Original scientific paper

RESOURCE ASSESSMENT OF WILD GARLIC (*ALLIUM URSINUM* L.)

[1]Đurić Branko, [2]Ratković Slađana, [3]Timoshyna Anastasiya

[1]Agriculture Faculty, Bulevar Vojvode Petra Bojovića 1A, Banja Luka, Bosnia and Herzegovina
[2]TRAFFIC International consultant, Bosnia and Herzegovina
[3]TRAFFIC International, c/o WWF Hungary Almos vezer utja 69/A, 1141 Budapest, Hungary

SUMMARY

The production, consumption and international trade in MAPs and phytomedicines, are growing and are expected to grow in future significantly. With this growth in global demand for MAPs and a large base of local demand for plant based traditional medicines, the pressure on the existing populations of MAPs has increased tremendously during the last few decades. Considering the number of species and the relatively small land area, Bosnia and Herzegovina (B&H) is among the five richest countries in Europe in terms of species density and diversity. While B&H is an important center of biodiversity for the region, it has the highest proportion of threatened plant species of any country in Europe. The region of Vlasenica was selected for the implementation of the FairWild Standard in Bosnia and Herzegovina, to develop an approach on how to harmonize the commercial utilization and conservation of the regional *Allium ursinum* population in the wild. Main purpose of this study is to demonstrate effective management and sustainable use of wild-collected plant, ensuring thereby the long-term survival of the natural population and contributing substantially to local livelihoods. The resource assessment (RA) was implemented as required by the FairWild standard. RA is an essential component of an adaptive management process and includes gathering information on distribution, identification of its target populations, inventory and total natural harvestable stock in the selected area. RA included data collection, resource inventory, yield and regeneration study, harvest impact assessment and monitoring and harvest adjustment. Results show that *Allium ursinum* is not in a danger of overexploitation in surveyed region due to the abundance of this plant species and proper management performed by local forest authorities. Conducting RA, jointly with local forestry authorities, it was found useful to test the resource assessment methodology, and further develop the species management plan. Appropriate recommendations for local forest authorities, companies, experts and collectors are included in RA.

Key words: *resource assessment, Allium ursinum, wild collection*

INTRODUCTION

The production, consumption and international trade in medicinal and aromatic plants (MAPs), are continuously increasing. With this growth in global demand for MAPs and a large base of local demand for plant based traditional medicines, the pressure on the existing populations of MAPs has increased tremendously during the last few decades. Over-collection of MAPs and habitat destruction are among the factors creating pressure on populations plants, and potentially threaten their survival in the wild. Implementation of measures for conservation of natural resources of MAPs and their habitats is therefore urged to ensure the continued availability and use of MAPs. Considering the number of species and the relatively small land area, Bosnia and Herzegovina (BiH) is among the five richest countries in Europe in terms of species density and diversity [1]. While BiH is an important

center of biodiversity for the region, it has the highest proportion of threatened species of any country in Europe [2]. After the official launch of the International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants (ISSC-MAP) version 1.0 (now FairWild Standard) in 2007, implementation through selected projects was conducted around the globe (including in India, Nepal, Cambodia, Lesotho, Brazil and Bosnia-Herzegovina) to test its applicability in different geographic, ecological and socio-economic conditions of wild plants collection. Within the BiH-subproject of "Saving plants that save lives and livelihoods" project, supported by BMZ and implemented by TRAFFIC, wild garlic (*Allium ursinum* L.) was chosen as target plant in the Vlasenica region. Vlasenica region was selected for the implementation of the Fair Wild Standard in Bosnia-Herzegovina, to develop an approach to sustainable harvesting of the *Allium ursinum* population in the wild. Main purpose of this project was to demonstrate effective management and sustainable use of wild-collected plant, ensuring thereby the long-term survival of the natural population and contributing substantially to local livelihoods. The resource assessment (RA) was implemented within the project as required by the implementation of FairWild Standard. RA is an essential component of an adaptive management process and includes gathering information on distribution, identification of its target population, inventory and total natural harvestable stock in the selected area.

MATERIAL AND METHODS

Background information

According to the Flora Europaea [3], *Allium ursinum* L. is present from Norway to Mediterranean and from Russia in the East to the Atlantic Ocean in the West. The Middle European species *Allium ursinum* L. is divided in two subspecies: subsp. *ursinum* that is present in west and central Europe, and subsp. *ucrainicum* which is characteristic for east and south Europe. On flat land and in valleys it creates a dense population. The plant favors humus, loose soil, alkaline, neutral or moderate acid soil, and places where the snow stays longer. It is possible to find it on sandy, rocky or slightly loamy surface. Wild garlic could rise from river planes till high mountainous places; up to 1900 m [4]. Usually it covers big surfaces in beech forest associations [5]. In Bosnia and Herzegovina, *Allium ursinum* can be found on mountains Sara (near city Kljuc), Osjecnica, near Banja Luka, on Vlasic, Kruscica, Vranica, near Sarajevo, Fojnica and Vares cities, on Bjelasnica, Treskavica, Romanija, around Bugojno and Kupres, near Vlasenica and Han Pijesak. *Allium ursinum*. is wide spread all over Bosnia and partly in Herzegovina [6]. The biggest area with *Allium ursinum* in Bosnia and Herzegovina is found in the Vlasenica region. According to data gathered from Trade chamber of Bosnia and Herzegovina, more than 200 tons of dried *Allium ursinum* leaves from that region was exported to the European Union during the harvesting seasons 2007 and 2008. More than ten companies purchase and export *Allium ursinum* from Bosnia and Herzegovina [1]. Collection of *Allium ursinum* takes place during the period of vegetation (April-October). Collection of young leaves should be in April and May, before flowering. Collection of the bulbs should be in places where the population of *Allium ursinum* is noticed; before leaves comes out (April) or at the end of vegetation, when leaves are dried (October). Recommendation in guidelines related to organic collection is that 80 % of the bulbs and 30 % of the plants at one area need to stay untouched to ensure regeneration of populations [7].

Selection of survey area was done upon information provided by local forest authorities, local communities, companies that collect in that region and MAPs collectors. Total surface covered by this Forest authority is 40 817 ha. The forest area is divided on organization units and in four of them the *Allium ursinum*. is present (Studeni Jadar, Tisca, Drinjaca Donja,

Gornji Jadar). These organization units are also divided on smaller blocks that are numbered. All four units were surveyed in the present project. *Allium ursinum* is present in so called "belt" that comes from Serbia and mountain Tara, it cover parts of community forest "Birac" and continues further to central Bosnia. The width of "belt" is between 300 and 500 m and it is located in different altitudes. In the present research, *Allium ursinum* populations start growing from 772 m to 1263 m above sea level. All maps for conducting RA were provided by State Forest Company of Republic of Srpska named "Srpske Sume". They have precise digital maps of every forest region under their responsibility. Company has maps of organization units as well as precise maps with blocks within units. Collectors and companies that buy medicinal plants use experience and local knowledge about terrain in this area.

Resource assessment methodology

Work on resource assessment was completed in several phases. First of all, primary data collection was done on the location. After that, secondary data collection was followed. The present study followed the resource assessment methodology as suggested by Leaman and Cunningham (2008) *Resource Assessment: A Guide to Implementing Principle 1; Maintaining Wild MAP Resources* [8]. Primary collection of data was conducted in April 2009 and secondary collection of data was completed during May 2009.

Primary data, that included information about the availability of *Allium ursinum*, its density, distribution within different organization units, present vegetative stages of *Allium ursinum*, availability of the locations, condition of the roads in the area, hardness of the terrain, mine fields and all other relevant information, were collected from local forest authority, forest keepers, owners of the collection companies, collectors and all persons that are connected with collection of *Allium ursinum*. through interviews. Guided by collected information, resource inventory was conducted in four organization units (30 blocks) jointly with the persons from Forestry authority. Resource inventory was done by simple random sampling method due to the size of area, complexity of the terrain and heterogeneity in distribution of resource. Simple random sampling is the basic sampling technique where a group of subjects (a sample) is selected for study from a larger group (a population). Each individual is chosen entirely by chance and each member of the population has an equal chance of being included in the sample. Every possible sample of a given size has the same chance of selection.

Using this method, sampling was done in each block within organizational unit where *Allium ursinum*. is present. Plots of 1x1 m were used as frame for measurements and counting. Number of plots placed in each block varies according to the distribution and availability of *Allium ursinum*. in a specified surveyed area. Two size classes of wild garlic were determined and for each plot the following data were collected: (1) number of leaves in class 1, (2) number of leaves in class 2, (3) total number of plants, (4) number of plants in juvenile stage, (5) number of plants with inflorescence , (6) mass of class 1, (7) mass of class 2, (8) average length of class 1, (9) average length of class 2, (10) average width of class 1, (11) average width of class 2, (12) GPS data, (13) photos, (14) comments about surrounding environment.

Secondary data were collected from state, municipality, forest and university documents, reports, articles, maps, official records and other published and unpublished materials. Data collected in the field were processed and analyzed to obtain the following information: density of *Allium ursinum* in the region, estimation of the total yield, abundance, ratio between different classes of wild garlic, ratio between fresh and dry matter. Statistical data processing was done using Microsoft Excel program. Density was calculated as number of plants per square meter and per hectare. Also, density of first and second class and juvenile stage was calculated. Flower buds were counted and expressed as number of plants with inflorescence out of total number of plants. Yield was calculated as total yield of *Allium ursinum* in the region (stock) as well as yield per hectare. Ratio between fresh and dry matter was done after drying of collected leaves.

RESULTS AND DISCUSSION

Resource inventory

Resource inventory provides information about the quantity (standing stock) of the target resource by estimating both resource density (number per unit area) and abundance (total number in a specified area). An inventory of the target resource provides a base line for monitoring changes in resource quantity in the collection as a result of collection management or other impacts [8]. Collection of *Allium ursinum* leaves takes place in the spring time when the leaves are young and fresh and there are flower stems but they are small and collectors does not pick them. Smaller leaves have lower price on the market. Because of that, two size classes were set up:

1. Class 1 includes leaves with lenght between 10 and 15 cm
2. Class 2 includes leaves with length over 15 cm

Additionally, density of juvenile stage (seedlings or plants with length under 10 cm) and density of plants with inflorescent was counted.

Table 1. Density of different classes of *Allium ursinum* in organization units

	Total surface (ha)	**Area covered with *Allium ursinum* (ha)**	**Class 1 (N°/m²)**	**Class 2 (N°/m²)**	**N° of plants**	**Juveniles (N°/m²)**	**Flowers (N°/m²)**
Studeni Jadar	7308	489	108.00	382.95	201.05	189.89	77.05
Gornji Jadar	5339	763	189.20	253.40	179.60	161.60	87.40
Drinjaca Donja	2978	296	149.45	289.45	175.64	177.09	52.00
Tisca	3027	152,8	176.80	235.20	158.00	326.80	46.00

As it can be seen from Table 1, the two groups of major differences are visible, the Class 2 and Juveniles. The highest average value was found for Class 2 in organization unit Studeni Jadar. This characteristic is not caused by human factor because there is no difference in collection methods and number of collectors in different units. Difference is caused by local characteristics, such as, soil, micro climate, surrounding vegetation and related interactions. Second distinction in quantity of Juveniles could be related to human impact, because Tisca has the lowest frequency of collection and collection is mostly non-commercial.

Table 2. Estimated Yield of *Allium ursinum* L. in different organization units

	Area of unit with garlic (ha)	**Estimated total mass per m² (1+2) (g)**	**Mass (t /ha)**	**Estimated total stock of unit (t)**
Studeni Jadar	489	754	7.54	3687.06
Gornji Jadar	763	663	6.63	5058.69
Drinjaca Donja	296	719	7.19	2128.24
Tisca	153	565	5.65	864.45
TOTAL	1701	675.25	6.75	11 738.44

It may, thus, be assumed that there are less injures of plants and destruction of habitat and vegetation. In terms of the number of plants of *Allium ursinum*, there are no significant differences among the surveyed units. They are relatively equal with unit Tisca at last position, regarding harder terrain conditions for collection in that unit.

Yield and regeneration study

Yield and regeneration study estimates the total and sustainable harvest yield of a target resource in a determined area and time required for seedlings to replace harvested individual plants [8]. Total yield of *Allium ursinum*. was calculated by analyzing the data of the weight of leaves per square meter and collection area per block and percentage of the blocks covered with the plant.

From Table 2 it can be seen that the total estimated mass in grams per m² varies from 565 g to 754 g. This variation is not high and could be explained by different soil characteristics, micro climate, surrounding vegetation, population dynamics and interaction between above-mentioned factors. Same conclusion is valid regarding total stock of the units, which follows size of the units. Total stock of the *Allium ursinum*. in the Vlasenica region can be estimated to be over 11000 tons.

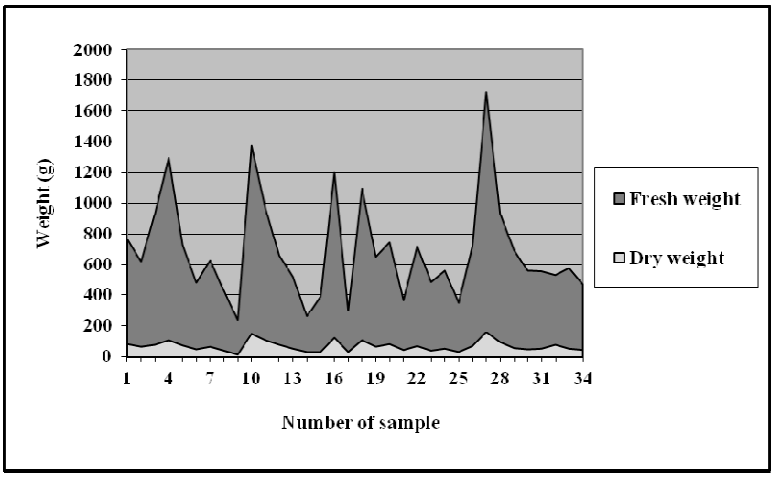

Chart 1. Fresh and dry weight of samples

Average length of leaves of Class 1 for the whole region is 11, 61 cm, and average length of the leaves of Class 2 for the whole region is 16, 99 cm. Average width of the leaves of Class 1 for the whole region is 4,14 cm, and average width of the leaves of Class 2 for the whole region is 6,55 cm. In 2007, according to official records collected from the local forest authority (Vlasenica region), 120 t of dry *Allium ursinum* was exported. In 2008, this amount was significantly lower with only 80 t exported. It is suspected, through the information gathered from collectors and from forest engineers and purchase managers, that real figures of export were 40% higher for dried *Allium ursinum* exported in these two years, which means around 170 t in 2007, and around 110 t in 2008. This 40% of dried *Allium ursinum* is collected without permission of the forest authority.

Amount of fresh matter per sample is between 240 g to 1724 g. Amount of dry matter per sample is between 16 g to 156 g (Chart 1). Average fresh/dry ratio is 9,7 and this is in conformity with literature data where it can be found that 8-10 kg of fresh *Allium ursinum* gives 1 kg of dry matter [4].

Combined with data from the resource inventory and yield data, gathering information on the species' regeneration provides the basis for estimating the sustainable harvest limit of the target resource. It is also used to estimate the recovery time needed to ensure sustainable harvesting [8].

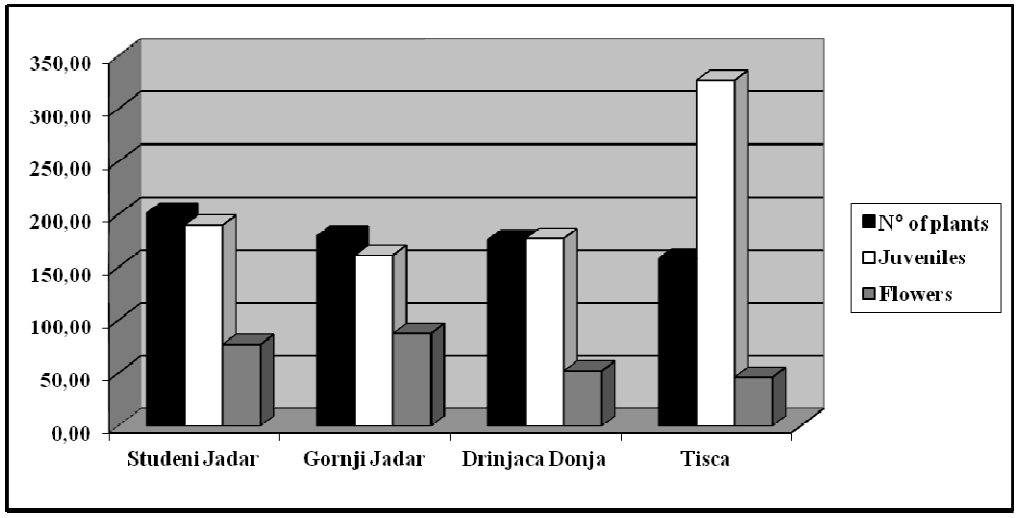

Chart 2. N° of plants, juveniles and flowers per organizational units

From Chart 2 it can be seen that the number of juveniles is very high, particularly, in the units Studeni Jadar and Gornji Jadar more than 90 % of total number of plants are juveniles. In units Drinjaca Donja and Tisca there is more plants in juvenile stage than mature plants. Additionally, number of flowers in samples is quite high. Number of mature plants bearing the flowers out of the total number of mature plants is around one third or more in all surveyed areas. Reproduction of *Allium ursinum* is mainly generative (with seeds), and seeds have good germination, hence it is assumed that the reproduction and regeneration of *Allium ursinum* in this region is secure.

Assessment of harvesting impact

Harvest impact assessment provides information about the effect of specific harvest treatments (different intensities, frequencies, and methods) on the target resource (reproduction, growth, survival, vigor, yield, quality). This information is needed to define a sustainable harvest protocol for the target resource that takes into account site-specific variables. Harvest impact was assessed to determine whether current harvest levels, technique and control are adequate for resource regeneration and productivity. Nature of harvest was studied and it was assessed whether the harvesting technique is destructive or not. Wild-harvesting of MAPs is largely carried out by the local population, mainly people over 40 years of age, predominantly women. Most harvesters belong to poorer or under-privileged groups in society and quite often depend on the additional income generated by wild-harvesting of MAPs. To some collectors, the wild-harvesting of medicinal plants provides a much needed additional income, to others it is the sole source of income. It is estimated that one collector can collect between 100 and 200 kg of fresh *Allium ursinum* leaves per day (150 kg on average). This quantity depends on density of *Allium ursinum* in collection area, size of leaves, slope of the terrain, density of the surrounding vegetation, and the age of collector, etc. Collection of *Allium ursinum* leaves takes place during second part of April and it continues in first part of May. In that period *Allium ursinum* leaves are young and fresh and plants are not in the flowering phase. Collectors pick *Allium ursinum* leaves by hand or they cut it with knifes. They choose healthy, long, leaves without damage and without petiole. They do not collect seedlings or the flowers because buyers request pure leaves. Collection of this type does not harm plants and does not disturb its regeneration. *Allium ursinum* blooms after harvest and produces seeds that ants disseminate around the

forest. Collection takes place in every surveyed organization unit every year. In some areas these activities are more intensive, and in some, like Tisca, are less intensive and collection is mainly performed for personal consumption. Every block in the unit is not equally exposed to collection. Local forest authority that gives permission for collection, change blocks permitted for collection every year, but they do not have long term plans for these activities.

According to collected data, 170 t of dry *Allium ursinum* was sold in 2007, which means that collectors collected between 1600 and 1700 t of fresh garlic and in 2008 the amount was around 1000 t of raw leaves. It can be seen that in 2007, around 15 % of total stock available in the region, was collected. In 2008, that percentage was under 10 %. These percentages don't represent serious treat for *Allium ursinum* population in the region.

For estimation of sustainable harvest quantities, it is necessary to take into consideration that in the region *Allium ursinum* is present in big quantities, that terrain does not allowed collection on every block, and that Forestry Authority rotate collection blocks, as well as that collection never exceeded 15 % of the total quantity. Sustainable harvest quantity for all units could be 60 % of the present stock of *Allium ursinum.* In the Table 3 the data on sustainable harvest quantities were given.

Table 3. Estimated/suggested sustainable harvest quantity per units

Organization unit	Estimated total stock of unit (t)	Suggested Sustainable Harvest Quantity (t) (60 % of total)
Studeni Jadar	**3687,06**	**2212,24**
Gornji Jadar	**5058,69**	**3035,21**
Drinjaca Donja	**2128,24**	**1276,94**
Tisca	**864,45**	**518,67**

Resources of *Allium ursinum*. in the Vlasenica region should be stable if the demand and current amount and intensity of collection remain unchanged.

CONCLUSIONS

Resource assessment was completed in Vlasenica region, which is main region with Wild garlic (*Allium ursinum* L.*)* in Bosnia and Herzegovina, using the internationally developed methodology [8]. The study was conducted in the frame of implementation of the FairWild Standard. In chosen region, four organization units (Studeni Jadar, Tisca, Drinjaca Donja, Gornji Jadar) were selected for implementation, and within those units, the study was conducted in 30 blocks. The results of resource assessment demonstrate that the current stocks of *Allium ursinum*, combined with high regeneration rates, current level of wild harvesting, are unlikely to be unsustainable. The authors recommend this resource assessment methodology to be applied for other MAP species in Bosnia and Herzegovina and region.

ACKNOWLEDGEMENTS

This survey was part of project "Saving plants that save lives and livelihoods" supported by BMZ, implemented by TRAFFIC.

REFERENCES

1. COMPANIES' CATALOGUE. (2006): *Medicinal and Aromatic Plants Mushrooms Wild Forest Products*, Foreign trade chamber of Bosnia and Herzegovina.
2. KATHE, W., HONNEF, S., HEYM, A. (2003): *Medicinal and Aromatic Plants in Albania, Bosnia-Herzegovina, Bulgaria, Croatia and Romania,* BfN – Skripten 91, Federal Agency for Nature Conservation.
3. FLORA EUROPAEA. (2001): Cambridge University Press, United Kingdom
4. DJURIC, B., GATARIC, DJ., RADANOVIC, D. (2007): *Samoniklo ljekovito bilje – prirucnik*; Kreativni centar „ Samo tako" , Banja Luka.
5. STAMENKOVIC, V. (2005): *Nase neskodljive lekovite biljke*, Trend, Leskovac;
6. TODOROVIC, V. (2007): *Morfoloske i bioloske karakteristike samoniklog luka (Allium ursinum L.)*, PhD disertation, University of Banja Luka, Agriculture Faculty.
7. GROUP OF AUTHORS. (2003): *Medicinal plants, Manual for Collectors Based on Principles of Organic Production*, GTZ/SIPPO.
8. LEAMAN D & CUNNINGHAM A.B. (2008): *Resource Assessment: A Guide to Implementing Principle 1; Maintaining Wild MAP Resources.* IUCN-SSC Medicinal Plant Specialist Group, ISSC-MAP.