UNIVERZA NA PRIMORSKEM
FAKULTETA ZA MATEMATIKO, NARAVOSLOVJE IN INFORMACIJSKE TEHNOLOGIJE

MAGISTRSKO DELO
(MASTER'S THESIS)

ZELENE STREHE KOT POTENCIAL ZA OHRANJANJE BIODIVERZITETE
(GREEN ROOFS AS POTENTIAL FOR BIODIVERSITY CONSERVATION)

SARA STIJAČIĆ

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Zelene strehe kot potencial za ohranjanje biodiverzitete

(Green roofs as potential for biodiversity conservation)

Ime in priimek: Sara Stijačić
Študijski program: Varstvo narave, 2. stopnja
Mentor: doc. dr. Živa Fišer
Somentor: izr. prof. dr. Peter Mackelworth

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Izvleček: Cilj te magistrske naloge je proučiti potenciale, ki jih ponujajo zelene strehe, s posebnim poudarkom na ohranjanju biotske raznovrstnosti. S pomočjo vprašalnikov smo želeli raziskati, kakšno znanje in mnenje imajo podjetja, ki se ukvarjajo z gradnjo zelenih streh, in splošna javnost, o temah, povezanih z biotsko raznovrstnostjo. Na vprašalniuke so odgovarjala podjetja in posamezniki tako v Sloveniji kot v Srbiji. Na podlagi literaturnih podatkov in podatkov, ki smo jih pridobili od podjetij, smo sestavili seznam rastlinskih vrst, ki se v Evropi uporabljajo za zelene strehe. Pregledali smo tudi slovenske avtohtone vrste z varstvenim pomenom (zavarovane vrste in vrste z rdečega seznama) ter preverili, ali so bile katere izmed vrst že uporabljene na zelenih strehah. Rezultati anket so pokazali, da ohranjanje biotske raznovrstnosti ni primarnega pomena pri sprejemanju odločitev strank za zelene strehe. Med najpomembnejše razloge so navedeni estetska vrednost in tehnični razlozi. Tujerodne vrste so v sedanjih zasaditvah zelenih streh bolj prisotne kot domorodne vrste, a te predstavljajo neizkoriščen potencial za uporabo na zelenih strehah. Upamo, da bo to magistrsko delo doprineslo nekaj novih podatkov o uporabi slovenskih rastlin na zelenih strehah in spodbudilo nadaljnje raziskave o uporabi avtohtonih vrst na zelenih strehah ter da bo ohranjanje biotske raznovrstnosti na zelenih strehah postalo še bolj aktualna tema.

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Abstract: This master's thesis aim is to examine the potentials that green roofs offer, with particular emphasis on biodiversity conservation. To understand the knowledge and attitudes towards biodiversity issues in the urban environment and the potential of green roofs, we surveyed companies engaged in the construction of green roofs, and the general public, both in Slovenia and Serbia. Based on literature review and our surveys, we have also compiled a list of plant species that are being used in green roofs in Europe. We have also surveyed the Slovenian native species of conservation concern (protected species and species included in the red list) and checked whether any of them has been previously used in green roofs. According to the results of our study, biodiversity conservation is not one of the main reasons for the clients of companies dealing with green roofs. The most important reasons for deciding for green roofs are aesthetic values and technical reasons. Non-native species are more dominant than native species in current green roof plantations, but native species definitely offer an untapped potential for use on green roofs. We hope that this master's thesis will provide some new data on the use of Slovenian plants on green roofs and encourage further research on the use of native species on green roofs and that the conservation of biodiversity on green roofs will become an even more current topic.

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Even though many unexpected things happened during the process, here we are at the end of a successfully completed task.

Persistence and work always give result.

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EX- Extinct
EW- Extinct in the Wild
CR- Critically Endangered
EN- Endangered
VU- Vulnerable
NT- Near Threatened
LC- Least Concern
DD- Data Deficient
IUCN RL- The International Union for Conservation of Nature's Red List
SLO RL- Slovenian Red List
SLO P- Slovenian protected species

1 INTRODUCTION

Current environmental problems require us to constantly strive to reduce their consequences and find new, more efficient solutions (Lepczyk et al. 2017, Williams et al. 2014). We are all aware of the negative consequences of pollution, overpopulation, destruction of natural habitats, climate change, and loss of biodiversity on our environment. The current situation stems directly from the fact that we have not dealt with these issues correctly. Urban environments are novel ecosystems that scientists try to deal with as best as possible and assess how best to manage them (Lepczyk et al. 2017). They are the essence of the problems we are trying to solve. In order to fully address this topic, we need to be aware of the conditions in urban environments. Impenetrable concrete surfaces, lack of green areas, traffic jams, glass skyscrapers, increased temperatures... It is not easy to find one solution for everything. A holistic and thorough approach is needed, giving rise to the idea of greening buildings.

Green roofs refer to all the systems that allow the greening and growth of different types of plants on top of buildings. Although this concept has been present since antiquity – with the Mesopotamian ziggurats dating back to 4000 BC being only one of the examples (Jim 2017), the roles of green roofs have changed throughout time and space. In the recent times, they have been proposed one of the nature-based solutions for cities (EPA 2009), for example as a tool for tackling environmental issues such as urban heat island effect (Jim 2015). What is more, green roofs have emerged as a tool for conserving biodiversity and offer promising results and additional opportunities to increase urban diversity (Madre et al. 2014, Williams et al. 2014, Mayrand & Clergeau 2018).

To understand their potential conservation role, we will review the ecological and technical specificities of green roofs regarding key factors affecting biodiversity (Mayrand & Clergeau 2018).

1.1 Green roofs through history

Green spaces fulfill many different roles in the urban environment, such as areas for recreational and cultural activities and social interactions, but have also important environmental benefits (Lee et al. 2015). In areas where green spaces are scarce, greening concrete roofs represent a great ecological solution for using space. Since concrete roofs are vastly present in urban environments, greening them would increase their present quality and add new ecological and biodiversity value not only to them, but to the whole environment (Lepczyk et al. 2017).

At first, ancient models of green roofs have appeared mainly because of the harsh environmental circumstances. People wanted to protect themselves from the sun, or on the

other side, the cold weather. Trees and herbaceous plants have already proven their abilities in providing shade or maintaining a favorable temperature (Jim, 2017).
The ancient ziggurats of Mesopotamia, built between 4,000 – 600 BC, are the earliest green roof example (Jim, 2017). They were considered as some sizeable religious monument. Ziggurats' gardens provided shade and enabled people to rest. Trees protected them from the sun, but also had ornamental values (see Fig.1).

Figure 1: The ancient ziggurats of Mesopotamia. Source: http://www.heathershimmin.com/a-brief-history-of-roof-gardens.

The Hanging Gardens of Babylon, constructed around 500 BC, are one of the Seven Wonders of the Ancient World. King Nebuchadnezzar, a well-known ruler in his time, built the Gardens for his spouse, Amytis, who yearned for scenes of her homeland Media mountainous nature. Gardens had a deep soil layer, so the trees could grow undisturbedly, and they were even irrigated through the developed irrigational system, which was taking water from the River Euphrates (see Fig. 2).

Figure 2: The Hanging Garden of Babylon. Source: *http://www.wikipedia.org.*

The Roman times are denoted by ancient Pompeii's green terraces, which belonged to wealthy families. From the same period, there is a rare written record about the ancient city, now Cairo, and its multi-story building with a roof garden. It was irrigated by an irrigational

system that included water wheels. In the north, Vikings used sod and earth pieces from their surroundings meadows. They realized that sod is a convenient insulator in their present cold climate.

Medieval Europe was an era in which green roofs were used as private gardens and proof of the wealth of many prominent families. They were built in private houses and churches. The Guinigi Tower in Tuscany, Italy, presents one of the oldest remaining examples of the medieval cities' roof gardens. It was built in 1384 by the notable merchant family. The most outstanding feature of this building was the famous native Mediterranean tree, Holm Oak (*Quercus ilex*), which was used primarily for good endurance and adaptation to local climatic conditions. In medieval times, it was believed that evergreen species, such as *Q. ilex*, bring renewal and rebirth.

Tuscany has more historical treasures; one of them is the roof garden in Villa Medici at Careggi, Italy. It was built in the fifteenth century. Medici's garden was full of flowers and fruit trees, and one of its parts was dedicated to the wild landscape. In the spirit of the Renaissance, the garden's appearance was blended entirely with the appearance of the house and the surrounding nature. Another famos Tuscan example is the residence of Pope Pius II , The Palazzo Piccolomini. It was located in Pienza, and was built in 1463. Palazzo's roof gardens, shown in Figure 3, were famous for their topiary art devotion and perfectly maintained trees and shrubs (Jim, 2017).

Figure 3**:** The Palazzo Piccolomini. Source*: http://www.heathershimmin.com/a-brief-history-of-roof-gardens*

People have known since ancient times to use all the benefits of nature in the best possible way. The turning point for green roof construction were definitely new concrete technologies, that were introduced on The World Expo in Paris in 1867. The green roof project presented there had almost all of the elements for waterproofing and drainage systems (Jim, 2017).

Green roofs are now a major part of the contemporary and landscape architecture. Their role has changed significantly over the years, from proof of wealth and aesthetic values to one of the leading change carriers for the better in urban areas.

1.2 The construction, composition and classification of green roofs

When building green roofs, it is very important to pay attention to each layer individually so that the whole project would be successful in the end. The layers work in such a way that if only one layer is not placed correctly or does not operate properly, the state of the whole system is disturbed.
As the fundamental layers of the entire green roof construction, we single out the original initial roof, vapor barrier, waterproofing barrier, and thermal insulation. Each layer has its own role. The role of the vapor barrier is to stop water's leakage through the thermal insulation because the latter should never be moistened. The waterproofing barrier's role is to protect the original roof. The original roof can never be moistened; it is also protected from mold or any additional damage through mechanical or environmental influences. The waterproofing barrier also protects the initial roof from a range of different temperatures, and it needs to be very resistant. The role of thermal insulation is to protect the load-bearing structures from any outside influences. The thermal insulation layers need to be very rigid and resistant.

The layers that are specific to green roofs are (Fig. 4):
1) the **anti-root protection**, which limits the penetration of plant roots,
2) the **protective layer** has its role in preserving the lower layers of the roof, and it retains water for the needs of vegetation on the green roof,
3) the **drainage layer** is expected to remove excess run-off water so that it will not damage the plants,
4) the **filter layer** stops the leaking of any particles into the drainage layer and then into the drains,
5) the **substrate** is often mineral soil; natural soil is not used for green roofs, as it is not homogeneous, and we cannot tell its effects on plant growth.
6) the **vegetation or greening layer** is usually designed according to different guidelines (Oberndorfer et al. 2007; Sekolovnik, n.d.).

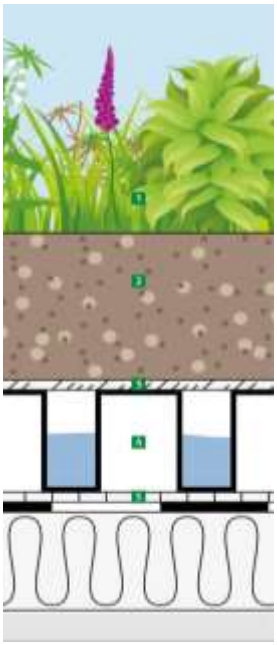

Figure 4: Example of green roof's layers. 1. plants mix (seeds), 2. substate, 3. filter layer, 4. drainage and water storage system, 5. protective layer. Source: https://www.optigruen.com/

There are different types of classifications of green roofs. The most important characteristics that distinguish between different types of green roofs are their technical specifications (substrate thickness, flat or curved surface, diversity of possible plant range, need for maintenance, weight), as well as intensity of their management (Manso et al. 2021). Causal relationships interconnect all these characteristics. The thickness and weight of the substrate mostly affect which type of plants will be planted and successfully developed. It also depends on the type of plants, whether maintenance will be necessary, and to what extent (Manso et al. 2021).

The most accepted classification of green roofs is the one into intensive and extensive ones (Manso et al. 2021) or extensive, simple intensive, and intensive ones (Green Roof Guidelines – Guidelines for the Planning, Construction and Maintenance of Green Roofs 2018):

- Intensive green roofs have a base thickness of more than 15-40 cm. Different plants (herbaceous plants, shrubs, and small trees) can thrive on them and they need regular watering and maintenance. Due to their thickness, intensive green roofs weigh more than extensive ones.
- Extensive green roofs have a base thickness of 6-20 cm (Catalano et al. 2018), which restricts the plant selection. Extensive systems are lightweight systems. There are several installation options; they can be installed either in existing flat roofs or on pitched roofs up to a slope of 30◦, thus improving the aesthetics of the previously unoccupied roof (Manso et al. 2021). Extensive green roofs usually do not need much of a maintenance. Sedums and CAM plants have shown the best on extensive green roofs.

Extensive/intensive classification is widely accepted by the industries that are dealing with the construction of green roofs. Knowing the differences between different types of green roofs makes it easier for companies to deal further with the initial design and installation processes.

On the other hand, scientists working on the biodiversity of green roofs use another type of green roof classification. The "Ecological typology", based on the classical stratum classification developed by Bournérias (1968), implies several strata (Fig. 5): the Muscinal stratum, which many compare with extensive green roofs, the Herbaceous stratum, which many compare with semi-extensive green roofs, and the Arbustive stratum, which many compare with intensive green roofs.

Every stratum has its own plant selection, and it is the same plant selection which implies basic green roof classification. Sedums and grasses are characteristic for extensive, while shrubs, bushes and flowering plants for intensive green roofs (Madre et al. 2014). Additionally, another specific type of green roofs is being promoted as the one improving biolodiversity — biodiverse/brown roofs. These roofs are dominated by different types and thicknesses of the substrate; primarily indigenous plant species are grown, attracting different and diverse fauna members (see Fig.5). Sometimes, the substrate surface of such roofs is left to self-vegetate from windblown and bird-assisted seed dispersal. Their biggest asset of such roofs is that they are most reminiscent of natural habitats (Kadas, 2006; GRO, 2011; Catalano et al. 2018). In any case, in order to choose suitable plants for different green roofs, one must be aware of their physiology, anatomy, and life strategy.

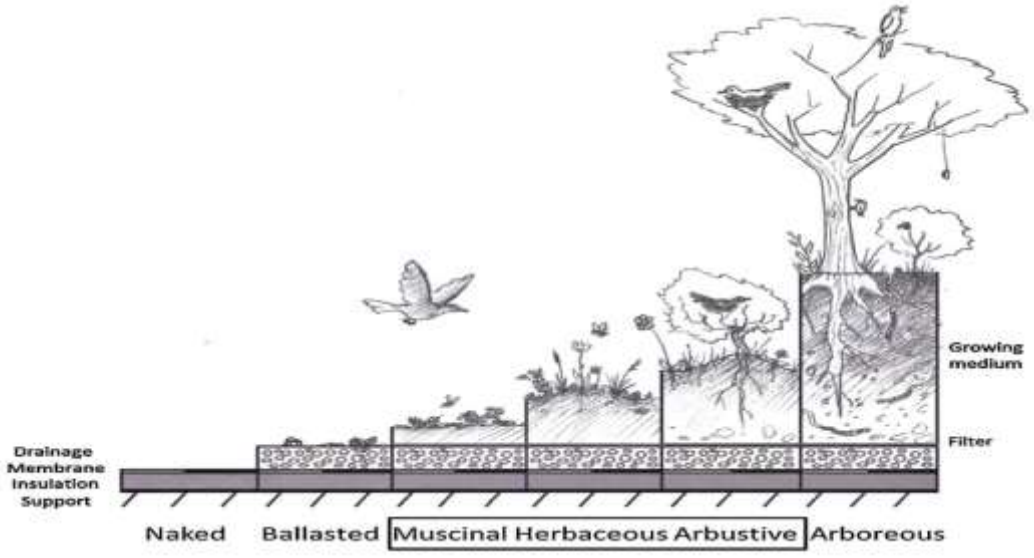

Figure 5: Different ecological strata, characteristic for extensive green roofs, based on ecological typology (Bournérias 1968) of green roof. Muscinal stratum: composed of bryophytes, lichens, and fungi and also small herbaceous plants, such as creeping succulents (e.g. *Sedum*). Herbaceous stratum: dominated by such non-woody herbaceous plants as grasses and flowering plants that can exceed 1 m in height at maturity. Arbustive stratum: shrubs, bushes, and young trees from 1 to 7 m high. Source: Madre et al 2014.

Another innovative approach to the construction of green roofs and the improvement of their technical characteristics are certainly the wetland types of green roofs. They are specifically constructed for the treatment of wastewater. Simple design, low energy requirements, and low implementation costs make them ideal for good water management solutions. Wetland plants are perfectly adapted to the humid environment and can benefit and thrive in such conditions (Knapp et al., 2019).

1.3 Selection of suitable plants for green roofs

Green roofs are usually harsh environments, with a lot of fluctuations and disturbances. Plant communities that can survive those conditions need to be able to recover and adapt rapidly (Oberndorfer et al. 2007). Caneva et al. (2015) stated that the most successful plants for growing on the green roof are the low-growing, shallow-rooted plants. It is advantageous if they tolerate increased sun, heat, cold, wind, drought, and salt exposure. It is desirable that they have the ability to self-propagate, and that they do not need much of a maintenance. Also, it is preferable that they have a modest nutrient demand and they do not require much water. All of the features that we have mentioned, eliminate almost all of the traditional annuals and perennials. On the other side, some very common green roofs plants, such as sedums, cannot tolerate excessive moisture, but are one of the most commonly used plants for green roofs.

While planning the vegetation cover of green roofs, it is important to be acquainted with the plants' biology and life span. Snodgrass & Snodgrass (2006) stated that the most common classification of the plants is usually the one regarding their yearly and growth cycle features. Using this classification, we divided plants into annuals, biennials, and perennials. The important differences between these plants are certainly the length of the life cycle, vegetative growth, dormancy, flower, and seed season (see Table 1)

Table 1: Differences between annual, biennial and perennial plants.

Differences	Annual	Biennials	Perennials
Duration of life cycle	One year	Two years	More than 2 years
Vegetative growth	All plant organs are developed during the first year	During the first year-leaves and food storage organs During the second year-flowers, fruit, seeds	More growing seasons
Death of the plant	After the first (and the only) growing season	After second growing season	Do not die after setting seed
Dormant period	Not present	Present	Present
Flowering season	Only one	Only one	More than one
Convenience for green roof use	Convenient	Not convenient	Convenient

In addition to the three above-mentioned groups of plants, literature on green roofs often groups plants into three other categories (Snodgrass & Snodgrass 2006): succulents, grasses, and herbs. The ones that are especially proven to be the best choice for extensive green roofs are certainly succulents. Their metabolism is what makes them so suitable for green roofs circumstances. CAM, or *Crassulacean acid metabolism*, is a physiological syndrome that has developed independently several times during evolution, and allows succulents to survive long periods without water and long wind and sun exposure (Males & Griffiths 2017). CAM plants are the ones usually living in arid and hot habitats. They have to store the water for an extended interval of time and therefore survive harsh conditions. Succulents have developed a specific pattern of stomatal conductance, renowned by primarily nocturnal opening, so they can avoid the loss of additional water through transpiration during daytime. The most common representatives of successful succulents on green roofs are *Sempervivum* L., *Sedum* L., *Delosperma* N.E. Br., and *Jovibarba* (DC.) Opiz. So, not only are succulents an excellent choice for green roofs because of their metabolism, but they also have a vast set of flowers and colors, thus providing beautiful aesthetics for a green roof as well. There are also a lot of grasses that could be used for green roofs. Even though grasses do not have some specific features that make them suitable for green roofs, as do succulents have, they still proved to be a good option. They still need some dose of frequent maintenance, but nothing concerning and nothing that would mean a huge increase in maintenance costs. The most frequently used genera for green roofs are *Festuca* L., *Andropogon* L., and *Sesleria* Scop. *Carex* L., a genus from the Cyperaceae family, is also frequently used in green roofs. Snodgrass & Snodgrass (2006) also mentioned some herbs that could be very viable choices for plant selection on the green roofs. Herbs offer more aesthetically pleasing views, as well as some delightful smells. Snodgrass & Snodgrass (2006) mentioned *Thymus* L., *Origanum* L., *Salvia* L., and *Allium* L. as good examples of herbs for green roofs. All of the above-mentioned plants are commonly planted on intensive green roofs.

1.4 Benefits of green roofs

What is most important about green roofs is that they perform all their roles simultaneously and efficiently. When installed correctly, green roofs offer numerous technical benefits, such as extended the longevity of a roof; they can reduce the range of temperature variations and regulate overall building temperature; they can lower the electricity bills and act like buffers/sound insulation for noise pollution; they increase property value, they act like proper storm-water management through reducing the runoff water; they also offer an ideal space for solar panels (Fig. 6; Manso et al. 2021; Snodgrass & Snodgrass 2006). What also sets green roofs apart from ordinary roofs is that they successfully cope with the urban effect of a heat island, reducing the consequences and alleviating them (Manso et al. 2021).

Figure 6: Examples of green roofs. Left: green roof with low biodiversity and a lower ecological value. Right: green roof with a high-level biodiversity and a high ecological value. Source: https://www.optigruen.com/

Benefits for people and people's general health are also very important. Studies showed that having green space in a nearby environment can improve one's focus, concentration, mood, and health (Wolch et al. 2014 and references therein). Some studies have even shown that productivity increases if we have a view or access to a green area in the immediate vicinity. Green roofs also improve air quality because green roofs plants purify the air and remove all harmful substances and dust (Fig. 7; Snodgrass & Snodgrass, 2006).

However, the most crucial benefit for conservational biologists is most certainly the role green roofs have in conserving and maintaining biodiversity in urban environments (Williams et al. 2014), which will be discuseed in Chapter 1.6.

Figure 7: Green roofs in nearby environment. Source:https://www.optigruen.com/

1.5 Potential drawbacks of green roofs

What makes green roofs unique systems is that they are entirely fabricated and specifically engineered. Usually, they have no similar resemblance to regular ground gardens, but in recent times, there is a rising number of gardens-like green roofs. A successful green roof project should thus involve engineers, architects, landscape architects, biologists, gardeners, and installers. Each of them is engaged for a particular reason: for the construction to be well thought out; for the correct set of the green roof; to make the green roof fit well into its surroundings; for the appropriate selection of suitable plants; for work supervision; for the calculation of costs and savings; for better overall performance. An all-inclusive approach is a must if a green roof is to be successful.

It is a fact that green roofs are more expensive than ordinary ones. They also require some specialised knowledge. Green roofs need time to be carefully planned and designed. It takes a lot of experts to turn an ordinary concrete roof into a small functional ecosystem. For the construction of green roofs, in most cases, large cranes need to be rented to raise all the material to the top of the building. The building is additionally loaded due to the weight of the entire construction. It also takes a little more time for the invested money to pay off or eventually return (Snodgrass & Snodgrass, 2006, Teotónio et al. 2018).

Green roof designers must have in mind different guidelines. They have to know the client's expectations, all the expenses, the span of the green roofs, safety matters, wider influences on surroundings, weight, depth and need for maintenance. They have to carefully select a specific list of plants that are ideal for that specific location.

The selection of plants is very specific and is often neglected. Specifics of each green roof should be taken into account: the planting medium, its organic content, pH, its retention capacity and other physical features all need to be estimated. Because the location of green roofs, sun exposure is far higher, wind and rain exposure also; all of that will affect the planting medium. All aspects of climate conditions should be considered as well.

But, what is most important is that in the end, all the effort, knowledge, and money are paid off. And not only will the invested money return soon, but we have also chosen a win-win scenario, in which we can enjoy, as well as the living world of the urban environment we live in. We have secured a place where we can relax, enjoy and watch the beautiful flowers, butterflies, and birds, and we have provided them a refuge more in these concrete jungles where we all live together. Green roofs and the living world that lives on them will, in turn, improve the condition of our wider environment by cleaning the air, absorbing the runoff water and reducing the temperature (Snodgrass & Snodgrass, 2006).

1.6 The conservation aspects of green roofs

1.6.1. The potential for using native plant species

Although only a small number of plant species represent the majority of plants presently used in green roofs, the potential for using different plant species is enormous. Native plants, if chosen wisely, can represent a suitable alternative to non-native (exotic) species. One of the advantages of using native plants instead of exotic ones is adaptation to the local climate (Paço et al. 2011), although, on the other hand, green roofs differ so much from natural environment that this argument is being highly debated (Manso et al. 2021, Cascone 2019). The use of native plants in urban environments proved beneficial also for local wildlife, such as insects and birds (Daniels & Kirkpatrick 2006).

The biodiversity crisis, marked first by extinctions of populations and then by species, is also calling for new approaches to species conservation. An extensive study of green roofs in France showed the presence of some protected species, among which for example the orchid *Anacamptis laxiflora* (Lam.) R.M. Bateman, Pridgeon & M.W. Chase.

The potential to use native plant species in order to create new urban landscapes was pointed out by Paço et al. (2011), who described the NativeScapeGR project, which was developed at the University of Lisbon with partner institutions. The main focus of this project was using native plant species in order to create new urban landscapes with the aim of selecting plants that would satisfy not only aesthetical features but also ecological ones. Low water requirements was one of the criteria for selecting plants, as well as the possibility for biodiversity enhancement. One of the assumptions of the project partners was that native species would be of great help for maintaining crucial characteristics of green roofs because they are the most adapted to the local climate conditions. The use of alien species was avoided. Water requirements were examined using different techniques, e.g., gravimetric measurements of potted plants and soil water balance. Some agricultural applications were also taken into account and extended to landscape areas. Biocrusts and mosses were of great interest to this study, considering the fact that they have already proved excellent for retaining water and reducing the temperatures on the roofs. During their experiment, they used native pokilohydric mosses and other plant species that have low water requirements. Through the use of several different irrigational levels, substrates, and aesthetic value assessments, they concluded that a roof planted with biocrusts could be an attractive possibility thanks to its low price and well-adapted features to dry, hot summers, specific to urban Mediterranean areas.

Another example is given by, Schröder & Kiehl (2020), who researched the possibility of the establishment of species of conservation value by using plant material from an ancient dry grassland for green roof establishment. They wanted to inquire if native sandy dry grassland species will survive the harsh conditions on green roofs and if they would

additionally contribute to the overall biodiversity on green roofs. The experiment was located on miniature roofs in northwestern Germany, where the climate is temperate oceanic. Taking the plant material directly from a suitable donor site is a typical example of ecological restoration. They tested a specific seed mixture with native sandy grassland species to see if they will form immune, viable and successful vegetation. This study concluded that using the raked plant material directly from grassland combined with native grassland plants is a perspective and effective way for greening roofs and increasing biodiversity.

Monterusso et al. (2005) and Caneva et al. (2015) both examined ecological approaches to plant selection. Their aim was to enlarge the pool of suitable native species for extensive green roofs in the Mediterranean by combining the ecological and physiological features of plants, the known climate factors and required properties on the green roof. Through this approach, they aimed at finding species perfectly adapted to the conditions on green roofs. In that way, these species would in the end also contribute to the overall biodiversity. The Mediterranean is a very diverse area with vibrant biodiversity and many of its species show precisely those characteristics that are desirable for the success of plants on green roofs: tolerance to sun exposure, wind, high temperatures, and drought. Caneva et al. (2015) emphasized that it is vital to select species not only according to their ecological characteristics but also to pay attention to their specific ecotypes because these ecotypes have evolved to a considerable extent and have maximally adapted to the existing conditions, which can sometimes be absolutely the same as those present on green roofs. Monterusso et al. (2005) emphasized the need for a better understanding of climatic conditions, how they affect native species and their substrate, and how they have adapted to them. They also mentioned that any plant taxon could be used on green roofs if the requirement is met that their conditions are equal to those in their natural habitats.

In practice, however, the use of native species in urban environment, including green roofs, is still in its infancy. Blackmore (2020) in his recent essay about the (non)use of native plants in urban green spaces, stated that: "*...while the architecture of futuristic cityscapes has advanced enormously, their horticulture lags far behind."* One of the reasons for this is the lack of providers of native plants, which seems to be the problem all over the globe. As a consequence, only a few green roof providers use native plants, and most of those are located in the US, while in Europe the situation is even worse.

One of the companies that could be singled out is Growild Inc (https://www.growildinc.com/), a company based in Fairview, Tennessee (US). The company has developed the native plants' use in contemporary landscapes. They offer a wide range of services, from consultation and design to installation and restorations. They have their own nursery with only native plants. This nursey counts over 300 different native plant species, which are available at all times for all projects and constructions.

As for European companies, the UK based British Bauder (https://www.bauder.co.uk/) and the German Optigrun (https://www.optigruen.com/) both include native plants in their offer. Although Bauder is primarily a company that deals with planning and construction of all kinds of roof systems, including green roofs, they offer plantations and seed mixtures of native British species, which they claim to be of native origin. Optigrun is an advanced and very diverse company, which strongly enters into sustainable spaces. They are primarily focused on green roofs and have a lot to offer. They offer economy, lightweight, nature, retention, pitched, garden, landscape, public, and solar green roofs. Almost every of the listed types of green roofs has its unique lists of plants used on them, and they are all focused on the best possible ecological and biodiversity value. They also strive to use native species at individual project sites.

1.6.2 Animal and plant conservation

Green roofs can act as an essential part of the connection between natural and urban habitats. Many scientists consider them as unique green islands or a special kind of biodiversity hotspot in cities, which tend to contribute even to the biodiversity of more expansive areas (Blaustein et al. 2016; Joimel et al. 2018). Numerous new studies have shown that green roofs in urban environments have great potential as habitat for species negatively impacted by urban habitat changes (Colla et al. 2009).

One of the approaches to coping with environmental problems in urban areas is undoubtedly reconciliation ecology, a branch of ecology which explores ways to encourage biodiversity in human-dominated ecosystems (Rosenzweig 2003). Through the idea of designing new spaces, which would satisfy both people and nature, reconciliation ecology exactly meets all the requirements that green roofs should meet, especially biodiversity conservation (Lundholm 2016; Rosenzweig 2016). If we want the green roofs to have positive effects on biodiversity conservation, they need to be carefully planned and established.

Animals

Green roofs can have different roles that would facilitate and contribute to the urban biodiversity. In addition to representing a new habitat, namely the physical space that species can inhabit, they also represent a vital link in connecting different kinds of habitats. They can also provide new food sources for many species of insects, birds, bats and other animal groups. They also represent crucial spaces that some species, such as birds, can use as breeding sites, as a resting place during migrations or flights (Wang et al. 2017).
We can make some predictions about the biodiversity on green roofs versus the one on bare roofs, using some classical ecological theories. We expect that green roofs will have higher species abundance and richness than bare roofs; conditions that green roofs offer will distinguish a lot in comparison to the ones on bare roofs; biodiversity on higher roofs will

differ from the biodiversity of lower ones; different species will be present depending on roof's height (Berthon et al. 2015).

Every habitat has its own basic components, such as food, cover, water, and space, which enable the life of different species in it. These characteristics are the ones that dictate what types of species will be present (Caneva et al. 2015). Green roofs represent a great way to reestablish habitat for invertebrates (Cantor 2008). Studies have shown that a great number of insects (spiders, beetles, ants, flies, bugs, and bees) are found on green roofs. Invertebrates, then in turn, attract other species like birds, some species of mammals, for example bats, and reptiles (Fernandez-Canero & Gonzalez-Redondo 2010). A study by Pearce & Walters (2012) confirmed that presence and the activity of bats were much higher over green roofs in comparison to bare roofs.

Green roofs may also promote the presence of bees and other pollinators. Bees represent an essential part of many ecosystems, but their presence has been significantly reduced (Potts et al. 2010). Some of the ecosystem services that they are providing are certainly pollination, providing the next generations of plants thus reducing the amount of work and maintenance around green roofs, because there is no need for replanting; they are also providing and establishing stable plant community through generations (Colla et al. 2009). The presence of plants, on the other hand, will ensure the presence of other species, which will in turn contribute to the new biological interactions and a more stable biological structure (Colla et al. 2009).

Some of the results of recent studies confirmed also the occurrence of species of conservation concern on green roofs. This is something that encourages and pushes scientists and conservationists forward to bring green roofs on a new level. Several studies about rare flora and fauna confirmed the presence of endangered or rare species of birds, spiders, and beetles (Brenneisen 2003, 2006; Colla et al. 2009) on green roofs in Basel, Switzerland. Furthermore, scientists in England and Switzerland tried to carefully design green roof habitats to mimic specific nesting ones for rare birds. They later on confirmed the presence of black redstart *Phoenicurus ochruros* Gmelin and Northern lapwing *Vanellus vanellus* Linnaeus (see Fig. 8; Baumann & Kasten 2010; Williams et al. 2014). Some studies in the Netherlands confirmed viable populations of endangered butterflies (Snep et al. 2011; Williams et al. 2014). Even some species of rare lizards have been found on the green roofs (Earth Pledge 2005).

Figure 8: *Phoenicurus ochruros (left) and Vanellus vanellus (right), two rare bird species, whose presence has been confirmed on green roofs. Source: https://livingroofs.org/ and http://www.urbanhabitats.org/.*

Plants

If one of the aims of green roofs is biodiversity conservation, native plants should be preferred over non-native ones. Moreover, native plants are already adapted to local climates, which makes them ideal for green roofs. They are present in sufficient numbers to conduct the experiments and try to test them as much as we can (Oberndorfer et al. 2007).

Non-native plants, on the other hand, may have negative impacts on the environment, even in urban environments, and may even become invasive (Manchester & Bullock, 2000). Invasive species are introduced, non-native organisms that can cause a lot of damage both at the economic or the environmental level. With their abilities, they often take precedence over native species and completely change the structure of the environment. That is why domestic indigenous species should be promoted wherever possible. The benefits they bring us are more diverse and valuable than all the others. What is important is that native species equally

rely on the quality of the environment so that a quality environment will contribute to them and consequently to humans (Lepczyk et al. 2017).

The possibility to use native plants has challenged conservationists if green roofs could represent also a habitat for some species of conservation concern, such as Red List or protected species. Brenneisen (2006) mentions that in Zurich, there are some 115 years-old green roofs which were built over a sand filtration system in Wollishofen (Fig. 9), and they support the growth of 9 orchid species. Among thise, *Orchis morio*, *O. latifolia*, and *O. militaris*, are listed in Red Data Books and classified as endangered. These roofs are today being used for orchid conservation.
Blair & Osmond (2020) give several examples about conserving protected and endangered plants species from different parts of the world. The state that roofs can play a supportive role in the provision of habitat for rare and endangered fauna; the plant *Hylotelephium telephium* could attract the butterfly *Parnassius apollo*, listed on the IUCN Red List of Threatened Species as vulnerable (http://www.iucnredlist.org/). In their research, Blair & Osmond (2020) focused on the potential of green roofs in Australia to protect the Eastern Suburbs Banksia Scrub, and its endangered species; *Banksia ericifolia*, *Banksia serrata*, *Leptospermum laevigatum*, *Epacris spp*., *Eriostemon australasius*, *Lepidosperma laterale*, *Monotoca elliptica*, and *Xanthorrhoea resinifera*.

Figure 9: Flat green roofs on Wollishofen are used today for orchid conservation. *Orchis morio* L. is one of the endangered Red Data plants found in Wollishofen. Source: https://land8.com/ and https://www.zhaw.ch.

1.7 Aims and objectives of this thesis

During the research for this thesis it has became clear to us that even though the scientific community has recognised the importance and many potentials of urban green areas for biodiversity conservation, including green roofs, the applications of this in practice is still in its incancy. Green roofs are an ideal solution for solving many modern urban environmental problems. They contribute to reduced temperature, better stormwater runoff management, better air quality, provide new habitats for plants and animals ... But what is most important to us and what we will pay the most attention to is undoubtedly the role of green roofs in biodiversity conservation.

The purpose of this master's thesis is to examine the potentials that green roofs have in terms of increasing biodiversity in cities, with an emphasis on plants. We wanted to find out which are the most common plants that companies use to green roofs, what is their origin and whether there is a possibility that green roofs could be used as a replacement habitat for endangered plants. We also wanted to check how much knowledge companies have about plant biology and ecology, and about biodiversity in general, that construct green roofs, and how much they actually focus on these topics. We also want to explore how much the public is aware of all the possibilities that green roofs offer. The most important potential we want to highlight is the possibility of preserving indigenous and endangered species on green roofs.

In order to obtain this information, we interviewed companies that deal with green roof construction, as well as the general public. Green roofs still not very common in Slovenia and Serbia, and we were curious about how much the general public is actually familiar with them.

We also realized that native plants are still not often used across the world, and that is why we chose them as our main point of interest for selecting plants suitable for green roofs.

We will test the following hypotheses:

H1: The aspect of maintaining biodiversity is not crucial for the decision of potential clients to install a green roof.

H2: Both in Slovenia and in Serbia, indigenous plant species represent untapped potential for greening green roofs.

H3: In the current plantings of green roofs in Slovenia and Serbia, plants of foreign origin predominate.

H4: There are differences in the perception of green roofs between the population of Slovenia and Serbia.

2 MATERIALS AND METHODS

2.1 Literature review

In the literature review, we found and evaluated many scientific studies that addressed the potential of green roofs in conserving biodiversity. According to our goals, we divided them into several groups: 1) articles dealing only with the general characteristics of green roofs, 2) articles dealing with biodiversity on green roofs, 3) articles exploring public opinion on green roofs include questionnaires on green roofs), and 4) articles dealing with some possible approaches to species conservation in cities in the future. With the help of the available literature, we came to the fundamental outcomes that we want to achieve in this master's thesis.

2.2 Survey about green roofs

2.2.1 Companies

In order to obtain an exhaustive list of companies that provide green roof construction in Slovenia and Serbia, we thoroughly searched through the internet by using the following keywords: "Zelene strehe", "Podjetja za zelene strehe", "Izdelava zelenih streh" (for Slovenian companies) and "Zeleni krovovi", "Preduzeća za zelene krovove", "Izgradnja zelenih krovova" (for Serbian companies). For each of the companies, we searched for a contact (e-mail or phone number).

We wanted to gather information from the Slovenian and Serbian companies that deal green roof construction about their knowledge about plant biology, ecology, and biodiversity in general, and how much these topics are important for them while constructing green roofs. We also wanted to find out which are the most common plants that companies use to green roofs and what their origin is. For this purpose, we compiled a questionnaire, translated into Slovenian and Serbian language. The questionnaire was composed of a series of closed and open-ended questions (Kalantari et al. 2016). The purpose of the questionnaire was to obtain information about characteristics of green roofs, to examine the companies' general knowledge about ecology, plants' nativeness, to inquire whether the companies employ experts from the field of plant selection and care, and lastly what is the companies' attitude towards biodiversity issues. We thoughtfully, with the help of the already existing literature, but also by ourselves, formed questions with which we wanted to gather as much valuable information as possible. We tried to compose questions in a way that would be easily perceived by everyone. The offered answers were maximally harmonized with the questions; they are clear and straightforward to set out; some questions have a Likert scale that describes certain traits (scale from 1 to 5; where 1 describes the trait that is the least important to you and 5 describes the trait that is the most important to you). The questionnaire included four different and coordinated sections: 1) The first one was about some general information

about the company's business, 2) the second one was about their clients and their needs, wishes, and motivation concerning the green roofs, 3) the third one included some questions about plants (origin, selection, nativeness...), and 4) the fourth section was about biodiversity.

The questionnaire was composed of 26 questions and it took around 10 minutes to complete. The questionnaires in English, Slovenian and Serbian language are included in Appendix 1.

Surveys (precisely, the link to the questionnaires) were sent to the companies by e-mail, together with a cover letter introducing ourselves and the purpose of this research. For companies that did not respond to our first email, we tried to get in contact both by e-mail and phone, and afterwards we resent the questionnaire again. We also tried over the phone, but the response from companies was not encouraging.

2.2.2 General public

Besides obtaining information from experts from the green roof construction, we also wanted to gather information from the Slovenian and Serbian general public. We wanted to know more about how much the public is aware of all the possibilities green roofs offer, how much they are interested in some ecological topics of urban areas, and their attitude toward native species. Again, we compiled a questionnaire, translated into Slovenian and Serbian language. The questionnaire for the general public was composed mostly of closed questions. There was only one open-ended question, where one could fill in some additional answers. The information we wanted to get from the public through these questions concerns some general knowledge about ecology and green roofs, green roof companies, and some general knowledge about biodiversity on green roofs. Our main topic of interest was to see how much knowledge about green roofs and their characteristics do people have. We formulated the questions so that they are simple and easy to understand, we adjusted and harmonized the answers, and we tried to be as clear and concise as possible. Some questions had yes or no answers; some had the Likert scale for describing the special traits included (scale from 1 to 5; where 1 describes the trait that is the least important to you and 5 describes the trait that is the most important to you).

The questionnaire for the general public has six different sections, focusing on: 1) general information about ecology in urban areas, 2) general knowledge about green roofs and acquaintance with companies that deal with them, 3) general characteristics of green roofs and their significance, 4) different aspects of green roofs, 5) issues related to the biodiversity on the green roofs, and 6) general socio-demographic questions. The purpose of this questionnaire was to see the extent to which the general public is aware of green roofs and their benefits, especially for the conservation of biodiversity and native species.

The questionnaire for the general public had 28 questions and it took around 10 minutes to complete. Questionnaires were compiled via Google Forms because it proved to be the most suitable option. We used the snowball technique or chain-referral sampling (https://humansofdata.atlan.com/2017/07/6-sampling-techniques-choose-representative-subset/) to maintain data, where we relied on our initial respondents to refer us to the subsequent respondents we may connect with for our survey. We also used random sampling, where we approached random people on the streets. So, to conclude, the sampling of the answers from the general public's questionnaires was conducted in two ways. The first one was online, and the second one was through live interaction.

Slovenian public opinion was obtained through live interaction during several days in Koper and online. And Serbian public opinion was obtained through live interaction in Belgrade and online. The surveys were performed between 8th and 20th of June, 2021.

2.3 Data analysis

The responses were automatically saved in MS Office Excel via Google Forms as a .csv file. After collecting the data, the further intention of our survey was to statistically analyze the answers, in MS Office Excel or R. We decided that we will only do qualitative analyses and some parts of quantitative analyses in Excel through various graphics and tables.

2.4 Selection of potential suitable Slovenian native plants and plants of conservation importance

In order expand a list of existing plant species used by green roof providers in Slovenia, we first searched through the literature to obtain an extensive list of plants used in green roofs in Europe. Snodgrass & Snodgrass (2006) and Van Mechelen (2015) were the main reference used, as they list European plants already used on the green roofs. We then checked to see which of those plants are native in Slovenia according to Mala Flora Slovenije (Martinčić et al. 2007). We produced a table combining the plants used in Europe and plants mentioned by the companies in our survey.

Afterwords, we searched through Slovenian species of conservation concern: legally protected species (Uredba o zavarovanih prosto živečih rastlinskih vrstah 2004), Species included in the Annex II of the Habitat directive that occur in Slovenia (Čušin et al. 2004) and species included in the Slovenian Red List (Pravilnik o uvrstitvi ogroženih rastlinskih in živalskih vrst v rdeči seznam 2002). We cross checked if any of those species, according to our knowledge, has previously been used in green roofs.

Given that the topic of this master's thesis is primarily the conservation of biodiversity, that is why we also focused on protected, endangered, and native species. We also used the IUCN

Red List categories; EX - extinct, EW - extinct in wild, CR - critically endangered, EN - endangered, VU - vulnerable, NT - near threatened, LC - least concern, DD - data deficient.

Table 2: List of IUCN Red List Categories. CR, EN and VU represent the threatened categories. Source: www.iucnredlist.org.

IUCN Categories	
Extinct (EX)	No reasonable doubt that the last individual has died;
Extinct in the Wild (EW)	Known only to survive in captivity, cultivation or well outside its natural range;
Critically Endangered (CR)	Facing extremely high risk of extinction in the wild;
Endangered (EN)	Facing a very high risk of extinction in the wild;
Vulnerable (VU)	Facing a high risk of extinction in the wild;
Near Threatened (NT)	Close to qualifying, or likely to qualify for a threatened category in the near future;
Least Concern (LC)	Population is stable enough that it is unlikely to face extinction in the near future;
Data Deficient (DD)	Not enough information on abundance or distribution to estimate its risk of extinction;

For all the plant species that we collected, we included in the table the information about the taxonomy (plant family), nativeness in Europe and Slovenia, and information about the plant's conservation importance. We also included the information about the life forms. We used Raunkiaer's classification of life forms as described in Martinčič et al. (2007). Raunkiaer's classicication groups together plants based on strategies how they survive unfavorable conditions according to how they protect their buds. Phanerophyta, Fa, are woody plants; the buds are 20cm above the ground and are protected by scaly leaves. They are subject to another division into mega and nanophanerophytes. Chamaephyta, Ha, the buds are approximately 5-10cm above the ground; dead plant parts provide additional protection. They are subject to another division into small shrubs, dwarf shrubs, carpet shrubs, cushion perennials, dwarf succulents. Hemikryptophyta, He, are herbaceous perennials whose aboveground parts die off when adverse conditions occur. Additional protection is provided by overhead dead parts and thus protects the buds. There exist an additional division into rosette, semi-rosette, tufted, and creeping hemikryptophyta. Geophyta, Ge, are herbaceous perennials whose aboveground organs die off when adverse conditions occur. They have underground organs that survive buried and later serve the plants to re-develop. Therophyta, Te, are annual herbs that survive the winter in the form of highly resistant seeds. Hydrophyta, Hi, are aquatic plants.

3 RESULTS

3.1 Surveys

At the end of the survey, we received altogether 14 answers from companies; nine from Slovenia and 5 from Serbia. We also received altogether 226 answers from general public; 101 from the Slovenian general public, and 125 answers from the Serbian general public. We then used a qualitative and quantitative approach to analyze the data collected from questionnaires.

3.1.1 Companies

With the help of data on the Internet, we found 58 companies that claim to offer construction, planning, design, or execution of works on green roofs. Some companies responded to us immediately. Some told us that the companies are no longer operational; some people have retired; some have even said that even though they offer green roofs as some of the listed activities, they have never actually actualized that yet because there is no demand. Some have told us that they only deal with installing insulation on roofs on which plants are later for green roofs planted.

During our search, we noticed a larger number of existing professional companies for the construction of green roofs in Slovenia (35) compared to Serbia (23; Table 3). We managed to collect 14 responses; 9 (nine) answers from companies based in Slovenia and 5 (five) answers from Serbia. The overall response rate was 24,1%; with 25,7% and 21,7% for Slovenia and Serbia, respectively. The companies who answered were willing to cooperate, and some even gave us useful additional information.

Table 3: List of companies that mention green roof construction under their services in Slovenia and Serbia.

	Companies based in Slovenia	**Companies based in Serbia**
1	A sistemi d.o.o.	Bašta Biro
2	ABA mont d.o.o.	Beovrt
3	Abj d.o.o.	cnt d.o.o
4	Babnik d.o.o	Cvetnik d.o.o
5	Bauder d.o.o.	Dima Company d.o.o
6	Džemal Ćorović s.p. Gradbeništvo, Mozaik	Gorovel d.o.o
7	Format d.o.o.	Grass garden
8	Gemax d.o.o	Green decor
9	Gradbeništvo DRS, d.o.o.	Hort garden studio
10	Harco d.o.o	Kota S d.o.o
11	Hribši d.o.o.	Landscape factory
12	Humko d.o.o.	Lever inženjering d.o.o

13	IBA d.o.o	Limo Mont d.o.o
14	Izolacija Zorman Team d.o.o.	LKV centar d.o.o
15	Kepic Izolacija SK d.o.o.	Maker d.o.o
16	Kern strešni sistemi	Matija Momirović PR BRIK
17	Klemaks gradnje d.o.o.	Studio tufna
18	Klemen Lavrič s.p., krovstvo in kleparstvo	Varga DIV Gradnja
19	Knauf Insulation d.o.o, Urbanscape	Vert gradnja d.o.o
20	Knuplež d.o.o.	Vitaverde d.o.o
21	Krovstvo in tesarstvo, Rok Škrbe s.p.	Waterproofing d.o.o
22	Kulturno društvo prostoRož	Zelena gradnja
23	My green roof, MGing d.o.o	Živeti sa biljkama d.o.o
24	Paneli, krovstvo, kleparstvo in storitve d.o.o	
25	Raptor d.o.o	
26	Rastroj Aleš Strojan s.p.	
27	Šircelj	
28	Stavbno Kleparstvo Fekonja s.p.	
29	Stireks d.o.o	
30	Streha Jančar, krovstvo, kleparstvo, d.o.o.	
31	Tesarstvo Kralj d.o.o	
32	Vaš profit d.o.o.	
33	Zelena Streha d.o.o	
34	Zelena streha Xeroflor	
35	Žlebovi Grič d.o.o	

General information about companies regarding green roofs

Only four companies from Slovenia and one from Serbia stated that they are specialized in green roofs only. Others said that green roofs are not their top priority because they offer other roof coverings. 66.7% of the Slovenian companies (six companies) said that they take care of everything concerning green roof construction by themselves. The same answer in Serbia was represented by 60% (three companies). The range of green roof projects that are completed annually was from 2 to 35 for the Slovenian companies and from 2 to 20 for the Serbian companies. Only 44% of the Slovenian companies hired the gardener (four companies), and 11.1% the biologist (one company). In Serbia, 80% of the companies hired landscape architect (four companies). None of the other experts were involved. All of the Serbian companies stated that they constantly adjust the plant selection to the individual specific project, while 11,1% of the Slovenian companies stated that always use the same plant template (one company), 55,6% said that they usually use the same plant template (five companies) and 33,3% of the Slovenian companies responded that adjust the plant selection to the individual specific project (three companies).

Plant selection

Only 44.4% of the Slovenian companies responded that they know what the native species are (four companies), and 80% of the Serbian ones know the same (four companies). 66,7% of the Slovenian companies stated that they already have enough informations about the plants, their needs, and the impact of green roofs on biodiversity (six companies); 33,3% said that they do not have enough informations and that they would like to know more (three companies). All of the Serbian companies stated that they have enough information about the plants, their needs, and the impact of green roofs on biodiversity. Concerning knowledge about the plants' origin, 60% of the Serbian companies stated that they know the origin for most plant species they use (three companies), 20% said that they know for some (one company), and 20% said that they know for all (one company). 44,4% of the Slovenian companies said that they do not know origin for any of the plants (four companies), 44,4% said that they know for some of the plants (four companies), and 11,1% said that they know for most of the plants (one company). 80% of the Serbian companies said that they would be prepared to replace non-native species with native ones (four companies), 20% said that they would, but only under certain conditions (one company). 33,3% of the Slovenian companies said that they would be willing to replace non-native plant species with native ones (three companies), 11,1% said yes (one company), but only under certain conditions, and 22,2% said that would not replace them (two companies) and 33,3% of the Slovenian companies said that they do not know the origin of the plants (three companies). Both Slovenian and Serbian companies said that their primary criteria for choosing plants for green roofs were the clients' specific desires or the offer of the green roof supplier.

Clients' needs, wishes, and motivation concerning the green roofs

According to Slovenian companies, initial set-up and maintenance costs are the main issue of concern for their customers (6 and 1 answers, respectively). The Serbian companies outlined that the lack of knowledge (3 answers) and concerns about possible negative consequences (2 answers) are their clients' primary concerns. The question with grading individual green roofs characteristics using the Likert scale provided us following answers, shown in Figure 10. Companies had to grade their clients' motivations for opting for green roofs. The possible reasons were actually some of the most known green roofs features; aesthetic value, additional usable area, money retention, technical reasons, and awareness of environmental issues. They could choose between one of the offered grades, from 1 to 5, where 1 represented the grade for the least important feature, and 5 represented the grade for the most important one.

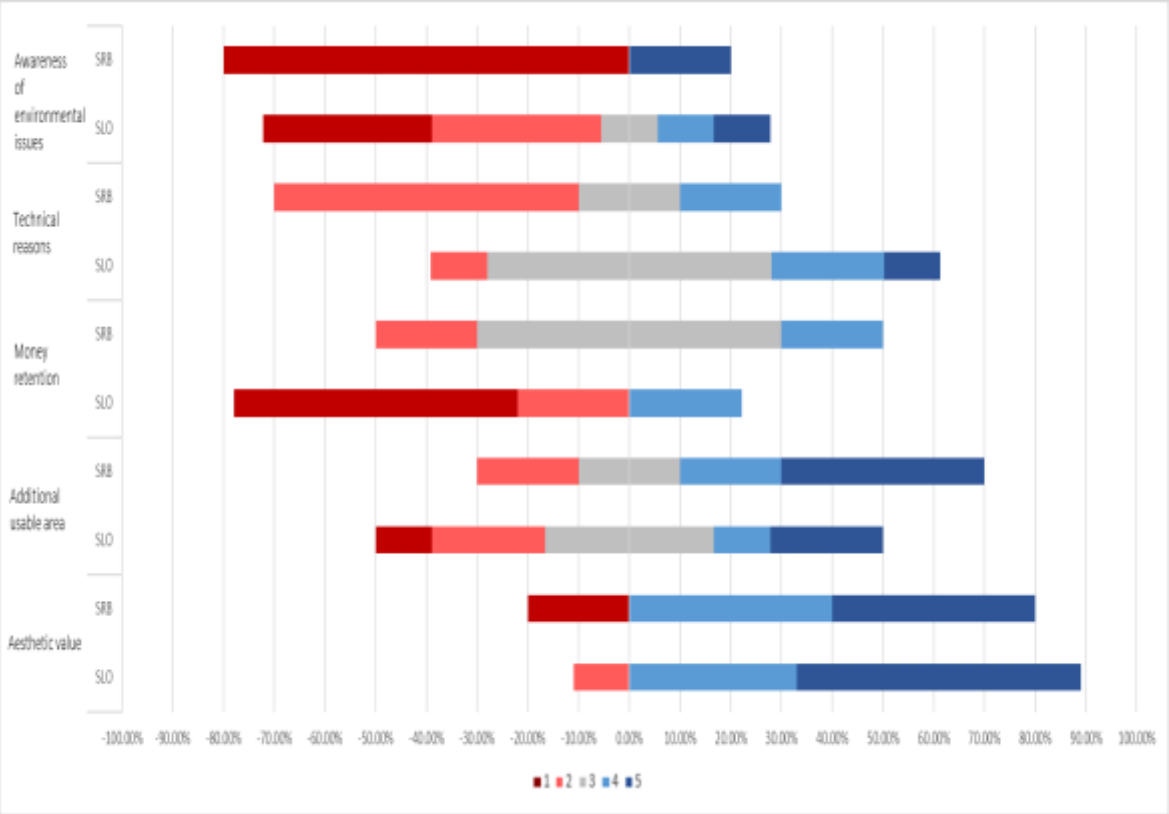

Figure 10: Companies' responses concerning important aspects of the green roof. Legend: 1- least important feature, 5 - most important feature.

Biodiversity

Companies have shown that they are generally aware of all aspects of green roofs that affect biodiversity. Non-native species' potential negative effect on biodiversity was the only thing companies were not aware about, shown in Figure 11.

In the end we tried to establish some continuum of responses by each company. Still, this was not possible. The answers were very diverse, and no broad conclusion can be drawn from them. For example, one of the companies stated that they are aiming for increased biodiversity, but then, they answered that they always use the same sample of plants for each project. Some of the companies would answer that they know the difference between native and non-native species and are aware that non-native species can negatively affect biodiversity. However, they are still not ready or willing to replace non-native species with native ones.

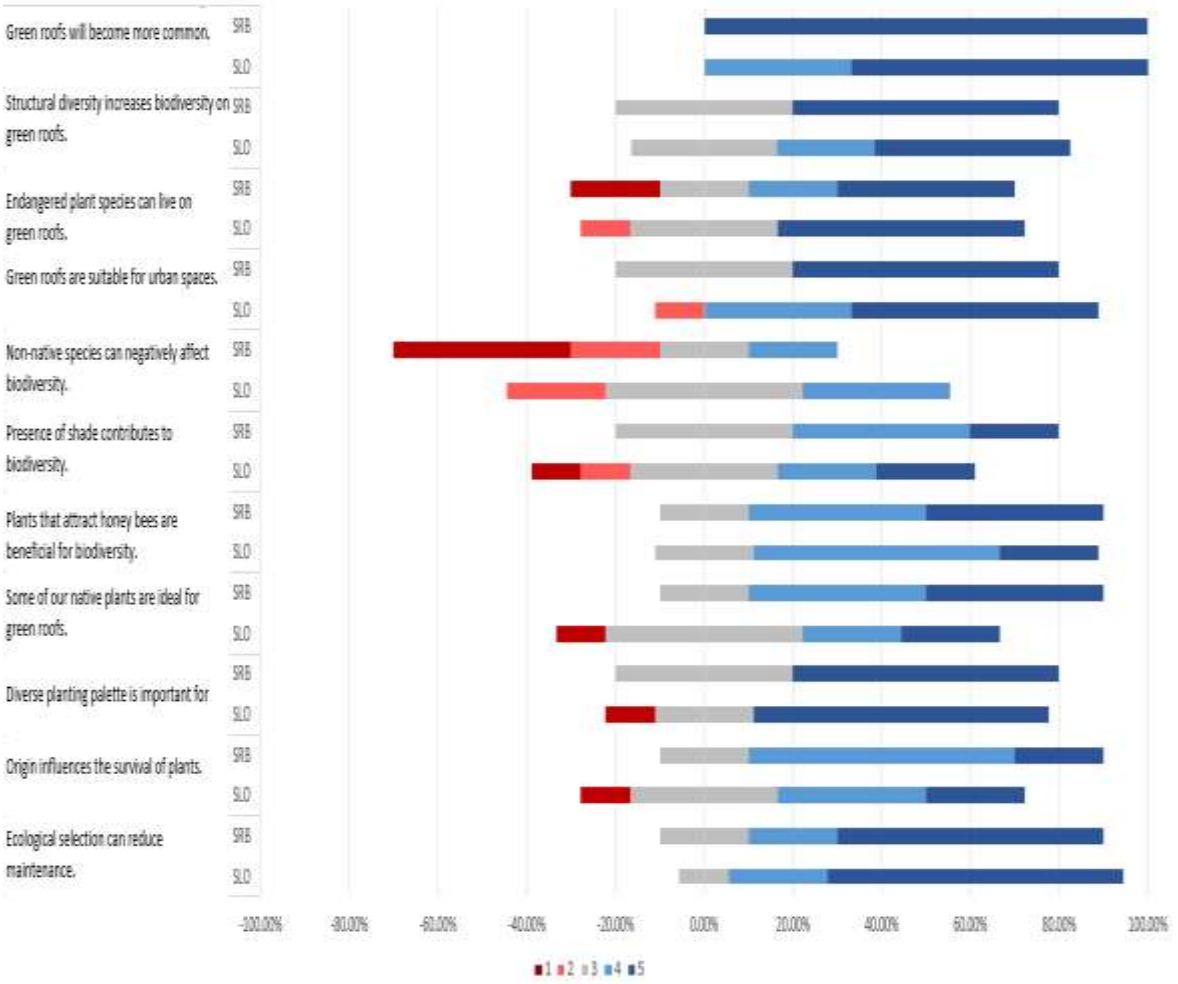

Figure 11: Companies' responses concerning important biodiversity features. Legend: 1- least important feature, 5 - most important feature.

What was exciting and encouraging to see was that the companies in which none of the green roof experts were engaged did not have any extensive knowledge about them, but they were willing to find out more.

Companies that emphasized that green roofs are their main activity, as a rule, had a hired gardener. However, they did not know the difference between native and non-native species, nor did they give high grades to biodiversity issues.

3.1.2 General public

Altogether we obtained 225 answers to our survey; 101 (one hundred and one) from the Slovenian public and 125 (one hundred and twenty-four) from the Serbian public. From 101 answers from Slovenian public, 30 were obtained in person, and 71 were obtained online. From 125 answers from Serbian public, 55 were obtained in person, and 70 were obtained online.

Socio-demographic data

Concerning people's highest level of education, people in Slovenia stated the following: 32,7% have high school degree, 44,6% have bachelor degree, and 20,8% have master's or PhD degree. People in Serbia stated next: 15,3% have high school degree, 54% have bachelor degree, and 30,6% have master's or PhD degree. The Slovenian public's fields of degree were natural (22,8%), technical (13,9%), medical (17,8%) and social (19,8%) sciences. The Serbian public's fields of degree were natural (35%), technical (32%), medical (5,8%%) and social (26,2%) sciences. The age structure of the Serbian general public was 29% for 18-24 group, 48,5% for 25-34 group, 5,6% for 35-44 group, 11,3% for 45-54 group, 4,8% for 55-64 group and 0,8% for more than 65 age group. The age structure of the Slovenian general public was 4% for younger than 18 group, 38,6% for 18-24 group, 39,6% for 25-34 group, 8,9% for 35-44 group, 6,9% for 45-54 group, and 2% for 55-64 group.

Public's opinion concerning the urban environment

All respondents (100%) from both Slovenia and Serbia stated that they think that environment is essential, that they do think that ongoing construction is harming the overall biodiversity in urban areas, that they enjoy green spaces in urban areas.

Familiarity with green roofs

78,2% of the general Slovenian public stated that they are familiar with green roofs, and 21,8% said that they are not. 80,8% of the general Serbian public said that they are familiar with green roofs, and 19,2% said that they are not familiar with them. 89,1% and 92% of the Slovenian and Serbian general public said that they have not heard for any company that is specializes in green roofs. They are entirely for the idea of supporting projects for promoting green roofs. Furthermore, 83,2% and 86,4% of Slovenian and Serbian general public, respectively, stated that they have never visited a building with an installed green roof.

Willingness to install a green roof

We offered them answers that would be common and that concern them the most. The general public was asked if they would be willing to pay more for green roofs if they: a) could spend leisure time on it, b) could have vegetable/ornamental garden on it, c) could observe different plants, insects, and birds, and d) knew that green roof would contribute to the city biodiversity. Answers are shown in Figure 12.

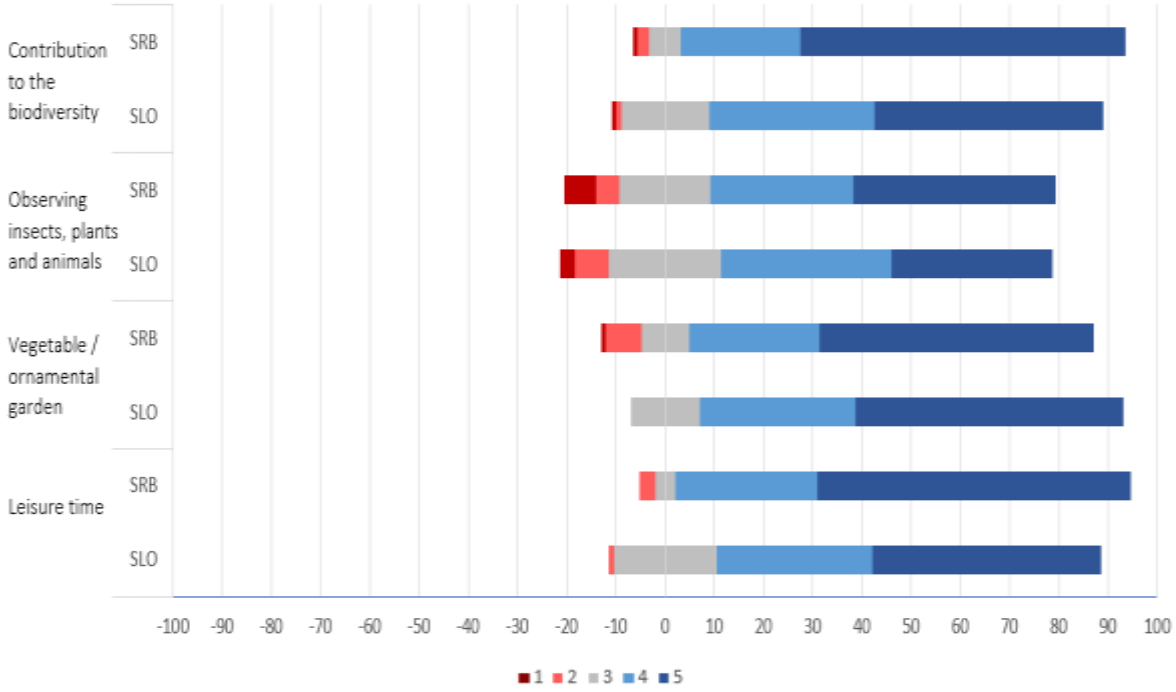

Figure 12: Different reasons and willingness of the general public, that would make them pay more for the construction of green roofs. Legend: 1 - not important at all, 5 – very important.

Regarding reasons not to install green roofs, the general public stated that the main ones are initial costs and lack of knowledge, followed by maintenance costs.

Table 4: Reasons why one would not install a green roof.

Reasons	Serbia	Slovenia	together
Initial set-up costs	25%	39.6%	64,6%
Lack of knowledge	25%	15.8%	40,8%
Maintenance costs	16.9%	19.8%	36,7%
Lack of expert advice	15.3%	9.9%	25,2%
Concerns about possible negative consequences	12.1%	12.9%	25%

Knowledge about native and endangered species

70,3 % and 61,6% of the Slovenian and Serbian general public said that they know the difference between native and non-native species. 88,1% of the Slovenian public stated that they are aware that we can preserve native species via green roofs. But, only 48,8% of the Serbian public stated that they are aware that we can preserve native species via green roofs. 11,9% and 51,2% of the Slovenian and Serbian general public were not aware of that possibility. 83,2% and 44,8% of the Slovenian and Serbian general public knew that some of the endangered species could inhabit green roofs. 16,8% and 55,2% of the Slovenian and Serbian general public did not know that.

Important characteristics of green roofs

The general public from both Slovenia and Serbia stated their opinion about green roofs' most essential characteristics. Positive environmental impacts of green roofs are perceived

very differently in Slovenia and Serbia, as the Serbian respondents marked this feature as very important, while Slovenian respondants marked this as much less important. Additional usable area is more important to Slovenian respondents to Serbian ones, and same is money retention. Answers are shown in Figure 13.

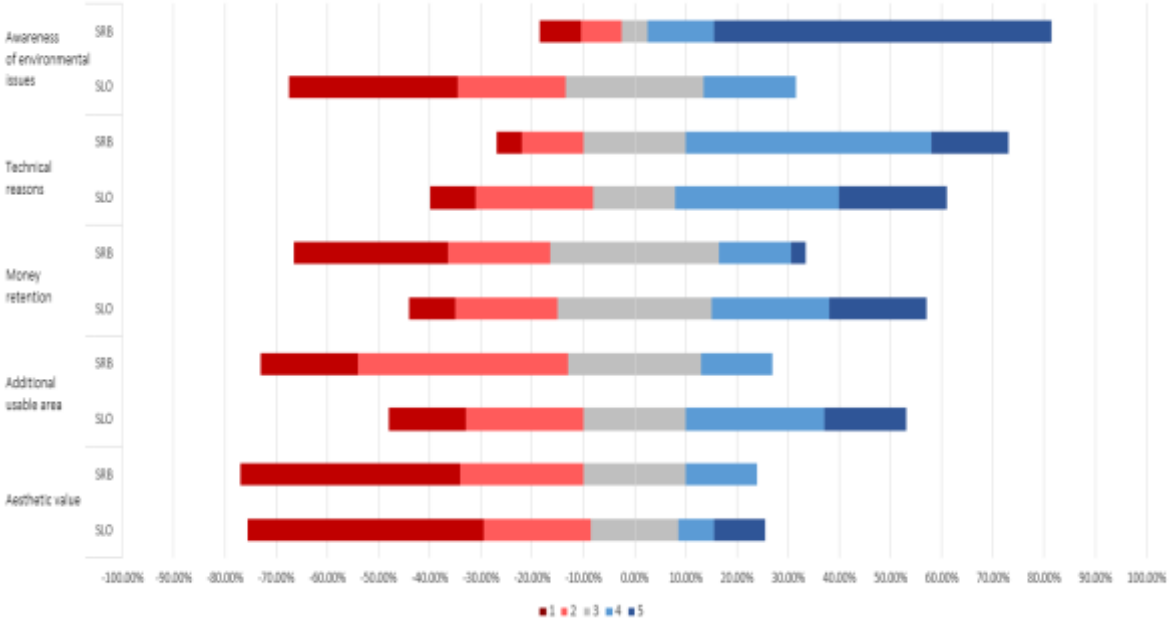

Figure 13: Public's responses concerning important aspects of the green roof. Legend: 1 - not important at all, 5 - very important.

The fifth part of the analysis was about biodiversity on green roofs. In general, both the Slovenian and Serbian public seem to be aware of the facts that biodiversity is important, and that green roofs represent an habitat for species, especially in urban areas. could be used for plant conservation in urban areas. The responses from the Slovenian and Serbian public are similar. However, the pablic was not so well aware about the negative effects of the non-native species. Answers are shown in Figure 14.

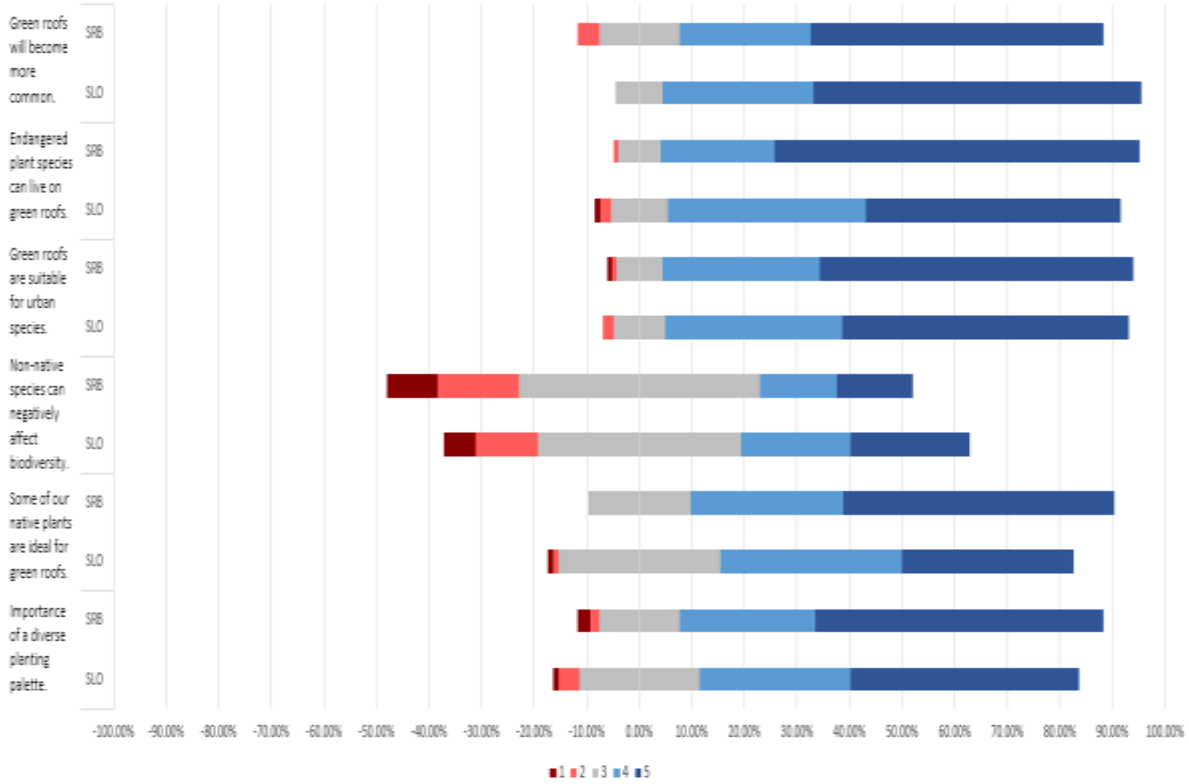

Figure 14: Public's responses concerning important aspects of biodiversity and its relation to green roofs. 1 - completely disagree, 5 - completely agree.

3.2 Plants used for green roofs

One of the most valuable outputs from the companies were lists of plants used for green roofs that companies gave to us. Each company listed a couple of plants that they use when planting roofs. In the end, we made a comprehensive list of plants mentioned by slovenian companies combined with species mentioned in other literature (see Table 7). We included information about the life forms as well as information about the conservation status.

Out of 66 plant species mentioned by companies, 28 were native to Slovenia

Out of 66 plants mentioned by the interviewed companies, four are legally protected in Slovenia: *Dianthus deltoides, Dianthus knappii, Iris humilis* and *Sempervivum juvani*, and four species mentioned by companies are included in the Slovenian Red List: *Centaurea cyanus, Festuca ovina, Hyssopus officinalis,* and *Salvia officinalis*. One Slovenian Red list species (*Alyssum montanum)* was mentioned by Snodgrass & Snodgrass (2006), but not by Slovenian companies.

Out of 48 plants mentioned by Snodgrass & Snodgrass 2006, two are legally protected in Slovenia: *Alyssum montanum* Pall. and *Sempervivum juvani* Strgar.

Most of the plants mentioned by the companies but also by Snodgrass & Snodgrass (2006) are Hemikryptophytes and Chamaephytes, which somehow agrees with the desired and necessary characteristics of plants that thrive on green roofs.

As the topic of this master's thesis is the conservation of biodiversity, we paid particular attention to protected, endangered, and native species. Finding out that some plant species of conservation concern are used for green roofs is an important information, and we want to emphasize that further. This supports the fact that green roofs can contribute to the preservation and promotion of biodiversity, not only on green roofs but also in the entire urban areas where they are located, especially since we know how much biodiversity is actually threatened by urbanisation. In table 6 we compiled the Slovenian species of conservation concern (legally protected species and species included in the Slovenian Red List) and checked in literature if their use has been ever mentioned for green roofs. In table 7, we compiled other Slovenian species that can be used on green roofs.

Table 5: List of plants used for green roofs in Europe. Lines in bold represent the species listed by the companies in our survey. Life forms: FA - Phanerophyta, HA - Chamaephyta, HE - Hemikryptophyta, GE - Geophyta, TE - Therophyta, HI – Hydrophyta. Protection status: IUCN RL – species included in one of the threatened categories of the IUCN Red List, SLO RL – plant included in Slovenian Red List; SLO P – legally protected plant species in Slovenia. Abbreviation of references: SN - Snodgrass & Snodgrass, 2006; CO - information obtained from companies in present study. *several cultivars mentioned (S.a. "Chloroticum", "Coral Carpet", "France", "Murale"). **several cultivars mentioned (S.j. "Blue Boy", "Georgette", "Oddity", "Saturn", "Silver Thaw"). ***plants used in constructed wetlands.

List of used and potentially used plant species for green roofs	Family	Life form	native Europe	native Slo	Protection status			Reference
					IUCN RL	SLO RL	SLO P	
***Acer palmatum* Raf.**	**Sapindaceae**	**FA**	**no**	**no**	**/**	**/**	**/**	**CO**
***Achillea millefolium* L.**	**Asteraceae**	**HA**	**yes**	**yes**	**/**	**/**	**/**	**CO**
Achillea tomentosa Fraas ex Nyman	Asteraceae	HA	yes	no	/	/	/	SN
Alchemilla saxatilis Buser	Rosaceae	HE	yes	no	/	/	/	SN
Allium schoenoprasum L.	Alliaceae	GE	yes	yes	/	/	/	SN
Alyssum montanum Pall.	Brassicaceae	HA	yes	yes	/	CR (E)	/	SN
Anthemis tinctoria L.	Asteraceae	HE	yes	yes	/	/	/	SN
***Anthericum ramosum* L.**	**Asparagaceae**	**HE**	**yes**	**no**	**/**	**/**	**/**	**CO**
Anthyllis vulneraria L.	Papilionaceae	HE	yes	no	/	/	/	SN
***Antirrhinum majus* L.**	**Plantaginaceae**	**HA**	**no**	**no**	**/**	**/**	**/**	**CO**
***Armeria maritima* Girard ex Boiss.**	**Plumbaginaceae**	**HA**	**yes**	**no**	**/**	**/**	**/**	**CO**
Aster alpinus L.	Asteraceaea	HE	yes	yes	/	/	/	SN
Aurinia saxatilis (L.) Desv.	Brassicaceae	HA	yes	yes	/	/	/	SN
***Buphthalmum salicifolium* L.**	**Asteraceae**	**HE**	**yes**	**yes**	**/**	**/**	**/**	**CO**
***Campanula carpatica* Jacq.**	**Campanulaceae**	**HE**	**yes**	**no**	**/**	**/**	**/**	**CO**
***Campanula cochleariifolia* Vahl**	**Campanulaceae**	**HE**	**yes**	**yes**	**/**	**/**	**/**	**CO**
Campanula rotundifolia L.	Campanulaceae	HE	yes	yes	/	/	/	SN
Carex flacca Schreb.	Cyperaceae	HE	yes	yes	/	/	/	SN
Carex humilis Willd. ex Kunth	Cyperaceae	HE	yes	yes	/	/	/	SN
***Carex morrowii* Boott**	**Cyperaceae**	**HE**	**no**	**no**	**/**	**/**	**/**	**CO**
***Centaurea cyanus* L.**	**Asteraceae**	**TE**	**yes**	**yes**	**/**	**EN (V)**	**/**	**CO**
Cerastium tomentosum Georgi	Caryophyllaceae	HA	yes	no	/	/	/	SN
***Chamaemelum nobile* (L.) All.**	**Asteraceae**	**TE**	**yes**	**yes**	**/**	**/**	**/**	**CO**
***Delosperma congestum* L.Bolus**	**Aizoaceae**	**HA**	**no**	**no**	**/**	**/**	**/**	**CO**
***Delosperma cooperi* L. Bol. Forma Cooperi**	**Aizoaceae**	**HA**	**no**	**no**	**/**	**/**	**/**	**CO**
***Delosperma deleeuwiae* Lavis**	**Aizoaceae**	**HA**	**no**	**no**	**/**	**/**	**/**	**CO**
Dianthus alpinus L.	Caryophyllaceae	HE	yes	no	/	/	/	SN
***Dianthus arenarius* L.**	**Caryophyllaceae**	**HA**	**yes**	**/**	**/**	**/**	**/**	**CO**
***Dianthus caesius* Sm.**	**Caryophyllaceae**	**HA**	**yes**	**/**	**/**	**/**	**/**	**CO**

***Dianthus carthusianorum* L.**	**Caryophyllaceae**	**HE/HA**	**yes**	**yes**	**/**	**/**	**SLOP**	**CO**
***Dianthus deltoides* L.**	**Caryophyllaceae**	**HE**	**yes**	**yes**	**/**	**/**	**SLOP**	**SN, CO**
Dianthus knappii (Pant.) Asch. & Kanitz ex Borbás	Caryophyllaceae	HA	yes	no	/	/	/	SN
Dianthus myrtinervius Griseb.	Caryophyllaceae	HA	yes	no	/	/	/	SN
Echeveria sp.	**Crassulaceae**	**HE**	**no**	**no**	**/**	**/**	**/**	**CO**
Echium russicum J.F. Gmel.	Boraginaceae	TE	yes	no	/	/	/	SN
Echium vulgare L.	Boraginaceae	TE	yes	yes	/	/	/	SN
***Festuca arundinacea* Lilj.**	**Poaceae**	**TE/HE**	**yes**	**yes**	**/**	**/**	**/**	**CO**
***Festuca glauca* Vill.**	**Poaceae**	**TE/HE**	**yes**	**no**	**/**	**/**	**/**	**CO**
***Festuca ovina* L.**	**Poaceae**	**TE/HE**	**yes**	**yes**	**/**	**VU (R)**	**/**	**CO**
***Fragaria vesca* Benth.**	**Rosaceae**	**HE**	**yes**	**yes**	**/**	**/**	**/**	**CO**
Galium verum L.	Rubiaceae	HE	yes	yes	/	/	/	SN
***Geranium sanguineum* L.**	**Geraniaceae**	**HE**	**yes**	**yes**	**/**	**/**	**/**	**CO**
***Helichrysum italicum* (Roth) G.Don**	**Asteraceae**	**HA**	**yes**	**yes**	**/**	**/**	**/**	**CO**
Herniaria glabra L.	Carryophyllaceae	TE	yes	yes	/	/	/	SN
***Hieracium aurantiacum* L.**	**Asteraceae**	**HE**	**yes**	**yes**	**/**	**/**	**/**	**SN, CO**
Hieracium lanatum Brot.	Asteraceae	HE	yes	yes	/	/	/	SN
***Hieracium pilosella* L.**	**Asteraceae**	**HE**	**yes**	**yes**	**/**	**/**	**/**	**SN, CO**
Hieracium villosum Lapeyr.	Asteraceae	HE	yes	yes	/	/	/	SN
***Hypericum polyphyllum* Boiss. & Balansa**	**Hypericaceae**	**HA**	**no**	**no**	**/**	**/**	**/**	**CO**
***Hyssopus officinalis* L.**	**Lamiaceae**	**HA**	**yes**	**yes**	**/**	**VU (R)**		**CO**
Iris humilis Schur	Iridaceae	GE	yes	yes	/	/	SLOP	SN
***Jasione laevis* Lam.**	**Campanulaceae**	**HE**	**yes**	**no**	**/**	**/**	**/**	**CO**
Jovibarba allionii (Jord. & Fourr.) D.A.Webb	Crassulaceae	HA	yes	no	/	/	/	SN
Koeleria macrantha (Ledeb.) Schult.	Poaceae	HE	yes	no	/	/	/	SN
***Lavandula angustifolia* Moench**	**Lamiaceae**	**HA**	**yes**	**yes**	**/**	**/**	**/**	**CO**
***Linaria alba* Moench**	**Plantaginaceae**	**HE**	**yes**	**no**	**/**	**/**	**/**	**CO**
***Linaria alpina* (L.) Mill.**	**Plantaginaceae**	**HE**	**yes**	**no**	**/**	**/**	**/**	**CO**
***Linaria flava* (Poir.) Desf.**	**Plantaginaceae**	**HE**	**yes**	**no**	**/**	**/**	**/**	**CO**
***Linaria purpurea* (L.) Mill.**	**Plantaginaceae**	**HE**	**yes**	**no**	**/**	**/**	**/**	**CO**
***Linaria vulgaris* Mill.**	**Plantaginaceae**	**HE**	**yes**	**no**	**/**	**/**	**/**	**CO**
Linum flavum L.	Linaceae	HE	yes	yes	/	/	/	SN
***Linum perenne* L.**	**Linaceae**	**HE**	**yes**	**no**	**/**	**/**	**/**	**CO**
Lotus corniculatus L.	Papilionaceae	HE	yes	yes	/	/	/	SN
Lychnis alpina L.	Caryophyllaceae	HA	yes	no	/	/	/	SN
Marrubium incanum Desr.	Lamiaceae	HA	yes	yes	/	/	/	SN
Origanum vulgare L.	Lamiaceae	HE	yes	yes	/	/	/	CO
Panicum sp.	**Poaceae**	**HE**	**no**	**no**	**/**	**/**	**/**	**CO**

***Papaver croceum* Ledeb.**	**Papaveraceae**	**TE**	**no**	**no**	**/**	**/**	**/**	**CO**
***Papaver rhoeas* L.**	**Papaveraceae**	**TE**	**yes**	**yes**	**/**	**/**	**/**	**CO**
***Pennisetum alupecoroides* (Lam.) Rich.**	**Poaceae**	**TE/HE**	**no**	**no**	**/**	**/**	**/**	**CO**
Petrorhagia saxifraga (L.) Link	Caryophyllaceae	HA	yes	yes	/	/	/	SN
***Potentilla argentea* Willd. ex Ledeb.**	**Rosaceae**	**HE**	**yes**	**yes**	**/**	**/**	**/**	**CO**
***Potentilla verna* Zimmeter**	**Rosaceae**	**HA**	**yes**	**/**	**/**	**/**	**/**	**CO**
Prunella grandiflora (L.) Jacq.	Lamiaceae	HA/HE	yes	yes	/	/	/	SN
***Prunella vulgaris* L.**	**Lamiaceae**	**HA/HE**	**yes**	**yes**	**/**	**/**	**/**	**CO**
***Salvia bicolor* Lam.**	**Lamiaceae**	**HA**	**no**	**no**	**/**	**/**	**/**	**CO**
Salvia jurisicii Kosanin	Lamiaceae	HE	yes	no	/	/	/	SN
***Salvia nemorosa* L.**	**Lamiaceae**	**HA**	**yes**	**no**	**/**	**/**	**/**	**CO**
***Salvia officinalis* L.**	**Lamiaceae**	**HA**	**yes**	**yes**	**/**	**VU (R)**	**/**	**CO**
Salvia pratensis L.	Lamiaceae	HE	yes	yes	/	/	/	SN
***Saponaria ocymoides* L.**	**Caryophyllaceae**	**HA**	**yes**	**no**	**/**	**/**	**/**	**CO**
***Satureja montana* L.**	**Lamiaceae**	**HA**	**yes**	**yes**	**/**	**/**	**/**	**CO**
Scabiosa columbaria L.	Dipsacaceae	HE	yes	no	/	/	/	SN
Scutellaria alpina L.	Lamiaceae	HE	yes	no	/	/	/	SN
Sedum acre L.	Crassulaceae	HA	yes	yes	/	/	/	SN
Sedum aizoon L.	Crassulaceae	HA	no	no	/	/	/	SN
*Sedum album**	Crassulaceae	HE	yes	yes	/	/	/	SN
***Sedum ellacombeanum* Praeger**	**Crassulaceae**	**HA**	**yes**	**no**	**/**	**/**	**/**	**CO**
***Sedum ewersii* Ledeb.**	**Crassulaceae**	**HA**	**yes**	**no**	**/**	**/**	**/**	**CO**
Sedum forsterianum Sm.	Crassulaceae	HA	yes	no	/	/	/	SN
***Sedum hispanicum* (L.) Raym.-Hamet**	**Crassulaceae**	**TE/HE**	**yes**	**yes**	**/**	**/**	**/**	**CO**
***Sedum hybridum* L.**	**Crassulaceae**	**HA**	**yes**	**no**	**/**	**/**	**/**	**CO**
Sedum pulchellum Azn.	Crassulaceae	HA	yes	no	/	/	/	SN
***Sedum reflexum* L.**	**Crassulaceae**	**HA**	**yes**	**yes**	**/**	**/**	**/**	**CO**
***Sedum rupestre* Oeder**	**Crassulaceae**	**HA**	**yes**	**no**	**/**	**/**	**/**	**CO**
***Sedum sexangulare* L.**	**Crassulaceae**	**HA**	**yes**	**yes**	**/**	**/**	**/**	**CO**
***Sedum spurium* M.Bieb.**	**Crassulaceae**	**HA**	**yes**	**yes**	**/**	**/**	**/**	**CO**
*Sempervivum juvani***	Crassulaceae	HA	yes	yes	/	EN(V)	SLOP	SN
Sesleria autumnalis (Scop.) F.W.Schultz	Poaceae	HE/TE	yes	yes	/	/	/	SN
***Silene viscaria* (L.) Jess.**	**Caryophyllaceae**	**HA**	**yes**	**/**	**/**	**/**	**/**	**CO**
***Teucrium chamaedrys* L.**	**Lamiaceae**	**HA**	**yes**	**/**	**/**	**/**	**/**	**CO**
Thymus citriodorus (Pers.) Schreb.	Lamiaceae	HA	yes	no	/	/	/	SN
Thymus praecox Opiz	Lamiaceae	HA	yes	yes	/	/	/	SN
Thymus pulegioides L.	Lamiaceae	HA	yes	yes	/	/	/	SN
***Thymus vulgaris* L.**	**Lamiaceae**	**HA**	**yes**	**yes**	**/**	**/**	**/**	**CO**
***Verbascum nigrum* L.**	**Scrophulariaceae**	**HE**	**yes**	**yes**	**/**	**/**	**/**	**CO**
***Veronica incana* L.**	**Plantaginaceae**	**HE**	**yes**	**no**	**/**	**/**	**/**	**CO**

Veronica prostrata L.	Scrophulariaceae	HE	yes	yes	/	/	/	SN
***Veronica spicata* L.**	**Plantaginaceae**	**HE**	**yes**	**no**	**/**	**/**	**/**	**CO**
***Vinca minor* L.**	**Apocynaceae**	**HA**	**yes**	**yes**	**/**	**/**	**/**	**CO**

Table 6: Slovenian plants (including lichens, mosses and ferns) of conservation concern that are suitable for green roofs. HL - Heim & Lundholm, 2013. CF - Campbell & Franco, n.d. NN - Nagase & Nomura, 2017. VM - van Mechelen, 2015. Other internet sources: OT[1]- Down to Earth. n.d. 2015. OT[2]- Hawke 2015. OT[3]- LifeMedGreenRoof n.d. OT[4] - Well thought-out solution from green roofing experts. n.d. OT[5]- Vegetation for extensive & biodiverse green roofs. 2012. OT[6]- Intensive vegetation – Herbaceous plants. n.d.

	Family	Life form	Status			Reference
			IUCN RL	SLO RL	SLO P	
Cladonia L. subgenus *Cladina*	Lichen: Cladoniaceae	-	/	/	SLO P	HL
Sphagnum L. (vse vrste)	Moss: Sphagnaceae	-	/	/	SLO P	CF
Adiantum capillus-veneris L.	Fern: Pteridaceae	HE	/	EN (V)	SLO P	OT[1]
Allysum montanum L.	Brassicaceae	HA	/	/	SLO P	VM
Arctostaphylos uva-ursi (L.) Spreng.	Ericaceae	HA	/	/	SLO P	OT[2]
Dianthus armeria L.	Caryophyllaceae	TE/HE	/	/	SLO P	VM
Dianthus barbatus L.	Caryophyllaceae	HA	/	/	SLO P	OT[3]
Dianthus plumarius L.	Caryophyllaceae	HE	/	/	SLO P	VM
Dianthus superbus L.	Caryophyllaceae	HE	/	/	SLO P	VM
Dianthus sylvestris Boiss.	Caryophyllaceae	HE	/	/	SLO P	VM
Galanthus nivalis L.	Amaryllidaceae	GE	NT	/	SLO P	OT[4]
Iris germanica L.	Iridaceae	GE	/	/	SLO P	OT[4]
Iris graminea Thunb.	Iridaceae	GE	/	/	SLO P	VM
Iris pseudacorus L.	Iridaceae	GE	/	/	SLO P	NN
Jovibarba hirta (Pollini) Opiz	Crassulaceae	HA	/	/	SLO P	OT[5]
Leontopodium alpinum Colm. ex Cass.	Asteraceae	HE	/	NT (0)	SLO P	OT[6]
Linnaea borealis L.	Caprifoliaceae	HA	/	CR (E)	SLO P	CF
Sempervivum tectorum L.	Crassulaceae	HA	/	/	SLO P	VM
Stipa capillata L.	Poaceae	HE	/	/	SLO P	VM

Table 7: Other Slovenian native plants that could be used on green roofs. BL - Blumberg, 2020. BR - Brachet et al., 2020. JU-Ju et al., 2021. KN- Knapp et al., 2019. OL - Olly et al., 2011. SU- Sutton et al., 2012. VM - van Mechelen, 2015. Other internet sources: OT[1] - Down to Earth. n.d. OT[8]- Getter & Rowe, 2008. OT[9]- Gardener's world. n.d. OT[10] - Green roof in the Village Elves Hideaway. n.d. OT[11] - *Trifolium rubens*, Green Roof Plant Feather clover. n.d.* plants used in constructed wetlands.

	Family	Life form	Status			References
			IUCN RL	SLO RL	SLO P	
Ajuga reptans L.	Lamiaceae	HE	/	/	/	VM
Allium carinatum L.	Amaryllidaceae	GE	/	/	/	VM
Antennaria dioica (L.) Gaertn.	Asteraceae	HA	/	/	/	VM
Arabidopsis thaliana (L.) Heynh.	Brassicaceae	TE	/	/	/	OL
Arabis hirsuta Royle ex Hook.f. & Thomson	Brassicaceae	HE	/	/	/	VM
Calluna vulgaris (L.) Hull	Ericaceae	HA	/	/	/	OT[7]
Caltha palustris L.	Ranunculaceae	HE	/	/	/	BL
Centaurea jacea L.	Asteraceae	HE	/	/	/	VM
Centaurea montana Burm.f.	Asteraceae	HE	/	/	/	BR
Centaurium erythraea Rafn	Gentianaceae	HE	/	/	/	VM
Convallaria majalis L.	Asparagaceae	GE	/	/	/	OT[8]
Cymbalaria muralis P.Gaertn., B.Mey. & Scherb.	Plantaginaceae	HE	/	/	/	VM
Euphorbia amygdaloides Lam.	Euphorbiaceae	HA	/	/	/	VM
Euphorbia cyparissias L.	Euphorbiaceae	HE	/	/	/	VM
Festuca amethystina Host	Poaceae	TE/HE	/	VU (R)	/	VM
Festuca ovina L.	Poaceae	TE/HE	/	VU (R)	/	VM
Filipendula vulgaris Hill	Rosaceae	HE	/	/	/	VM
Globularia cordifolia L.	Plantaginaceae	HE	/	/	/	VM
Helianthemum nummularium (L.) Mill.	Cistaceae	HA	/	/	/	VM
Hippocrepis comosa L.	Fabaceae	HE	/	/	/	VM
Inula hirta Pollich	Asteraceae	HE	/	/	/	VM
Juncus effusus L.	Juncaceae	HE	/	/	/	OT[8]
Knautia arvensis J.M. Coult.	Caprifoliaceae	HE	/	/	/	VM
Lotus corniculatus ssp. hirsutus L.	Fabaceae	HE	/	/	/	VM
Lythrum salicaria L. *	Lythraceae	HE	/	/	/	KN
Medicago lupulina L.	Fabaceae	TE/HE	/	/	/	VM
Medicago sativa L.	Fabaceae	HE	/	/	/	VM
Melica ciliata L.	Poaceae	TE/HE	/	/	/	VM
Mentha spicata L.	Lamiaceae	HE	/	/	/	JU
Phragmites australis (Cav.) Trin. ex Steud.*	Poaceae	TE/HE	/	/	/	KN
Plantago lanceolata L.	Plantaginaceae	HE	/	/	/	VM
Plantago media L.	Plantaginaceae	HE	/	/	/	VM
Polygala vulgaris L.	Polygalaceae	HA	/	/	/	VM

Polygonatum odoratum (Mill.) Druce	Asparagaceae	GE	/	/	/	VM
Polypodium vulgare L.	Polypodiaceae	HE	/	/	/	VM
Potentilla anserina Jeps.	Rosaceae	HE	/	/	/	SU
Primula auricula L.	Primulaceae	HE	/	NT (O)	/	OT[9]
Primula vulgaris Huds.	Primulaceae	HE	/	/	/	VM
Rhodiola rosea L.	Crassulaceae	HE	/	/	/	OT[10]
Rumex scutatus L.	Polygonaceae	HA	/	/	/	VM
Sedum album L.	Crassulaceae	HE	/	/	/	VM
Sedum dasyphyllum L.	Crassulaceae	HA	/	/	/	VM
Sesleria caerulea (L.) Ard.	Poaceae	TE/HE	/	/	/	VM
Silene vulgaris (Moench) Garcke	Caryophyllaceae	HA	/	/	/	VM
Succisa pratensis Moench	Caprifoliaceae	HE	/	/	/	VM
Taraxacum officinale (L.) Weber ex F.H.Wigg.	Asteraceae	HE	/	/	/	VM
Thymus serpyllum L.	Lamiaceae	HA	/	/	/	VM
Tragopogon pratensis ssp. orientalis (L.) Čelak.	Asteraceae	HE	/	/	/	VM
Trifolium arvense Walter	Fabaceae	TE	/	/	/	VM
Trifolium rubens L.	Fabaceae	HE	/	/	/	OT[11]
Viola arvensis Murray	Violaceae	TE	/	/	/	VM
Viola odorata L.	Violaceae	HE	/	/	/	VM

4 CONCLUSION

The purpose of this master's thesis was to examine the potentials that green roofs have in terms of increasing biodiversity in cities, with an emphasis on plants. We looked at this issue from different points of view: from the perspective of green roof providerds (companies that deal with green roof constructions), from the point of view from the general public and from the scientific point of view, represented by the examined scientific publications.

4.1 Attitude of surveyed companies and the general public towards biodiversity issues

One of the sections in the surveys aimed at understanding the attitude of the companies and of the general public towards biodiversity issues. While it seems that both companies and the general public is mostly aware of the importance of biodiversity, some of the companies from Slovenia answered also with a negative answer: for example, 3 out of 5 of the questioned Serbian companies companies (strongly) disagreed with the statement that non-nanitve species can negatively affect biodiversity. One Serbian company also disagreed with the statement that endangered plants can be planted on green roofs. Regarding some other questions, it was the Sloveanian companies that gave more negative answers: for example that some native plants are ideal for green roofs, or that it is important to plant a diverse planting pallette, or that the origin of the plants may be important for the survival of plants on green roofs. However, the negative answers were in minority, and most answeres agreed that these issues are important. Interestingly, also the general public gave the most negative score to the statement that non-native species can negatively affect biodiversity. It seems that the understanding of the concept of native and non-native species and their importance for biodiversity is still not clear to some surveyed companies and to the general public.

We also wanted to check how much knowledge do companies have about plant biology and ecology and biodiversity in general, and how much they focus on these topics. We believe that green roofs cover several different areas of interest and knowledge. Therefore, it is important to identify all known facts, as well as unknown ones, in order to facilitate the further process of getting acquainted with the topic. And to bring all the aspects that green roofs offer closer to a wider audience.

Companies were also asked what is (in their opinion) the most important reason why their clients opt for green roofs. Aesthetic reasons were the most frequent answer in both countries, and additional usable area seems to be important as well, but less so according to the Slovenian companies. On the other hand, both Slovenian and Serbian companies answered that awareness of environmental issues is not crucial when their clients opt for a green roof. As a matter of fact, companies stated that it was the least important reason for their clients. The same question was asked to the general public and the answers are really (diametricaly) different. This was very interesting, and we tried to come up with all the

possible reasons why such results came about. Maybe in fact companies are not well informed about the real motivation of their clients. Clients themselves may not be aware of the potential for green roofs to contribute to the maintenance of biodiversity. On the other hand, perhaps the surveyed public responded more intuitively rather than realistically and honestly. Maybe they are just aware of the possible contribution to biodiversity, but in fact for that reason alone they would never opt for green roofs. Especially since biodiversity is sometimes talked about a lot, and, at the time, unfortunately, little is done to actually solve the problems.

So, based on all the answers collected, we cannot accept or reject the first hypothesis (*Maintaining biodiversity is not crucial for the decision of potential clients to install a green roof*). Maintaining biodiversity seems to be a very important aspect influencing the decision about implementing a green roof for the Serbian companies, but not for the Slovenian companies. Perhaps such answers are a consequence of the expertise and nature of the companies that answered our questions. Perhaps there were more Serbian companies that were more informed about biodiversity and its maintenance. Maybe there were more of those Slovenian companies that just do the work, without getting too involved in the very topic of green roofs. So these are the possible reasons of such answers. And the real situation may be different.

As for the second hypothesis (*Both in Slovenia and Serbia, native plant species represent untapped potential for green roofs*), we wanted to check whether companies use native species in their roofs and to what extent. The Slovenian companies knew the origin of the plants, but only in some extent. The Serbian companies stated that they know almost for every plant. Also, the Serbian companies were more prepared to replace non-native plants with native ones, than the Slovenian companies. Here we would like to emphasize that our samples are not comprehensive enough to accept some of the answers in full. Perhaps these differences are due to the fact that Slovenian companies have more experience and are more familiar with the offer on the market, so they are already aware that the offer of native species is very weak.

People dealing with green roofs definitely do not consider nativeness to be an essential trait; that is, plants' nativeness is not their most important characteristic when selecting plants for green roofs. Plants' nativeness may not be something that has been promoted and insisted on, so perhaps that is why there is a gap between knowledge and practice or implementation. People generally believe that there are native species, both in Slovenia and in Serbia, that could be used on green roofs. Companies listed some of the plants that they are using in our questionnaire. Out of 66 plant species mentioned by companies, 28 were native to Slovenia. That is almost half of the total number. The rest of the mentioned plants were non-native to Slovenia. Native species really represent a huge potential when planting green roofs, anywhere in the world. They are the ones who are in the best possible way adapted to the present conditions, and they are the ones who will withstand all the changes that are current

in that given area. In the past, many studies have been done for the Mediterranean area. Lists have been made of many plants that are best adapted to climatic conditions, and more importantly, that are native to the region. Thus, the most efficient possible coverage on green roofs would be provided. Paço et al. (2011) have provided extensive data on the adaptation of biocrusts to the Mediterranean climate and on how native species, among other benefits, require less maintenance.

Due to the diverse climatic, geological and pedological conditions, both Slovenia and Serbia boast an abundant flora. We can find plant species that are maximally adapted different conditions, from mountainous, dry, temperate, to humid. From this large array of species, we should be able to find particular plants that posess the suitable characteristics for green roofs. The literature review revealed that we should be looking for perennial plants, long-living shrubs, drought-tolerant plants, plants that are resistant to prolonged sun exposure, plants that do not have long and well-developed roots, plants that can be exposed to wind and rain for a long time, etc.

Indeed, both Slovenia and Serbia own rich and abundant flora, from which they can single out and find precisely those species that would be successful and that could establish a long-term cover on green roofs. Many sedums, perrenials, even some grasses. Furthermore, native species would also contribute to many other burning problems in urban areas due to their adaptation to the local climate. The overall biodiversity would increase because native plants also attract native fauna, the effects of the urban heat island would be reduced, the stormwater runoff would improve... If people were more aware of all the benefits that the use of native species brings with it, we think that then they would be even more represented. Therefore, after all the conclusions presented, we can confidently say that the second hypothesis has been confirmed and accepted and that native plant species really represent untapped potential for green roofs.

It has become clear from our study, but also from literature (Blackmore, 2020), that non-native species are definitely more represented on green roofs than native ones. Nevertheless, it should be emphasized here that people are generally not fully informed about the origin of plants. Both general public and companies even said they would be willing to replace non-native species with native ones. They also believe that native species could be successful on green roofs. So why are native plants still rare on green roofs? Blackmore (2020) mentions two main reasons why there are not more threatened native plants planted in the cities: one is lack of knowledge about species, and the other is that these plants are difficult to obtain. The demand for native plants is not great, which is probably why companies do not decide to procure them and have them in their offer. On the other hand, exotic plants are much more represented and current, so obviously their demand is much higher. It is probably assumed that the maintenance of endangered or protected species is much more difficult, expensive and demanding, so maybe somewhere there is a fear of choosing such plants. Certainly, plant's nativiness has never been an important feature that has been insisted on when solving

modern ecological solutions, so maybe that's why it takes a little more time for people to be educated further and accept something new.

Also, both Slovenian and Serbian companies emphasized that the most important aspects of choosing plants for green roofs are the clients' specific desires and the existing offer of the green roof suppliers. This is the area where we need to work more and pay special attention. Educating both clients and, on the other hand, companies, would have a positive and comprehensive effect on the more frequent use of native species. But of course, even educating is not enough if there are no providers of native plants. Blackmore (2020) suggests that botanical gardens should be the institutions that should take up the challenge of becoming the main suppliers of native plants.

Nevertheless, what is undoubtedly a general conclusion is that that non-native plants are dominant in the current plantings of green roofs, both in the surveyed countries and abroad.

We would also like to mention the companies' responses regarding plants planted on green roofs. We have realized and concluded that it is necessary to educate both companies and the public more about the environmental benefits of green roofs, their potential, and how much they can contribute to their wider environment. We think that the frequency of green roofs would increase if the public was well and extensively informed. It is also necessary to involve different experts in each green roof construction project to ensure that each green roof goal is achieved. Also, we think it is essential to mention and support further research on plants used when planting green roofs-especially research on native and protected flora. There is a vast potential hidden there, which is currently untapped. We know that there are additional funds and motivating laws to support the construction of green roofs in countries like Germany and Switzerland. Many of these funds and laws also mention the use of native flora during construction (Williams et al. 2014). Maybe something like that is possible to establish in Slovenia and Serbia.

4.2 Current situation about green roofs in Slovenia and Serbia

Based on our research, we found more companies that deal with green roofs in Slovenia (35 companies) than in Serbia (23 companies). We have also noticed that Slovenian companies have realized more green roof projects compared to Serbian companies. Definitely, as a member of the European Union, Slovenia has access to many modern trends and funds dealing with the promotion of green roofs and environmental issues. Companies from Slovenia are perhaps better connected with Austrian and German companies dealing with green roofs, which are certainly one of the most advanced and have the most experience in this field. Furthermore, Serbian companies valued more additional space and money retention features of green roofs, while the Slovenian companies valued more technical and environmental features. Slovenian companies stated that their clients' biggest concerns are the costs of green roofs. In contrast, Serbian companies stated that their clients' biggest

concerns are lack of knowledge and fear of possible negative consequences. We would also like to underline that Slovenian companies do not employ as many experts as Serbian companies. Maybe that is why they did not know about the plant's origin and were not ready to replace non-native species with native ones. Different standards certainly determine the direction of interest and opportunities of the population. Thus, differences in potential reasons for accepting or rejecting a green roof project are expected. Also, awareness of environmental issues and their relevance in the media play an important role in choosing green roofs.

Concerning the answers from the general public, we have found only a few differences between Slovenia and Serbia and will emphasize them further. The Serbian general public stated that the environmental feature of green roofs is vital to them, unlike the Slovenian general public. Costs of set-up and maintenance proved to be a more significant concern to the Slovenian general public than the Serbian one. The Slovenian general public was more aware that green roofs can protect native and endangered plants than the Serbian general public. However, at the same time, the Slovenian general public was not aware that some of the Slovenian native plants could be preserved using green roofs. While the Serbian general public was aware that some of the Serbian native plants could be preserved using green roofs. Perhaps such differences are a consequence of the general presence and topicality of environmental issues in these two countries. Perhaps the Slovenian public, as well as Slovenian companies, are better acquainted with protected species and areas, given that investments in this area are constant. Money is, as always, an important item in such projects, and is certainly one of the deciding factors when choosing green roofs. Different standards in countries can also contribute to different perceptions and representation of such projects.

After the review of all collected answers, we can conclude that there are some differences in people’s perception of green roofs between Slovenia and Serbia, but we could not fully accept or reject the fourth hypothesis.

Green roofs are not still in the present consciousness of the public as being a worthy, valuable benefit to society. It will probably take more time and convincing to change the public's perspective from a known fact to an unknown one - from a regular, concrete roof to a green roof. Green roof accessibility has to become more common and represented. Access is required from several fronts, as well as the involvement of many various experts. A unique engagement between the city's authorities and its citizens is the best way to deal with implementing green roofs into urban environments. Constant communication and networking are needed to ensure the quality flow and availability of information, which green roofs professionals would offer to all stakeholders. Furthermore, we need to be aware of the impact of social media nowadays. Many green roofs activists and enthusiasts can engage themselves in developing a social network that would connect even more people, companies, and authorities.

Many different municipalities all over the world are using regulations to make green roofs more included in urban architecture. It is not only up to the environmental sector of every city's structure. The sector of finances, civil engineering, education, health, economic development, social development, have to be included. Because green roofs require attention from all of the mentioned sectors. Promoting, financing, planning, and realization of green roofs can be successful only if all included parts do their work. Governments and business leaders need serious additional education about green roofs and all the benefits these bring to the urban environments.

4.3 Green roofs and their possibilities for conservation of biodiversity

The fact that native threatened plant species have been found to occur on green roofs (e.g. Brenneisen, 2006) should encourage scientists conduct more studies on this topic. Scientists have already confirmed the presence of many important taxa, we just need to further substantiate the claims and provide more evidence for the benefits of the green roof's biodiversity.

The exploration of Slovenian flora revealed many plant species with varying life forms that could be used for green roofs. Our research grants the fundamental ecological knowledge needed for additional testing of species and, hopefully, terminal implementation into a thriving green roof system (van Mechelen, 2015).

One of the best pieces of advice for a better view of biodiversity on green roofs is using local soils, as it also contains locally present seeds. Furthermore, a combination of local soil and seeds may replicate local plant communities and habitats. Soils represent a particular combination of climatic, geological, and biological factors. Therefore, they are maximally suited for local conditions, and they provide maximum support for vegetation. Using this approach, without a lot of money and time invested, we would be able to achieve approximately the same result and a replica of the native flora and landscape (Dunnett, 2006).

Amiel Vasl & Heim (2016) have suggested that, in order to maintain a high level of biodiversity on green roofs, we should be careful considering existing natural processes that regulate ecosystems, the niche, and neutral theories. The niche theory implies a set of ecological and biological aspects of a unique habitat, which synchronically allow a species to survive. The neutral theory is speaking about all those random occurrences that could determine one species abundance.
In circumstances of constant expansion of urban areas, construction, and destruction of species' natural habitats, protection of endangered species in their natural, existing habitat will be and is challenging. That is why we need to use all pragmatic and innovative options to help preserve biodiversity to the maximum. Green roofs are one of those options. Data on the protection of endangered species on green roofs are still scarce, so further and more

extensive research should be insisted on. Green roofs certainly have the potential for species conservation (Osmond & Blair, 2016). The most important thing about thriving biodiversity on the green roof is always to plan, carefully design, and maintain in the right way (Wang et al. 2017).

Achieving any goals involving the living world is not easy. Especially because you have to consider so many different theories, rules, special features and characteristics. Like any other ecological restoration, green roof projects should aim to be realistic, well-grounded and reasonable, and have easily achieved goals (Williams et al. 2014).

5 DALJŠI POVZETEK V SLOVENSKEM JEZIKU

Trenutni okoljski problemi od nas zahtevajo, da si nenehno prizadevamo zmanjšati njihove posledice in poiskati nove, učinkovitejše rešitve (Lepczyk et al. 2017, Williams et al. 2014). Vsi se zavedamo negativnih posledic onesnaženja, prenaseljenosti, uničevanja naravnih habitatov, podnebnih sprememb in izgube biotske raznovrstnosti na naše okolje. Urbana okolja so novi ekosistemi, ki jih skušajo znanstveniki čim bolje pogledati in oceniti, kako jih najbolje upravljati (Lepczyk et al. 2017). Za popolno obravnavo te teme se moramo zavedati razmer v urbanih okoljih. Neprebojne betonske površine, pomanjkanje zelenih površin, prometni zastoji, stekleni nebotičniki, povišane temperature... Potreben je celosten in temeljit pristop, ki daje idejo o ozelenitvi stavb. Zelene strehe se nanašajo na vse sisteme, ki omogočajo ozelenitev in rast različnih vrst rastlin na vrhu stavb.

Najbolj sprejeta klasifikacija zelenih streh je tista na intenzivne in ekstenzivne (Manso et al. 2021) ali ekstenzivne, enostavne intenzivne in intenzivne (Smernice za zelene strehe - Smernice za načrtovanje, gradnjo in vzdrževanje zelenih streh 2018):
• Intenzivne zelene strehe imajo debelino podlage več kot 15-40 cm. Na njih lahko uspevajo različne rastline (zelnate rastline, grmičevje in majhna drevesa) in potrebujejo redno zalivanje in vzdrževanje. Intenzivne zelene strehe zaradi svoje debeline tehtajo več kot obsežne.
• Ekstenzivne zelene strehe imajo debelino podlage 6-20 cm (Catalano et al. 2018). Ti sistemi so lahki sistemi. Obstaja več možnosti namestitve; lahko jih namestimo bodisi na obstoječe ravne strehe bodisi na nagnjene strehe do nagiba 30 ° in tako izboljšamo estetiko prej nezasedene strehe (Manso et al. 2021). Ekstenzivne zelene strehe običajno ne potrebujejo veliko vzdrževanja. Najbolje so se na ekstenzivnih zelenih strehah izkazale vrste rodu *Sedum* in CAM rastline.
Če želimo izbrati ustrezne rastline za različne zelene strehe, moramo poznati njihovo fiziologijo, anatomijo in življenjsko strategijo.

Najpomembnejše pri zelenih strehah je, da vse svoje vloge opravljajo hkrati in učinkovito. Ob pravilni namestitvi zelene strehe ponujajo številne tehnične prednosti, na primer podaljšajo življenjsko dobo strehe; lahko zmanjšajo obseg temperaturnih nihanj in uravnavajo celotno temperaturo stavbe; lahko znižajo račune za elektriko in delujejo kot odbojniki / zvočna izolacija za onesnaženje s hrupom; povečujejo vrednost nepremičnine, delujejo kot pravilno ravnanje z meteorno vodo z zmanjšanjem odtočne vode; ponujajo tudi idealen prostor za sončne kolektorje (https://strigroup.com; https://www.sempergreen.com; Snodgrass & Snodgrass, 2006). Zelene strehe se ločijo od običajnih streh tudi v tem, da se uspešno spopadajo z urbanim učinkom toplotnega otoka, zmanjšujejo posledice segrevanja v mestih in jih blažijo (Manso et al. 2021). Najpomembnejša korist z vidika varstvene biologije pa je zagotovo vloga zelenih streh pri ohranjanju biotske raznovrstnosti v urbanih okoljih (Williams et al. 2014).

Zelene strehe so lahko bistveni del povezave med naravnimi in mestnimi habitati. Mnogi znanstveniki jih obravnavajo kot edinstvene zelene otoke ali kot vroče točke biotske raznovrstnosti v mestih, ki prispevajo celo k biotski raznovrstnosti širših območij (Joimel et al. 2018). Številne nove študije so pokazale, da imajo zelene strehe v urbanem okolju velik potencial kot habitat za vrste, na katere negativno vplivajo spremembe v mestnih okoljih (Colla et al. 2009).

Za uspešen projekt zelene strehe je ključno sodelovanje različnih strokovnjakov: inženirjev, arhitektov, krajinskih arhitektov, biologov, vrtnarjev in monterjev. Vsak od njih je angažiran iz določenega razloga: da je gradnja dobro premišljena; za pravilen sklop zelene strehe; da se zelena streha dobro prilega okolici; za ustrezen izbor ustreznih rastlin; za nadzor dela; za izračun stroškov in prihrankov; za boljše splošno delovanje. Če želimo, da bo zelena streha uspešna v svojih funkcijah, je tak integrativen pristop ključnega pomena.

V praksi je uporaba avtohtonih vrst v mestnem okolju, vključno z zelenimi strehami, še vedno v povojih. Blackmore (2019) je v svojem nedavnem eseju o (ne) uporabi avtohtonih rastlin v mestnih zelenih površinah izjavil: "... čeprav je arhitektura futurističnih mestnih pokrajin zelo napredovala, njihovo vrtnarstvo precej zaostaja." Eden od razlogov za to je pomanjkanje ponudnikov domačih rastlin, kar se zdi težava po vsem svetu. Posledično le nekaj ponudnikov zelenih streh za ozelenitev uporablja domače rastline; večina teh se nahaja v ZDA, medtem ko je v Evropi stanje še slabše.

Med raziskovanjem te naloge nam je postalo jasno, da kljub temu, da je znanstvena skupnost spoznala pomen in številne potenciale mestnih zelenih površin za ohranjanje biotske raznovrstnosti (vključno z zelenimi strehami), je njihova uporaba v praksi še vedno v povojih. Želeli smo opraviti raziskavo s podjetji in širšo javnostjo, da bi dobili čim širšo sliko in zbrali čim bolj verodostojne podatke. Zelene strehe so področje gradenj, ki v Sloveniji in Srbiji še ni tako zastopano in aktualno, želeli pa smo ugotoviti, koliko jih ljudje dejansko poznajo.

Spoznali smo, da se tako v Sloveniji in Srbiji, kot tudi drugod po svetu, domorodne rastline uporabljajo redkeje od tujih rastlin, zato smo želeli ojačati nabor domorodnih rastlin, primernih za szelene strehe.

Testirali smo naslednje hipoteze:
H1: Vidik ohranjanja biotske raznovrstnosti ni ključen za odločitev potencialnih strank, da namestijo zeleno streho.
H2: Tako v Sloveniji kot v Srbiji avtohtone rastlinske vrste predstavljajo neizkoriščen potencial za ozelenitev zelenih streh.
H3: V sedanjih nasadih zelenih streh v Sloveniji in Srbiji prevladujejo rastline tujega izvora.
H4: Med prebivalci Slovenije in Srbije obstajajo razlike v dojemanju zelenih streh.

V pregledu literature smo našli in ovrednotili številne znanstvene študije, ki so obravnavale potencial zelenih streh pri ohranjanju biotske raznovrstnosti. Osredotočili smo se na članke, ki obravnavajo le splošne značilnosti zelenih streh, članke, ki obravnavajo biotsko raznovrstnost na zelenih strehah, članke, ki raziskujejo javno mnenje o zelenih strehah, vključujejo vprašalnike o zelenih strehah) in na članke, ki obravnavajo nekatere možne pristope k ohranjanju vrst v prihodnosti v mestih.

Z namenom pridobitve informacij o trenutnem stanju na področju zelenih streh v SLoveniji in Srbiji smo se odločili, da sestavimo vprašalnike za podjetja, ki se ukvarjajo z izgradnjo zelenih streh, in za splošno javnost. Vprašalnike smo posredovali podjetjem in širši javnosti v Sloveniji in Srbiji; deloma preko spleta, del vprašalnikov za splošno javnost pa smo izvedli v živo. Vprašalnike smo podjetjem poslali po e-pošti in jih kontaktirali po telefonu. Slovensko javno mnenje smo pridobili z večdnevno interakcijo v Kopru in na spletu. Srbsko javno mnenje je bilo pridobljeno z živo interakcijo v Beogradu in na spletu. Raziskave so bile izvedene med 8. in 20. junijem 2021. Na koncu smo pridobili 9 odgovorov slovenskih podjetij in 5 odgovorov od srbskih podjetij. Pridobili smo tudi 101 odgovorov slovenske splošne javnosti in 125 odgovorov srbske splošne javnosti.

Odgovori so bili samodejno shranjeni v MS Office Excel prek Google Obrazcev. Po zbiranju podatkov je bil nadaljnji namen naše raziskave statistična analiza odgovorov v MS Office Excel. Odločili smo se, da bomo v Excelu delali le kvalitativne analize in nekatere dele kvantitativnih analiz prek različnih grafov in tabel. Po obdelavi vseh zbranih podatkov iz anket smo ugotovili, da med Slovenijo in Srbijo vsekakor obstajajo razlike. Prav tako je treba vztrajati pri dodatnem izobraževanju podjetij in javnosti, da bi jim še bolj približali vse okoljske koristi, ki jih lahko ponujajo zelene strehe. Ugotovili smo tudi, da v sedanjih nasadih prevladujejo neavtohtone rastline in da avtohtone rastline niso tako zastopane.

Da bi pridobili čimbveč informacij glede rastlin, ki se uporabljajo v zasaditvah na zelenih strehah, smo pregledali številne vire, npr. Snodgrass & Snodgrass (2006), Van Mechelen (2015) in Caneva et al. (2015). Pregledali smo tudi vse razpoložljive slovenske dokumente o zaščitenih in ogroženih vrstah: Seznam zavarovanih domorodnih rastlinskih vrst v Sloveniji, Rdeči seznam praprotnic in semenk (Pteridophyta & Spermatophyta) ter IV. prilogo Evropske Direktive o habitatih vrst (Natura2000) v Sloveniji. Nato smo poskušali poiskati podatke, ali se katere rastline iz omenjenih dokumentov pojavljajo tudi na zelenih strehah. Poskusili smo najti tudi rastline s posebnimi zahtevanimi lastnostmi za uspešno prisotnost na zelenih strehah. Po skrbnem zbiranju podatkov smo prišli do končnega seznama rastlin. Rastline, povzete v vsej razpoložljivi in preučeni literaturi, so bile organizirane v floristično zbirko podatkov, njihova imena pa so bila standardizirana v najnovejšo nomenklaturo z uporabo podatkov, ki so na voljo na spletnem mestu World Flora Online (http://www.worldfloraonline.org/).

Uporaba domačih slovenskih rastlin na zelenih strehah v Sloveniji še ni raziskana, zato upamo, da bo to prvi korak v pravo smer za vse prihodnje študije. Ker je tema magistrskega dela ohranjanje biotske raznovrstnosti, smo posebno pozornost namenili zavarovanim, ogroženim in avtohtonim vrstam.

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APPENDIX A *Questionnaire for the Slovenian companies*

Zelene strehe kot potencial za ohranjanje biodiverzitete

Vprašalnik za podjetja

Moje ime je Sara Stijačić in sem študentka drugega letnika magistrskega študija Varstva narave na Fakulteti za matematiko, naravoslovje in informacijske tehnologije Univerze na Primorskem v Kopru. Ta vprašalnik je del tekočih raziskav in rezultati bodo uporabljeni v magistrskem delu »Zelene strehe kot potencial za ohranjanje biotske raznovrstnosti« pod nadzorom prof. Žive Fišer in prof. Peterja Mackelwortha. Cilj vprašalnika je pridobiti informacije o odnosu ponudnikov zelenih streh do avtohtonih in tujerodnih rastlinskih vrst ter o vlogi zelenih streh pri ohranjanjanju biotske raznovrstnosti. Zavezujemo se, da so podatki o podjetjih zaupni in ne bodo posredovani tretjim osebam. Ob tej priložnosti se Vam iskreno zahvaljujem, da ste si vzeli čas in prispevali k mojemu delu.

* Required

Prosim označite ustrezno izjavo o vašem podjetju: *

- ◯ Naše podjetje je specializirano za zelene strehe.
- ◯ Naše podjetje ponuja veliko različnih strešnih kritin, vključno z zelenimi strehami.
- ◯ Nič od naštetega.

Če ste v prejšnjem vprašanju odgovorili "Nič od naštetega", prosim obrazložite na kratko svoj odgovor.

Your answer

Za gradnjo zelenih streh v našem podjetju: *

- ◯ Za vse poskrbimo sami.
- ◯ Najamemo zunanjega izvajalca.
- ◯ Nič od naštetega.

Če ste v prejšnjem vprašanju odgovorili "Nič od naštetega.", prosim obrazložite na kratko svoj odgovor.

Your answer

Koliko projektov z zelenimi strehami izvedete letno? *

Prosim, vnesite okvirno število.

Your answer

Kateri so glavni razlogi, ki vam jih naročniki navedejo pri razlogih za izbiro gradnje zelenih streh? *

Prosimo, razvrstajte naslednje značilnosti po pomembnosti od 1 do 5, kjer je 1 najmanj pomembna in 5 najpomembnejša (vsako številko uporabite le enkrat)

	1	2	3	4	5
estetska vrednost	○	○	○	○	○
dodatna uporabna površina	○	○	○	○	○
prihranek denarja / dolgoročni finančni vidiki	○	○	○	○	○
tehnični razlogi (zadrževanje vode, zmanjšanje toplote, energetska učinkovitost)	○	○	○	○	○
ozaveščenost o okoljskih vprašanjih (ohranjanje biotske raznovrsnosti, zmanjšanje onesnaževanja, zmanjšanje učinka toplotnih otokov)	○	○	○	○	○

Ali bi morda poleg zgoraj navedenih razlogov dodali še kakšen razlog?

Your answer

Kateri so glavni zadržki strank glede namestitve in vzdrževanja zelenih streh? *

- ◯ pomanjkanje znanja
- ◯ zaskrbljenost zaradi možnih negativnih posledic
- ◯ začetni stroški postavitve
- ◯ stroški vzdrževanja (npr. namakanje)
- ◯ pomanjkanje strokovnih nasvetov
- ◯ drugo

Ali vaše podjetje uporablja isti rastlinski pokrov (vzorec) za vse zelene strehe ali prilagodite izbiro rastlin glede na posamičen projekt? *

- ◯ Vedno uporabljamo isti vzorec.
- ◯ Ponavadi uporabljamo isti vzorec.
- ◯ Izbiro prilagodimo posamičnemu projektu.

Kateri so kriteriji vašega podjetja za izbiro rastlin za zelene strehe? *

Your answer

Ali poznate razliko med avtohtonimi (domačimi) in alohtonimi (tujerodnimi) vrstami? *

Prosim, izberite samo en odgovor.

- ◯ Poznam razliko.
- ◯ Mislim, da poznam razliko.
- ◯ Ne poznam razlike.

Kako dobro poznate rastline, ki jih uporabljate za gradnjo, glede na izvor rastlin (iz katerega območja - države ali celine - izvirajo)? *

Prosim, izberite samo en odgovor.

- ◯ Poznam za vse.
- ◯ Za večino poznam.
- ◯ Za nekatere poznam.
- ◯ Ne poznam za nobeno.

Ali lahko navedete 5 najpogostejših rastlinskih vrst, ki jih vaše podjetje uporablja pri izgradnji zelenih streh? *

Your answer

Če pri gradnji zelenih streh uporabljate tudi tujerodne rastline - ali bi jih bili pripravljeni nadomestiti z avtohtonimi? *

Prosim, izberite samo en odgovor.

- ◯ Da.
- ◯ Da, pod določenimi pogoji.
- ◯ Ne.
- ◯ Ne poznam izvora rastlin.

Če ste v prejšnjem vprašanju odgovorili "Da, pod določenimi pogoji.", prosim obrazložite na kratko svoj odgovor.

Your answer

Ali je v vašem podjetju vključen v postopek izgradnje zelenih streh kateri od naslednjih strokovnjakov: *

- ◯ agronom
- ◯ biolog
- ◯ vrtnar
- ◯ krajinski arhitekt
- ◯ drugo
- ◯ noben

Ali se vam zdi, da imate dovolj informacij o rastlinah, njihovih potrebah in vplivu zelenih streh na biotsko raznovrstnost? *

- ◯ Da, imam informacije.
- ◯ Nimam, ampak bi pa rad/-a vedel/-la več.

Skrbno načrtovana izbira rastlin lahko zmanjša posege vzdrževanja zelenih streh (npr. namakanje). *

	1	2	3	4	5	
sploh se ne strinjam	◯	◯	◯	◯	◯	v celoti se strinjam

Izvor semen močno vpliva na preživetje rastlin. *

	1	2	3	4	5	
sploh se ne strinjam	◯	◯	◯	◯	◯	v celoti se strinjam

Zavedam se pomena raznolike zasaditvene palete za spodbujanje biotske raznovrsnosti, vključno z žuželkami, pticami in netopirji. *

	1	2	3	4	5	
sploh se ne strinjam	◯	◯	◯	◯	◯	v celoti se strinjam

Nekatere naše avtohtone rastline so zelo primerne za zasaditev na zelenih strehah. *

	1	2	3	4	5	
sploh se ne strinjam	○	○	○	○	○	v celoti se strinjam

Rastline, ki privlačijo čebele, so koristne ne glede na to, ali so domorodne ali tuje. *

	1	2	3	4	5	
sploh se ne strinjam	○	○	○	○	○	v celoti se strinjam

Povečana razpoložljivost sence prispeva k biotski raznovrstnosti. *

	1	2	3	4	5	
sploh se ne strinjam	○	○	○	○	○	v celoti se strinjam

Uporaba tujerodnih vrst na zelenih strehah lahko potencialno negativno vpliva na biotsko raznovrstnost. *

	1	2	3	4	5	
sploh se ne strinjam	○	○	○	○	○	v celoti se strinjam

Zelene strehe lahko zagotovijo primeren življenski prostor za vrste v urbanem okolju. *

	1	2	3	4	5	
sploh se ne strinjam	○	○	○	○	○	v celoti se strinjam

Nekatere ogrožene rastlinske vrste bi lahko posadili na zelene strehe in tako prispevali k njihovi zaščiti. *

	1	2	3	4	5	
sploh se ne strinjam	○	○	○	○	○	v celoti se strinjam

Strukturna raznolikost (dodatek hlodov, kamnov, peska, naklona in tudi mešana globina tal) zagotavlja širši spekter življenskih pogojev in s tem povečuje biotsko raznovrsnost na zelenih strehah. *

	1	2	3	4	5	
sploh se ne strinjam	○	○	○	○	○	v celoti se strinjam

V prihodnosti bodo zelene strehe postale bolj pogoste. *

	1	2	3	4	5	
sploh se ne strinjam	○	○	○	○	○	v celoti se strinjam

Iskreno se vam zahvaljujemo za vaš čas. V kolikor dovoljujete, da vas v primeru dodatnih vprašanj v zvezi z vprašalnikom ponovno kontaktiramo, vas prosimo za vaše kontaktne informacije (ime in priimek, elektronski naslov in/ali telefonska številka). Vaši podatki bodo uporabljeni izključno za namen raziskave in ne bodo posredovani tretjim osebam.

Your answer

APPENDIX B *Questionnaire for the Serbian companies*

Зелени кровови као потенцијал за очување биодиверзитета (биоразноликости)

Анкета за предузећа

Моје име је Сара Стијачић и студент сам друге године мастер студија Заштите природе на Факултету за математику, природне науке и информацијске технологије Приморског универзитета у Копру. Овај упитник је део актуелног истраживања и резултати ће се користити у мом мастер раду „Зелени кровови као потенцијал за очување биодиверзитета" под надзором проф. Живе Фишер и проф. Петера Макелворта. Циљ упитника је прикупљање информација од представника фирми које се баве изградњом зелених кровова, потом сазнати какав је њихов став према домаћим (аутохтоним) и страним (алохтоним) биљкама, као и према улози зелених кровова у очувању биодиверзитета (биолошкој разноврсности). Обавезујемо се да су подаци о компанијама поверљиви и да неће бити прослеђивани трећим лицима. Овом приликом Вам се искрено захваљујем на учествовању и на томе што сте одвојили своје време за ово.

* Required

Означите одговарајућу изјаву о Вашем предузећу: *

- ◯ Наше предузеће је специјализовано за зелене кровове.
- ◯ Наше предузеће нуди много различитих кровних покривача, укључујући и зелене кровове.
- ◯ Ништа од наведеног.

Уколико сте у претходном питању означили одговор "Ништа од наведеног.", молимо Вас да га укратко образложите.

Your answer

Током изградње зелених кровова у нашем предузећу: *

- ◯ Целокупан посао радимо интерно.
- ◯ Ангажујемо спољног извођача.
- ◯ Ништа од наведеног.

Уколико сте у претходном питању означили одговор "Ништа од наведеног.", молимо Вас да га укратко образложите.

Your answer

Колико пројеката зелених кровова реализујете годишње? *

Молимо Вас, унесите број.

Your answer

Рангирајте по важности главне разлоге због којих се Ваши клијенти одлучују за изградњу зеленог крова: *

Употребите скалу од 1 до 5, где 1 представља најмање важно, а 5 најважније и сваки број искористите само једном (нпр. уколико естетску вредност оцените бројем 5, број 5 не можете поново искористити за остале одговоре)

	1	2	3	4	5
естетска вредност	○	○	○	○	○
додатна корисна површина	○	○	○	○	○
задржавање новца / дугорочни финансијски аспекти	○	○	○	○	○
технички разлози (задржавање воде, смањење топлоте, енергетска ефикасност)	○	○	○	○	○
свест о еколошким питањима (очување биодиверзитета, смањење загађења, смањење утицаја топлотних острва)	○	○	○	○	○

Да ли бисте можда додали још неки разлог поред горе наведених:

Your answer

Које су главне бриге Ваших клијената у вези са постављањем и одржавањем зелених кровова? *

- недостатак знања
- забринутост због могућих негативних последица
- почетни трошкови постављања
- трошкови одржавања (нпр. наводњавање)
- недостатак стручних савета
- друго

Да ли Ваша компанија користи исти одабир биљака за све зелене кровове или прилагођавате избор према појединачном пројекту? *

- Обично исти одабир.
- Увек исти одабир.
- Прилагођавамо одабир појединачном пројекту.

Који су критеријуми Вашег предузећа за одабир биљака за зелене кровове? *

Your answer

Да ли знате разлику између аутохтоних (домаћих) и алохтоних (страних) врста? *

Изаберите само један одговор.

- ◯ Знам разлику.
- ◯ Мислим да знам разлику.
- ◯ Не знам разлику.

Колико добро познајете биљке које користите за изградњу у погледу порекла биљака (из које земље или континента потичу)? *

Изаберите само један одговор.

- ◯ Знам за све.
- ◯ Знам за већину.
- ◯ Знам само за неке.
- ◯ Не знам ни за једну.

Можете ли да наведете 5 најчешћих биљних врста које Ваше предузеће користи у изградњи зелених кровова? *

Your answer

Ако за изградњу зелених кровова користите и алохтоне (стране) врсте биљака - да ли бисте били вољни да их замените аутохтоним (домаћим)? *

Изаберите само један одговор.

- ◯ Да.
- ◯ Само под одређеним условима.
- ◯ Не.
- ◯ Не знам које је порекло биљака.

Уколико сте у претходном питању означили одговор "Само под одређеним условима.", да ли бисте могли укратко да га образложите?

Your answer

Да ли је у Вашем предузећу неко од следећих стручњака укључен у процес изградње зелених кровова: *

- ◯ агроном
- ◯ биолог
- ◯ баштован
- ◯ пејзажни архитекта
- ◯ друго
- ◯ нико од наведених

Да ли сматрате да имате довољно информација о биљкама, њиховим потребама и утицају зелених кровова на биодиверзитет? *

- ◯ Да, имам довољно информација.
- ◯ Не, али волео/-ла бих да знам више.

Пажљив еколошки одабир биљака може смањити додатне интервенције одржавања (нпр. наводњавање). *

	1	2	3	4	5	
уопште се не слажем	◯	◯	◯	◯	◯	слажем се у потпуности

Порекло семена снажно утиче на опстанак биљака. *

	1	2	3	4	5	
уопште се не слажем	◯	◯	◯	◯	◯	слажем се у потпуности

Имам свест о важности разноликих садница за подстицање биолошке разноврсности, не само биљака, већ и инсеката, птица и слепих мишева. *

	1	2	3	4	5	
уопште се не слажем	◯	◯	◯	◯	◯	слажем се у потпуности

Неке наше домаће биљке су идеалне за зелене кровове. *

	1	2	3	4	5	
уопште се не слажем	○	○	○	○	○	слажем се у потпуности

Биљке које привлаче медоносне пчеле корисне су за биодиверзитет без обзира на њихово порекло. *

	1	2	3	4	5	
уопште се не слажем	○	○	○	○	○	слажем се у потпуности

Повећана доступност сенке доприноси свеукупном биодиверзитету. *

	1	2	3	4	5	
уопште се не слажем	○	○	○	○	○	слажем се у потпуности

Употреба страних врста на зеленим крововима може потенцијално негативно утицати на биодиверзитет. *

	1	2	3	4	5	
уопште се не слажем	○	○	○	○	○	слажем се у потпуности

Зелени кровови могу да пруже погодно станиште врстама у урбаним срединама. *

	1	2	3	4	5	
уопште се не слажем	○	○	○	○	○	слажем се у потпуности

Неке угрожене биљне врсте могу да се засаде на зеленим крововима и на тај начин бисмо допринели њиховој заштити. *

	1	2	3	4	5	
уопште се не слажем	○	○	○	○	○	слажем се у потпуности

Структурна разноликост (додавање дебла, камења, песка, нагиба и различите дубине земље) пружа шири спектар животних услова и на тај начин повећава биодиверзитет на зеленим крововима. *

	1	2	3	4	5	
уопште се не слажем	○	○	○	○	○	слажем се у потпуности

У будућности ће зелени кровови постати све чешћи. *

	1	2	3	4	5	
уопште се не слажем	○	○	○	○	○	слажем се у потпуности

Искрено Вам се захваљујемо на издвојеном времену. Уколико бисте били вољни да Вас поново контактирамо у случају додатних питања у вези са анкетом, молимо Вас да напишете Ваше контакт податке (име и презиме, адреса е-поште и / или број телефона). Ваши подаци ће се користити искључиво у сврху истраживања и неће бити прослеђени трећим лицима.

Your answer

APPENDIX C *Questionnaire for the Slovenian general public*

Zelene strehe kot potencial za ohranjanje biodiverzitete

Vprašalnik za splošno javnost

* Required

Ali so okoljske tematike za vas pomembne? *

- ◯ Da
- ◯ Ne

Ali se zavedate, da neomejene gradnje v mestih škodijo splošni biotski raznovrstnosti? *

- ◯ Da
- ◯ Ne

Ali so zelene površine v vašem kraju za vas pomembne? *

- ◯ Da
- ◯ Ne

Ali veste, kaj so "zelene strehe"? *

- ◯ Da
- ◯ Ne

Ali ste že slišali za kakšno podjetje, ki je specializirano za izgradnjo zelenih streh? *

- ◯ Da
- ◯ Ne

Ali podpirate spodbujanje izgradnje zelenih streh v mestnih okoljih? *

- ◯ Da
- ◯ Ne

Če ne, zakaj?

Your answer

Ali ste že kdaj obiskali stavbo z zeleno streho? *

- ◯ Da
- ◯ Ne

Za namestitev zelene strehe bi bili pripravljeni plačati več od navadne strešne kritine, če bi na njej lahko preživljali prosti čas (branje, sončenje). *

	1	2	3	4	5	
sploh se ne strinjam	◯	◯	◯	◯	◯	v celoti se strinjam

Za namestitev zelene strehe bi bili pripravljeni plačati več od navadne strešne kritine, če bi na njej lahko obdelovali zelenjavni ali okrasni vrt. *

	1	2	3	4	5	
sploh se ne strinjam	◯	◯	◯	◯	◯	v celoti se strinjam

Za namestitev zelene strehe bi bili pripravljeni plačati več od navadne strešne kritine, če bi na njej lahko uživali ob opazovanju različnih rastlin, žuželk in ptic. *

	1	2	3	4	5	
sploh se ne strinjam	◯	◯	◯	◯	◯	v celoti se strinjam

Za namestitev zelene strehe bi bili pripravljeni plačati več od navadne strešne kritine, če bi vedeli, da bo zelena streha prispevala k biotski raznovrstnosti v mestu. *

	1	2	3	4	5	
sploh se ne strinjam	◯	◯	◯	◯	◯	v celoti se strinjam

Ali obstaja še kakšen drug razlog, ki ni omenjen, zaradi katerega bi bili pripravljeni plačati več za zeleno streho?

Your answer

Katera je za vas najpomembnejša značilnost zelene strehe? *

Prosimo, razvrstite naslednje značilnosti po pomembnosti od 1 do 5, kjer je 1 najmanj pomembna in 5 najbolj pomembna. Vsako številko uporabite le enkrat.

	1	2	3	4	5
estetska vrednost	◯	◯	◯	◯	◯
dodatna uporabna površina	◯	◯	◯	◯	◯
prihranek denarja / dolgoročni finančni vidiki	◯	◯	◯	◯	◯
tehnični razlogi (zadrževanje vode, zmanjšanje toplote, energetska učinkovitost)	◯	◯	◯	◯	◯
ozaveščenost o okoljskih vprašanjih (ohranjanje biotske raznovrsnosti, zmanjšanje onesnaževanja, zmanjšanje učinka toplotnih otkov)	◯	◯	◯	◯	◯

Ali se zavedate še kakšne druge pomembne značilnosti zelenih streh?

Your answer

Kateri bi bili razlogi, da se ne bi odločili za namestitev zelene strehe? *

- pomanjkanje znanja
- zaskrbljenost zaradi možnih negativnih posledic
- začetni stroški postavitve
- stroški vzdrževanja (npr. namakanje)
- pomanjkanje strokovnih nasvetov
- drugo

Ali poznate razliko med avtohtonimi (domačimi) in alohtonimi (tujerodnimi) vrstami? *

- Da
- Ne

Ali menite, da lahko s pomočjo zelenih streh prispevamo k ohranjanju avtohtonih (domačih) vrst, posebno rastlin? *

- Da
- Ne

Ali menite, da bi lahko zelene strehe zagotovile nov dodaten prostor, na katerem bi lahko živele ogrožene vrste? *

- ◯ Da
- ◯ Ne

Zavedam se pomena raznolike zasaditvene palete za spodbujanje biotske raznovrsnosti, vključno z žuželkami, pticami in netopirji. *

	1	2	3	4	5	
sploh se ne strinjam	◯	◯	◯	◯	◯	v celoti se strinjam

Nekatere naše avtohtone rastline so zelo primerne za zasaditev na zelenih strehah. *

	1	2	3	4	5	
sploh se ne strinjam	◯	◯	◯	◯	◯	v celoti se strinjam

Uporaba tujerodnih vrst na zelenih strehah lahko potencialno negativno vpliva na biotsko raznovrstnost. *

	1	2	3	4	5	
sploh se ne strinjam	◯	◯	◯	◯	◯	v celoti se strinjam

Zelene strehe lahko zagotovijo primeren življenski prostor za vrste v urbanem okolju. *

	1	2	3	4	5	
sploh se ne strinjam	◯	◯	◯	◯	◯	v celoti se strinjam

Nekatere ogrožene rastlinske vrste bi lahko posadili na zelene strehe in tako prispevali k njihovi zaščiti. *

	1	2	3	4	5	
sploh se ne strinjam	◯	◯	◯	◯	◯	v celoti se strinjam

V prihodnosti bodo zelene strehe postale bolj pogoste. *

	1	2	3	4	5	
sploh se ne strinjam	◯	◯	◯	◯	◯	v celoti se strinjam

Koliko ste stari? *

Označite samo eno polje

- ◯ Mlajši od 18 let
- ◯ 18-24
- ◯ 25-34
- ◯ 35-44
- ◯ 45-54
- ◯ 55-64
- ◯ 65 in več

Katera je vaša najvišja stopnja izobrazbe? *

Označite samo eno polje.

- ◯ osnovnošolska
- ◯ srednješolska
- ◯ univerzitetna - dodiplomska
- ◯ univerzitetna - podiplomska (magisterij, doktorat)

Če ste končali srednjo šolo ali univerzo, navedite, kaj je področje vaše izobrazbe: *

Označite samo eno polje.

- ◯ Naravoslovje
- ◯ Tehnika
- ◯ Medicina
- ◯ Kmetijstvo
- ◯ Družboslovje ali humanistika
- ◯ Other: _____

APPENDIX D *Questionnaire for the Serbian general public*

Зелени кровови као потенцијал за очување биодиверзитета (биоразноликости)

Анкета за јавност

* Required

Да ли сматрате животну средину важном? *

- ◯ Да
- ◯ Не

Да ли сте свесни чињенице да прекомерна градња у градовима штети укупном биодиверзитету (укупној биоразноликости)? *

- ◯ Да
- ◯ Не

Да ли уживате у зеленим површинама у свом граду? *

- ◯ Да
- ◯ Не

Да ли сте некад чули за зелене кровове? *

- ◯ Да
- ◯ Не

Да ли сте чули за неку компанију која се специјализовала за зелене кровове? *

- ◯ Да
- ◯ Не

Да ли бисте подржали пројекат за промоцију употребе зелених кровова? *

- ◯ Да
- ◯ Не

Уколико не бисте, молимо Вас, напишите зашто.

Your answer

Да ли сте икада посетили зграду са зеленим кровом? *

- ◯ Да
- ◯ Не

Да ли бисте били спремни да платите више за постављање зеленог крова, уколико бисте на њему могли да проведете слободно време (читање, сунчање)? *

	1	2	3	4	5	
уопште се не слажем	○	○	○	○	○	слажем се у потпуности

Да ли бисте били спремни да платите више за постављање зеленог крова, уколико бисте на њему могли да имате башту са поврћем или украсну башту? *

	1	2	3	4	5	
уопште се не слажем	○	○	○	○	○	слажем се у потпуности

Да ли бисте били спремни да платите више за постављање зеленог крова, уколико бисте могли да на њему уживате у посматрању различитих биљака, инсеката и птица? *

	1	2	3	4	5	
уопште се не слажем	○	○	○	○	○	слажем се у потпуности

Да ли бисте били спремни да платите више за постављање зеленог крова, уколико бисте знали да ће зелени кров да допринесе биодиверзитету (биоразноликости) града? *

	1	2	3	4	5	
уопште се не слажем	○	○	○	○	○	слажем се у потпуности

Да ли постоји још неки разлог, који није већ наведен, због кога бисте били спремни да платите више?

Your answer

Која је по Вашем мишљењу најважнија карактеристика зеленог крова? *

Молимо Вас да поређате следеће ставке по важности од 1 до 5, где 1 представља најмање важно, а 5 најважније. Сваки број употребите само једном.

	1	2	3	4	5
естетска вредност	◯	◯	◯	◯	◯
додатна корисна површина	◯	◯	◯	◯	◯
уштеда новца / дугорочни финансијски аспекти	◯	◯	◯	◯	◯
технички разлози (задржавање воде, смањење топлоте, енергетска ефикасност)	◯	◯	◯	◯	◯
свест о еколошким питањима (очување биодиверзитета, смањење загађења, смањење утицаја ефекта топлотног острва)	◯	◯	◯	◯	◯

Да ли можда знате још неку важну карактеристику зелених кровова?

Your answer

Који би били разлози због којих се Ви не бисте одлучили да поставите зелени кров? *

- недостатак знања
- забринутост због могућих негативних последица
- почетни трошкови постављања
- трошкови одржавања (нпр. наводњавање)
- недостатак стручних савета
- друго

Да ли знате разлику између аутохтоних (домаћих) и алохтоних (страних) врста? *

- Да
- Не

Да ли знате да уз помоћ зелених кровова можемо да сачувамо аутохтоне (домаће) врсте из наше земље, посебно биљке? *

- Да
- Не

Да ли сте знали да зелени кровови могу да пруже нови додатни простор који угрожене врсте могу да населе? *

- ◯ Да
- ◯ Не

Свестан сам важности разноликих садница за подстицање биолошке разноврсности, не само биљака, већ и инсеката, птица и слепих мишева. *

	1	2	3	4	5	
уопште се не слажем	◯	◯	◯	◯	◯	слажем се у потпуности

Неке наше домаће биљке су идеалне за зелене кровове. *

	1	2	3	4	5	
уопште се не слажем	◯	◯	◯	◯	◯	слажем се у потпуности

Употреба страних врста на зеленим крововима може потенцијално негативно утицати на биодиверзитет. *

	1	2	3	4	5	
уопште се не слажем	◯	◯	◯	◯	◯	слажем се у потпуности

Зелени кровови могу пружити погодно станиште многим врстама у урбаним срединама. *

	1	2	3	4	5	
уопште се не слажем	◯	◯	◯	◯	◯	слажем се у потпуности

Неке угрожене биљне врсте могу се засадити на зеленим крововима и на тај начин бисмо допринели њиховој заштити. *

	1	2	3	4	5	
уопште се не слажем	◯	◯	◯	◯	◯	слажем се у потпуности

У будућности ће зелени кровови постати све чешћи. *

	1	2	3	4	5	
уопште се не слажем	◯	◯	◯	◯	◯	слажем се у потпуности

Колико имате година? *

Означите само једно поље.

- ◯ Испод 18
- ◯ 18-24
- ◯ 25-34
- ◯ 35-44
- ◯ 45-54
- ◯ 55-64
- ◯ 65 и више година

Који је највиши степен Вашег образовања? *

Молимо Вас, означите само један одговор.

- ◯ основна школа
- ◯ средња школа
- ◯ факултет (основне студије)
- ◯ факултет (мастер, докторске студије)

Уколико сте завршили факултет, означите која је сфера Ваше професије:

Означите само један одговор.

- ◯ природне науке
- ◯ техничке науке
- ◯ медицинске науке
- ◯ пољопривредне науке
- ◯ друштвене или хуманистичке науке