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Provisioning Ecosystem Services of Wild Plants Collected From Seminatural Habitats: A Basis for Sustainable Livelihood and Multifunctional Landscape Conservation

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Wild plants from seminatural habitats (meadows, pastures, shrubland, etc) provide numerous ecosystem services (ESs). However, because of land abandonment and reforestation processes, these habitats and the ESs provided by them are declining. The aim of this study was to identify how local people benefit from collecting wild plants from seminatural habitats, in order to link the identified ESs with conservation practices. The research was based on a survey of 85 inhabitants of the Pieniny Mountains (Poland). The results showed that 89% of respondents regularly collected wild plants from seminatural habitats for different reasons. The most common ESs gained from this activity were natural medicine, direct consumption, and food. Furthermore, particular species have crucial meaning for some ESs, such as direct consumption, food, natural medicine, and cosmetic purposes. For others, such as decoration, ritual purposes, or forage, only specific parts or types of plants, such as flowers, herbs, or grasses, are desirable, regardless of species. In terms of households, 38% used ESs from seminatural habitats as an additional source of livelihood. Promoting engagement in activities more adapted to the current economic situation (eg ecotourism and selling processed wild plant products) may be a good solution for using wild plants more profitably (serving as a basis for livelihood), combined with grassland conservation.

Keywords: *conservation; ethnobotany; provisioning ecosystem services; survey; Pieniny Mountains.*

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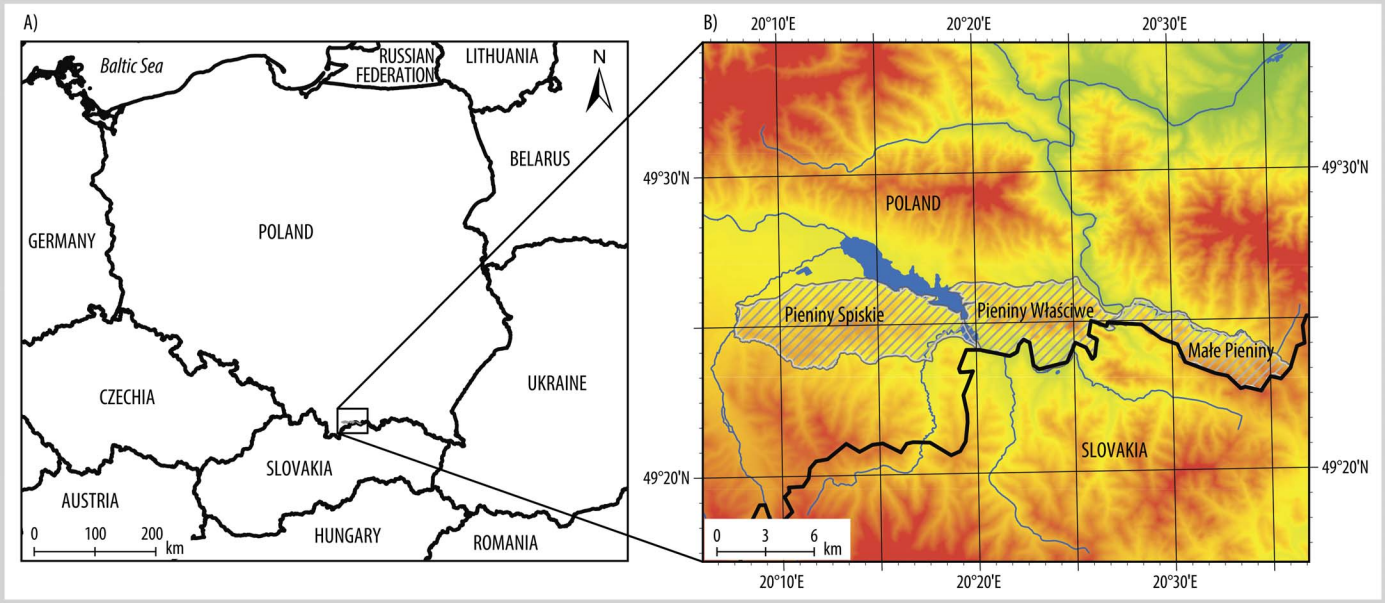
Introduction

Wild plant and animal products are provisioning ecosystem services (ESs) according to the Millennium Ecosystem Assessment (2005). However, Vári et al (2020) concluded that "wild plant products" is an umbrella term for a collection of ESs. In the Economics of Ecosystems and Biodiversity classification (TEEB 2010), the collection of wild plants involves a few provisioning ESs, such as provision of food, raw materials (fuels and fibers), and genetic, medicinal, and ornamental resources. These categories are similar to the Common International Classification of Ecosystem Services (Haines-Young and Potschin 2018), which lists wild plants used for nutrition, fibers, and other materials from wild plants for direct use or processing; wild plants used as a source of energy; and genetic material from plants.

In rural areas, ESs provided by wild plants may serve not only to satisfy one's own needs but also as a basis for livelihood (eg Poe et al 2013; Kaoma and Shackleton 2014; Vári et al 2020). Here, the main focus is put on the ESs provided by seminatural habitats. In this study, we define seminatural habitats as habitats of plant communities that have developed with longstanding land use (grazing, cutting, mowing, etc) on sites previously covered by forests. In the Pieniny Mountains, there are several groups of such plant communities, including swamps (reed swamps, sedge swamps, and swamp meadows), moist or mesic hay meadows, pastures, grazed or mowed xerothermic grasslands, herbaceous communities, heaths, roadside verges, shrubby communities, glade vegetation, and forest edges (Kaźmierczakowa and Pancer-Koteja 2004). Because of their species richness, typical species in these communities provide a range of ESs that may support livelihoods (Hönigová et al 2012). On the one hand, they can provide people with food, forage, and biofuel, as well as provide a foundation for the pastoral economy. On the other hand, herbal medicine, cosmetic, decoration, and ritual products made from wild plants can be sold (Nedelcheva et al 2011; Hönigová et al 2012). ESs provided by wild plants may foster the development of ecotourism; for example, traditional cuisine based on wild plants may serve as a tourism product (Łuczaj et al 2012; Derek 2021). However, as a result of socioeconomic transformations leading to land abandonment and reforestation processes, which have been particularly rapid in Central and Eastern Europe, mountain grasslands and other seminatural communities are some of

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FIGURE 1 Study area. (A) Location in Central Europe; (B) division into 3 parts.



the most endangered ecosystems in Europe (Medwecka-Kornaś 1977; Tokarczyk 2018; Peciña et al 2019). Moreover, the ecological, cultural, and economic role of seminatural meadows is still underestimated, as shown by the example of Jiuzhaigou National Park in China, where a policy of reforestation of valuable grasslands was implemented (Urgenson et al 2014).

The decrease in area of open spaces affects the ESs provided (Bieling 2013; Fontana et al 2014; Peciña et al 2019). Hence, the conservation of grasslands and other seminatural habitats may benefit sustainable livelihoods. Such habitats support the gathering of wild plants for provisioning purposes and for ecotourism development because of multiplier effects; for example, grasslands of the Pieniny Mountains are the source of many cultural ESs for tourists (Nowak-Olejnik et al 2020). At the same time, linking land use practices with conservation practices may be beneficial for both inhabitants and nature.

There are many studies on collecting wild plants in general (eg Łuczaj 2010, 2012; Hurley et al 2012; Kalle and Sõukand 2013; Reyes-García et al 2015; Palliwoda et al 2017). However, most consider only wild plants used as food (eg Łuczaj et al 2012; Kalle and Sõukand 2013; Stryamets et al 2015) or medicine (eg Sõukand and Kalle 2011; Łuczaj et al 2012; Stryamets et al 2015; Nand and Naithani 2018). Some studies refer to other provisioning ESs based on gathering wild plants, such as decoration or forage (eg Nedelcheva et al 2011; Kang et al 2017; Palliwoda et al 2017). Thus, there remains a significant gap in our knowledge of the bundle of ESs provided by wild plants. Many researchers solely analyzed wild forest plants used by local communities (eg Shackleton and Shackleton 2004; Agbogidi 2010; Dau and Elisha 2014; Fajobi and Fingesi 2018; Chamberlain et al 2020), but few studies have considered the utilization of plant species from seminatural habitats (eg Urgenson et al 2014). Our study also differs from other studies in that research on wild plant collection is mainly conducted using a nonrandom, intercept sampling method (eg Kalle and Sõukand 2013; Klepacki 2016; Palliwoda et al 2017), whereas we applied a random sampling method. This technique rarely appears in ethnobotanical studies.

The study aimed to investigate how local people benefit from collecting wild plants from seminatural habitats and, consequently, what possibilities this presents for combining sustainable livelihood with seminatural habitat conservation in mountain areas. The specific research question is, What ESs are provided by wild plants to local people? In addition, we discuss the possible contribution of ESs provided by wild plants to sustainable livelihoods and the related options for local people to conserve seminatural habitats.

Material and methods

Study area

The study was conducted in the Polish part of the Pieniny Mountains, Carpathians (Figure 1). The Pieniny Mountains, as a part of the Pieniny Klippen Belt, are characterized by a complex geological structure in which Mesozoic, Paleogene, and Quaternary rock formations coexist (Klimaszewski 1972). This low mountain range is around 35 km long and up to 6 km wide (Figure 1). Flora of this area is diverse and distinct from neighboring mountain regions (Zarzycki and Wróbel 2012). This is the result of specific environmental conditions of diverse geology and relief, as well as relative isolation. In addition, longstanding extensive land use has positively influenced both landscape diversity and biodiversity of the region. More than 1100 species of vascular plants are found there; almost 900 of them are native, about 150 are synanthropic, and more than 50 species are inherited or adventive (Zarzycki 2000).

The land use structure is dominated by forest and seminatural habitats, which cover 46 and 31%, respectively, of the study area (Table 1). The Dunajec river divides the Pieniny Mountains into 3 parts: the Pieniny Właściwe, the Małe Pieniny, and the Pieniny Spiskie (Figure 1). They are diverse in terms of land use as their management history differs. The Pieniny Spiskie has an agricultural character with seminatural vegetation covering 39% of the area and

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TABLE 1 Land use in the Polish part of the Pieniny Mountains.

Land use	Małe Pieniny (%)	Pieniny Właściwe (%)	Pieniny Spiskie (%)	Pieniny Mountains in general (%)
Forest	55	57	35	46
Seminatural vegetation	29	21	39	31
Arable land	11	17	21	17
Built-up area	4	3	3	3
Water bodies	1	3	1	2

Source: Based on Head Office of Geodesy and Cartography n.d.

arable land covering 21%. The Małe Pieniny and the Pieniny Właściwe are dominated by forest. The Małe Pieniny has the highest share of built-up areas, because the only town in the Pieniny Mountains, Szczawnica, is there. Moreover, most of the area of the Pieniny Właściwe is protected within Pieniny National Park (PNP). The huge landscape diversity makes the area particularly suitable for tourism.

Data collection and analysis

To obtain information on ESs provided by wild plants found in seminatural habitats, a survey of inhabitants of the Pieniny Mountains was conducted. Applying the Common International Classification of Ecosystem Services (Haines-Young, Potschin 2018) as a starting point for the selection of ESs provided by wild plants from seminatural habitats, 9 categories of provisioning ESs were distinguished. The naming of these ESs followed Hönigová et al (2012) and Palliwoda et al (2017): direct consumption; food; fibers and other materials from wild plants for direct use as, or processing into, natural medicines; cosmetics; decoration; ritual purposes; fertilizers; forage; and wild plants used as a source of energy in the form of biofuels. Wild plants used for nutrition were divided into 2 classes: direct consumption and food. Direct consumption involves satisfying hunger occasionally during a walk, whereas food concerns wild plants brought home to prepare a meal or preserves. As a group, genetic material from plants was excluded, because gathering seeds or other parts of plants to maintain or spread their population may be an indirect motivation to produce other ESs, such as food or medicine.

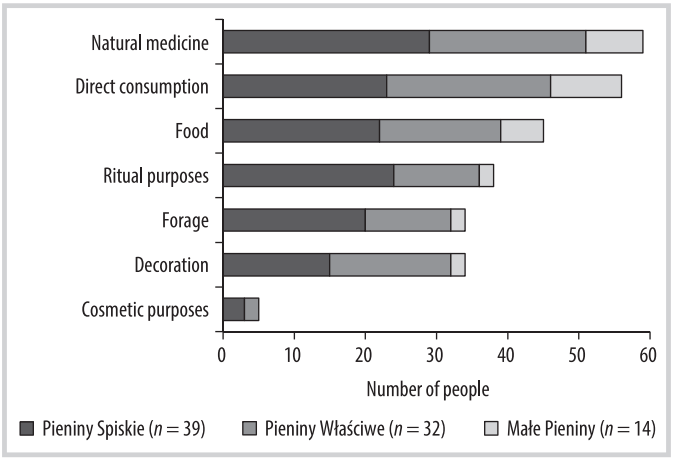
In the first part of questionnaire, respondents were asked whether they collected plants from seminatural habitats. If the answer was "yes," information on specific plant species used for particular purposes, referring to provisioning ESs mentioned earlier, was gathered. In the next step, residents were asked whether they used these resources only to satisfy their own needs or whether they also sold them. In the latter case, participants were asked to indicate in which of the following activities they or members of their households are involved: livestock grazing and feeding with hay, the sale of collected herbs and fruits, the sale of preserves from collected plants, the sale of decoration pieces, and the sale of animal products (dairy, honey, etc). In addition, qualitative comments on these issues were gathered.

A random sampling method was used. The sample was relatively small; thus, the results should be interpreted with caution. A total of 85 residential addresses were drawn from 2732 households located within the boundaries of the Pieniny Mountains using the ArcGIS Sampling Tool (Create Random Points). The total number of households in the Pieniny Spiskie was 1201, in the Pieniny Właściwe was 872, and in the Małe Pieniny was 659. An address database was obtained from the Statistical Office, and residential buildings were selected based on the Topographic Objects Database (Head Office of Geodesy and Cartography n.d.). The share of addresses drawn from the Pieniny Spiskie was 3.2% (39 households), from the Pieniny Właściwe was 3.7% (32 households), and from the Małe Pieniny was 2.1% (14 households). In every household, 1 resident was interviewed. If the first-choice resident refused to participate, the interviewer asked at the next-door household. A total of 85 questionnaires were collected from September 2019 to February 2020. The response rate was 50%.

Botanical names of plant species listed by respondents were identified afterward, based on the local occurrence of plant species. Plants occurring only in nonseminatural habitats (ie in forests) were excluded from the list. However, it was assumed that plants occurring in both seminatural and nonseminatural habitats (eg *Vaccinium* sp) were collected from both types of habitat, depending on their accessibility. Therefore, they were included in the study.

Statistical analyses were performed in SPSS Statistics (IBM SPSS 25). The influence of the place of residence (part of the Pieniny Mountains) was analyzed by performing cross-tabulation (chi-square test). Cramér's V test was applied to measure the strength of the relationships.

FIGURE 2 ESs provided by wild plants from seminatural habitats.



Results

Of the interviewed residents, 89% declared that they collected wild plants from seminatural habitats. The greatest percentage concerned people who used wild plants for natural medicine (69%), followed by direct consumption (66%) and food (53%), whereas the smallest percentage concerned cosmetic purposes, at only 7% (Figure 2). Fertilizers and biofuel production were not mentioned.

Involvement in the plant collecting process differed in terms of the place of residence. The share of people collecting wild plants was highest in the Pieniny Spiskie (95%) and lowest in the Małe Pieniny (79%). Collecting

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TABLE 2 Relationship between ESs provided by wild plants from seminatural habitats and place of residence.

Statistical test	In general	Natural medicine	Food	Direct consumption	Rituals	Cosmetics	Decoration	Forage
Chi square	3.089[a)]	1.449	0.760	1.531	10.383*	1.114	6.192*	6.009*
Cramér's V	0.191	0.131	0.095	0.134	0.350*	0.114	0.270*	0.266*

Note: Cramér's V test measured the strength of association: negligible (0.0 to <0.1), weak (≥0.1 to <0.2), moderate (≥0.2 to <0.4; Fagerholm et al 2019).
[a)] Poor data distribution.
* $P < 0.05$.

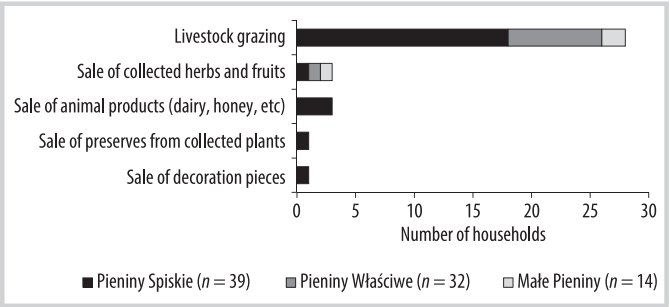
plants for natural medicine, forage, and food production, as well as ritual and cosmetic purposes, were the most common reasons among the residents of the Pieniny Spiskie. Only consumption and decoration purposes had the highest share within residents from the Pieniny Właściwe. Nonetheless, the chi-square test indicated that only forage, ritual, and decoration purposes differed significantly among the regions. The relationship between mentioned ESs and place of residence was moderate according to Cramér's V test (Table 2).

Around 38% of respondents' households used ESs from grasslands for their livelihood. A third of households were involved in livestock grazing and feeding with hay (33%). The sale of collected herbs and fruit concerned only 4% of households. Other types of livelihood were practiced by individuals: sale of preserves from collected plants, sale of decoration pieces, and sale of some animal products (dairy, honey, etc) obtained indirectly from grasslands (Figure 3). In terms of place of residence, the highest share of respondents were involved in selling products derived from seminatural habitats in the Pieniny Spiskie (51%), whereas the shares in the Pieniny Właściwe and Małe Pieniny were lower at 28 and 21%, respectively (Figure 3). The chi-square test indicated that only livestock grazing and feeding with hay differed significantly depending on the place of residence. In addition, according to Cramér's V test, the relationship between these variables was moderate (Table 3).

The results showed that particular species had crucial meaning only in the provision of some ESs related to collecting plants (direct consumption, food, natural medicine, and cosmetic purposes; Table 4). The other ESs (decoration, ritual purposes, or forage) were based on specific parts or types of plants (flowers, herbs, or grass; Table 4).

The widest range of plants (20 were named) was used for natural medicine (Table 4). Most common were herbs used for infusions (St. John's wort, nettle, and mint), fruits for liquors (blackthorn and hawthorn), and dandelion flowers for syrup. Apart from oral intake, ribwort plantain was used externally for dressing wounds (Table 4).

FIGURE 3 Livelihoods based on ESs provided by wild plants from seminatural habitats.



Respondents named 9 wild plants for direct consumption and 11 for food preparation. The most popular wild plants for direct consumption included wild fruits (ie wild strawberry, blueberry, raspberry, and blackberry), followed by sorrel (Table 4). Regarding the preparation of food, fruits (above all blueberry) and sorrel played the most important roles.

The list of plants used for cosmetic purposes included 7 species (Table 4). For decoration purposes, the flowering stage of plants was most important (Table 4). The ritual that engaged the most people in collecting wild plants was an annual celebration in the Catholic Church on 15 August: the Feast of the Assumption of Mary. For this, different wild plants were collected, especially herbs, giving the festival its folk name of Virgin Mary of Herbs (Table 4). Usually, plants gathered for this purpose are useful in the household for food, medicine, and so forth. People also prepare wreaths made with flowers for the Octave of Corpus Christi (another feast celebrated in the Catholic Church).

In the case of forage, mainly grass and hay were mentioned (Table 4).

Discussion

ESs provided by wild plants

Most residents of the Pieniny Mountains collected wild plants and consequently used the ESs provided by them. Our results contrast with those of Biró et al (2014), whose research indicated that wild plants are no longer collected. However, other researchers have observed that collecting wild plants is still popular (eg Łuczaj 2010; Kalle and Sõukand 2013; Schulp et al 2014; Reyes-García et al 2015; Palliwoda et al 2017). Furthermore, some researchers (eg Łuczaj 2012; Klepacki 2016) identified a wider range, in comparison to our findings, of wild plants from seminatural habitats used for specific purposes, which may result from stronger bonds with local customs. Thus, engagement in collecting wild plants may vary among specific countries and regions depending on local traditions and their vitality.

However, ESs provided by wild plants were still more common in the agricultural community, represented here by the Pieniny Spiskie. This is in line with the results of many studies (eg Łuczaj et al 2012; Menendez-Baceta et al 2012; Schulp et al 2014). When it comes to the structure of ESs, significant differences concerned forage and ritual purposes, which were the most popular among residents of the Pieniny Spiskie, as well as decoration, which was relatively unpopular there in comparison to other parts of the Pieniny Mountains. This could be related to the provisioning ESs being more important in low-income regions, such as mountain

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TABLE 3 Relationship between livelihoods based on ESs provided by wild plants from seminatural habitats and place of residence.

Statistical test	In general	Livestock grazing	Sale of collected herbs and fruits	Sale of animal products	Sale of preserves	Sale of decoration pieces
Chi square	5.894	6.201*	0.659[a)]	3.668[a)]	1.194[a)]	1.194[a)]
Cramér's V	0.263	0.270*	0.088	0.208	0.118	0.118

Note: Cramér's V test measured the strength of association: negligible (0.0 to <0.1), weak (≥0.1 to <0.2), moderate (≥0.2 to <0.4; Fagerholm et al 2019).
[a)] Poor data distribution.
* $P < 0.05$.

agricultural areas, because they contribute to economic welfare (Stryamets et al 2015). In contrast, the group of cultural ESs provided by wild plants, which may also include decoration (Reyes-García et al 2015), is more typical of regions with higher income (Stryamets et al 2015). This is the case in the Małe Pieniny, where the only town is located and people can earn a living outside of agriculture.

Wild plant ESs refer to various ESs that are used by people to differing extents. Thus, different ESs based on wild plants should be investigated separately. The most common ESs based on wild plants from seminatural habitats were natural medicine and food. Forage, ritual purposes, and decoration were less important, and cosmetic purposes were quite rare. Fertilizers and biofuel production were not mentioned. This is in line with the findings of many researchers who underlined that the main uses of wild plants are food and medicine (eg Reyes-García et al 2005; Łuczaj 2010; Grasser et al 2012; Schunko et al 2012; Poe et al 2013; McLain et al 2014; Palliwoda et al 2017). Moreover, the results of Stryamets et al (2012) indicate that in high-income countries (eg Sweden), the only provisioning ES based on wild plants is food, whereas in middle-income countries (eg Ukraine), the bundle of provisioning ESs based on wild plants is broader and includes herbal medicine, decoration products, and forage. To a certain extent, this contradicts the results of other researchers (eg Schunko et al 2012; Palliwoda et al 2017), who found that different provisioning ESs based on wild plants are also used by people in high-income regions (eg Austria and Germany). These differences may indicate that ESs provided by wild plants depend on not only individual factors, such as personal income, but also previous (childhood) experiences, access to specific habitats, and so forth. Thus, investigation of the previously mentioned factors influencing ESs provided by wild plants poses an important challenge for further research. Our study focused solely on ESs provided by wild plants from seminatural habitats, whereas others considered wild plants from forests (eg Stryamets et al 2012) or both seminatural and forested habitats (eg Schunko et al 2012; Palliwoda et al 2017). Consequently, more research is needed to examine the relationship between the type of habitat and the bundle of ESs provided by wild plants.

The ESs depended on the different attributes of plants. Particular species played a crucial role in the case of some ESs, for example, direct consumption, food, natural medicine, and cosmetic purposes. However, for other ESs (decoration, ritual purposes, or forage), only a specific part or type of plant, such as flowers, herbs, or grass, was desirable. In this study, medicinal purposes included the widest range of species. This is in line with the results of Peciña et al (2019), who found that natural medicine ESs were tightly linked to plant diversity. Other researchers have confirmed that the widest range of plants is used for natural medicine purposes (eg Reyes-García et al 2005; Tardío et al 2005; Stryamets et al 2012 for Ukraine). In contrast, direct consumption and food, which were the second most common ESs in the present study, in terms of number of species used, were reported by different authors as involving the greatest number of plant species (eg Stryamets et al 2012 for Sweden; Palliwoda et al 2017). These dissimilarities may result from a different level of traditional ecological knowledge in the regions compared. However, differences may also be the result of a discrepancy in the classification of plants providing food and medicine ESs. In this study, liquids derived from wild plants, such as infusions and liquors, which can trigger some health effects, were assigned to the natural medicine category, whereas in the studies of Reyes-García et al (2015) and Schunko et al (2012), they were classed as beverages. They are often used for both reasons. As this shows, many categories can overlap; for example, wreaths and bunches of flowers and herbs used for ritual purposes can later serve decoration and medicinal purposes (Łuczaj 2011, 2012).

Applications in sustainable livelihood and conservation

As in the study of Poe et al (2013), in our study, less than half of the respondents used ESs provided by wild plants for their livelihoods. However, this share was higher by almost 10% in the study of Poe et al (2013). This may result from the inclusion of indirect benefits in their study, such as involvement in education related to wild plants, which was not addressed in the present study. Provisioning ESs played a more important role for livelihood in the agricultural part of the study area (Pieniny Spiskie). However, benefits from using seminatural habitats served as an additional source of income for the household, rather than as the main source. Wild plants are still commonly used for livelihood in local communities in undeveloped regions of the world. For example, in Nepal, according to the findings of Olsen and Larsen (2003), wild medicinal plants contributed 3 to 44% of household income. Similar results were obtained in the Western Himalayas, India, by Nand and Naithani (2018).

The decline in use of ESs provided by wild plants from seminatural habitats causes a decrease in the diversity of plant communities, hinders local income diversification, and results in a steady loss of traditional ecological knowledge. As previously stated, ESs provided by wild plants from seminatural habitats provide direct benefits for sustainable livelihoods. Fontana et al (2014) showed that traditionally managed meadows provide the largest extent of ESs based on edible and healing plants, as well as aesthetics. Thus, linking local livelihoods with ecotourism and conservation on a greater scale may positively influence the whole

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TABLE 4 Plants from seminatural habitats used by local residents.

Species mentioned by respondents			Natural medicine	Food	Direct consumption	Rituals	Cosmetics	Decoration	Forage
English	Polish	Latin							
Blackberry	Jeżyna	*Rubus* spp		3	**9**				
Blackthorn	Tarnina	*Prunus spinosa*	**8**	2	2				
Blueberry	Borówka	*Vaccinium* spp	**6**	**15**	***25***				
Broad-leaved thyme	Macierzanka	*Thymus pulegioides*	1				1		
Chamomile	Rumianek	*Matricaria chamomilla*	2	1		2	1	1	
Clover	Koniczyna	*Trifolium* spp			1	1			1
Coltsfoot	Podbiał	*Tussilago farfara*	1						
Comfrey	Żywokost lekarski	*Symphytum officinale*	1						
Common centaury	Centuria pospolita	*Centaurium erythraea*	3		1	1			
Common daisy	Stokrotka	*Bellis perennis*				2	1	2	
Common dandelion	Mniszek lekarski	*Taraxacum officinale*	**12**			1	1		
Common nettle	Pokrzywa	*Urtica dioica*	**14**	1			2		2
Field horsetail	Skrzyp polny	*Equisetum arvense*	2			1			
Hawthorn	Głog	*Crataegus* spp	**7**	1	1				
Horseradish	Chrzan	*Armoracia rusticana*		1					
Juniper	Jałowiec	*Juniperus*	1						
Mint	Mięta	*Mentha* spp	**12**	1		4	1		
Orchid	Storczyk	*Orchidaceae*						1	
Raspberry	Malina	*Rubus* spp	**6**	**9**	***22***				
Ribwort plantain	Babka lancetowata	*Plantago lanceolata*	4						
St John's wort	Dziurawiec	*Hypericum perforatum*	***20***						
Sorrel	Szczaw	*Rumex* spp		**5**	**6**				
Tansy	Wrotycz	*Tanacetum vulgare*	1			1		2	
Tormentil	Pięciornik	*Potentilla erecta*	1						
Wild rose	Dzika róża	*Rosa* spp	3						
Wild strawberry	Poziomka	*Fragaria* spp		**9**	***35***		1		
Violet	Fiołek	*Viola* spp						1	
Yarrow	Krwawnik	*Achillea millefolium*	3			1			
Other			Herbs	—	—	Herbs	—	Flowers and herbs	Grass or hay
Number of mentioned species			20[a)]	11[a)]	9[a)]	9[a)]	7[a)]	6[a)]	2[a)]

Note: Numbers in the table refer to the number of people who mentioned collecting a specific plant for a particular ES. Roman, bold, and bold italic indicate the frequency of collecting specific plants for a particular ES: rare (<5 respondents, Roman), medium (5–15 respondents, bold), frequent (>15 respondents, bold italic).
[a)] Numbers refer to the overall number of species collected for a particular ES.

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socioecological system. For example, a beneficial solution may be a combination of ecotourism with extensive livestock grazing. This would enable production based on processed milk; it yields a more attractive profit than milk production, which was mentioned by residents as unprofitable and was the main reason that livestock grazing was being abandoned.

In this context, an example of such a practice is conservation grazing, as already conducted in the study area by PNP. It is an active conservation measure for certain types of grasslands, such as pasture with perennial ryegrass *Lolium perenne* and crested dog's-tail *Cynosurus cristatus,* which have to be grazed to maintain their condition. In addition, it involves the local community in grassland conservation, because the traditional herding systems are an integral part of social cohesion in rural landscapes (Salomon et al 2013). Furthermore, it increases the potential attractiveness for tourists, because seasonally pastured livestock contributes to the cultural ESs of grasslands, according to Bengtsson et al (2019). In addition, accompanying actions, such as cultural festivals, as well as the production of dairy and wool products, bring direct and indirect financial benefits. Although it is a successful initiative, PNP only conserves the most endangered habitats because of financial and ownership limitations (Tokarczyk 2018). Hence, only plant communities within the borders of the protected area are conserved. A large area of seminatural habitats is still located outside PNP. Thus, residents should preserve seminatural habitats if it can be economically justified.

Respondents underlined that collecting wild fruit (eg blueberries, raspberries, and wild strawberries) for purchase is nowadays unprofitable, although it was commonly practiced in the past. Stryamets et al (2012) highlighted that promotion of local products made from wild plants, such as jams and herbal tea, could enhance the livelihoods of local people, because processed wild plants command a high price. In this regard, it is important to implement an appropriate regional marketing strategy. Local products that already exist should be promoted at the institutional level. In this way, ecotourists who seek traditional products based on local natural resources could be attracted to the region. These can be edible products (eg jams from blueberries, raspberries, and wild strawberries), alcoholic and nonalcoholic beverages (eg herbs for infusions, like chamomile and mint), natural cosmetics (eg common nettle for hair care purposes and ointment from tormentil for pruritus), decoration pieces, and products used for rituals, which are still popular in the whole of Poland. Examples of products used for rituals include palms prepared from plants for Palm Sunday (a week before Easter) made from dried grass (dyed) and dried flowers. Some wild plant products from seminatural habitats are included in the List of Traditional Products of the Polish Ministry of Agriculture and Rural Development (2021). The increased popularity of local products would yield higher prices. Thus, harvesting plants from seminatural habitats could be more profitable. At the same time, this provides an incentive for mowing grasslands.

Although complex conservation measures may need the support of protected area managers, other more financially profitable actions may be combined with the conservation of some types of seminatural habitats. Hence, the combination of landscape conservation with sustainable livelihood may contribute to the maintenance of a multifunctional landscape. This poses many challenges, because different stakeholders have conflicting interests and needs for a particular ES may clash. However, only multifunctional landscapes are sustainable, because they provide the best balance among different ESs (eg Palomo et al 2014). Moreover, multifunctional landscapes are more desirable for ecological and sociocultural reasons and are economically more beneficial, because they provide diverse livelihoods for people (de Groot et al 2010). This can be applied in the Pieniny Mountains and in other mountainous regions where similar reforestation processes occur because of land abandonment. As mentioned in the introduction, this is particularly true for Central European countries (Medwecka-Kornaś 1977; Tokarczyk 2018; Peciña et al 2019).

Conclusions

Wild plants from seminatural habitats provide a bundle of ESs for inhabitants of the Pieniny Mountains. However, both the provision of specific types of ESs based on wild plants and the number and importance of particular species varied greatly depending on the ESs. The most common ESs based on wild plants were natural medicine, food, and direct consumption. These ESs also involved the widest range of collected species. Forage, ritual purposes, and decoration had less important meanings. For these ESs, particular species also played a minor role and might be easily replaced by other charismatic plants (decoration and ritual purposes) or herbs with similar properties (forage).

As a result of declining interest in livestock grazing and mowing meadows for forage, grasslands and other seminatural habitats are disappearing through natural forest encroachment (Tokarczyk 2018). This has implications for nature conservation as multifunctional land use and landscape mosaics decrease. Therefore, the restoration of traditional activities is vital for the conservation of grassland and shrubby habitats in the Pieniny Mountains. However, this is only possible if the economic profits of such activities are sufficient to provide livelihoods for the local community.

Currently, around half of respondent households use (directly or indirectly) wild plants from seminatural habitats as an additional livelihood income. However, most live in the Pieniny Spiskie (the part of the study area with the highest share of agricultural land) and are involved in livestock grazing. They are gradually abandoning the land for economic reasons. What is more, only a few households sell products derived, directly or indirectly, from seminatural habitats (herbs and fruit, preserves from collected plants, dairy, honey, or decoration pieces). This should be encouraged, especially in peripheral mountainous areas, where the livelihood options are limited and sustainable use of nature is an attractive option. A solution is the promotion of livelihoods based on wild plants that are adapted to the current economic situation. For example, livestock grazing could be combined with ecotourism. At the institutional level, the marketing of local products, directly or indirectly, based on local resources is essential. Growing demand for provisioning ESs based on cultural needs might sustain local community livelihoods. This could support all 3 pillars of sustainability (economic, natural, and social) and link local livelihoods with nature conservation and culture

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preservation. In other words, a whole sustainable socioecological system can be achieved.

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