IN SITU CONSERVATION POSSIBILITIES OF SOME ENDEMIC SPECIES IN GÖLKÖY CAMPUS, BOLU

By

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ABSTRACT

IN SITU CONSERVATION POSSIBILITIES OF SOME ENDEMIC SPECIES IN GÖLKÖY CAMPUS, BOLU

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In this thesis, the *in situ* conservation possibilities of target species in the Campus Area of Abant Izzet Baysal University were studied. Firstly, 5 preservable areas were selected as Gene Management Zones (GMZs) in appropriate areas of the Campus. In order to detect the diversity and density of plant species' population, Modified Wheel Point Method with loop was used in surveys, between May 2011 and July 2013. 85 different plant species from 31 different families were collected in 475 loop points and two of collected species were endemic: *Trifolium elongatum* Willd., and *Arum hygrophilum* Boiss. subsp. *euxinum* (R.R. Mill.) Alpınar. Morphological characters of collected 10 specimens for each endemic species, described by the Flora of Turkey, were measured. Then, mean, standard deviation, min, and max were calculated for the characters by SPSS 21 Package Software. Plant coverage areas calculated in 5 GMZs were 88.8%, 95.5%, 90.0%, 88.7%, and 95.0%, respectively.

Meantime, frequencies of target species were 3.36% and 2.94%. Topographic features and soil content affecting biodiversity: water logging, soil texture, electrical conductivity, total salt, pH in water-logged soil, lime ($CaCO_3$), P_2O_5/K_2O, organic substance, total nitrogen, organic carbon were measured. Effects of climate, construction, crowd etc. were also compared by previous studies in the Campus and possibility for *in situ* conservation in the Campus Area was discussed.

Keywords: Biodiversity, Climate, Endemic, Gölköy/Bolu, *In Situ* Conservation, Gene Management Zones, Modified Wheel Point Method

ÖZET

BAZI ENDEMİK BİTKİ TÜRLERİNİN GÖLKÖY / BOLU YERLEŞKESİNDE *IN SITU* KORUNMASI OLANAKLARININ ARAŞTIRILMASI

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Bu tezde; Abant İzzet Baysal Üniversitesi Kampüs alanında hedef bitki türlerinin *in situ* (yerinde) korunma olanakları çalışıldı. İlk olarak Kampüs'ün uygun yerlerinde beş adet korunabilir Gen Koruma ve Yönetme (GEKYA) alanı seçildi. 2011 Mayıs ve 2013 Temmuz tarihleri arasında bitki türlerinin çeşitliliği ve populasyonlarının yoğunluğunu belirlemek için arazi gezilerinde lup ile modifiye edilmiş tekerlekli nokta yöntemi kullanıldı. Toplam 475 lup noktasından 31farklı aileden ikisi endemik 85 farklı tür toplandı. Bitki kompozisyonundaki tüm bitki türleri için bitki ile kaplı alan ve endemik türlerin frekans değerleri ölçüldü. Endemik türler *Trifolium elongatum* Willd. ve *Arum hygrophilum* Boiss. subsp. *euxinum* (R.R. Mill.) Alpınar'dır. Endemik türlerden 10 adet örnek alınarak "The Flora of Turkey and the East Aegean Islands" adlı eserde belirtilen morfolojik karakterler temel alınarak ölçüldü ve bu karakterlerin ortalama, standart sapma, en az ve en çok istatistik bilgileri SPSS 21 paket programı ile hesaplandı. Arazilerin bitki örtme oranı sırasıyla %88.8, %95.5, %90.0, %88.7 ve %95.0 olarak ölçülürken hedef türlerin frekans değerleri ise %3.36 ve %2.94 olarak ölçüldü. Biyoçeşitliliği etkileyen toprak içerik ve özellikleri (suyla doymuş toprak, toprak içeriği, iletkenlik, toplam tuz miktarı, toprak pH değeri, kireç (CaCO3), P_2O_5/K_2O, organik madde, toplam nitrojen, organik karbon) de ölçüldü. İklim, yapılaşma ve nüfus yoğunluğunun etkileri kampus alanında daha önce yapılan çalışma ile karşılaştırılarak bölgenin *in situ* korunma olanakları tartışıldı.

Anahtar Kelimeler: Biyoçeşitlilik, İklim, Endemik, Gölköy\Bolu, *In Situ* Koruma, Genetik Koruma ve Yaşatma Alanı, Modifiye Tekerlekli Nokta Yöntemi.

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CHAPTER 1

INTRODUCTION

1. Genetic Resources

Genetic resources (GR) are any kinds of genetic or other material of plants, animals, microbials or other origin with functional heredity units [1]. They have actual or potential uses food, feed, ornamentals, drug etc. They include: animals and plants; and plant parts: seed, seedlings, etc.; fungi, bacteria and some other single-celled organisms; cell cultures; chromosomes; and DNAs (deoxyribonucleic acid). Plants and animals have been transported from country to country and from continent to continent for thousands of years for their possible potential uses outside their region of origins – as cultivated plants (wheat, barley, pulses, oil crops, and /or medicinal plants) or improved seeds, and domesticated animal-breds. The classical methods, which contributed highly to exchange of genetic resources, and the modern methods, supported by biochemistry, molecular biology, and gene technology have brought a rapid growth for fruitful utilization of genetic material and information in the various regions and application areas[2].

Genetic resources, whether plant, animal or micro-organisms, are used for various purposes, from basic research to the development of end-products. Users may contain universities, research institutes, and private companies in various sectors such as pharmaceuticals, agriculture, horticulture, cosmetics, and biotechnology. Biological diversity, here, referring the diversity in the living organisms on earth is essential for the human, for the livelihood and the cultural integrity of the people, and for the planet.

Many expeditions on genetic resources have been implemented. Number of accessions conserved in about 1,400 genebanks worldwide has increased by approximately 20 since 1996, reaching 7.4 millions [3]. Animal genetic resources, in addition to plant genetic resources, have also received great attention for collection, preservation, and evaluation. FAO's Global Animal Genetic Resources for Food and Agriculture Databank has, for example, information on a total of 7,616 livestock breeds. About 20% of reported breds are considered to be under threats today [4]. Sixty-two breds have become extinct just during the last six years, meaning each month a bred has been lost. These figures I mentioned here have presented only a partial picture of genetic erosion [4]. The main cause for genetic erosion, according to FAO's State of the World's Plant Genetic Resources for Food and Agriculture, is the rapid and continous replacement of local varieties by modern varieties. The faster the replacement in farmers lands by modern varieties the higher the risk that diverse genes existed in farmers' varieties have been lost.

The Convention on Biodiversity adopted in Rio de Janeiro in 1992 has accredited the importance of genetic diversity and its conservation, which comprised three elements: the conservation of biological diversity, its sustainable use and the equitable distribution of benefits arising from its use. Today, there have been 179 countries and the European Union in the Convention [3].

1.1. Plant Genetic Resources

Plant genetic resources (PGR) are considered the sum of all of the genes in plant species. They are on what biodiversity are based. They are made up of modern cultivars, land races, obsolete cultivars, breeding stocks, wild forms of cultivated crops, and wild species – some even not cultivated today. Genetic diversity is the key to meet food and feed demands for everyday growing population of the world. The universally accepted term for “genetic diversity” by the Convention on Biological Diversity [5], includes not only living entites but also their ecosystems and habitats especially soil, as an integral part of the diversity [6].

Plant genetic diversity provides the raw material and valuable characteristics for improving crop productivity, resistance against the diseases, the pests, and changing climatic and environmental conditions. PGRs are, in other words, a part of agro-biodiversity, the sum of all genes, and important agents for a self sufficient agricultural production. Some genes for self sufficiency like male sterility, dwarfness, and various disease resistances have been extensively incorporated into the cultivars grown in large areas.

Scant genetic base can be hazardous for the survival of species and restricts the improvement of better yielding cultivars. Therefore, the breeders need diverse genetic sources for these specific traits in the germplasm collections when the need arises. These plant genetic resources, which are important for world food security, disappear too rapidly on these days. They are threatened by climatic changes, pests, substitution of traditional local cultivars by high yielding cultivars because of market oriented economy, and human activities - deforestation, spreading of towns, construction of roads, overgrazing, and urbanization [8]. Therefore, conserving plant diversity by combating new pests and diseases, improving better adapted high yielding varieties for different environments in order to secure food, becomes really important each and every day [9].

1.1.1. Plant Genetic Resources in the World

Around one billion people go hungry every day in the world today. Expecting nine billions people in the world by 2050, countries must spend greater efforts to meet the demand for food one of the feasible approaches to obtain sustainable enough food production is to promote the preservation and accelerate utilization of plant genetic resources logically [3]. Plants, as known, provide much of the food for human and animals. Most countries have become concerned over the extent of genetic vulnerability and, then, the need for a greater diversity deployment. However, improved techniques and better indicators are still needed to establish base lines in order to monitor, evaluate, and utilize genetic diversity [3].

Agriculture plays a key role in reducing poverty and insecurity caused by food shortages around the world. Longerstanding underinvestment in agriculture, food security and rural development; spikes in food prices; and global financial crises have led to an even worsened hunger and poverty in many developing countries. Sustainable use of preserved species of plant genetic resources is considered possibly to alleviate the hunger through improved plant breeding and production programs.

Some PGR research programs, which are run by universities, international and regional research institutes, botanical gardens, and gene banks in the world, focus on genetic resources of specific species' and their wild relatives while some others focus on cultivars or landraces of one taxon. There are a huge amount of possibly 6,565,620 accessions in various national genebanks and global germplasm (Table 1-2), [10]. In some of them, even native and universal ones are preserved.

Table 1: Regional and subregional distribution of accessions in national genebanks (international and regional genebanks are excluded)

Region	Number of accessions
Africa	354,196
America	1,731,255
Asia and the Pacific	2,294,060
Europe	1,725,315
Near East	460,794
Total	6,565,620

After FAO

Table2: Global germplasm holdings for various crop groups

Commodity	Number of accessions
Cereals	3,157,578
Food legumes	1,069,897
Roots and tubers	204,408
Vegetables	502,889
Nuts, fruits, and berries	423,401
Oil crops	181,752
Forages	651,024
Sugar crops	63,474
Fiber crops	169,969
Medicinal, aromatic, spice, and stimulant crops	63,474
Industrial and ornamental plants	152,325
Other	262,993
Total	6,998,760

After FAO: Views 2009 and country reports.

1.1.2. Plant Genetic Resources In Turkey

The richness of diversity for species in Turkey was emphasized in many publications [3-6-10-11-14-15]. Studies on Turkish flora have been accelerated, especially after the publication of 10 volumebook of the Flora of Turkey and East Aegean Islands [12-13]. The motivated studies have also shown the richest diversity in the species of Turkey, especially in ferns, seeds, and primitive plants. At the first quarter of 20th century, pioneering Turkish scientist Mirza Gökgöl collected wheat landraces from all over Turkey and evaluated them for basic characteristics. Gökgöl identified about 18.000 types of wheat and among them he identified 256 new varieties [39]. There are, today, various studies on some plant species although studies on primitive plants of Turkey have not been completed yet [11].

Turkey is the first country completed and published a national inventory about its 122 Important Plant Areas (IPAs). IPAs have included botanical, geographical, and geological characteristics of the species, and were evaluated about the importance for their conservation and threats [23]. Western Black Sea Region, Bolu province in which, has conserved areas (Figure 4). Biodiversity conservation, either *ex situ or in situ*, of plants in Turkey was conducted within the National Program on Conservation of Plant Genetic Resource/ Diversity since 1960s. The designation of the first National Park in Turkey was in 1958, even when environmental problems were not yet as intensive as today [3]. In the early 1970s, environmental conservation policies were institutionaliazed in Turkey. In early 1980s and 1990s legal boundings for the environmental protection were achieved and put into the national programmes. The Ninth Development Plan, covering the years 2007 to 2013, determined Turkey’s biological diversity as a priority to protect, develop and produce a new economic value [3].

Turkey is located in the subtropics zone in between 36°- 42° latitudes north and 26°- 45° longitude east. The total area is 77,945,000 hectares (Area 779,452 km², Anatolia 755,688 km², Thrace 24,888 km²). The surface of Turkey is divided by the Dardanelles, the Sea of Marmara and the Bosporus in the west; and surrounded by Black Sea in the north; Aegean Sea in the west; Mediterranean Sea in the south.

Topography and ecological factors induced the emergence and diversification of varieties because of its own three phytogeographic regions: Mediterranean, Euro-Siberian, and Irano-Turanian (Figure 1) [50].

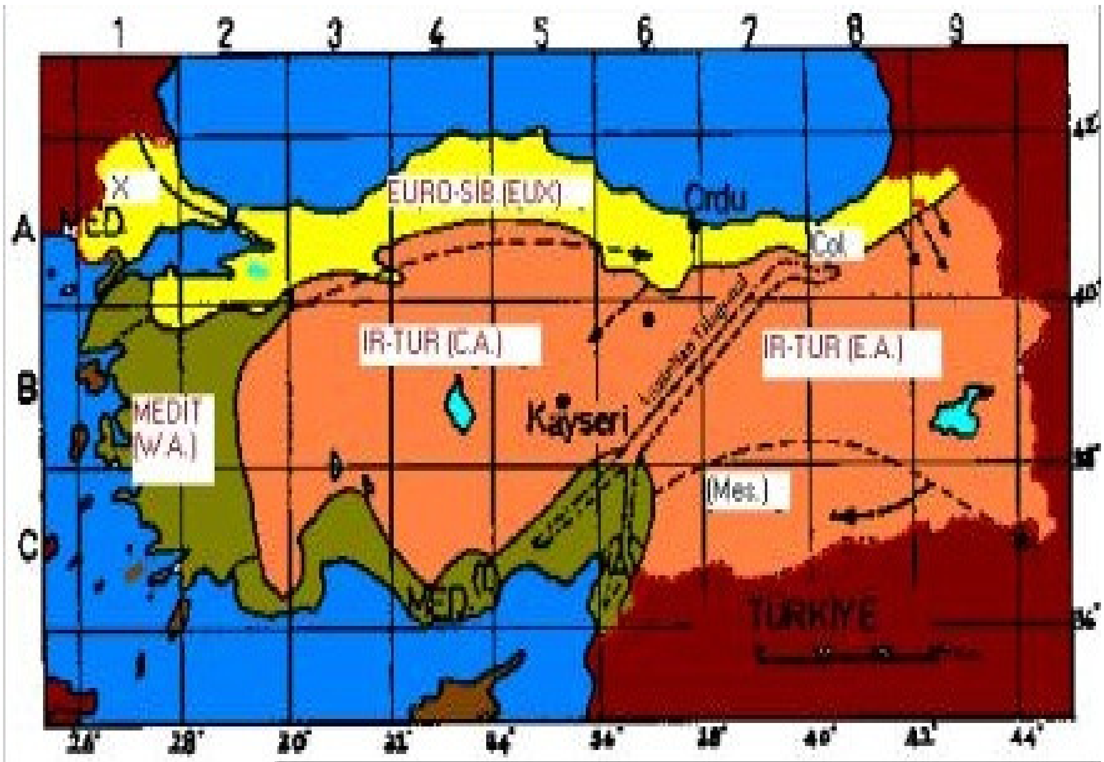

Figure 1: Phytogeographic regions of Turkey.

The Thrace of Turkey is a fertile hilly land and the Asian part - Anatolia - of Turkey consists of an inner high plateau with mountain ranges along north-west coasts. The plateau extends from Aegean coast with river valleys. Other plateau in

Anatolia rises towards the east and bounded by step mountain ranges on the north and south.

There are also climatical differences in Turkey. North Anatolia experiences heavy rainfall all year around. West and South Anatolia have typical mild Mediterranean coastal climate. Winters are wet, summers are long; hot and constant drought prevails from May to September. Although summer precipitation is negligible, humidity is not as low as it is on the Central Plateau. Rainfall in the Mediterranean belt varies considerably from one year to another. Temperatures tend to be higher in South Anatolia than west. In South West of Marmara Sea, the Mediterranean climate is modified by the lower temperatures and higher rainfalls of North Anatolia [3].

Since Turkey is located in a geographically and climatically favourable place as we mentioned above, plant diversity is richer. Flora of Turkey includes over 11,000 vascular plant taxa compared with the 12,500 species in Europa [14]. Two of the Vavilov's Center of Origin (i.e. Near Eastern and Mediterranean Centers) extends into Turkey. This, of course, indicates that Turkey is one of the Centers of Origin and/or Centers of Diversity of several crop plants with wild weedy, cultivated forms, and many plant species. Moreover, Turkey is also one of the domestication centers where ancient agriculture is started. Turkey is the gene center of some forest trees (fir, spruce, cedar, juniper, sweet gum etc.) and wild relatives of world-wide important cultivated plants (wheat, barley, lentil, chickpea, apple, pear, cherry, walnut, pistachio, and chestnut etc.). Additionally, Turkish flora also covers up many economically important timber species, medicinal, aromatic, industrial, and ornamental plants [15]. Turkey is described as microcenters for many crops, as well, such as *Amygdalus* spp., *Cucumis melo, Cucumis sativus, Cucurbita moshata,* *Cucurbita pepo, Lens culinaris, Lupinus* spp., *Malus* spp., *Medicago sativa*, other annual *Medicago* spp., *Onobrychis viciifolia, Phaseolus vulgaris, Pistachio* spp., *Prunus* spp., *Pyrus* spp., *Trifolium* spp., *Vicia faba, Vitis vinifera,* and *Zea mays* [17].

As a result, Turkey is very rich in plant species and it has 75% of the total number of plant species prevail in the Europe. One third of Turkish flora is twice more diverse than that of neighboring countries. Therefore, Turkey is one of the most important biodiversity centres in the world [19] and, unfortunately, a major part of its endemic species is threatened severely [21]. Turkey shows the characteristics of a small continent for biodiversity, because of ecosystem variability induced by different forms of agriculture, forest, mountain, steppe, wetland, coastal, marine, and their combinations.

1.2. Conservation of Plant Genetic Resources

The conservation of plant genetic diversity with its transition types and their wild relatives is an essential issue in the world today. Not only are better yields needed today, but also resistance to pests and higher quality. Plant genetic diversity in the world disappears too rapidly despite all intensive conservation efforts carried on timber companies, farmers, overgrazing, spreading of roads, towns, cities, industrial enterprises, urbanization, diseases, and pests [8]. Therefore, many research programs around the world study the conservation of plant genetic resources. In a world, where around one billion people go hungry every day -with an expectation of a world population of nine billion by 2050- plant genetic resources must be conserved delicately [9].

Plant genetic resources, with their genetically transmitted characteristics, ensure food security by scientist in different conservation programs. PGR conservation areas are international agricultural research centers, universities, regional research organizations, gene banks, seed banks, natural parks, gene conservation and management areas, wildlife breeding stations, field gene banks, *in vitro* banks, DNA Banks, cryobanks, botanical gardens, farmer fields, etc [3]. At the most basic level, genetic resources can be conserved either *in situ* (in their natural setting) or *ex situ* (outside their natural setting) or blend of both. Conservation of PGR includes collection, characterization, evaluation, maintenance, distribution, and utilization of plant genetic structures.

1.2.1. *In Situ* Conservation

In situ means preservation of natural resources, landraces, wild, and wild related varieties in natural habitats, national parks, special sites, farms, and villages. Protected areas in the world have grown from approximately 56,000 to about 70,000 between 1996 and 2007. The total area covered, in the same period, has expanded from 13.0 to 17.5 million km^2 [10]. In Turkey, the percentage of the protected areas under various statues to the country's total surface increased from 4% to about 6% after 2000 [15]. *In situ* programs such as national parks, nature conservation areas, nature parks, wild life development areas, special environmental protection zones, natural sites, natural assets and gene preservation and management areas have been established in Turkey since the 1950s [3].

National environmental strategies, plans and programs which have been put into action in Turkey are listed below:

1. National Plant Genetic Resources and Plant Diversity Conservation Program (1976),
2. National Environmental Action Plan (1998),

3. National Plan for *In situ* Protection of Plant Genetic Diversity (1998),
4. National Biological Diversity Strategy and Action Plan (2001, revised in 2007),
5. National Agenda 21 Programme (2001),
6. National Wetland Strategy (2003),
7. Turkish National Forestry Programme (2004),
8. National Science and Technology Policies 2003-2023 Strategy Document (2004),
9. Turkish National Action Program Against Desertification (2005),
10. National Environmental Strategy (2006),
11. National Rural Development Strategy (2006).

In situ conservation includes both site and/or population selections. Studies firstly focus on the centers of target species *in situ*. Endangered species, genetically eroded, lowered population numbers or broad but matchless species taxonomically and evolutionarily and those, suitable for agricultural studies are prior species for *in situ* conservation. Secondly, selection of areas is very important for conservation of biodiversity. Hence, criteria for selection of areas: abundance of target species, genetic diversity of target species' population, individuals number in population, accessibility, and conservation status, which was not affected much by factors such as human, grazing, urbanization, etc.

It is believed, in recent years, that the best maintenance and conservation of target species is achieved in "Gene Management Zones -GMZs". GMZs must carry some properties such as highly diverse plant species, involvement of target species, involvement of extinct or extincting speices, and close to optimum conditions for evolution among existing populations. Management plans protect areas and plants against grazing, timber harvesting, and etc. In site or population selection for GMZs, priority is to capture the core variability within the species in order to represent the variability of the region. The following physical features of the chosen reserve areas are studied and detailed information [22] are collected: elevation, topography, slope, exposure, soil type, soil moisture conditions, and climatic factors. During studies number of plant species might increase if new target species are observed.

There are various important projects, about *in situ* conservation, conducted at national level in cooperation with ministries of Agriculture and Rural Affairs (MARA) and Ministry of Environment and Forestry (MEF), NGOs (Non-Governmental Organizations), and some Universities [15], (Table 3).

Table 3: *In situ* conservation programs in Turkey (National Biological Diversity Strategy and Action Plan 2007).

Conservation Programs	Foundation Year	Responsible Institution	Number	Area
National parks	1958	MEF	39	878,801.00
Nature parks	1983	MEF	29	78,868.00
Nature conservation areas	1987	MEF	32	63,008.00
Nature monuments	1988	MEF	105	5,541.60
Wildlife improvement areas	1966	MEF	80	1,205,599.00
Wildlife breeding stations	1966	MEF	22	4,551
Protection forests	1950	MEF	57	394,853.00
Gene conservation forests	1994	MEF	193	27,735.60
Seed stands	1969	MEF	338	46,086.04
Special environment protection regions	1988	MEF	14	1,206,008.00
Ramsar areas	1994	MEF	12	200,000.00
Natural archaeological protection Aaeas	1973	MTC	1003	
Natural assets	1973	MTC	2370	
Gene conservation and management areas	1993	MARA/MEF	3 Pilot study areas	Bolkar Mt., Kazdag and Ceylanpınar Farm
MARA: Ministry of Agriculture and Rural Affairs; MEF: Ministry of Environment andForestry; MTC: Ministry of Tourism and Culture				

In situ conservation's advantages are the continutaion of evolutionary processes against abiotic –excess or lack of temperature, moisture, water, light - and biotic - fungi, bacteria, viruses and any other organisms- agents. Preservation of wild and alien species in habitat without collection, a dominant method yet, is good for plants, which are not suitable for *ex situ* condition.

One of the main disadvantages is that *in situ* protection requires land. Preservation efforts and farmers in the *in situ* practices and/or productions need land to plant wild relatives of a species. One needs the land enough to avoid pollen or pest carriage between different cultivation areas for most of the species. Farmers, also, can face difficulties in the preservation of desired diversity and traits; moreover, *in situ* conservation is more expensive than *ex situ* one. When farmers change their management techniques suitable for modern varieties, and, their varieties to modern ones on the lands, the lost of landraces, wild relatives, etc. increases.

Plants complete evolutionary process under *in situ* conditions. Evolution does not provide only appearing of new useful characters, at the same time loss of old desired traits. Therefore, plant materials, collected *in situ* preservation areas must simultaneously be stored in gene banks as well. In other words, *in situ* preservation must not be considered alone but with *ex situ.* The same is true for the opposite: *ex situ* goes well with *in situ.*

1.2.2. *Ex Situ* Conservation

This method is applied outside rather than the original places of species. *Ex situ* conservation involves sampling, transfer, and storage of particular species' populations away from their original locations. *Ex situ* provides reservoir for breeders to improve yields, quality, disease, and pest resistance. It is the cheapest and simplest way for plant genetic resources to protect outside their natural habitats. However, a serious problem exists *ex situ:* evolution cycle of plants in *ex situ* breaks.

Botanical gardens, gene banks, agricultural research institutes, universities, laboratuaries are *ex situ* conservation sites. Large amount of plant germplasms are stored there at low cost. National Plant Germplasm System (NPGS) is the largest *ex situ* collection system in the world. *Ex situ* was practiced under certain moisture and temperature conditions. Plant genetic materials, and seed mostly, are periodically regenerated to prevent the lost of genetic accessions and / or lines for the future. Conditions at -20 ℃ -40 ℃ are for long period conservation and 0 ℃ are for the short time storage [3].

Ex situ conservation has advantages like lower cost, faster sample handling, larger amount storage, easier access of breeders to resources, higher security against diseases, changing conditions of environment, changing climates and newly appeared statues. Moreover, it is efficiently reproducible and easily accessable for characterization, evaluation, and utilization [3].

Disadvantages of *ex situ,* on the other hand, are the requirements for developed technology, cutting of evolution of species, disappearance of genetic varieties in each regeneration cycle. Therefore, *ex situ* is not appropriate for species, which fail to survive under dry and cold conditions [11].

Varietal richness in cultivated and natural plants attracted several scientists in the past; Vavilov, Zhukovsky, Harlan etc. In the same period as Gökgöl, well known Russian scientist Zhukovsky conducted 3 collecting missions to Turkey during 1925-1927. Zhukovsky was encouraged by Vavilov and his missions were supported by The Botany Society of the Soviet Union. During three years of hard work in Turkey, Zhukovsky collected around 10,000 samples of cereals, forages and vegetables. The material was an enormous contribution to plant varieties of the Soviet Union [39].

In Turkey, *ex situ* studies started in 1964. Collections have been made for annual programs. These programs have involved cereals, vegetables, aromatic and medicinal plants, food legumes, ornamentals, herbs, etc. Nowadays, international gene bank in İzmir has 50, 000 samples and approximately 600 species. Today, about 55,000 materials over about 2,700 species are kept in the National Gene Bank (Table 4) [15]. About 7,000 vegetatively propagated plant genetic material, mainly fruit genetic resources are kept in national field gene banks at 15 institutes (including AARI, İzmir). Garlic, some medicinal and aromatic plants, and ornamental collections are also kept at Aegean Agricultural Research Institute (AARI) as field collections (Figure 3) [51]. The biggest gene bank was opened in Ankara in 2010 (Figure 2) [52], National Gene Bank. The national collection contain landraces, local types, wild and weedy relatives, and other wild species of especially economically important plants and, moreover, of endemic species (totally over 70,000 accessions of seed and vegetative collections). The main users of the material are both national and international plant scientists [3].

Figure 2: Seed samples in National Gene Bank, Ankara

Table 4: Number of species and accessions at the Gene Bank, AARI.

Plants	Number of species	Number of accessions
Cereals	169	19,325
Industrial crops	58	4,388
Vegetables	92	7,357
Ornamental plants	127	1,216
Forages and fodder plants	398	7,656
Food legumes	34	6,633
Medicinal and aromatic plants	198	1,546
Endemic species	874	5,297
Other species (including vegetables)	735	1,105
Total	2,692	54,523

Figure 3: Some seed production activities in AARI, İzmir

1.3. National Plan For *In Sıtu* Conservation of Plant Genetic Diversity In Turkey

Turkey has a unique position with its genetic diversity. Though, the conservation of genetic diversity of cultivated plants, their wild relatives, transitional forms and globally important forest trees are not emphasized, even ignored. Efficient conservation of plant genetic resources -cultivated plants, their primitive forms, and important forest trees- are also needed for plant and tree improvement programs around the world. Longer improper utilization of natural resources changes the original structure of plant genetic diversity drastically in recent years. Furthermore, there has not been any efficient program or strategy for *in situ* conservation of plant genetic resources till soon [11].

An *in situ* conservation project, supported for the first time by a special fund (Global Environment Facility, GEF) of The World Bank, was initiated in 1993 by the Ministries of Agriculture and Rural Affairs (MARA), Forestry (MOF), and Environment (MOE) in Turkey. This pilot project aimed to conserve the genetic diversity of wild relatives of cultivated plants and forest tree species with global importance. The objectives of the project were to train scientists in various aspects of *in situ* conservation, to upgrade the laboratory facilities in the research institutes of MARA and MOF, to establish *in situ* conservation programs for conserving genetic diversity of target species selected in pilot sites (Kazdağı and Bolkar mountains, and Ceylanpınar State Farm), and to develop an *in situ* GMZ concept, which can also be used for other species throughout the country. To achieve the last goal and to incorporate GMZs concept and experiences from the project into existing conservation programs, the MOE had a 'National Plan for *in-situ* conservation of genetic diversity in Turkey’ prepared [11]. The draft copy, after obtaining views of various national institutions, of the National Plan was also presented in the International Symposium held on "*In-Situ* Conservation of Plant Genetic Diversity" on November 4-8, 1996 in Antalya, Turkey to solicit the views of the international experts. The comments and criticisms from both national and international experts were incorporated into the present version of the National Plan [11].

1.3.1. The Region

Bolu province (827,600 ha) is located in the Western Black Sea region (Figure 4, 6), [27, 44], where the topography, the soil structureand the climate expresses a high level of heterogenity. The environmental conditions, in that case, increase the phenotypic and genetic diversity of local plant populations. Therefore, Bolu has also been chosen as one of the pilot regions for the "*In situ* Conservation Project of Plant Genetic Resources in Turkey" in 1993, due to its richer plant diversity and location in the transition point of Euro-Siberian and Irano-Turanian phytogeographic regions [24].

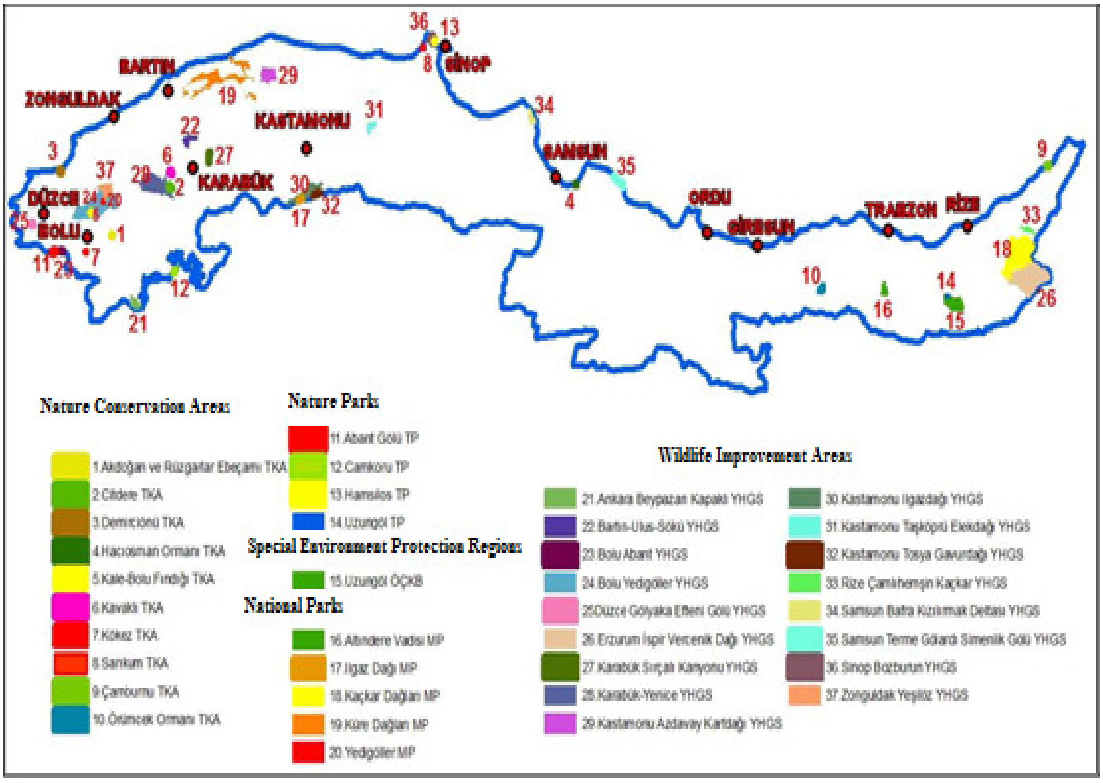

Figure 4: Conserved areas in Black Sea Region, Turkey.

The recent studies in Bolu province have also reflected higher plant diversity. Karakiriş mountain, Bolu (1999) carried the richness of 511 taxa in 72 families, 13.50% taxa being endemic [40]. Another study in the Abant Nature Park (2003), Bolu showed the existence of 664 species in 84 families [41], with an endemism of 8.1%. In 2008, flora of Gölcük/Bolu was studied and 475 taxa in 80 families were determined and endemism was 3.5% [42].

Gölköy Campus (Figure 5) [36] is in the western part of the city -located on the Kuzu Dağı- and lays at the latitude 40°43’25” N and longitude 31°30’45” E, its highest altitude is 899 m [25].

In the map of P.H. Davis, [25, 26] naming the regions as“well known”, “moderately known”, and “little known or unknown” named Gölköy Campus in moderately known areas [25]. Until now, whereas some areas have been conserved in Bolu (Table 5) [27], there has not been any *in situ* conservation studies in the Campus of Abant Izzet Baysal University (AIBU) nor in Bolu province reported.

The number of endemic species in the Flora of Campus study was 19 during 1994-1995 but now this number is 16. The endemism ratio was 4.3% [25], 3,7% now. Endemic species found in the Gölköy Campus area were:

Linum hirsutum L. subsp. *anatolicum* (Boisss.) Hayek var. *anatolicum*

Trifolium elongatum Willd. (Syn.: *Trifolium pannonicum* Jacq. subsp. *elongatum* (Willd) Zoh.

Crataegus tanacetifolia (Lam.) Pers.

Bupleurum sulphureum Boiss.&Balansa

Eryngium bithynicum Boiss.

Ferulago thirkeana (Boiss.)Boiss.

Hieracium ovalifrons (Woronow & Zahn) Üksip

Taraxacum aznavourii Soest

Tripleurospermum rosellum (Boiss.& Orph.) Hayek var. *album* E.Hossain

Tripleurospermum conoclinum (Boiss.&Balansa) Hayek

Verbascum armenum Boiss.& Kotschy ex Boiss. var. *occidentale* Hub.-Mor.

Verbascum caudatum Freyn.& Bornm.

Chrysothesium stellerioides Jaub.&Spach Hendrych (Syn.: *Thesium stellerioides* Jaub.& Spach)

Asperula pestalozzae Boiss.

Arum hygrophilum Boiss. subsp. *euxinum* (R.R. Mill.) Alpınar (Syn.: *Arum euxinum* R.R. Mill.

Crocus biflorus Mill.subsp. *pulchricolor* (Herb.) B.Mathew

Because of the reasons mentioned above, the Campus site was chosen for the research area.

Table 5: Conserved areas in Bolu.

Conserved areas	Programs	Province	Area (ha)
Yedigöller	National Park	Bolu	1,637
Akdoğan and Rüzgarlı Ebeçamı	Nature Conservation Area	Bolu	195
Kökez	Nature Conservation Area	Bolu	330
Kalefındığı	Nature Conservation Area	Bolu	477
Abant Gölü	Nature Park	Bolu	15
Abant	Wildlife Improvement Areas	Bolu	165
Total			**2,819**
% of total land			**0.34**

Figure 5: Gölköy Campus/Bolu

CHAPTER 2

MATERIAL AND METHODS

2.1. The Study Area: Abant Izzet Baysal University Gölköy Campus, Bolu

Abant Izzet Baysal University was established in 1992. Campus of Abant Izzet Baysal Üniversity (Figure 5) [36] is situated in the A3 Grid square and flora consists of the Western sector of the Euxine province [25]. Campus is in the western part of city -located on the Kuzu Dağı- and lays at the latitude 40°43'25" N and longitude 31°30'45" E, its highest altitude is 899 m. Büyüksu River is the main stream at the north part of the Gölköy Campus. There are 4 villages around the Gölköy Campus area. These are Gölköyü, Aşağı Karaköy, Yukarı Karaköy and Yumrukaya villages [25].

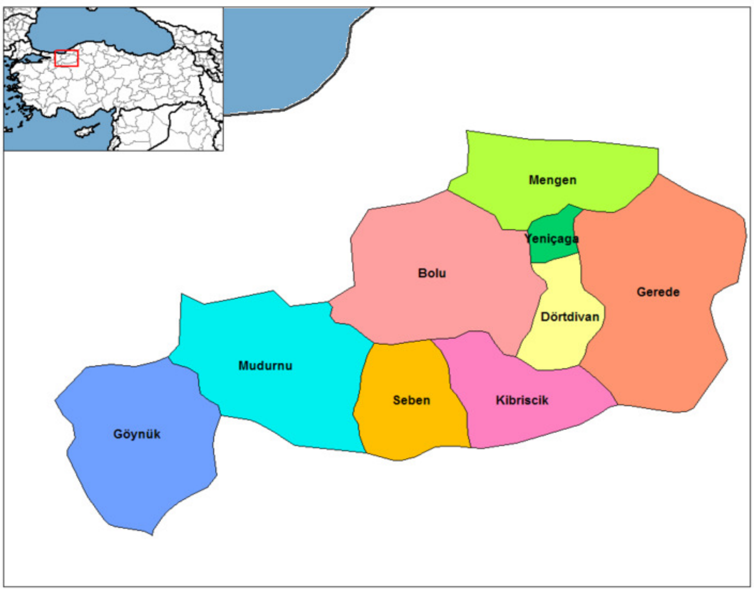

Figure 6: The map of Bolu province with its counties

2.2. Climate of Bolu

Climate of Bolu demonstrates temporary features between Mediterranean climate with a very cold less rainy winter and oceanic climate. The average precipitation in Bolu between 1970-2012 (Figure 7) is 558.3 mm [37]. However, mean annual precipitation was 754.5 mm in 2010, 487.0 mm in 2011 [37], more than 600 mm in 2012. The most rainy months are December, January, and May (Table 6). The least rainy month is August. The highest temperature in Bolu is 39.8°C in August and the lowest temperature is -24.3°C in January (Table 6) [37]. Temperature in Bolu is below 0°C during 8 months of the year [37].

Climatic characteristics affect the plant diversity [53]. Effects of climatic changes on species are:

- Loss of habitat,
- Changes in species distribution,
- Changes in population structure,
- Competitive ability,
- Increased disease susceptibility,
- Parasite-host relations,and
- Increased physiological stress.

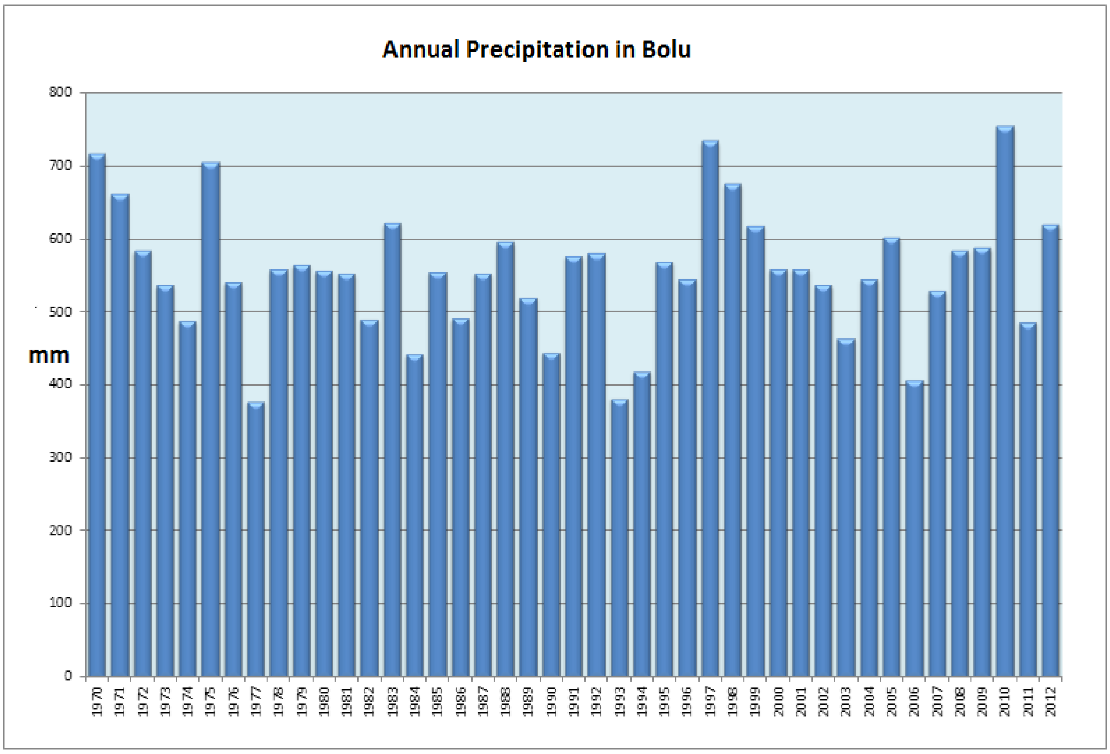

Figure 7: Annual mean precipitation of Bolu between 1970-2012

Table 6: Extreme maximum, minimum, average temperatures (^{o}C) and precipitation (mm) in Bolu, during 1998-2013.

BOLU	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Maximum Temp.(°C)	19.8	20.8	28.0	31.8	34.4	37.0	39.3	39.8	37.3	34.4	26.2	23.5
Minimum Temp.(°C)	-24.3	-24.0	-17.8	-10.0	-2.3	2.2	4.4	3.2	0.4	-5.8	-19.6	-22.6
Average Temp.(°C)	0.7	2.0	5.0	9.8	14.0	17.4	19.9	19.7	16.1	11.8	6.9	3.1
Mean Monthly preci.(kg/m2)	57.7	45.4	52.0	51.7	60.1	52.7	31.0	25.2	27.1	42.9	45.8	63.4

2.3. Sampling Areas in Gölköy Campus

This study was conducted, with a target first for endemic species, in a grassland part of Abant Izzet Baysal University Gölköy Campus during 2011 and 2013. The altitude of the study sites (Table 7) ranges from 811 m to 851 m. The campus is located between 40°42’N and 40°43’N between 031°30’E and 031°31’E. The slopes of fields are about 1%, 1.5%, 4%, 1%, 2% for GMZs 1-5. Plant samples were collected during 2011 May – 2013 July. Firstly, five gene management zones were selected (Figure 8) [36], with field surveys for possible *in situ* conservation. These zones suitable for the conservation are chosen based on their security for destroys, which might have been induced by human, grazing, urbanization, etc.

Therefore, areas chosen were:

1. The front side of the Art and Science Faculty (East of Cultural Center),
2. Between Rectorate building and medical faculty, on the right of the road,
3. North of Morphology building,
4. West of Dormitories, Memorial Forest,
5. Behind the Medicine faculty, near the Tennis Court.

Figure 8: Research zones in the Gölköy Campus.

The location of study sites in Gölköy Campus and with their altitudes were given in Table 7.

Table 7: The latitude (N), longitude (E), and altitude (m) of potential *in situ* sites conservation in the Gölköy Campus, Bolu.

Five *in situ* conservation sites					
	1st Area	**2nd Area**	**3rd Area**	**4thArea**	**5thArea**
Latitude (N)	40°42.886’	40°42.948’	40°43.232’	40°42.863’	40°43.254’
Longitude (E)	031°30.893’	031°31.231	031°31.392	031°30.612	031°31.621’
Altitude(m)	851	846	840	847	811

2.4. Soil Features of ResearchAreas

Soil was digged between 0-30 cm depth and soil samples were taken up in each area. Then, soil characteristics were analized in the Soil Laboratories of Agriculture and Livestock Directorate, Bolu Governor (Table 8).

Table 8: Soil characteristics of research sites – 1.

Soil characteristics	1st Area	2nd Area	3rd Area	4thArea	5thArea
Depth (cm)	0-30	0-30	0-30	0-30	0-30
Water-logged %	74.8	66	82.5	66	69.3
Electrical conductivity	3.750	3.180	3.440	3.490	3.090
Total salt %	0.190	0.140	0.190	0.150	0.140
pH in water-logged soil	7.01	7.61	7.38	6.92	7.62
Lime % ($CaCO_3$)	7.80	22.40	24.20	29.60	27.30
Nutrient useful for plant P_2O_5/K_2O	10.20	5.40	0.60	11.40	4.30
	133.90	70.30	64.80	108.10	65.60
Organic substance %	4.40	2.70	5.90	4.40	2.80
Total nitrogen %	0.22	0.14	0.30	0.22	0.14
Organic carbon %	2.55	1.56	3.40	2.55	1.60

The highest amount of organic substance was with 5.90% in 3rd area. The highest salt levels were in 1st and 3rd areas. The pH degrees ranged between 7-8. Lime in 1st area was the lowest with 7.80% and the richest area is 4st area with 29.60%. The 1st area had the highest amount of useful nutrients for plant and total nitrogen-organic carbon was the highest in 3rd area with a range of 0.30% - 3.40%. Topographic features of areas were different in study sites (Table 9), which might have been resulted in differences in the biodiversity.

Table 9: Soil characteristics of research sites – 2.

Topographic Features	**1st Area**	**2nd Area**	**3rd Area**	**4th Area**	**5th Area**
Soil texture	Clay	Clay Loam	Clay	Clay Loam	Clay Loam
Total salt %	Weak-Salty	Saltless	Weak-Salty	Weak-Salty	Saltless
pH	Nötr	Light Alkaline	Light Alkaline	Nötr	Light Alkaline
Lime %	Mid-level	High-Limy	High-Limy	High-Limy	High-Limy
P_2O_5	Highest	Low	Very Low	Highest	Low
K_2O	Richest	Sufficient	Sufficient	Richest	Sufficient
Organic substance	High Humic Level	Mid-Humic level	High Humic Level	High Humic Level	Mid-Humic level
Total nitrogen	Rich	Well	Rich	Rich	Well

2.5. Vegetation Method

Importance of gene management zone's population structure, diversity, and individuals of target species in the population for *in situ* conservation were mentioned above. Therefore, vegetation method was used in order to determine the population properties in the GMZs and measure the characteristics of the vegetation. Transect, loop, point frame, quadrant, cover scale, weight, visual estimation, pantograph are some common vegetation methods. In previous grassland vegetation studies in Turkey, different methods were utilized: loop, transect, wheel point, modified wheel point [9], [30], linear transect method [28], transect method [43], and modified loop method [31], [33], [34].

Kinsinger *et al.* [26] indicated that the loop method was the most rapid method. This method is useful for observing the existance of any vegetation patterns in the environment. Because of the advantages we used modified wheel point method with loop [29], [30], [31], [32,] [33], [34], in order to determine the plant diversity at the sites in the Gölköy Campus. Surveys were made along side four main directions starting from the middle of each area, between May 2011 and May 2013 and. Wheel was run and plant specimens striked to loop were collected (Figure 9). Totaly 475 spots measured in 5 GMZs. Vegetation species were counted at each point. For example, if a plant was present in the first and second circles, both were recorded. These plant species were dried and are deposited at the Abant Izzet Baysal University Herbarium of Biology Department. The specimens were identified with the help of Flora of Turkey [13].

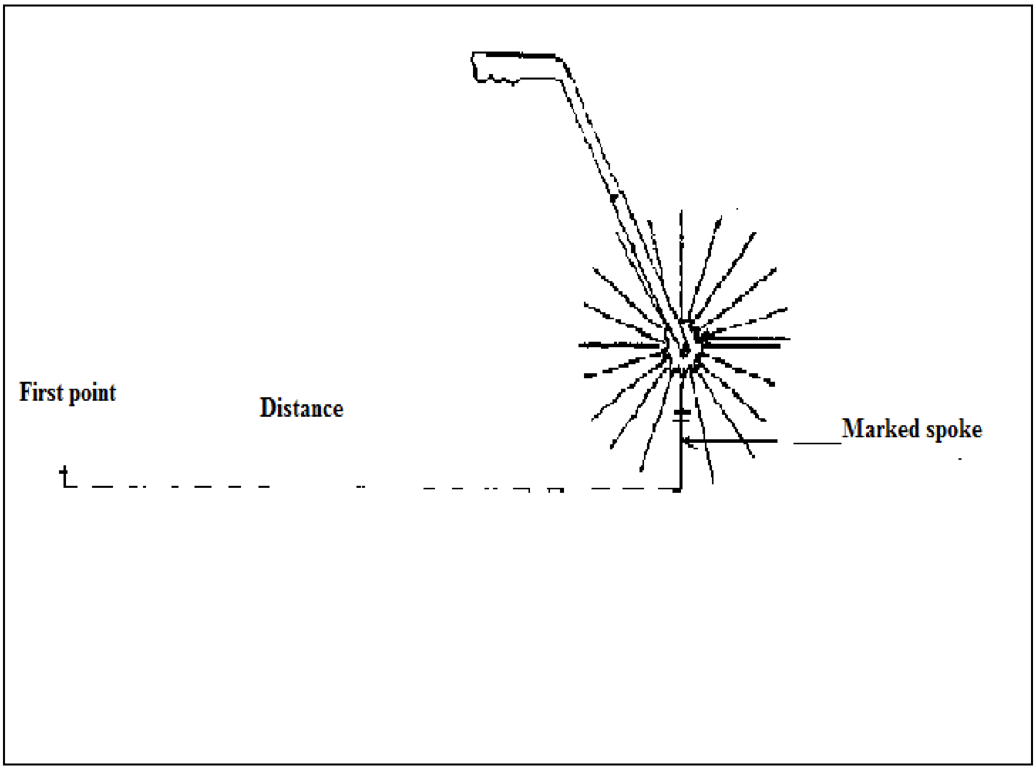

Figure 9: Wheel point method.

Morphological characters of 10 specimens collected for each endemic species measured as in the Flora of Turkey [13] and mean, sd, min, max, and CI% of these characters were calculated by SPSS 21 Package Program (Table 10-15). Percentage plant covered area and frequency of endemic species in botanical composition were measured (Table 23, 24) as well. Totally 85 different plant species were collected and these plants were determined with 475 points of loop. In areas some spots were empty and there was no plant. For example in 1st area, 14 spots did not striked to any plant. In plant covered area percentage calculations (Table 23), plant detected loop number is divided by total loop number and multiplied by 100. Frequency means probability of collecting species in spots at location. Plant detected spots numbers were divided by total spots number [28]. These values were also statistically analyzed with SPSS 21 Package Program. Statistics for the data were given in Table 12-15.

CHAPTER3

RESULTS

3.1. Species and Families in Gene Management Zones

In the study, 475 spots were chosen and a total of 85 plant species (Figure 10) from 31 families were identified in 5 study zones. The most collected families were (Table 16): *Fabaceae* 20.00%, *Asteraceae* 9.41%, *Lamiaceae* 7.06% and *Rosaceae* 5.88%. Numbers of species collected from five areas were 33, 33, 26, 19, and 17 (Tables18-22). Numbers of families were 19 in 1st area, 15 in 2nd area, 17 in 3rd area, 13 in 4th, and 5th areas (Table 17). Morphological characters of 10 specimens collected for each endemic species measured as in the Flora of Turkey [13] and mean, sd, min, max, and CI% of these characters were calculated by SPSS 21 Package Program (Table 10-15).

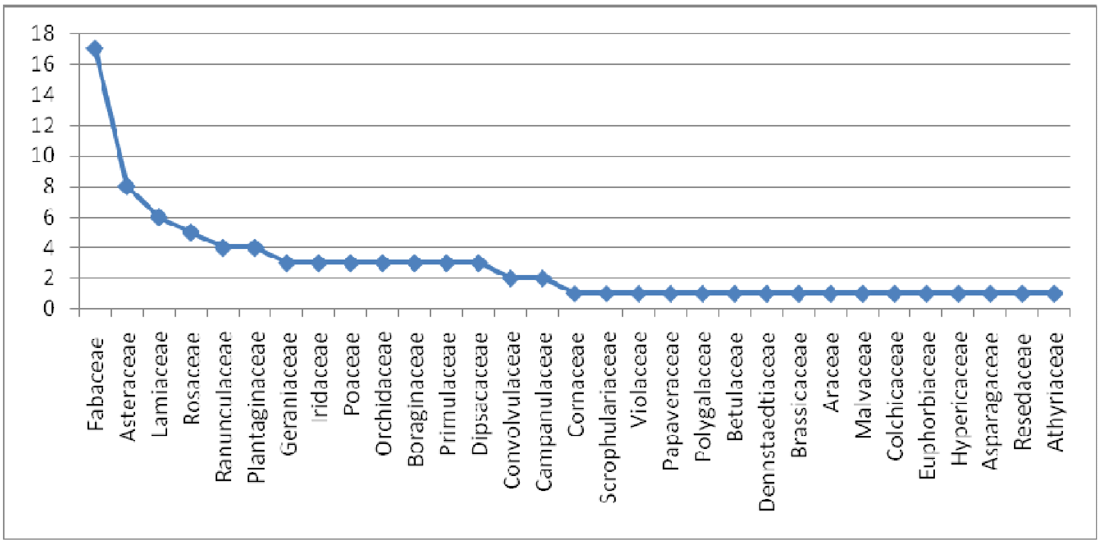

Figure 10: Number of collected species based on the families in the Gölköy Campus, 2011-2013

Table 10: The characteristics of *Trifolium elongatum,* an endemic species in the Gölköy Campus

Descriminative characters	Flora of Turkey(Zohary, 1970)	Present study, 2014
Plant orientation	Erect	Erect
Plant life cycle	Perennial	Perennial
Plant length (cm)	20-40	22-33
Shape of stipules	Linear-subulate free portions	Linear-subulate free portions
Stipula long × width (mm)	Not indicated	29 × 10
Shape of leaflets	Linear to oblong-lanceolate	Linear to oblong-lanceolate
Biggest leaflet (central lobe) long × width (mm)	Not indicated	27 × 12
Smallest leaflet (central lobe) long × width (mm)	Not indicated	8 × 3
Shape of inflorescence	Ovoid to ovoid-oblong	Ovoid to ovoid-oblong
Inflorescence length (cm)	Not indicated	2-3.5
Calyx type	Cylindrical	Cylindrical
Shape of calyx tube	Subulate, acute, stellate or reflexed in fruit	Subulate, acute, stellate or reflexed in fruit
Calyx teeth (long × short) (mm)	Not indicated	3 × 2.5
Calyx tube length (mm)	Not indicated	3–4
Corolla colour	White to cream	White to cream
Standart length (mm)	Not indicated	6–9.5
Wings length(mm)	Not indicated	2–4
Keel length (mm)	Not indicated	3–5

Table 11: The characteristics measured in 10 plant samples of *Trifolium elongatum*, an endemic species in the Gölköy Campus

Descriminative characters	1. plant	2. plant	3. plant	4. plant	5. plant	6. plant	7. plant	8. plant	9. plant	10. plant
Plant length (cm)	31.7	32.7	24.9	32.2	30.8	23.3	23.2	29.3	26.5	22.5
Stipula long × width (mm)	24 × 13	29 × 16	22 × 11	17 × 12	28 × 16	15 × 13	19 × 11	21 × 13	16 × 10	20 × 14
Biggest leaflet (central lobe) long × width(mm)	18 × 9	27 × 12	17 × 9	22 × 8	22 × 11	14.5 × 7	14 × 7	22 × 11	17 × 11	15 × 7
Smallest leaflet (central lobe) long × width (mm)	8 × 3	15 × 5	17 × 7	16 × 5	13 × 5	8 × 4	8 × 4	12 × 4	9 × 4	13 × 5
Inflorescence length (cm)	2.9	3	3.1	3.4	2.6	2.7	2.3	2.8	2.7	2.8
Calyx teeth (long × short) (mm)	3.5 × 3	4.5 × 4	4 × 3	4 × 3	4 × 3	4 × 4	6 × 3	4 × 2.5	3.5 × 3	4 × 3
Calyx tube length (mm)	3	3.5	4	4	4	4	3	3	3	3.5
Standart length (mm)	7.5	8	7	8	8	7	6	9	7	9.5
Wings length (mm)	3	3	2.5	3	3	2.5	3	3.5	3	3.5
Keel length (mm)	4	4	5	4.5	4.5	3	4.5	4.5	4	4.5

Table 12: Statistics of endemic *Trifolium elongatum*

Descriminative characters	Mean	Sd (0.05)	Min.	Max.	0.95 CI
Plant length (cm)	27.71	4.0736	22.5	32.7	± 2.52
Stipula length (mm)	21.40	5.060	15	29	± 3.14
Stipula width (mm)	12.90	2.025	10	16	± 1.16
Biggest leaflet (central lobe) length (mm)	18.85	4.2299	14	27	± 2.62
Biggest leaflet (central lobe) width (mm)	9.20	1.932	7	12	± 1.20
Smallest leaflet (central lobe) long (mm)	11.90	3.479	8	17	± 2.16
Smallest leaflet (central lobe)wide (mm)	4.60	1.075	3	7	± 0.67
Inflorescence length (cm)	2.83	0.2983	2.3	3.4	± 0.18
Calyx teeth (long) (mm)	4.15	0.7091	3.5	6	± 0.44
Calyx teeth (short)(mm)	3.15	0.4743	2.5	4	± 0.29
Calyx tube length (mm)	3.50	0.4714	3	4	± 0.29
Standart length (mm)	7.70	1.0328	6	9.5	± 0.64
Wings length (mm)	3	0.3333	2.5	3.5	± 0.21
Keel length (mm)	4.25	0.5401	3	5	± 0.33

Table 13: The characteristics of *Arum hygrophilum* subsp. *euxinum*, an endemic species in the Gölköy Campus

Descriminative Characters	(Zohary, 1970) Flora of Turkey	Present study 2013
Plant tube shape	Vertical	Vertical
Petiole length (cm)	15-20	15-21
Petiole colour	Purplish	Purplish
Lamina	Oblong-hastate, ovate-lanceolate	Oblong-hastate, ovate-lanceolate
Spathe lamina (cm)	Not indicated	4-6
Spathe colour	Purplish or greenish-purple outside	Purplish or greenish-purple outside
Spathe tube (cm)	1.5-3	1-3
Spathe length×width (cm)	6.5-11 × 1.5-4	6-9 × 1-2
Spadix length (cm)	4.5-7	4-6
Female zone (mm)	6-10	5-13
Lower zone (mm)	2-3.7	1-2
Male zone (mm)	1.5-4×2-3.5	2-4
Upper sterile zone (mm)	3-7	3-7
Appendix (cm)	2.5-4.5	2-5
Leaf length × width (cm)	Not indicated	6-9 × 3-5 cm
Scape length (cm)	18-45	20-35

Table 14: The characteristics measured in 10 plant samples of *Arum hygrophilum* subsp. *euxinum*, an endemic species in the Gölköy Campus

Descriminative Characters	1. plant	2. plant	3. plant	4. plant	5. plant	6. plant	7. plant	8. plant	9. plant	10. plant
Petiole length(cm)	20.6	17.3	15.4	17.2	16	21	17	15.5	15	17.3
Spathe lamina (cm)	4.9	5.5	5.2	4.7	5.6	5	5.6	5.5	5.5	4.1
Spathe tube (cm)	2.7	2.3	2	1.8	2.4	2	1.4	2	3	2.9
Spathe length×wide (cm)	7.6 × 1.2	7.8 × 1.7	7.2 × 1.3	6.5 × 1.3	8 × 1.5	7 × 1.4	7 × 1.3	7.5 × 1.2	8.5 × 1.6	7 × 1.5
Spadix length (cm)	5	6	4.1	4.6	6	4.8	4.8	5.4	6	4.7
Female zone (mm)	5	7	5	6	6	5	5	13	10	8
Lower zone (mm)	1	1.5	2	2	2	1	1.5	1	1	2
Male zone (mm)	4	2	3	3	3	2	3	2	3	3
Upper sterile zone (mm)	5	7	5	5	6	4	5	3	6	4
Appendix (cm)	3.4	4.1	2.5	2.9	4.2	3.6	3.2	4.5	3.9	3
Leaf length×width(cm)	8 × 4.2	7.3 × 3.5	6.4 × 1.5	6.6 × 3.2	8.8 × 4.2	7.9 × 3.3	7.3 × 2.7	7.5 × 4.9	6.8 × 3.5	7.5 × 3.5
Scape length (cm)	35	24.8	20.6	23.5	25.5	26.8	23	24.5	22.3	23.4

Table 15: Statistics of endemic *Arum hygrophilum* subsp. *euxinum*

Descriminative characters	Mean	Sd (0.05)	Min.	Max.	0.95 CI
Petiole length (cm)	17.23	2.06	15	21	± 1.28
Spathe lamina(cm)	5.16	0.49	4.1	5.6	± 0.3
Spathe tube (cm)	2.25	0.50	1.4	3	± 0.31
Spathe length (cm) Spathe width (cm)	7.41 1.40	0.58 0.17	6.5 1.2	8.5 1.7	± 0.36 ± 0.11
Spadix length (cm)	5.14	0.67	4.1	6	± 0.42
Female zone (mm)	7	2.66	5	13	± 1.65
Lower zone (mm)	1.5	0.47	1	2	± 0.29
Male zone (mm)	2.8	0.63	2	4	± 0.39
Upper staline zone (mm)	5	1.15	3	7	± 0.71
Appendix (cm)	3.53	0.64	2.5	4.5	± 0.4
Leaf length (cm) Leaf width (cm)	7.41 3.45	0.71 0.92	6.4 1.5	8.8 4.9	± 0.44 ± 0.57
Scape length (cm)	24.94	3.93	20.6	35	± 2.44

Table 16: Families and species with their ratios in the study sites at the Gölköy Campus

Family	Number of species	%
Fabaceae	17	20.00%
Asteraceae	8	9.41%
Lamiaceae	6	7.06%
Rosaceae	5	5.88%
Ranunculaceae	4	4.71%
Plantaginaceae	4	4.71%
Geraniaceae	3	3.53%
Iridaceae	3	3.53%
Poaceae	3	3.53%
Orchidaceae	3	3.53%
Boraginaceae	3	3.53%
Primulaceae	3	3.53%
Dipsacaceae	3	3.53%
Convolvulaceae	2	2.35%
Campanulaceae	2	2.35%
Cornaceae	1	1.18%
Scrophulariaceae	1	1.18%
Violaceae	1	1.18%
Papaveraceae	1	1.18%
Polygalaceae	1	1.18%
Betulaceae	1	1.18%
Dennstaedtiaceae	1	1.18%
Brassicaceae	1	1.18%
Araceae	1	1.18%
Malvaceae	1	1.18%
Colchicaceae	1	1.18%
Euphorbiaceae	1	1.18%
Hypericaceae	1	1.18%
Asparagaceae	1	1.18%
Resedaceae	1	1.18%
Athyriaceae	1	1.18%
Total	**31 families 85 species**	**100.00%**

Table 17: Families existed in each of five potential gene management zones (GMZ)

Families in the 1st area	Families in the 2nd area	Families in the 3th area	Families in the 4th area	Families in the 5th area
Scrophulariaceae	*Scrophulariaceae*	*Malvaceae*	*Asparagaceae*	*Athyriaceae*
Fabaceae	*Fabaceae*	*Fabaceae*	*Fabaceae*	*Fabaceae*
Primulaceae	*Primulaceae*	*Primulaceae*	*Primulaceae*	*Primulaceae*
Asteraceae	*Asteraceae*	*Asteraceae*	*Asteraceae*	*Asteraceae*
Rosaceae	*Rosaceae*	*Rosaceae*	*Rosaceae*	*Rosaceae*
Geraniaceae	*Araceae*	*Geraniaceae*	*Geraniaceae*	*Orchidaceae*
Polygalaceae	*Convolvulaceae*	*Polygalaceae*	*Polygalaceae*	*Resedaceae*
Lamiaceae	*Lamiaceae*	*Lamiaceae*	*Lamiaceae*	*Lamiaceae*
Violaceae	*Dennstaedtiaceae*	*Violaceae*	*Hypericaceae*	*Violaceae*
Poaceae	*Poaceae*	*Campanulaceae*	*Campanulaceae*	*Poaceae*
Ranunculaceae	*Ranunculaceae*	*Convolvulaceae*	*Euphorbiaceae*	*Convolvulaceae*
Iridaceae	*Boraginaceae*	*Ranunculaceae*	*Iridaceae*	*Iridaceae*
Plantaginaceae	*Plantaginaceae*	*Plantaginaceae*	Plantaginaceae	*Dipsacaceae*
Orchidaceae	*Brassicaceae*	*Colchicaceae*		
Papaveraceae	*Papaveraceae*	*Araceae*		
Boraginaceae		*Dipsacaceae*		
Betulaceae		Orchidaceae		
Dipsacaceae				
Cornaceae				

Table 18: Species collected from the 1st probable gene management zone

1. *Melampyrum arvense* L. var. *arvense*
2. *Geranium dissectum* L.
3. *Cornus mas* L.
4. *Trifolium pratense* L. var. *sativum* Schreb.
5. *Dactylis glomerata* L. subsp. *glomerata*
6. *Rosa canina* L.
7. *Geranium asphodeloides* Burm.f. subsp. *asphodeloides*
8. *Iris sintenisii* Janka subsp. *sintenisii*
9. *Lathyrus laxiflorus* (Desf.) O.Kuntze subsp. *laxiflorus*
10. *Viola sieheana* W. Becker
11. *Ranunculus constantinopolitanus* (DC.) d'Urv.
12. *Anacamptis coriophora* (L.) R. M. Bateman, Pridregon & M.W.Chase
13. *Buglossoides arvensis* (L.) I.M. Johnst. subsp. *sibthorpiana* (Griseb.) R. Fern
14. *Potentilla fruticosa* L. subsp. *floribunda* (Pursh) Elkington
15. *Trifolium campestre* Schreb. subsp. *campestre* var *campestre*
16. *Plantago lonceolata* L.
17. *Papaver rhoeas* L.
18. *Echium vulgare* L. subsp. *vulgare*
19. *Clinopodium vulgare* L. subsp. *vulgare*
20. *Polygala anatolica* Boiss. &Heldr.
21. *Geranium pyrenaicum* Burm.f.
22. *Melilotus officinalis* (L.) Desr.
23. *Carpinus betulus* L.
24. *Knautia integrifolia* (L.) Bert. var. *bidens* (Sm.) Borbás
25. *Potentilla argentea* L.
26. *Primula acaulis* (L.)L. subsp. *acaulis* Syn.: *P. Vulgaris* Huds.
27. *Bellis perennis* L.
28. *Scabiosa argentea* L.
29. *Ranunculus arvensis* L.
30. *Anagallis arvensis* L. var. *arvensis*
31. *Anacamptis pyramidalis* (L.) L.C.M. Richard
32. *Lamium purpureum* L. var. *purpureum*
33. *Filipendula vulgaris* Moench

Table19: Species collected from the 2nd probable gene management zone

1. *Papaver rhoeas* L.
2. *Trifolium pallidum* Waldst. & Kit.
3. *Vicia sativa* (L.) subsp. *nigra* (L.) Ehrh. var. *segetalis* (Thuill.) Ser. ex DC.
4. *Melilotus officinalis* (L.) Desr.
5. *Convolvulus galaticus* Rostan ex Choisy
6. *Lamium purpureum* L. var. *purpureum*
7. *Pteridium* Gled. Ex Scop. *aquilinum* (L.) Kuhn
8. *Convolvulus arvensis* L.
9. *Songuisorba minor* Scop. subsp. *muricata* (Spach) Briq.
10. *Lotus corniculatus* L. var. *alpinus* Ser.
11. *Medicago sativa* L. subsp. *sativa*
12. *Plantago lanceolata* L.
13. *Filipendula vulgaris* Moench
14. *Clinopodium vulgare* L. subsp. *vulgare*
15. *Coronilla varia* L. subsp. *varia* L.
16. *Tussilago farfara* L.
17. *Triticum aestivum* L.
18. *Dactylis glomerata* L. subsp. *glomerata*
19. *Lathyrus aphaca* L. var. *biflorus* Post
20. *Primula acaulis* (L.) L. subsp. *acaulis* Syn.: *P. vulgaris* Huds.
21. *Dorycnium graecum* (L.) Ser.
22. *Consolida regalis* Gray subsp. *paniculata* (Host) Soo
23. *Chondrilla juncea* L. var. *juncea*
24. *Anagallis arvensis* L. var. *arvensis*
25. *Cyclamen coum* Miller var. *coum*
26. *Stachys byzantina* C. Koch
27. *Bellis perennis* L.
28. *Rapistrum rugosum* (L.) All
29. *Melampyrum arvense* L. var. arvense
30. *Echium vulgare* L. subsp. *vulgare*
31. *Centaurea triumfetti* All.
32. *Arum hygrophilum* Boiss. subsp. *euxinum* (R.R. Mill.) Alpınar (**endemic**)
33. *Veronica persica* Poiret

Table 20: Species collected from the 3rd probable gene management zone

1. *Trifolium elongatum* Willd. (**endemic**)
2. *Cephalanthera rubra* (L) L.C.M. Richard
3. *Onobrychis oxydonta* Boiss.
4. *Anacamptis pyramidalis* (L.) L.C.M. Richard
5. *Teucrium polium* L.
6. *Convolvulus galaticus* Rostan ex Choisy
7. *Potentilla argentea* L.
8. *Cytisus hirsutus* L. Syn.: *Chamaecytisus hirsutus* (L.) Link
9. *Thymus longicaulis* C. Presl subsp. *longicaulis* Syn.: *T. longicaulis* var. *subisophyllus* (Borbas) Jalas
10. *Filipendula vulgaris* Moench
11. *Polygala anatolica* Boiss. & Heldr.
12. *Campanula persicifolia* L. subsp. *persicifolia*
13. *Clinopodium vulgare* L. subsp. *vulgare*
14. *Ranunculus gracilis* E.D.Clarke
15. *Malva sylvestris* L.
16. *Cichorium intybus* L.
17. *Picris hieracioides* L. subsp. *hieracioides*
18. *Colchicum umbrosum* Steven
19. *Geranium asphodeloides* Burm.f. subsp. *asphodeloides*
20. *Arum hygrophilum* Boiss. subsp. *euxinum* (R.R. Mill.) Alpınar (**endemic**)
21. *Knautia integrifolia* (L.) Bert. var. *bidens* (Sm.) Borbás
22. *Viola sieheana* Becker
23. *Bellis perennis* L.
24. *Trifolium campestre* Schreb. subsp. *campestre* var *campestre*
25. *Primula acaulis* (L.) L. subsp. *acaulis* Syn.: *P. vulgaris* Huds.
26. *Globularia trichosantha* Fish. &C.A.Mey

Table 21: Species collected from the 4th probable gene management zone

1. *Geranium pyrenaicum* Burm.f.
2. *Polygala anatolica* Boiss. & Heldr.
3. *Cytisus hirsutus* L. Syn.: *Chamaecytisus hirsutus* (L.) Link
4. *Trifolium striatum* L.
5. *Thymus longicaulis* C. Presl subsp. *longicaulis* Syn.: *T. longicaulis* var. *subisophyllus* (Borbas) Jalas
6. *Campanula glomerata* L. subsp. *hispida* (Witasek) Hayek
7. *Bellis perennis* L.
8. *Veronica jacquinii* Baumg
9. *Euphorbia seguieriana* Neck subsp. *niciciana* (Borbás ex Novák) Rech.f.
10. *Lotus corniculatus* L. var. *alpinus* Ser.
11. *Anthemis pseudocotula* Boiss.
12. *Primula acaulis* (L.) L. subsp. *acaulis* Syn.: *P. vulgaris* Huds.
13. *Ornithogalum narbonense* L.
14. *Crocus speciosus* M.Bieb. subsp. *speciousus*
15. *Trifolium elongatum* Willd. (**endemic**)
16. *Geranium osphodeloides* Burm.f. subsp. *asphodeloides*
17. *Potentilla argentea* L.
18. *Trifolium campestre* Schreb. subsp *campestre* var *campestre*
19. *Hypericum perforatum* L. subsp *perforatum*

Table 22: Species collected from the 5th probable gene management zone

1. *Anacamptis pyramidalis* (L.) L.C.M. Richard
2. *Dorycnium pentaphyllum* Scop. subsp. *herbaceum* (Vill.) Rouy
3. *Coronilla varia* L. subsp. *varia* L.
4. *Mentha longifolia* (L.) Harley subsp. *typhoides* (Briq.) Harley var. *typhoides*
5. *Reseda lutea* L. var. *lutea*
6. *Viola sieheana* Becker
7. *Convolvulus arvensis* L.
8. *Vicia articulata* Hornem.
9. *Scabiosa argentea* L.
10. *Pilosella piloselloides* (Vill.) Soják subsp. *megalomastix* (N.P.) Sell&West
11. *Dactylis glomerata* L. subsp. *glomerata*
12. *Crocus olivieri* J.Gay subsp. *olivieri*
13. *Tussilago farfara* L.
14. *Lamium purpureum* L. var. *purpureum*
15. *Filipendula vulgaris* Moench
16. *Bellis perennis* L.
17. *Primula acaulis* (L.) L. subsp. *acaulis* Syn.: *P. vulgaris* Huds.

Figure 11: Endemic species *Arum hygrophilum* subsp. *euxinum*

Figure 12: Endemic species *Arum hygrophilum* subsp. *euxinum*

Figure 13: Endemic species *Trifolium elongatum*

3.2. Plant Covered Area

One of the main goals of researches in vegetation studies, the determining the area that covered by plants. Vegetation productivity, invasion of new species, erosion of soil have a very tight relation between coverage areas. Thus, if the area covered by vegetation is known treatment process and a good cultural method can be applied [43]. Plant covered area percentages show richness of individual species in zones.

$$\text{Plant covered area (\%)} = \frac{\text{Plant detected loop number}}{\text{Total loop number}} \times 100$$

Plant covered area for 1stGMZ: 33 different species were collected from 125 spots and totaly in 14 spots plants were absent. Plants were detected in 111 spots.

Plant covered area (%) for 1st area $= \frac{111}{125} \times 100$

= 88.8 % of area covered with plant.

Plant covered area for 2ndGMZ: 33 different species were collected from 110 spots and totaly in 5 spots plants were absent. Plants were detected in 105 spots.

Plant covered area (%) for 2nd area = $\frac{105}{110} \times 100$

= 95.5 % of the area covered with plant.

Plant covered area for 3rdGMZ: 26 different species were collected from 100 spots and totaly in 10 spots plants were absent. Plants were detected from 90 spots.

Plant covered area (%) for 3rd area = $\frac{90}{100} \times 100$

= 90 % of the area covered with plant.

Plant covered area for 4thGMZ: 19 different species were collected from 80 spots and totaly in 9 spots plants were absent. Plants were detected in 71 spots.

Plant covered area (%) for 4th area = $\frac{71}{80} \times 100$

= 88.75 % of the area covered with plant.

Plant covered area for 5thGMZ: 17 different species were collected from 60 spots and totaly in 3 spots plants were absent. Plants were detected in 57 spots

Plant covered area (%) for 5th area = $\frac{57}{60} \times 100$

= 95 % of the area covered with plant.

Table 23: Plant covered areas (%) for 5 GMZs.

Areas	Number of spots plants deteceted (n)	Number of total spots sampled (n)	Plant Covered Area (%)
1st	111	125	88.8 %
2nd	105	110	95.5 %
3rd	90	100	90.0 %
4th	71	80	88.7 %
5th	57	60	95.0 %
Total	444	475	93.4 %

3.3. Frequency of Target Species

The distribution of species in the vegetation indicates species' frequency. Frequency of a species is how often or rare existence in a vegetation of species. That shows us dominant, rare, in danger situation of species.

One endemic species was collected from 2nd area, *Arum hygrophilum* subsp. *euxinum* (10 spots). Thus, endemic species' frequency in 2nd area is:

Frequency for endemic *Arum hygrophilum* subsp. *euxinum* = $\frac{10}{110} \times 100$= 9.09 %

Two endemic species were collected from 3rd area, *Trifolium elongatum* (5), and *Arum hygrophilum* subsp. *euxinum* (4).

Frequency for endemic *Trifolium elongatum*= $\frac{5}{100} \times 100$= 5 %

Frequency for endemic *Arum hygrophilum* subsp. *euxinum*= $\frac{4}{100} \times 100$= 4 %

Frequency for endemic *Trifolium elongatum* in 4th area= $\frac{11}{80} \times 100$= 13.75 %

In this study total frequency of the target species in all areas (475 spots) were shown in Table 24. Total spots number of target species (Table 24) was divided by 475 spots number and frequency were measured totaly.

For endemic *Trifolium elongatum* ($\frac{16}{475} \times 100 = 3.36$)

For endemic *Arum hygrophilum* subsp. *euxinum* ($\frac{14}{475} \times 100 = 2.94$)

Table 24: Detected spots number and frequency of target species in areas.

	Trifolium elongatum	***Arum hygrophilum* subsp. *euxinum***
1st site	0	0
2nd site	0	10
3rd site	5	4
4th site	11	0
5th site	0	0
Total	16	14
Frequency %	3.36	2.94

3.4. Statistical Calculations of Target Endemic Species

This study aimed the possible *in situ* conservation of endemic species in the Gölköy Campus area. Two endemic species were collected from 5 Gene management zones. Characters of these species were descrimined for *in situ* in this study. Descriminative characters were measured of endemic species. Characters were described according to the Flora of Turkey. The descriminative characters studied here (Tables 12-15). Leaf length, spathe lamina characters for endemic *Arum hygrophilum* subsp. *euxinum*, stipula length/width, biggest leaflet length/width, smallest leaflet length/width, inflorescence length, calx teeth length, calyx tube length, standart length, wings length, keel length characters for endemic *Trifolium elongatum* absent in Flora of Turkey which were measured in this study. Measured values in this study are in the favorable to avarage values of Turkey shown in Table 10, Table 13.

CHAPTER 4

DISCUSSION

This study was conducted in the Campus of Abant Izzet Baysal University, Bolu in order to determine the GMZs and *in situ* conservation probabilities of plant species in GMZs. Topographic properties, climatic characteristics, population diversity of target species, and plant covered areas in GMZs were described. Modified Wheel Method with loop was used for vegetation in field surveys. 85 different plant species and two endemic species were collected in areas only. Endemics are *Trifolium elongatum, Arum hygrophilum* subsp. *euxinum*.. These species are least concern (LC) according to the IUCN Red List Categories in Red Data Book of Turkish Plants [21].

Furthermore, 31 families and 85 different species were collected from 475 spots. 17 species which are the most belong to *Fabaceae* family (20%), *Asteraceae* familiy represented with 8 species (9.41%) and *Lamiaceae* family represented with 6 species (7.06%), *Rosaceae* family represented with 5 species (5.88%), *Ranunculaceae* and *Plantaginaceae* families represented with 4 species (4.71%) in the areas. Other 25 families show between 4% and 1%. *Trifolium elongatum* belongs to *Fabaceae* family, *Arum hygrophilum* subsp. *euxinum* belongs to *Araceae* family. *Araceae* (1.18%) families are one of the smallest families in 5 GMZs. Floristic Study of Campus [25] reported 19 endemic species. In this study in 5 GMZs only 2 endemic species were reported. Because the choosing of areas based on the *in situ* conservation priorities which can not be affected from human, overgrazing, urbanization, roads, city or industry, not presence of endemic species in areas.

Studies began in 2011 May and thought as one year period but in chosen GMZs sufficient endemic species could not be collected to calculate because of these endemic species and were less in zones and over collecting threats the species. Between 2011 and 2012 years numbers of endemic plant species were not sufficient to collect. These calculated 10 endemics from each other were observed collected and calculated in 2013 summer. According to the Table 6 and Figure 7 about climate of Bolu, mean annual precipitation was very high (754.5 mm) in 2010 and below the mean (558.3 mm) level in 2011, 487 mm. Annual precipitation of Bolu in 2012 was about 600 mm [37]. Extremely precipitation values in 2010 and 2011 could be affect the especially endemic species in plant biodiversity. Meteorological observation values reported according to the last 50 years in 1996 [26] the most rainy months were December, January and February whereas according to the Table 6 in this study the most rainy months are December, January and May. Mean annual precipitation of Bolu reported as 545.6 mm in that study but now mean annual precipitation of Bolu is 558.3 mm [37]. In the same study, the coldest month was February with -34 °C while -24.3 °C is the coldest degrees of Bolu in January, now. Also, 9 months were below 0 °C along the year in Bolu but 8 months are below 0 °C, now according to the Table 7.

As mentioned above, changing climatic conditions affect the population diversity, species' maintaining. In short periods, plants can not be adapted to changed conditions. Climatic changes affect competitive ability, normal period of evolution in population, resistance to diseases. Gölköy Campus area also has been under the overgrazing and heavy urbanization-construction. Fields and forests have been threatened with faculty and dormitory buildings. These might have caused decreasing or disappearing of species' numbers especially endemic species. Around Gölköy Campus, especially near the lake, the lands around the dormitories along Yumrukaya village and around the Medical Faculty are utilized by human and grazed by village animals extensively. Furthermore, these factors can affect the plant population in Gölköy Campus area.

Two endemic plant species were determined in chosen GMZs while 19 endemic species were described (1996) in Flora of Abant Izzet Baysal Campus study [25]. According to the new studies, endemic plant species number is 16. Other endemic species present in Gölköy Campus but areas except 5 GMZs can not provide probabilities for *in situ* conservation of endemic species and suffer from threats as mentioned above in Gölköy Campus.

In this study GMZs were chosed according to the conservation probabilities. Because chosen GMZs in this study are not utilized heavily and threatened, they can provide opportunitiy for *in situ* conservation of endemic species. Endemic species were exist in 2nd, 3rd, 4th areas. But both of endemic species together were collected in 3rd area. Families number in that area were 17 and 26 different plant species were collected. 1st and 2nd areas have the most species numbers, 31 different species. Organic substance and nitrogen amounts are high-mid and rich-well in 5 GMZs. K_2O are sufficient or rich (Table8, 9). Topographic features of areas were different in study sites (Table 9), which might have been resulted in differences and richness in the biodiversity. So, plant species can be choosed according to the conserving priorities such as endemics and can be conserved in these GMZs.

As a result of this study, disappearing of the plant species can be observed because of buildings, grazing, climatic changes etc. Priority of endangered species' conservation is providing of sustainability of species. Other than these endemic species, some endangered species (*Vicia sativa* spp. *nigra*, *Medicagosativa*, *Medicago* spp. annual, *Onorbrychis* spp., *Thymus* spp., *Papaver* spp.) were collected in this study according to the National Plan for *In Situ* Conservation of Plant Genetic Diversity In Turkey [11]. So, floristic studies are very important to expose the natural resources. In the areas must be studied and conservation management planes must be applied in Gölköy Campus. Species must be collected to conserve *in situ* before buildings or urbanization etc. factors and farmers must be educated about over grazing.

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