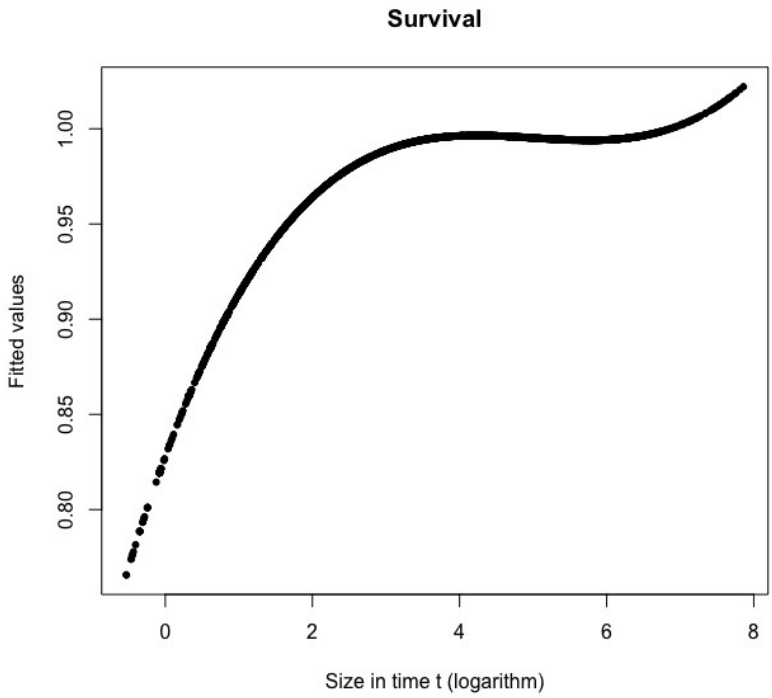


Figure 9 – The most informative model of survival displayed (*surv ~ (size+size*^{2}*+size*^{3}*)*); logarithmic size in time *t* on X axis; fitted values of the model on Y axis

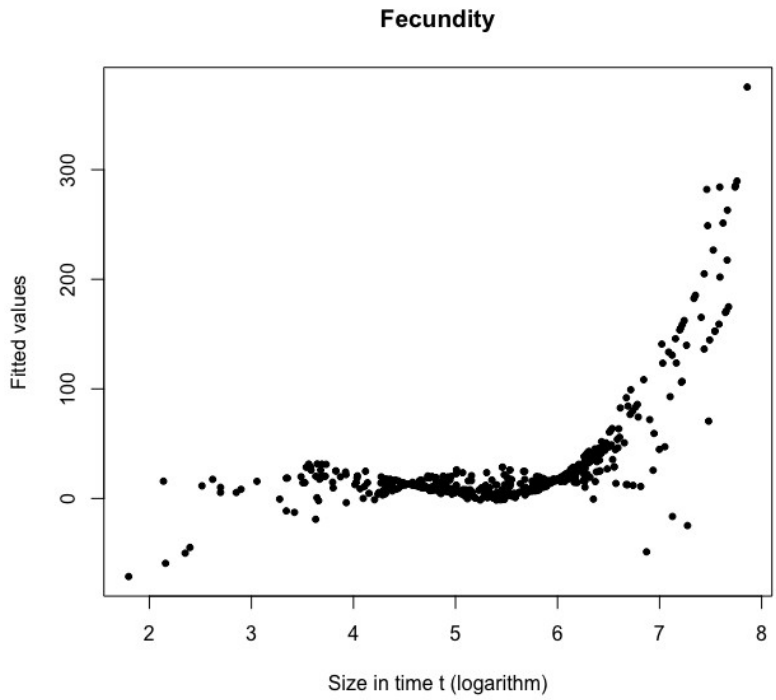


Figure 10 – The most informative model of fecundity displayed (*caps ~ (size+size²+size³) * PM*); logarithmic size in time *t* on X axis; fitted values of the model on Y axis

The survival of plants was analysed also as a percentage of deaths in every year and both valleys. The highest dead rate occurred in 2017 in Mengusovská valley and in 2020 in Mlynická valley. The least deaths happened in 2018 for both valleys (*Tab. 13*).

Table 13 – Percentages of marked plants deaths in each year and both valleys

year	**Mengusovská valley**	**Mlynická valley**
2014	2.96 %	-
2015	8.50 %	11.36 %
2016	11.93 %	7.94 %
2017	13.89 %	10.96 %
2018	1.97 %	5 %
2019	10.65 %	12.12 %
2020	5.24 %	13.41 %

3.6. Fitted vital rates

Growth of individuals in Mengusovská and Mlynická valley fitted with the best model can be found in *Fig. 11, 12* – size is logarithmic. Single cushion area varies from having one rosette to large ellipsoid individuals. The smallest individuals are taking up area of 0.118 cm^2. The size of a seedling is 0.46 cm^2. The biggest individual covers 2587.573 cm^2 (0.259 m^2). Average size of the cushion is 1293.846 cm^2 (0.129 m^2).

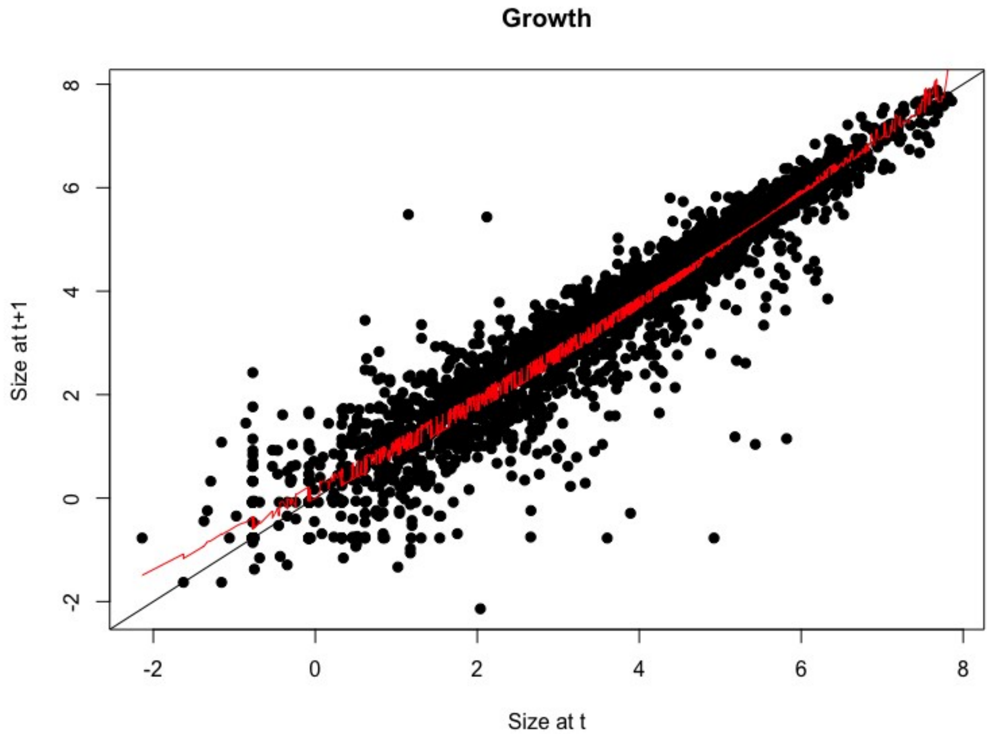
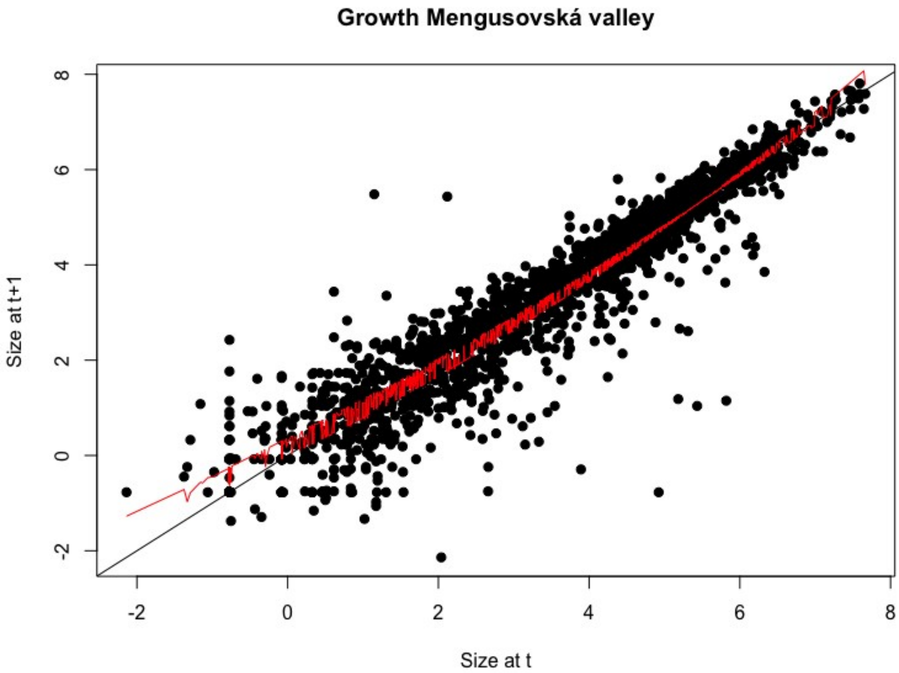


Figure 11 – Diagram of growth created from all marked individuals from both valleys; each dot represents one individual; logarithmic size (cushion area) at time *t* on X axis and logarithmic size (cushion area) at time *t+1* on Y axis (both in cm^2); red line representing the fit of most informative model for growth: *sizeNext ~ (size+size²) * PM*



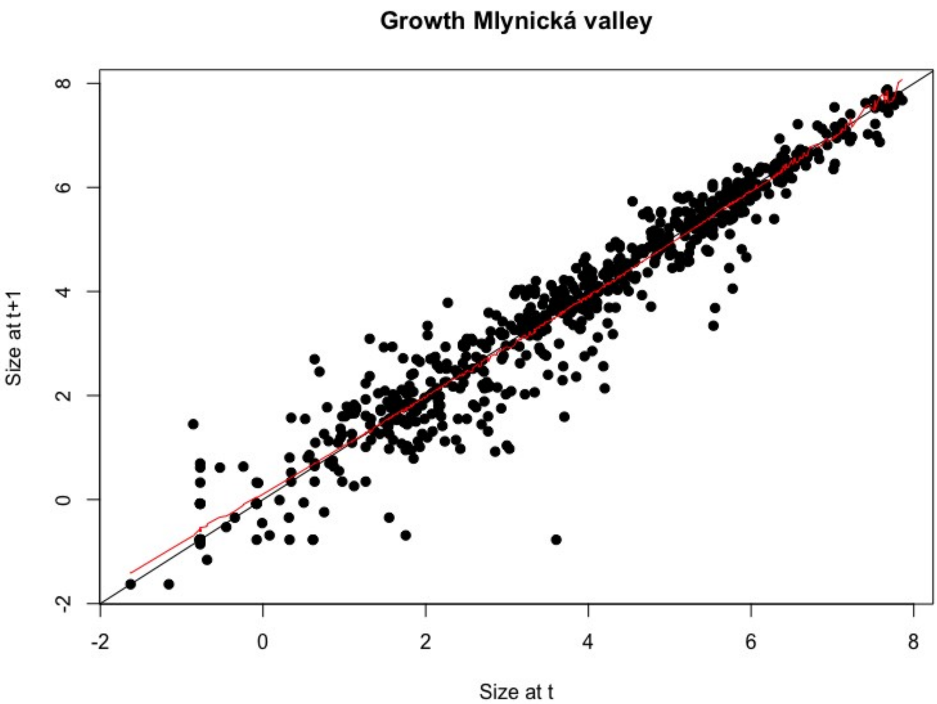


Figure 12 - Diagrams of growth created from marked individuals from Mengusovská valley above, from Mlynická valley beneath; each dot represents one individual; logarithmic size (cushion area) at time *t* on X axis and logarithmic size (cushion area) at time *t+1* on Y axis (both in cm^2); red line representing the fit of most informative model for growth: *sizeNext ~ (size+size^2) * PM*

All individuals have high probability to survive. Some of the small individuals of *S. acaulis* have the lowest survival probability of 0.65 (65%). Majority of individuals have high survival probability varying from 0.9 - 1 (90 - 100%) (*Fig. 13*). Survival of individuals from separate valleys fitted with the best model is presented in *Fig. 14*.

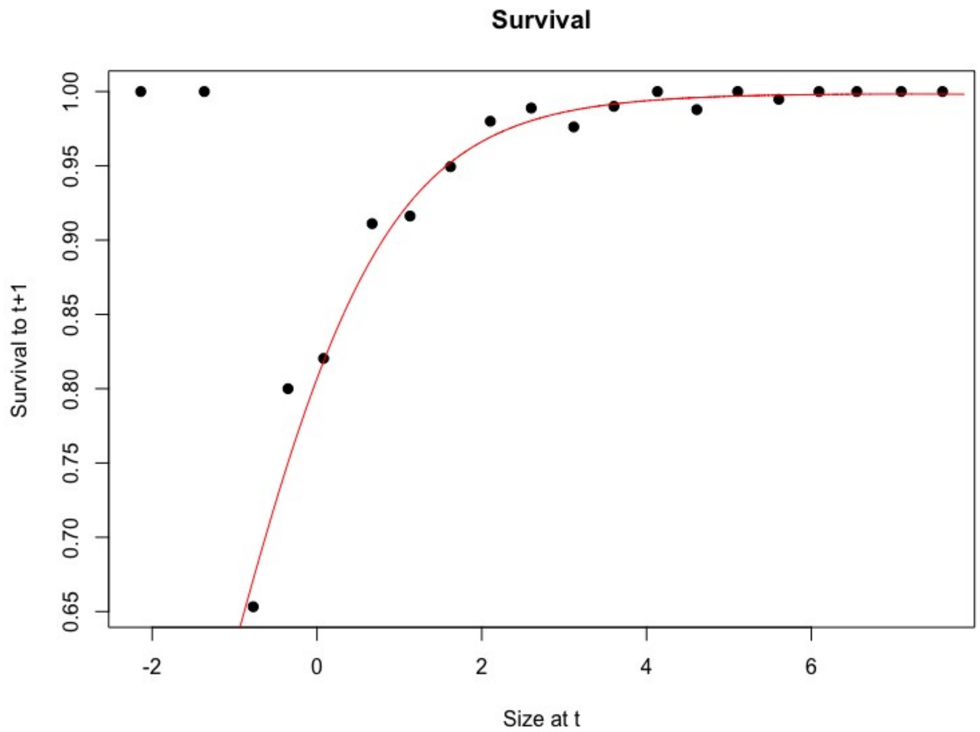


Figure 13 – Diagram of survival related to size of the cushion created from all marked individuals from both valleys; each dot represents the probability of survival of certain cushion size; logarithmic size (cushion area) at time *t* on X axis (cm^2) and survival to time *t+1* on Y axis (% of possibility); red line representing the fit of most informative model for survival: *surv ~ (size+size^2+size^3)*

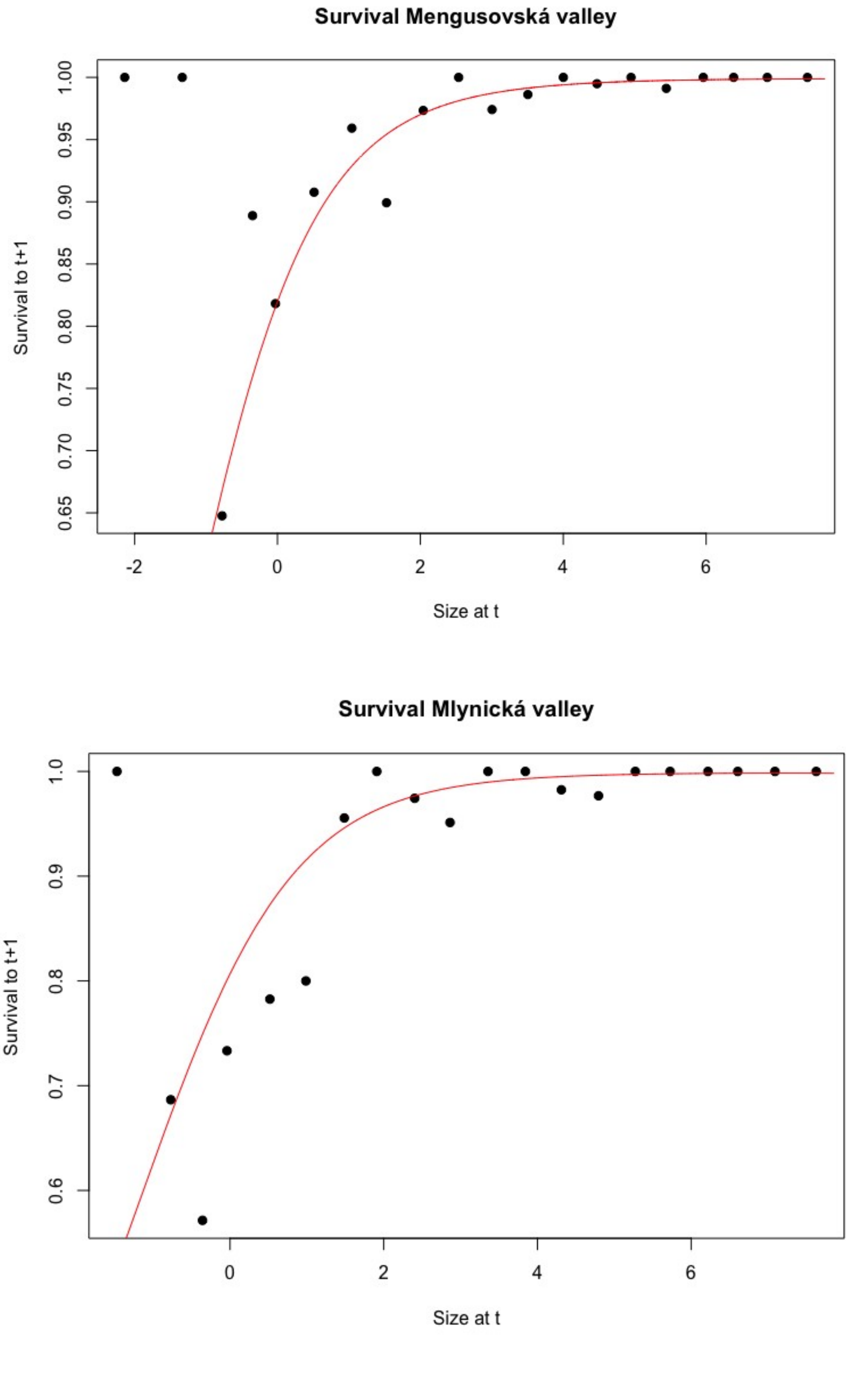


Figure 14 - Diagram of survival related to size of the cushion created from all marked individuals from Mengusovská valley above, from Mlynická valley beneath; each dot represents the probability of survival of certain cushion size; logarithmic size (cushion area) at time *t* on X axis (cm^2) and survival to time *t+1* on Y axis (% of possibility); red line representing the fit of most informative model for survival: $surv \sim (size+size^2+size^3)$

3.7. Integral Projection Models

The probability of growth is displayed on P matrix showing growth and survival (Survival/Growth Kernel) being the most prevalent by individuals bigger than 900 cm^2 (*Fig. 15*). F matrix representing fecundity shows that individuals above 1100 cm^2 size are most likely to create a seedling (Fecundity Kernel) (*Fig. 16*).

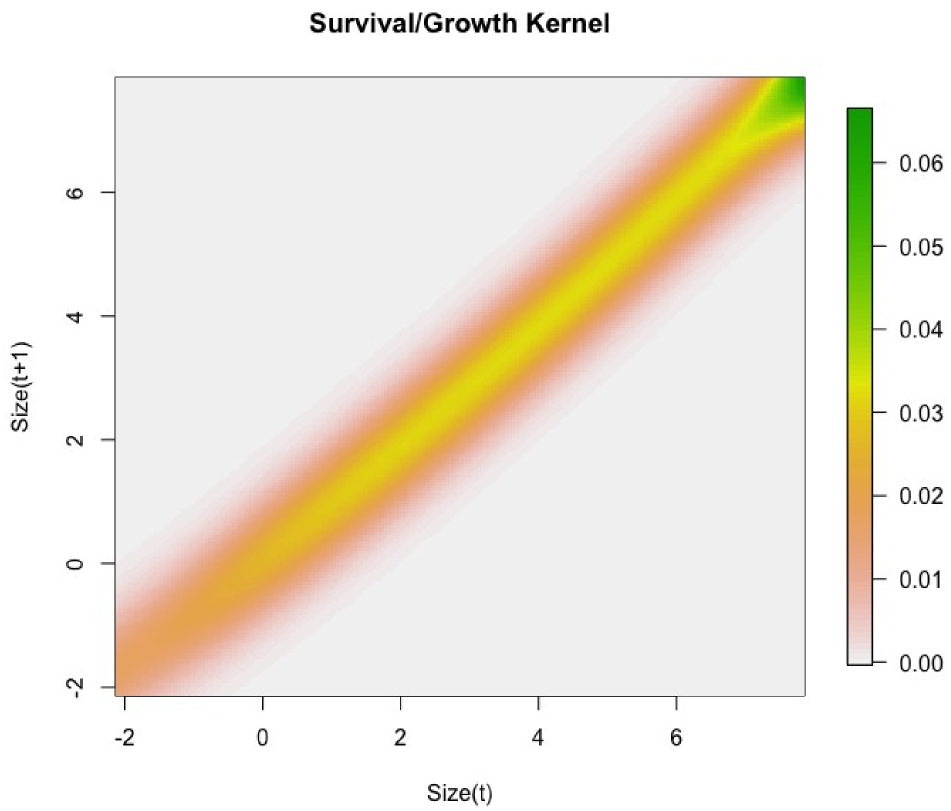


Figure 15 – Survival/Growth Kernel (P matrix) created from all individuals of both valleys; logarithmic size at time *t* on X axis, logarithmic size at time *t+1* on Y axis (both in cm^2); colours represent the probability of growth and survival; the colour scale is on the right side of the Kernel, the darker the more probable

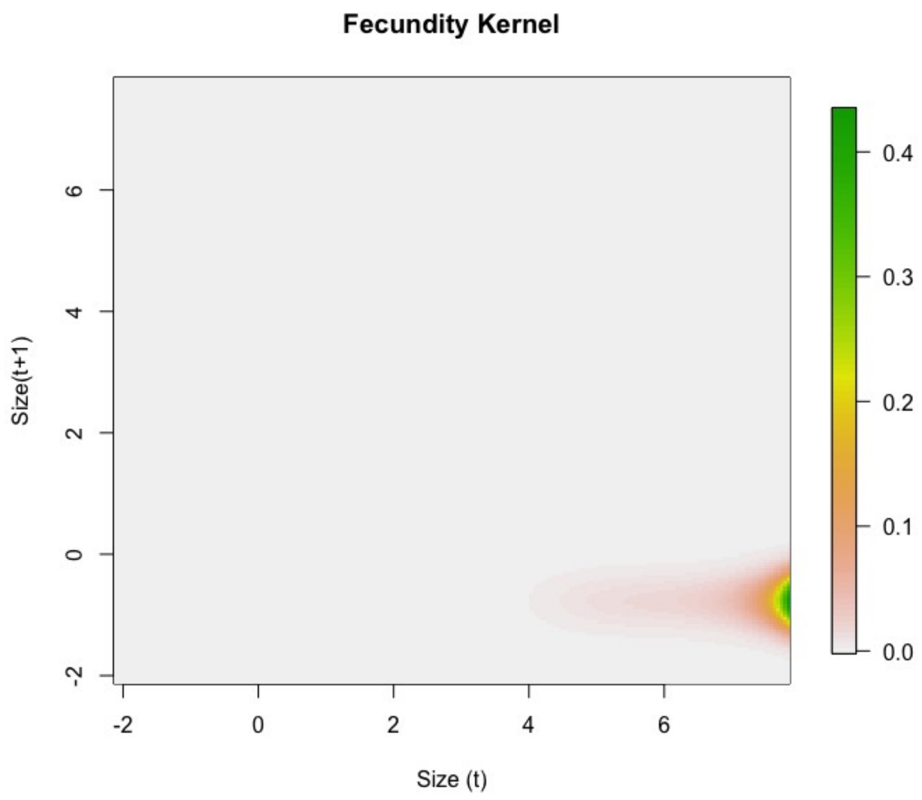


Figure 16 – Fecundity Kernel (F matrix) created from all individuals of both valleys; logarithmic size at time *t* on X axis, logarithmic size at time *t+1* on Y axis (both in cm²); colours represent the probability of growth and survival; the colour scale is on the right side of the Kernel, the darker the more probable

Populations of *S. acaulis* are not stable and they are growing with a very low probability as shown on IPM Kernels (*Fig. 17, 18*). Only the biggest individuals around 1000 cm^2 have higher probability to reproduce, reaching 40 %.

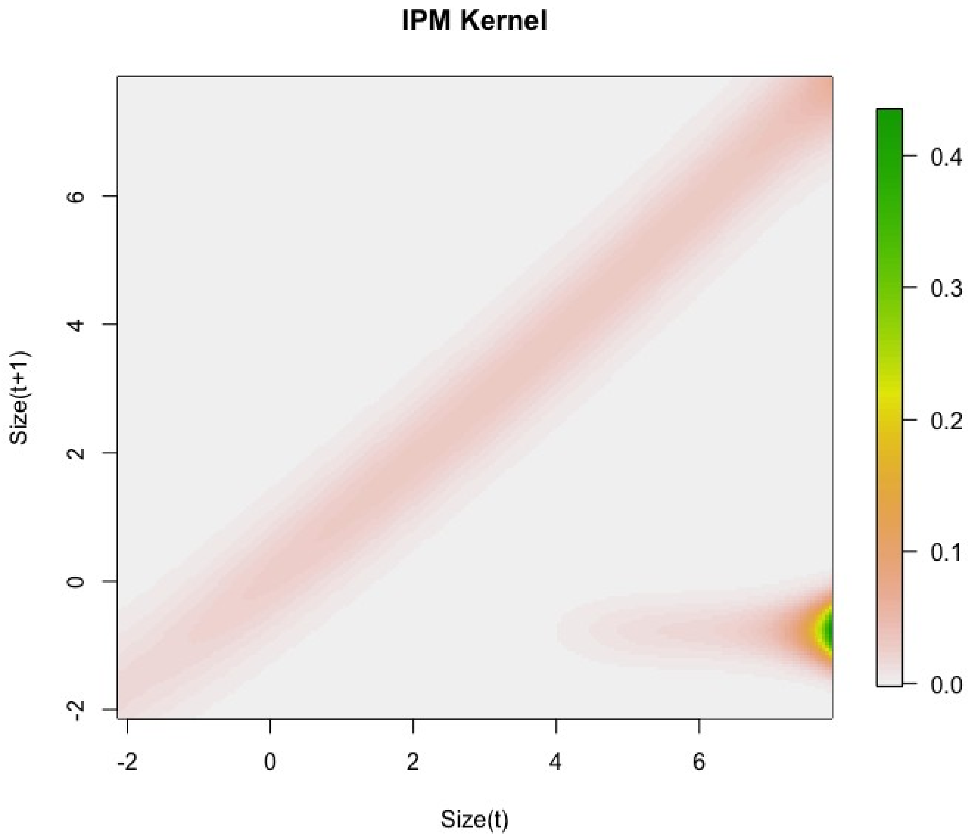


Figure 17 – IPM Kernel created from all individuals of both valleys; logarithmic size at time *t* on X axis, logarithmic size at time *t+1* on Y axis (both in cm^2); colours represent the probability of growth, survival and reproduction; the colour scale is on the right side of the Kernel, the darker the more probable

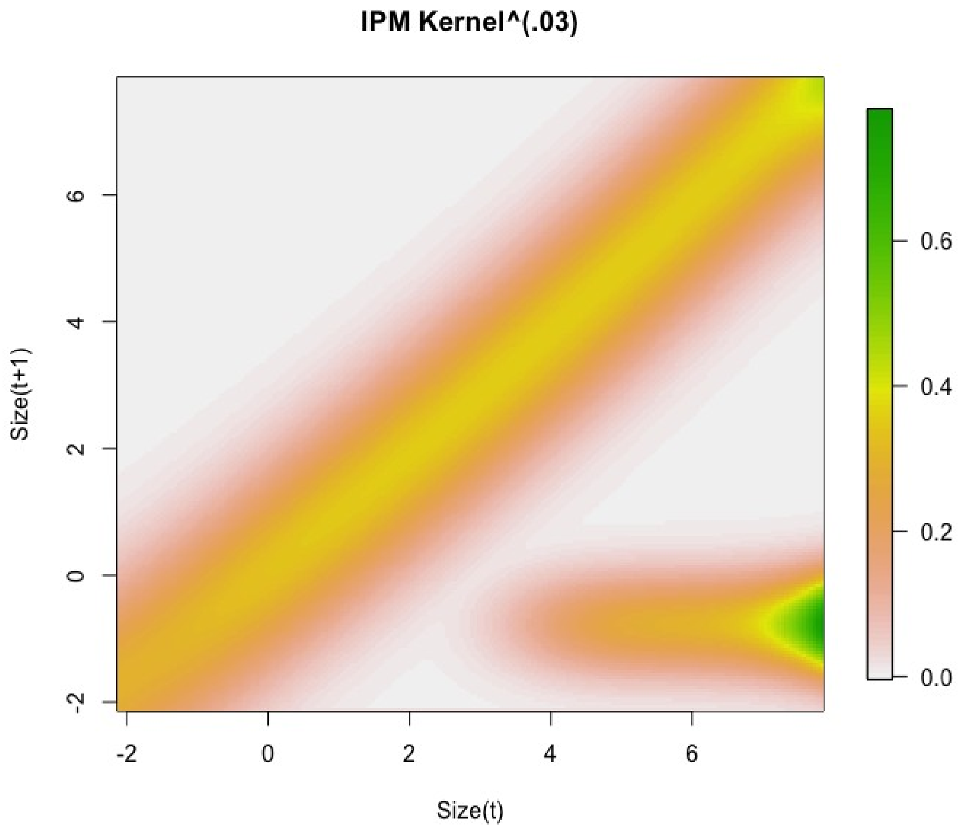


Figure 18 –IPM Kernel $^{0.03}$ for better visibility created from all individuals of both valleys; logarithmic size at time *t* on X axis, logarithmic size at time *t+1* on Y axis (both in cm^2); colours represent the probability of growth, survival and reproduction; the colour scale is on the right side of the Kernel, the darker the more probable

Population growth rate (λ) for all individuals of all years and both valleys equals 0.9089. Lambda equals 0.9086 for Mengusovská valley, and 0.9076 for Mlynická valley. This is showing that both *S. acaulis* populations are shrinking.

Cushions with the size from 0.6 to 7.4 cm^2 which grow and survive successfully are the ones contributing to population growth rate shown on elasticity figure (*Fig. 19*).

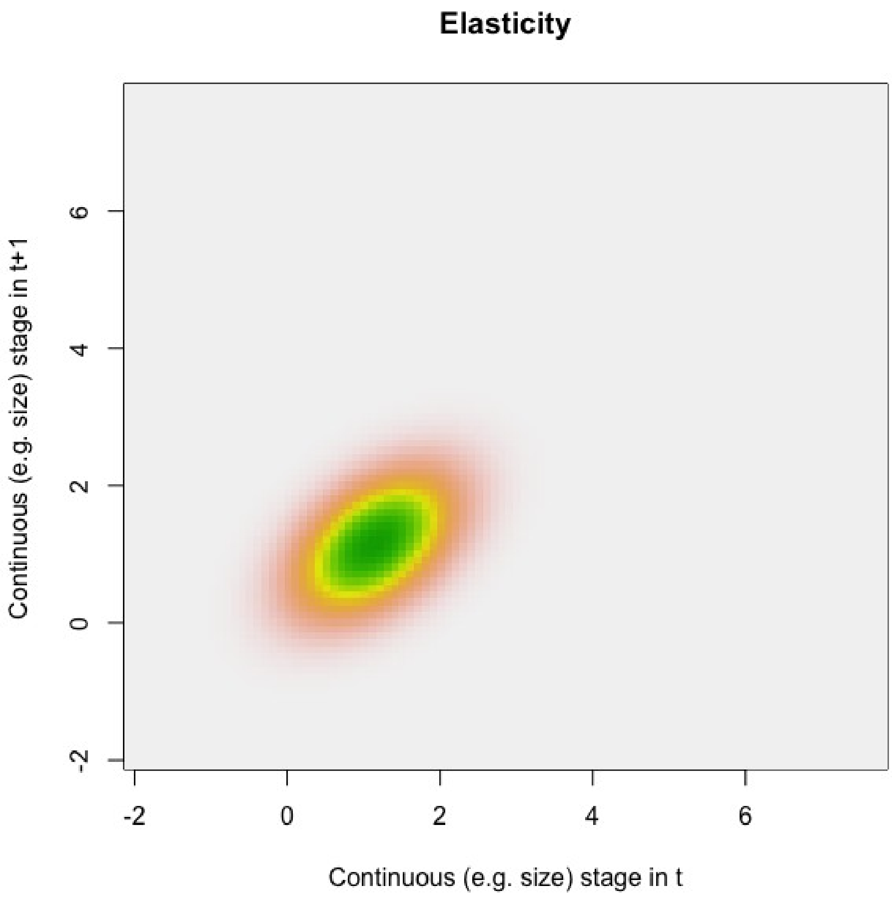


Figure 19 – Elasticity figure created from all individuals of both valleys; logarithmic size at time *t* on X axis, logarithmic size at time *t+1* on Y axis (both in cm^2); colours represent the probability of growth, survival and reproduction, the darker the more probable

4 Discussion

4.1. Facilitation and vegetation structure

The vegetation composition of Slovak individuals of *S. acaulis* was monitored only on the last year of our study in summer 2020. More plant species environmental optima were associated with the cushion in comparison with open ground, *Luzula sp.* being the most abundant plant within the cushion structure followed by *Cerastium alpinum* and *Crepis sp.* while *Saussurea alpina* and mosses are linked the most with open space. Also, we found that the species richness is higher in the cushion than in open ground (p-value = 0.002708), being in accordance with other reports. Multiple studies shown that *S. acaulis* has a strong facilitation ability and that the species richness is higher within its branches (Molenda et al., 2012; Reid and Lortie 2012; Cranston et al., 2012; Bonanomi et al., 2016). However, only Cranston et al. (2012) and Bonanomi et al. (2016) shared the list of plant species found and only Cranston et al. (2012) analysed the association of plants towards cushion or open space. They discovered that *Carex sp*., *Erigeron compositus*, *Sedum lanceolatum* and *Oxytropis campestris* were most common within the cushion and *Potentilla nivea*, *Solidago multiradiata*, *Festuca idahoensis*, *Geum rossii* and *Dryas sp*. were the most abundant in open ground.

There were some minor inconsistencies between the studies. Antonsson et al. (2009) claimed that it is possible that *S. acaulis* is acting as a nurse plant only at altitudes higher than a specific threshold and is acting more as a competitor in lower altitudes as more plant species were found inside the cushions only at altitudes above 1280 m a.s.l. in northern Sweden with their sites ranging from 1150 to 1447 m elevation. We cannot compare this as our study sites have very similar elevation differing only by 18 meters, that being 1927 and 1945 m a.s.l. which should already be elevations where facilitation prevails. Yet, species composition was discovered to be comparable inside and outside the cushions in Sweden, in contrary to our discovery of a various plants having their environmental optima either inside or outside the structure. This could be due to elevation differences or climate conditions. On the other hand, these above-mentioned studies state that facilitation is supposed to be more frequent in stressful environments, however Bonanomi et al. (2016) proves that it is appearing more in intermediate level of stress. Their study sites are located in central Italy at elevations varying from 2000 to 2750 m and the plant cover and species richness seemed to shift along the elevation gradient being the highest in the medium environmental severity. In this study, the facilitation is not becoming more frequent with increasing altitude, but more frequent at intermediate elevations - in contrary to Cranston et al. (2012) or Antonsson et al. (2009) claiming that facilitation is increasing with altitude, whose studies did not consist full altitudinal range research and consisted only of few sites, so the lack of data could be the reason for the inconsistency.

Cranston et al. (2012) studied facilitation abilities in connection with the effect of gender. *Silene acaulis* was reviewed in two localities in the northern Rocky Mountains of Montana, USA at elevations 2317 and 2560 m. As female's and hermaphrodite's allocation patterns are different, even the facilitation abilities vary. Hermaphroditic individuals are said to support more plant species than female ones and facilitation should increase with elevation. However, the test of correlation between the environmental optima of plants growing within the cushion and the gender on our study sites was not significant, as well as the difference in species richness in cushions of different gender. There is only a limited dataset of gender composition of our study sites as only few individuals were flowering. This could be the main cause of discovering almost no correlations with the sex of cushions. Hermanutz and Innes (1994) reported that the presence of anther-smut *Microbotryum violaceum* (Pers.) Deml & Oberwinkler may modify the sex ratio and even sterilize both sexes. This anther smut was found at our study sites on few individuals, but it was not widespread therefore no special attention was dedicated to it in this study. Gender information was also added to dataset for IPMs assuming that the sex of the individuals did not change throughout the years. There is no connection between the gender and percentage of vegetation growing within the cushion which was recorded every year as the analysis of variance test was not significant. This could be due to the fact that the sex may be changing so this information was not correctly assigned to or maybe the gender of Slovak individuals is simply not affecting its facilitation ability. We were also comparing the compactness of the cushion or the number of capsules with the gender, but the p-values were higher than 0.05.

4.2. Gender composition

The breeding system of our Slovak populations is gynodioecious; individuals consist of females, hermaphrodites or individuals with both flowers (indeterminate gender). This was expected as gynodioecy is the most common in *S. acaulis* populations (Shykoff, 1988; Shykoff et al., 1992). The frequency of females is claimed to be increasing towards higher elevations (Alatalo and Molau, 1995; Chen et al., 2017) however, no such pattern was found in article by Delph and Carroll (2001) where female frequency varied between sites but was rather random, not increasing with altitude. We studied gender composition in 4 localities where Furkotská valley is in the highest altitude of 2080 m a.s.l. while Mengusovská valley is in 1945 m and Mlynická valley in 1927 m elevation. The frequency of female individuals was higher on three of them (Mengusovská valley (other side of the river), Mlynická valley and Furkotská valley) while it was lower in Mengusovská valley. This is interesting as Mengusovská valley is separated by a river, and on our study site, where the marked individuals were located, hermaphrodite individuals were dominant (44 to 17). However, only a few meters away across the river the gender frequency shifted, and females were dominant there (42 to 23). The gender lability of *S. acaulis* is well known (Alatalo 1997) along the fact that sometimes female and hermaphrodite flowers are not only growing on the same genet but also on the same ramet (Alatalo and Molau, 1995) called as an indeterminate gender displaying that the distribution from pure female to pure hermaphrodite is continuous (Shykoff 1988). In northern Sweden Latnjavagge valley (1000 m a.s.l.) females were found to be quite stable, while the shift from hermaphrodite to male state was more probable (Alatalo 1997). So, the difference of sex ratio on areas located in the same valley in close proximity is rather remarkable – this could happen due to presence of anther smut, or maybe this is a different population with distinctive genetic composition as the river can act as a physical barrier. Also, the sex identification was conducted only during June and July in 2020 and it is possible that different flowers may appear on the plants in various times of summer, or they are flowering twice a year as the production of ripe seeds was observed in Norway in both June and then again in September (Jones and Richards, 1962).

Cranston et al. (2012) discovered that female individuals are larger than hermaphrodites, which was also the case in our study. The correlation between gender and size of the cushion was the only significant effect of sex of marked individuals we established (p = 0.0116), which showed that hermaphrodite individuals are the smallest, females are larger, and the indeterminate gender cushions were even bigger. But recorded number of cushions with both flowers was only 11 out of 185. In contrary, some studies' results showed that the size differences between females and hermaphrodites were absent (Canelles et al., 2018; Hermanutz and Innes 1994; Alatalo and Molau 1995) and that mean plant size of hermaphrodites was only slightly higher in the article by Canelles et al. (2018) inconsistent to our findings. This was studied on three populations of *S. acaulis* in Swiss Alps and three populations in Spanish Pyrenees at elevations varying from 2020 to 2700 m a.s.l. covering the main mountain ranges in South Europe. The number of flowers per plant with different gender was not significant even in varying altitudes. We did not study the effect of elevation, but Furkotská valley was in higher elevation (2080 m a.s.l.) and the number of flowers seemed to be a little lower than in Mengusovská and Mlynická valley, but the p value was slightly higher than 0.05, tested with analysis of variance, therefore this is not significant.

4.3. Temperature and moisture effect

Climatic stress did not seem to have a convincing impact on reproductive performance in Canelles et al. (2018) and on our study population as well. In seeking for the best predictors of vital rates in *S. acaulis* populations in High Tatra Mountains we found no effect of climate on the species performance. Various studies suggest that climate might not have a great impact on the cushion plants as also Canelles et al. (2018) proposes by claiming that *S. acaulis* may not be so responsive to climate but rather other factors. Chardon et al. (2018) implies that for example disturbance can override the effect of climate. Areas disturbed by human trampling consisted of larger *S. acaulis* cushions with lower species richness, diversity and population density. The effect of nutrient availability is reportedly essential in extreme arctic conditions and can be a limiting factor more than climate (Alatalo and Little, 2014). We were not looking into nutrient availabilities and human trampling should not be a problem at our areas as they are located further from the hiking trail where entry without a permission is prohibited. On the other hand, few studies showed that specific climatic variables do have effect on species performance (Waddle 2017; Peterson et al., 2018; Ferrarini et al., 2019a; Ferrarini et al., 2019b). The number of growing degree-days above 5°C has the most significant effect for Ferrarini et al. (2019a; 2019b) but this variable was analysed not as the amount of these days in a year but as a summary of temperatures of these days, therefore this parameter was in degrees Celsius and not just a number of days possibly causing some inconsistency with this parameter studied in our analyses. Mean July temperature and mean soil moisture were significant for Peterson et al. (2018). Waddle (2017) proposes that mean July temperature and total precipitation from June to August influence fruit set output and that moss campion prefers dry and cool years for reproduction. This could be potentially changing as climate patterns are visibly shifting.

Various experimental warming studies on *S. acaulis* were conducted (Alatalo and Totland, 1997; Fosaa et al., 2011; Alatalo and Little 2014) using mostly open-top chambers (OTC). Experiment of Fosaa et al. (2011) shows increase in vegetation height and cover of herbs and graminoids growing over *S. acaulis,* which are probably superior competitors. Alatalo and Totland's (1997) simulated climate change conditions enhanced earlier flowering of cushions inside the OTC, but after one year there was a poor trend of premature flowering while the seed production was unchanged. According to warming and nutrient enhancement experiments by Alatalo and Little (2014), *S. acaulis* seems to be the most responsive to increase in both temperature and nutrients, but the least responsive in only temperature manipulations showing the importance of nutrients availability in alpine environment. Although these effects initially increased the cushions' cover, by the seventh year of experiments the combined treatment had a significant negative effect on the cover. Peterson et al. (2018) suggests that local adaptation and life history plasticity are shaping the species' responses, so any prediction is difficult to make but it is clear that these will change with the climate warming.

Our climate data were calculated for the exact positions of study populations, so even though there can be some variation, the analysed climate should match the real conditions. On the other hand, it is possible that some other not examined climate variable was influencing our populations. The monthly mean temperatures within -5°C and 5°C are suitable for *S. acaulis*, together with maximum temperatures below 20°C and more than 1200 mm of precipitation per year (Canelles et al., 2018). The monthly mean temperatures on our study sites were varying from 0.9°C to 1.66°C, maximum temperature reaching 25.05°C and precipitation per year fluctuating within 992.2 and 1238.7 mm, meeting the moss campion's requirements for population maintenance. The effect of climate is often discussed as difficult to establish as so many other factors are coming into play along the singularity of the locations and plant populations.

4.4. Vital rates predictors

Slovak individuals of *S. acaulis* were monitored for 7 years in Mengusovská and 6 years in Mlynická valley. The dataset was divided into two subsets with seedlings together with smallest individuals of the size up to 0.6 cm^2 and adult individuals larger than 0.6 cm^2. This was done due to problems with data distribution. The number of smallest cushions was large (418 individuals in the first dataset) so the gaussian distribution was impossible to achieve. Also, we wanted to isolate the predictors' effects on adult individuals as there is only little variability in a large number of small individuals and seedlings. Therefore, we have two separate exploration results for different size classes. We have decided to find the best models to the vital rates which we used in further analyses as this improves approximation of population projection matrices (Gross et al., 2006).

The effect on vital rates was tested with various predictors along *size*, $size+size^2$ and $size+size^2+size^3$. $Size+size^2$ was the most informative for growth model and $size+size^2+size^3$ was the most informative for both survival and growth. Survival is only influenced by dimension of the cushion, but growth and fecundity are also influenced by the compactness of a cushion. The tightness of moss campion's branches manipulates the microclimatic conditions and also the facilitation of the plant. Stem density is increasing with elevation together with the microclimate amelioration (Bonanomi et al., 2016). Lower altitude areas are consisting of looser cushions which are unable to trap heat or water efficiently, while high altitude areas consist of very compact cushions with ability to maintain higher temperature and moisture but reduced space for other plant species to facilitate. This could be the reason why facilitation is mostly prevalent in the middle elevation gradient as discovered by Bonanomi et al. (2016) and the fact that with higher altitude comes extreme stress so the cushion increases its stem density to survive rather than pursuing plant to plant interactions. It is possible that our study sites are located in the middle of elevation gradient, where cushions' stem density is not so high therefore it still has facilitation abilities as the environmental conditions are not so stressful, supported by the result of no prevalent effect of climate.

4.5. Population dynamics

The population growth rate (λ) values are showing that populations will be decreasing at the rate of 9.11% per year as their value is 0.9089, which is very fast. Some individuals are often shrinking, as withering parts of the biggest individuals were visible in the field. Population in Mengusovská valley is decreasing with λ value of 0.9086 and population in Mlynická valley is supposed to decrease even more due to λ value of 0.9076. Even though *S.*

acaulis is widely studied, population growth rates (λ) for this species are scarce. Projection matrix for total population of *Silene acaulis* located in the USA (900 to 1800 m a.s.l.) analysed by Morris and Doak (1998) had dominant eigenvalue (λ) of 1.0095 suggesting that their population should grow at the slow rate of 0.95% per year. Villellas et al. (2016) studying two Spanish populations of *S. acaulis* located in lower and higher altitudes had population growth rate of 0.831 for lower population (1950 m a.s.l.) and 1.109 for higher population (2700 m a.s.l). This is in accordance with our results as the Slovak study sites were located at 1927 and 1945 m elevation and the population growth rate is very similar. Presented λ values are mostly higher than 1 so the populations are increasing in size. Only our populations and lower Spanish population (Villellas et al., 2018) are shrinking. It could be possible that populations located up to 2000 m a.s.l. are performing worse, but that is not the case of populations analysed in the USA being even lower than our study sites (Morris and Doak, 1998). The populations seem to be evolving in different ways and it is possible that also the continent makes a difference.

Another cushion plants' population dynamics like *Minuartia sedioides*, *Saxifraga oppositifolia*, *Carex firma* (Lärcher et al., 2010), *Azorella compacta* (Kleier et al., 2015) or *Arenaria polytrichoides* (Chen et al., 2020) was studied as well but not using Integral Projection Models. Kleier et al. (2015) determined the growth rate by the changes in cushion dimensions presenting that the rate of radial growth is 0.4 cm per year. Chen et al. (2020) studied population density and individual size distribution by using cushion size as a proxy for age creating 6 size classes and calculated the density as the average number of individuals per square meter. They showed that the number of smaller and bigger cushions varied among elevations - lower elevations included less young and more adult and old cushions while more small cushions dominated in higher elevations. Slovak study sites are very similar in elevation therefore the size of cushions was not correlated with altitude. Even though these methods work as well, using IPMs brings more precise results as they are using continuous size of the cushions and not only artificially created size classes.

Integral projection models are useful tools that evaluate the dynamics of populations which are dependent on continuous variables (Metcalf et al., 2013). However, there is no study of moss campion that uses IPMs to evaluate the population dynamics as it is usually estimated with matrix models (Morris and Doak 1998 or Villellas et al., 2016). Integral Projection Models were created for all individuals together and for each valley separately. The models were very similar, therefore the matrices for both populations were shown and described. Seedlings are contributing only with their size and probability of survival, while adult flowering individuals are contributing also with probability to reproduce. The survival and growth Kernel is showing that all individuals have relatively low probability to grow and survive. Small seedlings are more susceptible to die due to their size and therefore higher sensitivity to various effects as early frost or competition. Survival is positively correlated with size of the cushion (Doak and Morris. 2010). The fecundity Kernel is showing that only the biggest cushions are able to reproduce. The probability of establishment was rather low in both valleys and it was counted as the ratio of discovered seedlings and total amount of capsules in the population from previous year. The average probability of establishment in Mengusovská valley was around 2% and in Mlynická valley around 0.5%. However, these probabilities are definitely not accurate as we could overlook some new seedlings and most importantly, we did not study the whole valleys but only specific areas so the seedlings could be established somewhere further. We also did not analyse the number or viability of seeds inside the capsules, but this could be done in future studies. The IPM Kernels are showing that *S. acaulis* individuals are able to grow and survive with low probability and the largest of them even successfully reproduce, but the populations are decreasing, and the likelihood of expanding is getting lower. Most of the individuals are surviving but also visibly shrinking. Medium flowering cushions with the size varying from 0.5 cm^2 to 7.4 cm^2 able to reproduce are the ones contributing to the population growth rate, so it is important to maintain the survival of these. Smallest individuals and seedlings are the ones that need to be protected to be able to withstand the most sensitive life stage.

5 Conclusion

Silene acaulis is a well-adapted plant able to survive harsh conditions which are not so favourable for many species. Its ability to buffer abiotic stress for other organisms across trophic levels is making it extremely significant species of arctic environment to maintain biodiversity. The facilitation effect of this plant is significant. More plants' environmental optima were associated with the cushion in comparison with open ground and the species richness is higher inside the cushion. The breeding system of Slovak moss campion is gynodioecious consisting of mostly female and hermaphrodite individuals, with some individuals with indeterminate gender, consisting of both female and hermaphrodite flowers on one plant. However, the sex ratio of our population can change over time (or maybe even did change already) as the gender expression is unstable and there is a scarce presence of anther smut capable of sterilizing the cushion's gender. The effect of gender on facilitation and survival was not confirmed maybe because of the low sample size but could be explored in further studies on more individuals. We studied the effect of temperature and precipitation on population performance, but no correlation was found. It is difficult to accurately predict species behaviour in the future as every population can be performing specifically. For now, it is important to be aware that Slovak populations are still continuing to reproduce but not maintaining stability. It is good to be alert that the individuals are shrinking. We should continue with observations of these or maybe more populations and be responsive by creating a detailed conservation plan if anything changes.

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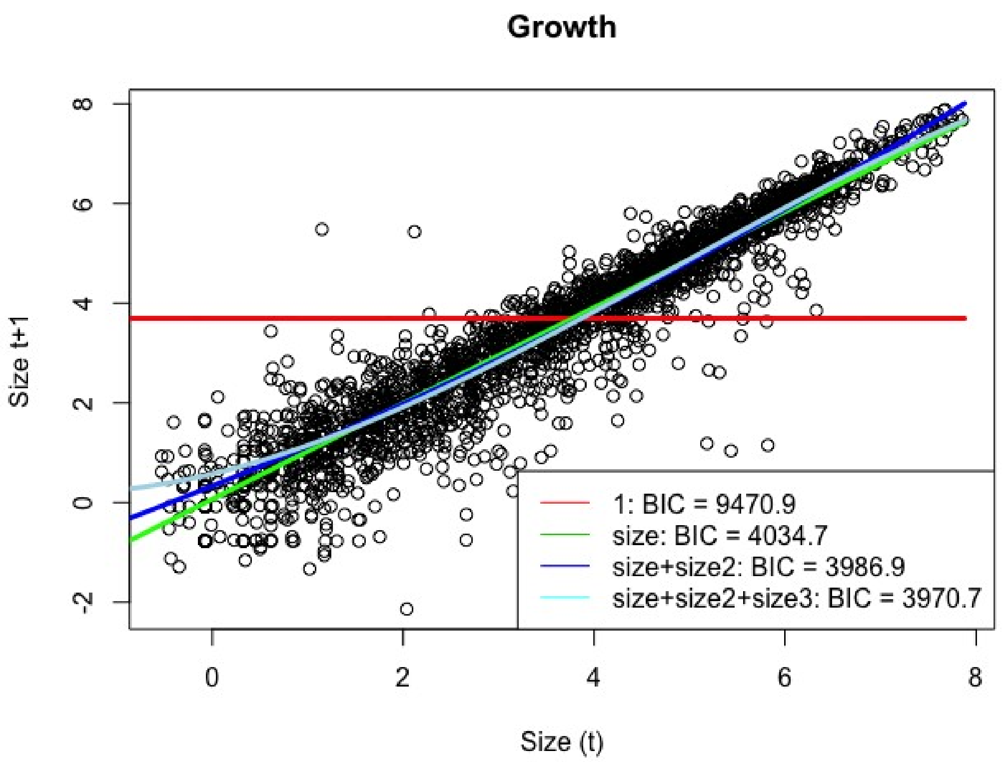
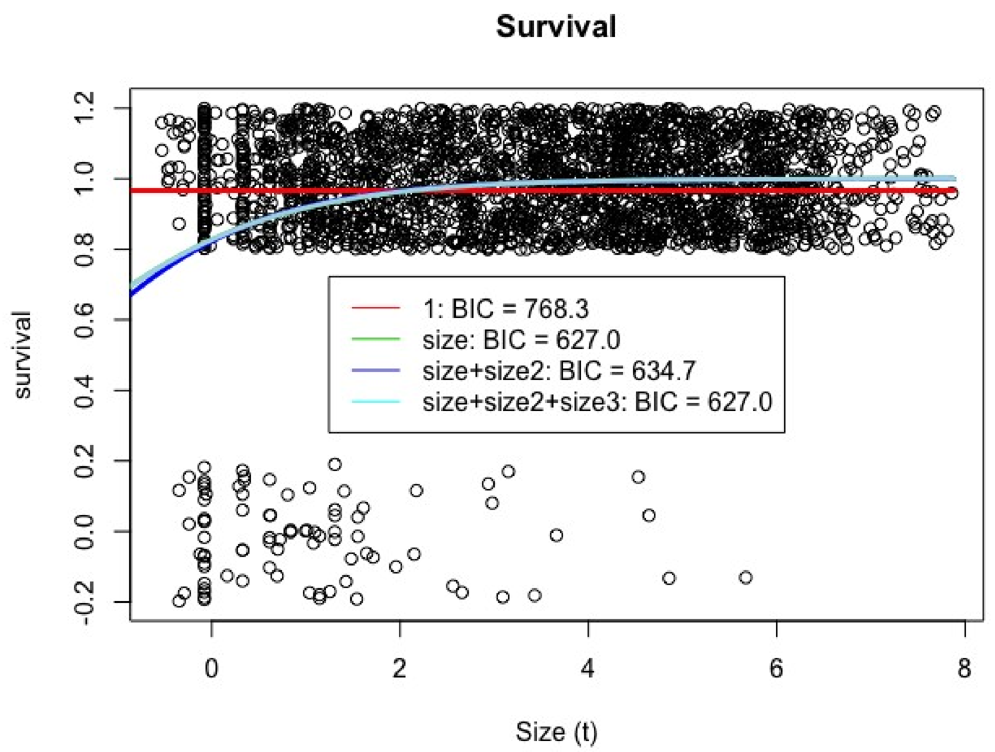
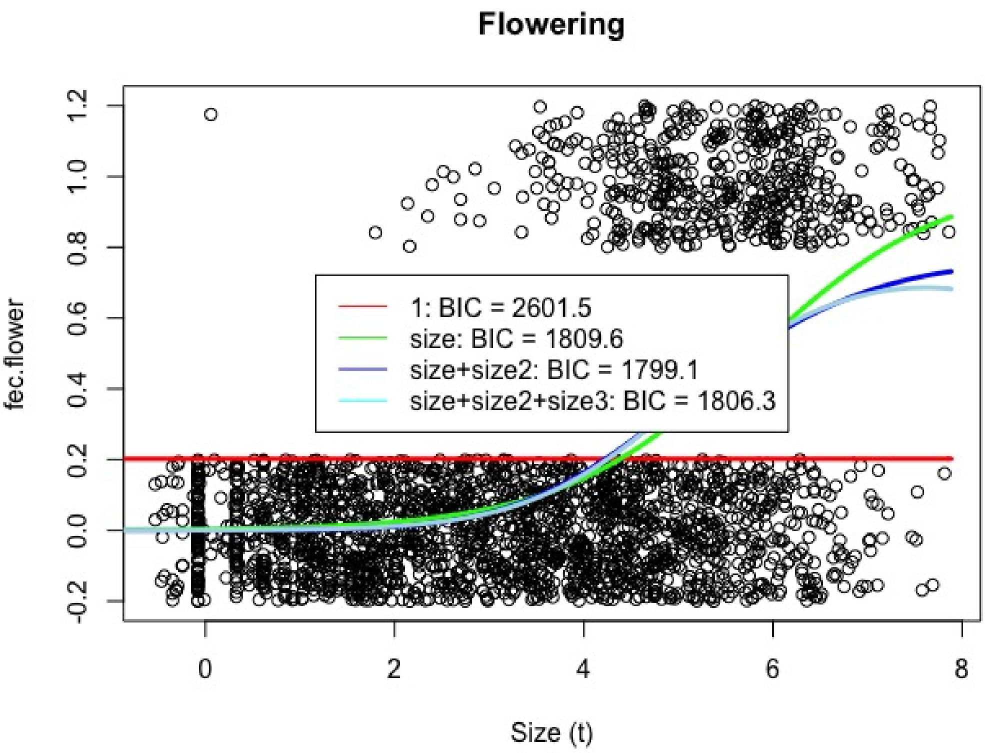
Attachment 1







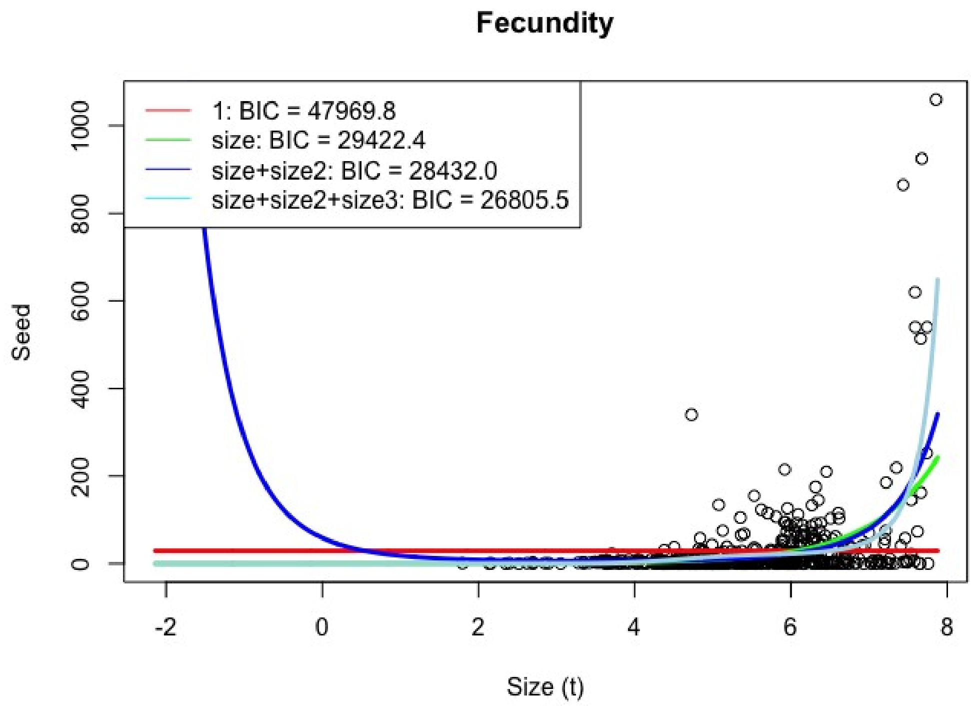


Figure 20 - Graphs of growth, survival, flowering and fecundity of the adult cushions in both valleys; each dot represents individual of certain cushion size; logarithmic size (cushion area) at time *t* on X axis (cm^2); values of BIC for specific models presented

Attachment 2: Localities

Table 14 - Occurrence localities of *S. acaulis* subspecies in Slovakia (Goliášová et al., 2012)

Silene acaulis* subsp. *excapa
Carpaticum. **Nízke Tatry (The Low Tatras)** - Chabenec (J. Šmarda 1955 BRNU). – Krúpova hoľa – Ďumbier (M. Deyl et Soják 1967 PR). – Ďumbier (Kupčok 1896 PR. BRNU; Domin 1919 PRC; Foltýn 1928 PR. PRC; Horák 1932PRC; V.Nábělek 1935BRA; Futák 1947SLO; J.Dvořák 1951BRNM; Májovský 1952 SLO; Měsíček 1967 PR). – Kozí chrbát (Horák 1932 PRC; Blattný 1958 BRa). – Ďumbier. Burtnická roveň (F. Maloch 1921 PRC. BRNU). – Králička (Vicherek 1964 BRNU). **Západné Tatry (The West Tatras)** - Salatín (Jos. Dostál 1926 PRC; Krist 1927 BRNU; Trapl 1931 PR. 1941 SLO). – Spálená dolina (Jos. Dostál 1926 PRC). – Baníkov (Jos. Dostál 1925. 1926 PRC). – Smutná dolina (Scheffer 1928 SLO). – Plačlivô (Švestka 1926 BRNM; Černoch 1932 BRNM). – Ostrý Roháč (Jos. Dostál 1926 PRC). – Volovec (s. coll. 1921 PRC; Vítek 1927 BRNM; J. Šmarda 1935 BRNU; F. Nábělek 1940 SLO; Novacký 1940 BRA). – Račkove plesá (Margittai 1914 PRC; s. coll. 1980 ROZ). – Bystrá (Jos. Dostál 1946 PRC).

– Veľká Kamenistá (Pyšek 1978 ROZ; Šrůtek 1978 ROZ; E. Králik 1990 SLO).

– Tomanova dolina (Unar 1968 BRNU).

– Predný Úplaz (Jos. Dostál 1928 PRC).

– Ľaliové sedlo (Švestka 1931 BRNM).

Vysoké Tatry (The High Tatras)

- Kriváň (F. Weber 1923 BRa. 1935 PR. 1936 BRA).

– Nižné Temnosmrečinské pleso (S o j á k 1955 PR).

– Temnosmrečinská dolina (Švestka 1931 BRNM).

– Chalubinského vráta (Švestka 1931 BRNM).

– Furkotská dolina (Domin 1925 PRC; Polívka 1938 PR; Vaněch 1969 BRNM).

– Wahlenbergove plesá (J. Šmarda 1959 BRNU).

– Furkotský štít (F. W e b e r 1925 BRA).

– Solisko (D o m i n 1919 PRC).

– Bystrá lávka (s. coll. 1970 BRA).

– Mlynická dolina (Schuster 1920 PR; Oberberger 1921 PR; Jos. Dostál 1933 PR; Šourek 1948 PR).

– Mlynica. pod vodopádom Skok (J. Šmarda 1934 BRNU).

– Satan (F. Weber 1925 BRA).

– Kôprovský štít (Jos. Dostál 1951 PR).

– Kôprovské sedlo (F. Nábělek 1940 SLO).

– Mengusovská dolina (Margittai 1915 PRC; Žertová 1953 PR).

– Hincovo pleso (Zlatník 1922 BRNM; J. Šmarda 1934 BRNU; Jos. Dostál 1938 PRC; Černoch 1952 BRNM).

– Kotlina Žabích plies (Sterneck 1902 PRC).

– Rysy (Zlatník 1921 BRNM; Vítek 1927 BRNM; Güttler 1931 PRC; Futák 1940 SLO).

– Ostrva (Širjaev 1925 BRNU).

– Tupá (Jos. Dostál 1946 PR).

– Gerlach (F. Weber 1922 PR. 1923 BRA; Švestka 1928 BRNM).

– Končistá (F. Weber 1923 BRa).

– Velická dolina. Kvetnica (Kláštersky 1925 PR; Paclová 1968 SLO).

– Velická dolina (Jos. Dostál 1956 PR).

– Poľský hrebeň (Domin 1919 PRC; Horák 1932 PRC; Novacký 1948 BRa).

– Veľká Studená dolina. Vareškové pleso (P o s p í š i l 1947 BRNM).

– Sedielko (F u t á k 1946 SLO; s. coll. 1954 PR; Foltínová 1969 BRA).

– Malá Studená dolina (Futák 1943 SLO).

– Pfinnova kopa (Paclová 1968 SLO).

– Bielovodská dolina. Zelené Kačacie pleso (Zajacová 1962 SLO).

– Bielovodská dolina. pod Zadnou kopou (Beličková et Liptáková 1962 SLO).

– Široká (Jos. Dostál 1954 PR).

– Lomnické sedlo (Domin 1919 PRC; Pospíšil 1947 BRNM).

– Skalnatá dolina. Cmiter (Jos. Dostál 1947 PRC).

– Čierne pleso (Schidlay 1939).

– Dolina Zeleného plesa. Zelené pleso (Podpěra 1924 BRNU; Futák et Opluštilová 1943 SLO; Futák 1946 SLO).

– Baranie sedlo (letz 2008 SAV).

– Čierny štít (Jos. Dostál 1949 PRC).

– Kolový štít (Švestka 1927 BRNM).

– Veľká Svišťovka (Jílek 1929 PRc).

Belianske Tatry (The Belianske Tatras)

- vrch Havran (Zlatník 1922 BRNM).

– Ždiarska vidla. Rendy (Jos. Dostál 1969 PR).

– Ždiarska vidla (Soják 1969 PR).

– Zadné Meďodoly (Zajacová 1962 SLO).

– Kopské sedlo (Soják 1955 PR).

– vrch Hlúpy (M. Deyl 1938 PR).

– vrch Kopa (Čer- noch 1929 BRNM; Suza et Doležal 1929 PR. PRC. BRNM. BRNU).

– Jatky (s. coll. 1968 PR).

– vrch Bujačí (V. N á b ě l e k 1936 BRA; s. coll. 1955 PR).

– Dolina Siedmich prameňov (s. coll. 1880 BRA; V. V r a n ý 1885 BRa).

Liptov basin

- Liptovský Hrádok. Nové jazierka (J. Š m a r d a 1927. 1936 BRNM).

Silene acaulis* subsp. *longiscapa

Carpaticum.

Nízke Tatry (The Low Tatras)

- Ďumbier. Chata pod Ďumbierom (M. D e y l et S o j á k 1967 PR).

– Ďumbier. Štefánikova chata (s. coll. 1930 PR).

– Ďumbier (Foltýn 1928 PRC; Futák 1947 Slo).

Západné Tatry (The West Tatras)

- Smutná dolina (Jos. Dostál 1926 PRC; Součková et J. Šmarda 1950 BRNM).

– Ostrý Roháč (M. Deyl 1938 PR).

– Kamenistá dolina. záver (Švestka 1935 BRNM).

– Temniak (Soják 1955 PR).

– Kresanica (Švestka 1935 BRNM).

– Rozpadlý grúň (Unar 1960 BRNU).

– Žľab spod Diery (Unar 1969 BRNU).

– Kondratova kopa (Jos. Dostál 1930 PRc).

Vysoké Tatry (The High Tatras)

- Mlynická dolina (J. Šmarda 1958 BRNU).

– Satan (F. Weber 1923 BRNM).

– Kotlina Žabích plies (Širjaev 1925 BRNU).

– Ostrva (J. Šmarda 1958 BRNU).

– Bielovodská dolina. pod Zadnou kopou (Liptáková et Zajacová 1962 SLO).

– Zámky (Klášterský 1925 PR).

– Dolina Bieleho plesa (Krajina 1924 PRC; Futák 1943 Slo).

Belianske Tatry (The Belianske Tatras)

- Stará Poľana. Javorinka (Domin et Krajina 1926 PRC).

– Nový (Ronninger 1918 W; Pulchart et Souček 1935 BRNM).

– vrch Havran (Lakowitz 1883 PR; Domin 1929 PRC; Futák 1943 SLO; F. Nábělek 1943 SLO; Májovský 1957 SLO; Klášterský et Měsíček 1959 PR; Vašák 1967 PR).

– Ždiarske sedlo (Hodoval 1971 BRA).

– Tristárska dolina (Futák 1943. 1946 SLO).

– Ždiarska vidla (F. Nábělek 1940 SLO; Kneblová 1951 PR; Májovský 1957 SLO; J. Šmarda et Vaněčková 1962 BRNM; Vašák 1967 PR; Chrtek et Deylová 1979 PR).

– Zadné Meďodoly. pod Kopským sedlom (l e t z 1993 SAV).

– Kopské sedlo (D o m i n 1919 PRC).

– Široké sedlo (Jos. Dostál 1968 PR).

– vrch Hlúpy (Krajina 1925 PRC; Sillinger 1926 PR).

– vrch Kopa (Černoch 1929 BRNM; Suza et Doležal 1929 SLO. PR).

– Jatky (Vašák 1967 PR).

– Košiare (J. Dvořák 1949 BRNM).

– vrch Bujačí (Domin et Krajina 1925 PRC; Širjaev 1929 BRNU; Pulchart et Souček 1934 BRNM; V. Nábělek 1936 BRA; M. Deyl 1938 PR; Jedlička 1946 BRNU; J. Dvořák 1947 BRNM; Kavka 1948 BRA; Šourek 1948 PR; Vašák 1967 PR).

– Galfovka (Domin 1933 PRC).

– Holubyho dolina (Otruba 1932 PR).

– Skalné vráta (s. coll. 1947 BRNM; s. coll. 1961 PR).

– Dolina Siedmich prameňov (V. Vraný 1885 BRA; Otruba 1932 PRc).

Attachment 3: Permission

22 JÚN 2020 POŠTA

MINISTERSTVO
ŽIVOTNÉHO PROSTREDIA
SLOVENSKEJ REPUBLIKY

Odbor štátnej správy ochrany prírody a krajiny

toto rozhodnutie nadobudlo právoplatnosť
dňa 26. 06. 2020

Bratislava, 22.06.2020
Číslo: 7878/2020-6.3
28614/2020

Rozhodnutie

Ministerstvo životného prostredia Slovenskej republiky, odbor štátnej správy ochrany prírody a krajiny ako príslušný orgán štátnej správy podľa § 2 ods. 1 písm. c) zákona č. 525/2003 Z. z. o štátnej správe starostlivosti o životné prostredie a o zmene a doplnení niektorých zákonov na základe žiadosti Botanického ústavu AV ČR, veřejná výzkumná instituce, Zámek 1, 252 43 Průhonice, Česká republika, zastúpenej Doc. Ing. Janom Wildom, PhD. – riaditeľom (ďalej len „žiadateľ"), doručenej dňa 27.04.2020, v súlade s § 46 zákona č. 71/1967 Zb. o správnom konaní (správny poriadok) v znení neskorších predpisov (ďalej len „správny poriadok"), § 89 ods. 1 písm. a) bod 1 a 2 a § 89 ods. 2 zákona č. 543/2002 Z. z. o ochrane prírody a krajiny v znení neskorších predpisov (ďalej len „zákon o ochrane prírody")

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rozhodnutie Ministerstva životného prostredia Slovenskej republiky, odboru štátnej správy ochrany prírody č. 6189/2017-6.3 zo dňa 21.08.2017 (ďalej len „rozhodnutie"), ktorým bol vydaný žiadateľovi súhlas na výskum rastlinných druhov silenka bezbyľová (*Silene acaulis*) a kurička rozchodníkovitá (*Minuartia sedoides*), a súčasne povolené výnimky zo zákazov územnej i druhovej ochrany podľa zákona o ochrane prírody, v súvislosti s výskumným projektom tak, že jeho výroková časť znie:

„Ministerstvo životného prostredia Slovenskej republiky, odbor štátnej správy ochrany prírody a krajiny (ďalej „ministerstvo") ako príslušný orgán štátnej správy podľa § 2 ods. 1 písm. c) zákona č. 525/2003 Z. z. o štátnej správe starostlivosti o životné prostredie a o zmene a doplnení niektorých zákonov v znení neskorších predpisov, § 65 ods. 1 písm. h) a § 83 ods. 1 zákona č. 543/2002 Z. z. o ochrane prírody a krajiny v znení neskorších predpisov (ďalej len „zákon o ochrane prírody"), na základe žiadosti Botanického ústavu AV ČR, veřejná výzkumná instituce, Zámek 1, 252 43 Průhonice, Česká republika, zastúpenej Doc. Ing. Janom Wildom, PhD. – riaditeľom (ďalej len „žiadateľ"), v súlade s § 40 ods. 2 a 3 písm. d) zákona o ochrane prírody a s § 46 zákona č. 71/1967 Zb. o správnom konaní (správny poriadok) v znení neskorších predpisov (ďalej len „správny poriadok")

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zo zákazov územnej ochrany ustanovených v § 14 ods. 1 písm. c), § 15 ods. 1 písm. a) v znení § 14 ods. 1 písm. c), § 16 ods. 1 písm. a) v znení § 14 ods. 1 písm. c); § 14 ods. 1 písm. h), § 15 ods. 1 písm. a) v znení § 14 ods. 1 písm. h), § 16 ods. 1 písm. a) v znení § 14 ods. 1 písm. h) zákona o ochrane prírody a zo zákazov druhovej ochrany ustanovených v § 34 ods. 1 písm. a) a b) zákona o ochrane prírody. Výnimkou sa povoľuje žiadateľovi pohybovať sa mimo vyznačeného turistického chodníka alebo náučného chodníka za hranicami zastavaného územia obce, zbierať rastliny vrátane ich plodov na území, na ktorom platí 3. až 5. stupeň ochrany, úmyselne trhať, zbierať, rezať, vykopávať alebo ničiť chránenú rastlinu druhu

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MINISTERSTVO
ŽIVOTNÉHO PROSTREDIA
SLOVENSKEJ REPUBLIKY

Odbor štátnej správy ochrany prírody a krajiny

Bratislava, 22.06.2020
Číslo: 7878/2020-6.3

Rozhodnutie

Ministerstvo životného prostredia Slovenskej republiky, odbor štátnej správy ochrany prírody a krajiny ako príslušný orgán štátnej správy podľa § 2 ods. 1 písm. c) zákona č. 525/2003 Z. z. o štátnej správe starostlivosti o životné prostredie a o zmene a doplnení niektorých zákonov na základe žiadosti Botanického ústavu AV ČR, veřejná výzkumná instituce, Zámek 1, 252 43 Průhonice, Česká republika, zastúpenej Doc. Ing. Janom Wildom, PhD. – riaditeľom (ďalej len „žiadateľ"), doručenej dňa 27.04.2020, v súlade s § 46 zákona č. 71/1967 Zb. o správnom konaní (správny poriadok) v znení neskorších predpisov (ďalej len „správny poriadok"), § 89 ods. 1 písm. a) bod 1 a 2 a § 89 ods. 2 zákona č. 543/2002 Z. z. o ochrane prírody a krajiny v znení neskorších predpisov (ďalej len „zákon o ochrane prírody")

m e n í

rozhodnutie Ministerstva životného prostredia Slovenskej republiky, odboru štátnej správy ochrany prírody č. 6189/2017-6.3 zo dňa 21.08.2017 (ďalej len „rozhodnutie"), ktorým bol vydaný žiadateľovi súhlas na výskum rastlinných druhov silenka bezbyľová (*Silene acaulis*) a kurička rozchodníkovitá (*Minuartia sedoides*), a súčasne povolené výnimky zo zákazov územnej i druhovej ochrany podľa zákona o ochrane prírody, v súvislosti s výskumným projektom tak, že jeho výroková časť znie:

„Ministerstvo životného prostredia Slovenskej republiky, odbor štátnej správy ochrany prírody a krajiny (ďalej „ministerstvo") ako príslušný orgán štátnej správy podľa § 2 ods. 1 písm. c) zákona č. 525/2003 Z. z. o štátnej správe starostlivosti o životné prostredie a o zmene a doplnení niektorých zákonov v znení neskorších predpisov, § 65 ods. 1 písm. h) a § 83 ods. 1 zákona č. 543/2002 Z. z. o ochrane prírody a krajiny v znení neskorších predpisov (ďalej len „zákon o ochrane prírody"), na základe žiadosti Botanického ústavu AV ČR, veřejná výzkumná instituce, Zámek 1, 252 43 Průhonice, Česká republika, zastúpenej Doc. Ing. Janom Wildom, PhD. – riaditeľom (ďalej len „žiadateľ"), v súlade s § 40 ods. 2 a 3 písm. d) zákona o ochrane prírody a s § 46 zákona č. 71/1967 Zb. o správnom konaní (správny poriadok) v znení neskorších predpisov (ďalej len „správny poriadok")

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zo zákazov územnej ochrany ustanovených v § 14 ods. 1 písm. c), § 15 ods. 1 písm. a) v znení § 14 ods. 1 písm. c), § 16 ods. 1 písm. a) v znení § 14 ods. 1 písm. c); § 14 ods. 1 písm. h), § 15 ods. 1 písm. a) v znení § 14 ods. 1 písm. h), § 16 ods. 1 písm. a) v znení § 14 ods. 1 písm. h) zákona o ochrane prírody a zo zákazov druhovej ochrany ustanovených v § 34 ods. 1 písm. a) a b) zákona o ochrane prírody. Výnimkou sa povoľuje žiadateľovi pohybovať sa mimo vyznačeného turistického chodníka alebo náučného chodníka za hranicami zastavaného územia obce, zbierať rastliny vrátane ich plodov na území, na ktorom platí 3. až 5. stupeň ochrany, úmyselne trhať, zbierať, rezať, vykopávať alebo ničiť chránenú rastlinu druhu silenka bezbyľová (*Silene acaulis*) na území Tatranského národného parku, v lokalite Národných prírodných rezervácií Mlynická dolina, Mengusovská dolina, Furkotská dolina, Velická dolina a Belianske Tatry – oblasť Kopského a Vyšného Kopského sedla, a súčasne ju držať a prepravovať, v súvislosti s realizáciou výskumu uvedeného druhu chránenej rastliny.

Podmienky povolenia výnimky v zmysle § 82 ods. 12 zákona o ochrane prírody:

1. Osoby oprávnené vykonávať predmetný výskum sú: Doc. RNDr. Zuzana Münzbergová, PhD., RNDr. Tomáš Dostálek, PhD. a Bc. Emma Krchová.
2. Realizátori výskumu budú v prípade potreby sprevádzaní najviac dvomi pomocníkmi z radov študentov.
3. Žiadateľ vykoná zber šetrným spôsobom a iba v nevyhnutnom rozsahu za účelom stanovenia produkcie semien a vykonania genetickej analýzy.
4. Všetky semená rastlín žiadateľ ponechá v dotknutých lokalitách.
5. Žiadateľ zabezpečí priebežné odstraňovanie značenia odumretých jedincov.
6. Po ukončení výskumných prác žiadateľ upraví výskumné plochy do pôvodného stavu, t. j. odstráni z nich všetok antropický materiál (visačky, kovové tyčky a pod.)
7. Žiadateľ sa bude pohybovať mimo vyznačených alebo náučných turistických chodníkov iba v minimálnej miere a len za účelom realizácie výskumnej činnosti.
8. Žiadateľ písomne oznámi návštevu dotknutých lokalít na adresu Štátnej ochrany prírody Slovenskej republiky, Správy Tatranského národného parku (ďalej len „S-TANAP“) alebo prostredníctvom e-mailu (www.sopsr.sk/kontakty) najmenej 3 pracovné dni pred plánovanou návštevou.
9. Žiadateľ odovzdá informácie o chránených a vzácnych druhoch, ktoré budú zistené počas realizácie výskumu vo forme zápisu do Komplexného informačného a monitorovacieho systému (KIMS) na internetovej stránke www.biomonitoring.sk.
10. V prípade potreby sa žiadateľ preukáže pracovníkom S-TANAP alebo členom stráže prírody, ktorí vykonávajú kontrolu v teréne fotokópiou tohto rozhodnutia.

Osobitné predpisy, ako aj ostatné ustanovenia zákona o ochrane prírody, ostávajú vydaním tohto rozhodnutia nedotknuté.

Rozhodnutie platí do 31.12.2025.“.

O d ô v o d n e n i e

Dňa 27.04.2020 bolo na ministerstvo doručené podanie žiadateľa o povolenie výnimiek zo zákazov územnej i druhovej ochrany ustanovených v zákone o ochrane prírody v súvislosti s realizáciou výskumu chránenej rastliny druhu silenka bezbyľová (*Silene acaulis*).

Listom, ktorý bol na ministerstvo doručený dňa 28.05.2020 žiadateľ doplnil svoje podanie o informáciu, že má záujem o zmenu rozhodnutia, a súčasne o predĺženie jeho platnosti do 31.12.2025 z dôvodu potreby rozšírenia výskumu o ďalšie lokality a osoby, ktoré sú oprávnené na vykonávanie výskumných činností. Žiadateľ požaduje zmenu, ako i predĺženie platnosti rozhodnutia z dôvodu potreby získania komplexných poznatkov o vplyve klimatických zmien na dynamiku chránenej rastliny druhu silenka bezbyľová (*Silene acaulis*), ako i z dôvodu prognózovania vplyvu klimatických zmien na druhy alpínskych ekosystémov. Prostredníctvom e-mailu zo dňa 17.06.2020 žiadateľ opätovne doplnil svoje podanie o informáciu, že žiada o zmenu rozhodnutia súčasne z dôvodu potreby povolenia držby a prepravy dotknutého druhu chránenej rastliny.

Z obsahu žiadosti je zrejmé, že výskumný projekt je zameraný na skúmanie vyššie uvedeného druhu chránenej rastliny. Rastlinný druh kurička rozchodníkovitá (Minuartia sedoides), ktorá bola zahrnutá do výroku rozhodnutia, nepatrí medzi chránené druhy rastlín v zmysle vyhlášky Ministerstva životného prostredia Slovenskej republiky č. 24/2003 Z. z., ktorou sa vykonáva zákon o ochrane prírody. Vzhľadom na uvedené ministerstvo predmetný rastlinný druh neuviedlo vo výroku tohto rozhodnutia.

Ministerstvo podľa § 82 ods. 7 zákona o ochrane prírody zverejnilo dňa 18.05.2020 na svojej internetovej stránke informáciu o začatí predmetného konania a takisto určilo lehotu písomného alebo elektronického potvrdenia záujmu byť účastníkom konania. Do konania sa v stanovenej lehote neprihlásil žiaden ďalší účastník.

Listom č. 7878/2020-6.3 zo dňa 25.05.2020 si ministerstvo vyžiadalo k žiadosti odborné stanovisko od Štátnej ochrany prírody Slovenskej republiky (ďalej len „ŠOP SR"). Stanovisko bolo ministerstvu doručené dňa 10.06.2020, listom ŠOP SR/761-003/2020 zo dňa 08.06.2020.

Listom č. 7878/2020-6.3 zo dňa 24.02.2020 ministerstvo v zmysle § 33 ods. 2 správneho poriadku oboznámilo žiadateľa s podkladmi pre rozhodnutie. Žiadateľ sa k podkladom rozhodnutia vyjadril prostredníctvom e-mailu zo dňa 15.06.2020 tak, že so stanoviskom ŠOP SR súhlasí.

Ministerstvo žiadosť spolu s ostatnými podkladmi rozhodnutia preskúmalo v celom rozsahu a dospelo k nasledovnej správnej úvahe.

Výskumný projekt je súčasťou celoeurópskeho výskumu, ktorého cieľom je štúdium vplyvu klimatických zmien na dynamiku, t. j. napr. zmenu priestorovej štruktúry, populačnej hustoty, ako i početnosti populácie chránenej rastliny druhu silenka bezbyľová (*Silene acaulis*). V rámci výskumu bol vytýčený trvalý transekt, označený na oboch koncoch kovovými klincami, zaznamenanými pomocou GPS, a súčasne zakreslenými do mapy. Približne vo vzdialenosti 1 meter z oboch strán od vytýčeného transektu realizátori výskumu vyhľadávajú a následne označujú všetky jedince skúmaného druhu drôtikom s kovovou alebo plastovou visačkou s číslom. Následne zmerajú ich veľkosť a zistia počet kvetov a vyvinutých toboliek dotknutých jedincov. Súčasne je zistená produkcia semien, pričom semená sú ponechané priamo na mieste. Značenie jednotlivých rastlín pomocou drôtikov je nevyhnutné z dôvodu, že niektoré jedince sa vyskytujú v tesnej blízkosti a ich zameranie pomocou pásma alebo GPS by neumožňovalo ich jednoznačnú identifikáciu v nasledujúcich rokoch.

V súčasnosti výskum prebieha na území Národných prírodných rezervácií Mlynická a Mengusovská dolina. Žiadateľ má záujem pokračovať v uvedenom výskume, a súčasne ho rozšíriť o skúmanie a porovnanie kvitnutia dotknutých jedincov na pôvodných, ako aj nových lokalitách, t. j. na území Národných prírodných rezervácií Furkotská dolina, Velická dolina a Belianske Tatry, oblasť Kopského sedla, ako i Vyšného Kopského sedla z dôvodu potreby získania podrobných údajov o vplyve klimatických zmien na dynamiku chránenej rastliny druhu silenka bezbyľová (*Silene acaulis*). V nových lokalitách bude sledované pohlavie kvitnúcich rastlín, pomer pohlaví a vykonaný súpis ostatnej vegetácie, rastúcej v trse záujmového druhu pre jednoznačnú identifikáciu označených jedincov. Označovanie jedincov a odber rastlinného materiálu bude realizovaný len v pôvodných lokalitách a hlavný zber dát bude prebiehať v období mesiacov jún až august, tzn. od obdobia kvitnutia dotknutého druhu chránenej rastliny.

Podľa § 89 ods. 1 písm. a) bod 1. a 2. zákona o ochrane prírody orgán ochrany prírody môže ním vydané rozhodnutie z vlastného podnetu alebo na návrh účastníka konania zmeniť, ak dôjde k zmene skutočností, rozhodujúcich na vydanie rozhodnutia alebo ak to vyžadujú záujmy ochrany prírody a krajiny, chránené týmto zákonom. Súčasne podľa § 89 ods. 2 zákona o ochrane prírody môže platnosť ním vydaného rozhodnutia z vlastného podnetu alebo na návrh účastníka konania predĺžiť, a to aj opakovane za splnenia podmienok, uvedených v tomto zákone.

Ministerstvo má za to, že predĺženie, ako i rozšírenie dotknutého výskumu o nové lokality, sú dôležité pre získanie potrebného množstva relevantných údajov o chránenej rastline druhu silenka bezbyľová (*Silene acaulis*). Získané dáta budú prínosom pre zabezpečenie efektívnej ochrany populácie dotknutého druhu chránenej rastliny, ako i ochrany biotopov, v ktorých sa vyskytuje, a súčasne budú východiskom pri predpovedaní vplyvu klimatických zmien na ďalšie druhy alpínskych ekosystémov.

Vzhľadom na skutočnosť, že lokality, na ktorých sa bude realizovať predmetný výskum, sú súčasťou územia európskeho významu SKUEV0307 Tatry a oblasť Kopského a Vyšného Kopského sedla taktiež súčasťou chráneného vtáčieho územia SKCHVÚ030Tatry, ktoré patria do Európskej sústavy chránených území (ďalej len „Natura 2000"), ministerstvo má za to, že pokračovanie výskumného projektu významnou mierou prispeje k zlepšeniu poznatkov o skúmanom území, ako aj k celkovému mapovaniu a poznaniu vybraného druhu v dotknutých lokalitách. Vzhľadom na vysoko odborný prístup, ako i rozsah monitorovacích plôch, ministerstvo je toho názoru, že pokračovanie výskumného projektu nebude mať nepriaznivý vplyv na populácie druhov ani na dotknuté chránené územia. Výskumné činnosti, ktoré budú vykonávať riešitelia uvedeného vedecko-výskumného projektu, sú činnosťami, ktoré priamo súvisia so starostlivosťou o územia Natura 2000, sú pre starostlivosť o tieto územia potrebné a významným spôsobom prispievajú k ich ochrane.

Vzhľadom na uvedené, ako aj na skutočnosť, že sú splnené podmienky ustanovení zákona, rozhodlo ministerstvo tak, ako je uvedené vo výrokovej časti tohto rozhodnutia.

Súčasne ministerstvo uvádza, že prijatím zákona č. 356/2019 Z. z. (účinný od 1.1.2020), ktorým sa mení a dopĺňa zákon o ochrane prírody a ktorým sa menia a dopĺňajú niektoré zákony (ďalej len „novela zákona o ochrane prírody"), nastala zmena v ustanovení § 56 zákona o ochrane prírody a na vykonávanie prieskumu alebo výskumu sa nevyžaduje súhlas orgánu ochrany prírody.

Z dôvodu nadobudnutia účinnosti novely zákona o ochrane prírody ministerstvo žiadateľa upozorňuje na vybrané ustanovenia zákona o ochrane prírody, ktoré je žiadateľ povinný pri vykonávaní činnosti podľa tohto rozhodnutia dodržiavať:

1. Podľa § 56 ods. 3 zákona o ochrane prírody je oprávnená osoba povinná najmenej

sedem dní vopred v elektronickej podobe alebo listinnej podobe oznámiť organizácii ochrany prírody začatie a ukončenie prieskumu a výskumu osobitne chránenej časti prírody a krajiny. Po ukončení prieskumu a výskumu je oprávnená osoba povinná do šiestich mesiacov odovzdať organizácii ochrany prírody správu o jeho výsledku; pri viacročnom prieskume a výskume je oprávnená osoba povinná odovzdať priebežnú správu o jeho výsledku každoročne do 31. januára príslušného kalendárneho roka. Oprávnená osoba môže pri odovzdávaní údajov určiť podmienky, za akých možno tieto údaje sprístupňovať a poskytovať o nich informácie. Informácie o prieskume a výskume organizácia ochrany prírody zverejňuje na svojom webovom sídle; ustanovenia osobitného predpisu (zákon č. 185/2015 Z. z. Autorský zákon v znení neskorších predpisov).

2. Podľa § 56 ods. 4 zákona o ochrane prírody pri vykonávaní prieskumu a výskumu oprávnená osoba spolupracuje s vlastníkom, správcom alebo nájomcom pozemku, na ktorom sa prieskum a výskum vykonáva, ak je to vzhľadom na spôsob jeho vykonávania potrebné, pričom je povinná rešpektovať jeho práva a oprávnené záujmy. Ak ide o prieskum a výskum v záujme ochrany prírody a krajiny a nedôjde k dohode s vlastníkom, správcom alebo nájomcom pozemku, na ktorom sa má prieskum a výskum vykonať, o vykonaní prieskumu a výskumu a o podmienkach, za akých sa môže vykonať, rozhodne orgán ochrany prírody.

Ministerstvo súčasne upozornilo žiadateľa, že vydaním rozhodnutia ostávajú nedotknuté osobitné predpisy (napr. povolením výnimky nie sú dotknuté vlastnícke vzťahy), ako aj ostatné ustanovenia zákona o ochrane prírody.

Poučenie

Proti tomuto rozhodnutiu možno podľa § 61 správneho poriadku podať rozklad v lehote 15 dní odo dňa jeho doručenia na Ministerstvo životného prostredia Slovenskej republiky, Nám. Ľ. Štúra 1, 812 35 Bratislava.

Toto rozhodnutie nie je preskúmateľné súdom podľa zákona č. 162/2015 Z. z. Správny súdny poriadok v znení neskorších predpisov, pokiaľ nebol vyčerpaný riadny opravný prostriedok.

MINISTERSTVO ŽIVOTNÉHO PROSTREDIA SR
Nám. Ľudovíta Štúra 1, 812 35 BRATISLAVA
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Mgr. Lenka Jamborová
riaditeľka odboru