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FACULTY OF ENVIRONMENTAL SCIENCES

MSc. THESIS

Analyzing selected environmental and cultural landscape parameters to explain non-forest woody vegetation elements in the landscape - A case study based on field survey and GIS

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Declaration:

I hereby declare that I wrote this diploma thesis entitled, “Analyzing selected environmental and cultural landscape parameters to explain non-forest woody vegetation elements in the landscape - A case study based on field survey and GIS” independently, under the direction of Peter Kumble, MLA, Ph.D. and doc. Ing. Jan Skaloš. The work presented in this thesis is, to the best of my knowledge, original. The field work and field data collection were conducted on my own and other literature and data sources used are referenced in the work. I have listed all literature and publications from which I have acquired information.

Prague, 23rd of April 2014 Katherine B. Kennedy

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Abstract

Human activities shape the landscape structure of a particular area – including the area's forest and non-forest woody vegetation elements. However, while extensive research has been conducted on forest elements (Bürgi et al., 2004; Hersperger and Bürgi, 2009; Szabó, 2010; Szabó and Hédl, 2011, etc.), this hypothesis has not been yet tested for non-forest woody vegetation elements using GIS and statistical tools. The underlying aim of this thesis is to determine if, and to what extent, selected relevant environmental and cultural factors affect the existing non-forest woody vegetation and, if so, to analyze which factors are the most significant.

The premise of the thesis is that landscape characteristics such as non-forest woody vegetation can provide significant information on past and present anthropogenic and environmental influences and can also serve as an important guide in selecting future land management strategies.

The study area is located in the Central Bohemian (Czech: Středočeský kraj) region within the Czech Republic. Following a literature review of other non-forest woody vegetation studies, a field investigation was conducted of selected attributes and characteristics. Data were statistically analyzed to determine if there are correlations between the attributes of non-forest woody vegetation and the characteristics of their location – both human and environmental.

The results of the study indicate significant relationships between the structure of non-forest woody vegetation (i.e. linear, patch or point) and the presence of water, rock and the particular land management technique of the area. The study also found that the composition of the non-forest woody vegetation (i.e. mix, mostly tree, tree, mostly shrub, or shrub) has a significant relationship to the presence of water, but no relationship to the presence of rock or the land management techniques of the area.

The data and results of this study can be used for further investigations of additional relationships between vegetation attributes and locational characteristics.

Keywords: land management, anthropogenic, Czech Republic, structure, composition

Abstrakt

Lidská činnost vytváří strukturu krajiny určité oblasti – včetně jejich lesních a nelesních dřevin vegetačních prvků. Avšak zatímco rozsáhlý výzkum byla proveden na téma lesních prvků (Bürgi et al., 2004; Hersperger and Bürgi, 2009; Szabó, 2010; Szabó and Hédl, 2011, etc.), tato hypotéza ještě nebyla testována u nelesních dřevních vegetačních prvků pomocí GIS a statistických nástrojů. Cíl této práce je zjistit, zda a do jaké míry vybrané faktory životního a kulturního prostředí ovlivňují stávající nelesní dřevní vegetaci, a pokud ano, analyzovat nejvýznamnější faktory.

Předpoklad práce je, že charakteristiky krajiny, jako je nelesní dřevní vegetace mohou poskytnout významné informace o minulých a současných antropogenních a environmentálních vlivech a mohou také sloužit jako důležité vodítko při výběru strategie budoucí správy půdy.

Studijní oblast se nachází ve středních Čechách – Středočeském kraji – v České republice. Po prozkoumání literatury zabývající se studiem nelesní dřevní vegetace bylo provedeno polní šetření vybraných atributů a vlastností. Data byla statisticky analyzována k určení, zda existuje korelace mezi atributy nelesní dřevní vegetace a charakteristiky jejich umístění.

Výsledky studie ukazují významné vztahy mezi strukturou nelesní dřevní vegetace (tj. lineární, patch nebo bodové) a přítomností vody, kamení a technologie a strategie správy půdy v konkrétní oblasti. Studie rovněž zjistila, že složení vegetace nelesních dřevin (tj. smíšené, převážně stromy, stromy, převážně keře, keře) má významný vztah k přítomnosti vody, ale žádný vztah k přítomnosti kamení a technologie a strategie správy půdy v konkrétní oblasti.

Údaje a výsledky této studie lze použít pro další šetření vztahů mezi vegetačními atributy a vlastnostmi konkrétní lokace.

Klíčová slova: hospodaření s půdou, antropogenní, Česká republika, struktura, složení

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1. Introduction

The landscape characteristics of an area can provide significant information to explain past and present anthropogenic and environmental influences, and can thus serve as an important guide to land managers in selecting future management strategies.

Present vegetation parameters are one of many landscape characteristics that can be used as a tool to analyze human and natural impacts in a particular area, determine the functionality or value of the area from an ecological perspective, and develop the appropriate means to conserve or protect ecological integrity.

This study focuses specifically on non-forest woody vegetation elements as ecologically, aesthetically and historically significant landscape segments. The presence of non-forest woody vegetation in the landscape is the result of historical mutual acting of natural and anthropogenic factors. Thus, understanding the underlying natural and human influences within a particular area characterized by non-forest woody vegetation leads to a better understanding of land-cover changes on a local level and future landscape trends.

Purpose and aims of the study

Human activities that are very much limited by natural settings of the landscape, shape the present landscape. This is also true for forest and non-forest woody vegetation elements. However, while the relatively extensive research on forest history has been done (Bürgi et al., 2004; Hersperger and Bürgi, 2009; Szabó, 2010; Szabó and Hédl, 2011, etc.), this hypothesis has not yet been tested for non-forest woody vegetation elements, based on GIS and statistical tools. Therefore, the underlying aim of this thesis is to answer the questions: 1) If and to what extent selected relevant environmental and cultural parameters affect the existing non-forest woody vegetation, and if so, 2) to analyze which factors are the most significant. Further research questions are presented after the literature review in Chapter 2.

The premise of the study is that landscape characteristics of an area can provide significant information on past and present anthropogenic and environmental influences, and can also serve as an important guide in selecting future management strategies.

The overall objective will be met by fulfilling the following concrete objectives:

- To analyze the present state distribution of woody vegetation elements in the landscape, based on the field survey;
- To determine and record selected natural and cultural landscape factors that could be relevant predictors to explain present state of non-forest woody vegetation elements in the studied landscape; and
- To determine which factors are the most significant to explain the presence of the non-forest woody stands in the present landscape, i.e. determine which parameters are influencing the location of the various woody stand biotopes in the landscape, depending on its composition and structure based on the use of GIS and statistical tools.

2. Literature review

This literature review is divided into five main sections: 1) definitions, 2) importance of non-forest woody vegetation, 3) history of forest and non-forest cover in the Czech Republic, 4) research on locational parameters and 5) purpose and aims of this study.

2.1 Definitions

It is important to distinguish between a forest stand and a non-forest woody vegetation stand. Various countries use different terminology for stands representing the same or comparable characteristics as the stands in the Czech Republic that this study focused on. For example, “scattered greenery,” “scattered trees” and “accompanying vegetation” are terms sometimes used to mean non-forest woody vegetation.

2.1.1 Forest

According to the Forestry Act No. 289 (1995), a forest “shall mean forest stand with its environment and land designated for the fulfillment of forest functions.” A forest stand “shall mean trees and shrubs of forest tree species which, in their particular environment, fulfill forest functions.” Forest functions, “shall mean contributions towards the general well-being of society conditional on the existence of forests, which consist of wood-producing and non-wood producing functions.”

According to the Forestry Department of the Food and Agriculture Organization (FAO) of the United Nations, a “forest” is considered “land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds *in situ*. It does not include land that is predominantly under agricultural or urban land use. It includes windbreaks, shelterbelts and corridors of trees with an area of more than 0.5 hectares and a width of more than 20 meters.”

2.1.2 Non-forest

Non-forest growths are in the context of Czech landscape represented by the scattered woody stands and accompanying linear woodlands (along roads, streams etc.) (Skaloš et al., 2014). “The non-forest wood elements category includes all wood element stands, clusters of trees, or solitary trees, with the exception of forest land" (Skaloš and Engstová, 2010). In one study, non-forest habitats are defined as habitats of natural and semi-natural character, outside of built-up areas but within city limits, and mainly associated with lakes, ponds, and watercourses (Kelcey and Müller, 2011).

"Other wooded land" is defined by the FAO as "land not classified as forest, spanning more than 0.5 hectares; with trees higher than 5 meters and a canopy cover of 5-10 percent, or trees able to reach these thresholds *in situ*; or with a combined cover of shrubs, bushes and trees above 10 percent. It does not include land that is predominantly under agricultural or urban land use." The FAO defines "other land" as "all land that is not classified as Forest or Other wooded land. It includes agricultural land, meadows and pastures, built up areas, barren land, etc., and includes all areas classified under the sub-category "other land with tree cover." The sub-category "other land with tree cover" is "land classified as Other land, spanning more than 0.5 hectares with a canopy cover of more than 10 percent of trees able to reach a height of 5 meters at maturity." This sub-category "excludes scattered trees with a canopy cover less than 10 percent, small groups of trees covering less than 0.5 hectares and tree lines less than 20 meters wide."

A "shrub" is defined by the FAO as a "woody perennial plant, generally more than 0.5 meters and less than 5 meters in height at maturity and without a definite crown. The height limits for trees and shrubs should be interpreted with flexibility, particularly the minimum tree and maximum shrub height, which may vary between 5 meters and 7 meters" (United Nations, 2010).

Hedgerows are characteristic of the Central Bohemian landscape and are considered non-forest vegetation. Hedgerows are narrow linear strips of shrubs, which may or may not be managed and may be with or without occasional trees (Davies et al., 2004).

2.2 Importance of non-forest woody vegetation

Forest and non-forest growths have a wide range of functions in the landscape (Ryszkowski and Kedziora, 2007), e.g. aesthetic, land-forming and eco-stabilizing (McCollin, 2000). They have a positive impact on water drainage, thus reducing the risk of soil erosion (Pattanayak and Mercer, 1997), and their importance in mitigating climate change and climate extremes is also clear (Nair et al., 2009; Plieninger, 2011; Manning et al., 2006). Non-forest tree growths play a fundamental ecological role in heavily-utilized landscapes with a low representation of permanent greenery (Bulíř and Škorpík, 1987). In addition, these growths bear witness to historical utilization of the landscape, including wide-ranging utilization of trees for various purposes by traditional society (Harmer et al., 2001) and play an important role in the heritage of the landscape (e.g. Schama, 1995).

2.2.1 Structure

Non-forest woody vegetation plays a significant role in the structure and functionality of the landscape. One of the most important characteristics is its landscape structure as a patch or a linear corridor. Combined, the matrix, patches, and corridors are a valuable ecological unit for analyzing and understanding landscapes (Forman and Godron, 1981).

On a larger scale, when patches and corridors are considered forest, they are recognized as interconnecting habitats that should be protected. For example, in 1991 the European Union established the European Ecological Network (EECONET) and the Pan-European Ecological Network in 1995 (Nowicki et al.,1996). These ecological networks consist of both core areas referred to as "biocenters" and corridors referred to as "biocorridors." The goal of this system is to ensure connectivity and protect biodiversity (Boitani et al., 2007).

On the national level, the Czech Republic developed the Territorial System of Ecological Stability (TSES) to sustain biological diversity and lessen the threats to ecological stability. Non-forest woody vegetation plays an important role in this system. The TSES has three main levels: supraregional, regional, and local, and is also comprised of biocenters and biocorridors. The biocenters must have high ecological stability and be able to permanently maintain the appropriate ecological conditions for species to genetically thrive. Connecting the biocenters are biocorridors of similar conditions and resources, which allow for movement and protection of biological diversity (Buček et al., 2000). In addition to biocenters and biocorridors, "interacting elements" is a third component of the TSES, recognized on the local level. These interactive elements may actually consist of non-forest woody vegetation but they must be comprised of favorable conditions for species playing a significant role to ecosystem functionality (Buček et al., 2000). Interacting elements are also referred to as stepping stones - individual habitat patches contributing to the connectivity between other habitat areas. These elements are unique and cannot be replaced once removed.

Non-forest woody vegetation in the form of patches, linear corridors and points may be comparable in some ways to biocenters, biocorridors, and interacting elements, yet on a much smaller scale. Though it may not provide favorable conditions for the most significant species within a particular ecosystem, non-forest woody vegetation can still provide habitat, shelter, partial connectivity and add vegetative variation. Ultimately this is still useful in the protection of biological diversity, as many studies suggest that heterogeneity, connectivity and areas of semi-natural elements have a positive effect on species richness and abundance (Billeter et al., 2007).

2.2.2 Biodiversity and heterogeneity

Landscape heterogeneity is an environmental factor that describes the diversity of vegetation communities, thus also biodiversity. In a more homogenous landscape, the habitat conditions can only host a limited amount of vegetation, whereas a more heterogeneous landscape reflects the richness of vegetation and associated habitats. Habitat loss and fragmentation are two very serious threats to biodiversity. The interaction between spatial heterogeneity, functionality of the ecosystem and the response of organisms is highlighted by studies that show maintenance of connectivity on a natural level may be a critical remedy to habitat loss and fragmentation (Rubio and Saura, 2012).

Increased non-forest patches, linear features, and points may actually characterize landscape fragmentation, and using non-forest vegetation as an indicator of fragmentation can contribute to the understanding of land cover changes on a local level (Olsen et al., 2007). However, depending on the past and present land use, non-forest vegetation may also indicate an increase of heterogeneity in a once homologous landscape area. Since non-forest vegetation plays such a significant role on the structure and functionality of the landscape, it can be used as an indicator to read and analyze the landscape for improved management measures.

2.2.3 Ecological benefits of riparian non-forest woody vegetation

Intensely utilized landscapes, such as much of the agricultural land in the Czech Republic, benefit greatly from non-forest vegetation. The ecological value provided by non-forest woody vegetation is significant and addresses many land and water issues that are commonly found in an intensively utilized agricultural landscape. In these particular types of landscapes, stream corridors are often channelized, or straightened, and the adjacent vegetation is disturbed or removed.

One of the most common examples of non-forest vegetation in the Czech Republic is in the form of linear corridors along streams or similar water features. The roots of riparian vegetation help to protect and stabilize the banks along streams from erosion and scouring. Riparian vegetation also helps to improve water quality by decreasing surface runoff or agricultural field runoff. In addition, vegetated terraces are erosion control measures for soil management and water quality protection (Pattanayak and Mercer, 1998).

Woody elements, such as tree rows or hedgerows hold significant importance for landscape research because of their various beneficial properties within a landscape. Not only do they support recreation and they also serve as habitats for extensive flora and fauna (Hirt et al., 2011).

2.3 History of forest and non-forest cover in the Czech Republic

Political, technological and socioeconomic changes affect the way humans manage and utilize the land, and this is consistently reflected through landscape structure. In order to fully understand the present day landscape, it is necessary to have historical information. Within the past 50 years, the magnitude and rate of change in the Czech Republic landscape structure increased drastically (Lipský, 1995). The driving influence behind this change is when the Communist regime took control after WWII. Before this significant time in history, record books from as far back as the 15^{th} century indicate that landowners and farmers had the most influence behind the resulting landscape structure (Szabó, 2010). Resulting data from Szabó's study indicates that it is likely the rate of landscape change was slow and steady in Czech Republic since the 17^{th} century.

In the past, non-forest vegetation was created as linear boundary to a border between the cleared agricultural land and woodland. These particular boundaries were commonly characterized by a bank and a ditch (Szabó, 2010) and may also be known as hedgerows.

Naturally occurring non-forest vegetation is often found on steep slopes with rocky soils, despite the surrounding land use (Szabó, 2010).

2.4 Research on locational parameters

2.4.1 Mapping and analyzing woody elements in the landscape

The ability to map and analyze existing linear landscape elements is critical for research, comprehensive catchment planning, and especially for restoration of these certain landscapes.

Specific studies on identifying linear landscape elements in general are quite rare and are usually based solely on satellite data, which infrequently possesses the ability to detect woody elements in the landscape (Kantelhardt et al., 2003; Egbert et al., 2002; Griffith et al., 2000; Hladnik, 2004). In 2011, a geographic information systems (GIS) statistical procedure to combat these limitations and allow for quantification of a wide range of linear features, such as tree rows, avenues and hedges on a regional scale was created. Through the works of Ulrike Hirt, Melanie Mewes and Burghard C. Meyer of the Department of Shallow lakes and Lowland Rivers, at the Lebibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, this framework has provided a practical framework for more in depth mapping and analyzing of landscape structures. The process for the creation of this framework is explained in their journal article, “A new approach to comprehensive quantification of linear landscape elements using biotope types on a regional scale,” and focuses on The Middle Mudle River catchment (2700 km^2) in Saxony, Germany, as the study area.

This procedure was based on a number of different data sets, which were produced through an overlay process in GIS and followed by a statistical assessment. The first dataset was the natural regions map, which divided the catchment area of study into five different natural regions. Second, a meso-scale soil map for agricultural land split the catchment area of study into eleven different soil site groups. The third dataset, the biotope and land use map for the German federal state of Saxony, was based on a list of biotope and land uses, containing both linear and areal information. Additionally, in regards to woody elements, a database was used to yield information on these particular features within the specific study area in high detail, through the use of high-resolution color infrared aerial photographs and visual interpretation techniques. With the given information, the aim of the authors was to distinguish and interpolate the differences in linear structures of biotopes for variable spatial entities. For example, as stated by Hirt et al., 2011:

"Data on linear landscape elements can be combined with data concerning natural regions, climate, soil, agricultural data or social data. For the present study, we have chosen a natural region dataset, because of the high differentiation of landscape information, and soil data layer reflecting the local geological, topographical, climate and hydrological quality" (Hirt et al., 2011 p. 581).

The methodology for the study first used of GIS to cross-process all digital databases of the five natural regions and the eleven soil site groups of the study catchment area. Through this data processing, over 8,500 data records were produced. Second, was the creation of two data sets according to biotope types, both containing information about natural regions, soil site groups and biotope types. Lastly, a correction of the geometrical faults created by intersecting process was made. After the correction process, all desired information on the area of the Middle Mudle River as well as linear information could be retrieved, and statistical information was produced (Hirt et al., 2011).

The framework created by the study was successful in producing extensive information that creates the ability to quantify and analyze specific landscape structures on a regional scale. The study also advances the research of linear landscape elements, especially the quantification and analysis of woody vegetation.

2.4.2 Methodology for interpreting data

The importance of vegetation spatial data in the European landscapes is highlighted in a landscape ecology study, "A standardized procedure for surveillance and monitoring European habitats and provision of spatial data" (Bunce et al., 2008). The study presents very interesting and applicable relevance to the aims of this thesis. The study examined how statistical information obtained through dependable methodology is necessary for interpreting ecological data at a landscape level. The methodology used in the procedures consisted of field recording, monitoring, and surveillance of 130 general habitat categories, followed by determining if there is any statistical correlation on an environmental gradient.

Along this gradient included environmental as well as site and management characteristics, as additional characteristics to record of the monitored habitats. The study authors also used linear and point features for ensuring the data is interpolatable on a landscape level. The prominent underlying goal was to prove how these ecological concepts may affect the spatial arrangement of habitats, allowing for a stable interpretation of changes that occur in the patterns and processes observed. Habitat categories, rather than vegetation, were the focus because, within an animal conservation aspect, habitats correlate more significantly with vegetation structure, as opposed to vegetation classes (Bunce et al., 2008; Fox et al., 2003).

The authors explain that the surveying of habitats may be conducted through sampling either a large amount of sample units or by a small amount of larger units. However, the researcher must be consistent with the sample size, so there can be a direct comparison between data and spatial modeling.

"As there is no optimal sample unit size for all the habitats and landscapes at a continental scale; due to variation at landscape, path and management; a 1 km square is a workable compromise, matching ease of survey, data content and obtaining an adequate number of sample units for estimates of statistical probability" (Bunce et al., 2008).

From analyzing climate and topographical data of randomly drawn 1 km squares in a particular region, the extent of a parameter or characteristic that should be considered in the research can be determined. After examining the parameters to be considered in the study, five general habitat categories were created: Urban, Crop, Sparsely Vegetated, Treed or Shrubs and Wetland. Additional environmental (such as foil and rock type) and management (such as forestry and recreation) parameters were surveyed to further specify ecological characteristics at the landscape level.

The recording process was carried out using a formatted data table divided by the five habitats and the selected characteristics to observe. After data collection in the field, further characteristics such as slope, angle and geology were obtained from available datasets. Visual data such as aerial photographs and cadastral maps, at a scale of 1:10:000 were also used to delineate the elements in the study area and also determined the "minimal mapping element" size. Linear and point elements were also recorded using the same procedure, which were then mapped in GIS to compare the surrounding surveyed habitat characteristics such as rock outcrops, water and ownership. This procedure was then tested and validated numerous times through field workshops in a variety of different landscapes. After having shown significant validation of a reproducible procedure, the study indicates the collected data can be used as a reliable source for European nature conservation policy.

2.4.3 Current state of non-forest woody vegetation research

There are few recent studies that address the present non-forest woody vegetation in Central Bohemia. However, a variety of studies do address the importance of non-forest woody vegetation and the role it plays as hedgerows or field boundaries, farm trees, shelterbelts and as agroforestry measures. Many of the literature articles focused on how the vegetation has been affected over time from long-term landscape changes by both environmental and/or cultural parameters (Peterson 2005; Sklenicka et al. 2009; Plieninger, T. et al., 2012; Skaloš et al., 2012a; Skaloš et al., 2012b; Skokanova and Eremiasova, 2012; Demková and Lipský, 2013).

Roads and paths are noticeable features that are commonly found in many landscapes. Studies have shown they have significant impacts on their natural surroundings such as impacting the adjacent soil composition (Angold, 1997; Coffin, 2007; Hill and Pickering, 2006; Müllerova et al., 2011; Spellerberg, 1998). A variety of factors such as slope, prevailing winds and surrounding landcover can either reduce or exacerbate the level of impact intensity roads and paths may actually have (Forman and Alexander, 1998). A recent study addressed another factor that has been minimally researched. Müllerova et al. (2011) examined the effects of road and path building materials on adjacent vegetation. Researching a variety of existing parameters at a case study site in Central Bohemia, Czech Republic may be useful in determining the extent that anthropogenic factors, compared to natural factors, have on the surrounding landscape.

The study found a strong association with changes in vegetation and distance from the road. The species composition changed with distance, as the less competitive stress tolerant species were found at a greater distance away from the roadside. The study's primary aim to evaluate the influence of different environmental factors was complimented with a successful method gathering and recording field data.

Other articles focused primarily on the importance and conservation value of non-forest woody vegetation for various reasons including conservation of cultural and agricultural landscapes (Orlowski and Nowak, 2007), its potential as an adaptive response to climate change in a modified landscape (Manning et al., 2009), and the provision of biodiversity as a field boundary (Le Cœur et al., 2002; Hinsley and Bellamy, 2000; Ouin and Burel, 2002).

The article, "Is there a forest transition outside forests? Trajectories of farm trees and effects on ecosystem services in an agricultural landscape in Eastern Germany" by Plieninger et al., (2012), focused on the tree-based agricultural system in European rural landscapes. The study looked at the farm trees in Eastern Germany over a lengthy period (1964-2008), and its aim was to "analyze the spatial-temporal dynamics of farm trees and woodlands in an agricultural landscape." The study primarily used aerial photographs and digital orthophotos.

Orlowski and Nowark's 2007 article, "The importance of marginal habitats for the conservation of old trees in agricultural landscapes," presented a case study in southwestern Poland of champion trees (large, old trees) in an intensively managed agricultural area of 5480 ha. The study consisted of fieldwork to identify the number of champion trees, and how often they occurred in the study area. The fieldwork similarly looked at what factors may be a probable cause for the presence of the trees, and also examined the composition and role of habitat type. Patches and linear characteristics were regarded as two sub-habitat categories that looked at champion trees *within* the habitats, and not as the vegetation fully representing the entire patch or linear feature.

Studies that aim to identify, examine and map the presence of existing non-forest vegetation have been conducted in a variety of ways, yet differ based on aspect of non-forest woody vegetation that was of interest. For example, in a study, "Why and how we should study field boundary biodiversity in an agrarian landscape context" (Le Cœur et. al, 2002), communicative networking with locals was used in addition to field surveying. Interviews with farmers as well as a management-practice monthly survey were distributed within the study site.

An actual methodology for mapping non-forest woody elements was tested by Skaloš and Engstová (2010), who provided a significant amount of other research regarding non-forest woody vegetation. Though this particular study focused on long-term structural changes and used historic cadastral maps and aerial photographs, it is interesting to note a tactic used for field surveying the existing vegetation. The non-forest woody vegetation was divided into three categories: non-forest woods inside the village, open landscape scattered vegetation and tree alleys or roadside scattered vegetation. This was to acknowledge the vegetation feature shape with its basic landscape function characteristics. It is also stressed that there is no detailed classification system for non-forest woody vegetation as a dynamic, multifunctioning land cover type (Skaloš and Engstová, 2010).

In spite of the substantial research on the importance of non-forest woody vegetation, a research gap exists because there is little known about the particular factors actually shaping the *present* non-forest woody vegetation. The main goal of this thesis case study is to fill that gap and contribute information directly focused on the present state of the vegetation structure and composition, in order to expand on the minimal research to-date. Analysis of natural and cultural landscape factors can be used as present-day indicators to explain the frequency of different non-forest woody vegetation features in the landscape.

2.5 Purpose and aims of the study

Human activities that are very much limited by natural settings of the landscape, shape the present landscape. This is also true for forest and non-forest woody vegetation elements. However, while the relatively extensive research on forest history has been conducted (Bürgi et al., 2004; Hersperger and Bürgi, 2009; Szabó, 2010; Szabó and Hédl, 2011, etc.), this hypothesis has not yet been tested for non-forest woody vegetation elements, based on GIS and statistical tools. Therefore, the underlying aim of this thesis is to answer the questions: 1) If, and to what extent, selected relevant environmental and cultural parameters affect the existing non-forest woody vegetation; and if so, 2) to analyze what factors are the most significant ones.

Further research questions include: 1) What structural type (linear, patch, point) of non-forest woody vegetation elements prevail? 2) What is the prevalent composition (mixed, mostly shrub, mostly trees, shrubs, trees) of the non-forest woody vegetation? and 3) Are the environmental and cultural parameters affecting structure different from those affecting the composition of non-forest woody vegetation?

The premise of the study is that landscape characteristics of an area can provide significant information on past and present anthropogenic and environmental influences, and can also serve as an important guide in selecting future management strategies.

The overall objective will be met by fulfilling the following concrete objectives:

- To analyze the present state distribution of woody vegetation elements in the landscape, based on field survey;
- To determine and record selected natural and cultural landscape factors that could be relevant predictors to explain present state of non-forest woody vegetation elements in the studied landscape; and
- To determine which factors are the most significant to explain the presence of the non-forest woody stands in the present landscape, i.e. determine which parameters are influencing the location of the various woody stand biotopes in the landscape, depending on its composition and structure based on the use of GIS and statistical tools.

3. Methodology

This chapter describes the methods of data collection and data analysis. It characterizes the background materials used (which were primarily maps and field data) so that the significance of the background materials and the objective value of the conclusions can be assessed.

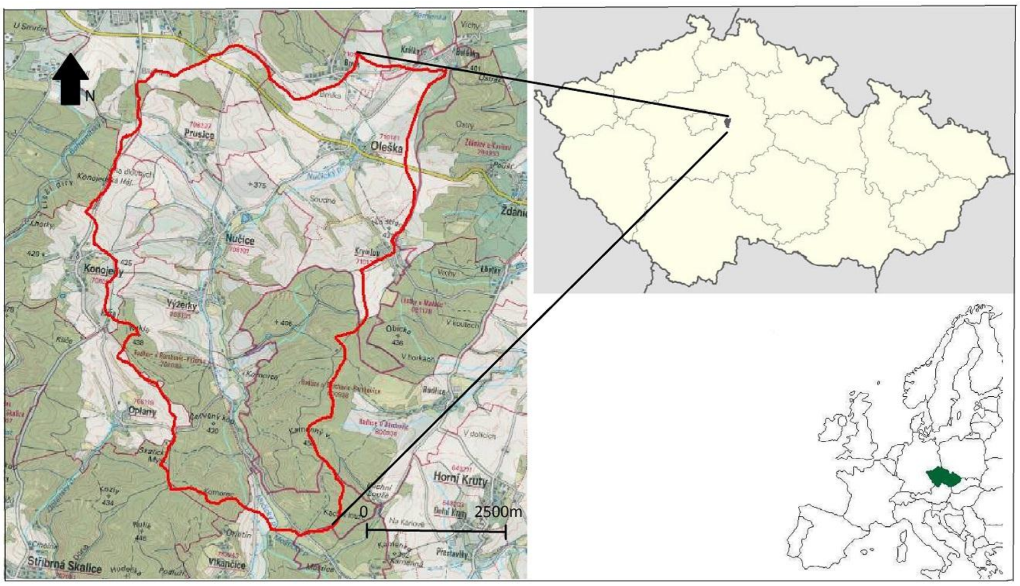
The study consisted of several methodological steps:

- Identification of case study area
- Source data and their processing
- Classification system
- Monitored characteristics
- Statistical analysis

3.1 Identification of case study area

The study area is located in the Central Bohemian (Czech: Středočeský kraj) region within the Czech Republic. The study area watershed is primarily in the administrative unit of the Prague East District and partly in the Kolín District. The coordinates of the study area are 14°52’41.048”E, 49°57’55. 418”N and the total area within the study area is 3256 hectares (ha). The general study area location is shown on Figure 3.1.

Figure 3.1 General Case Study Area Location



Note: Figure indicates localization of case study area (boundary in red) within Czech Republic (basemap sources: Wikimedia Commons, Czechia_-_outline_map.svg; and Geoportal INSPIRE, WMS-ZM10).

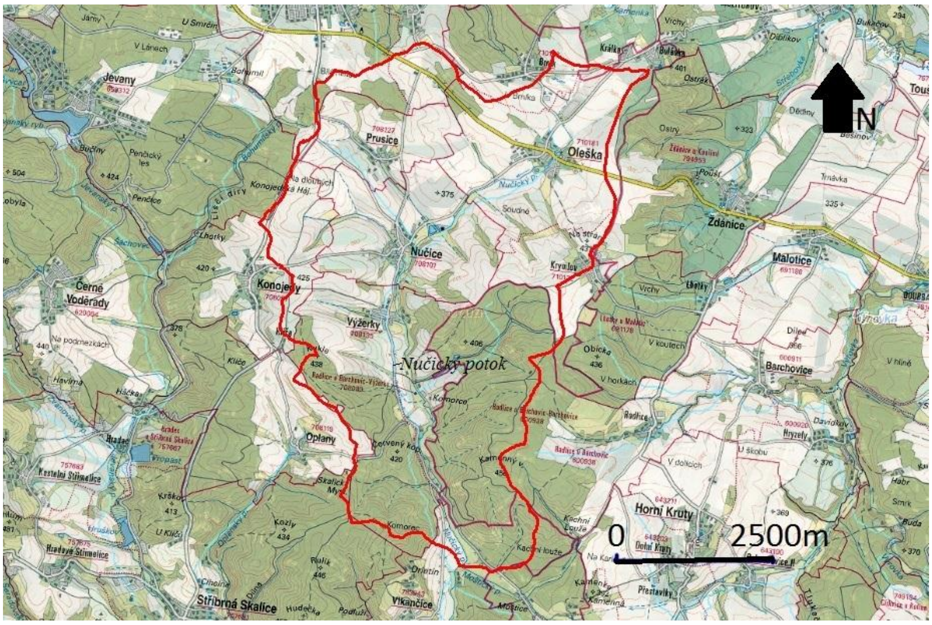
We focused on this area of the Czech Republic as part of The Faculty of Environmental Sciences forest history research particularly the Bohemian region. This general area consists of the type of landscape that contains non-forest woody vegetation as a semi-natural condition landscape. Results of studies in this area could lend important additional information to the overall research.

The specific case study area boundaries were delineated using watershed boundaries because this is the landscape segment which functions in a homogenous way respecting hydrological parameters. The primary vegetation types tend to coincide with the hydrological characteristics of the particular watershed area.

Initially located and chosen using ArcGIS watershed boundaries in the Czech Republic, this particular watershed has significantly noticeable non-forest woody vegetation features. The surrounding watersheds have larger areas of forest and would not lend themselves as well to the study.

After choosing the watershed boundary, it was printed on A3 from 1:6,000 to 1:10,000 scale. This scale shows non-forest woody vegetation features indicated on orthophotographs obtained from Geoportal WMS servers. This served as a useful data source to compare the orthophoto and the present site characteristics observed during field visits. The case study area boundaries are shown on Figure 3.2.

Figure 3.2 Case Study Area Boundaries



Note: Figure indicates case study boundary in red (basemap source: Geoportal INSPIRE, WMS-ZM10).

3.2 Source data and their processing

This study used two forms of data collection – primary (field investigations) and secondary (maps and aerial photographs). Initially, a literature review of other non-forest woody vegetation studies was conducted to determine which attributes non-forest woody vegetation should be documented (i.e., structure, composition, area calculations) and which characteristics may be good predictors of non-forest woody vegetation location. The literature review was followed by field investigation of specific attributes and characteristics to determine present conditions.

The field visits and field observations were conducted from November 2013 through February 2014. The observation techniques included walking the case study area and taking detailed field notes. As each non-forest woody feature was identified, the feature and its location were photographed in the field and the location recorded on a map.

Data sources for mapping included information available through web-based sources. These included Google Earth (primarily for real time orientation while conducting field visits) and the geospatial sources available through Geoportal CUZK (geoportal.cuzk.cz).

Geoportal CUZK offers datasets and network services to the public. Through Geoportal, “INSPIRE” (Infrastructure for Spatial Information in the European Community) viewing services were used for geographical names, territorial administrative units, transport networks, waters, protected areas and orthophotographic views. All technical data sources imported to ArcGIS were transformed to the S-JTSK_Krovak_East_North coordinate system.

The following Geoportal WMS viewing services were accessed and used:

- Geonames, administrative boundaries, Orthophotos,
- ZABAGED (Hydrography, altitude, hydrological features, roads, water, topology, relief - at a 1:10,000 scale),
- WMS - ZM 10 (Base map 1:10,000 scale)

- CENIA (typology, classification of soil types according to TKSP and WRB 2006, and CENIA chranena_uzemi – which shows various Nature Management)

Other geographic data sources used as reference material and or as tools included:

- ArcGIS 10 (student)
- Google Earth (2014 GEODIS Brno) – Provided accurate GPS in the field as well as precise location coordinates and elevation measures on site and while reviewing the field data after collection.
- CZECH Geological Survey – CZE CGS 1M SOIL MAP and Geological Map 1:500,000,
- European Soil Portal – Soil Databases 1:250,000
- Romportl Typology GIS data layer

Section 3.4 below introduces a table listing each parameter used in this study and the data source.

In some cases, the list of attributes and characteristics was further refined based on data availability – i.e., whether information was readily available from existing sources or field investigation. For example, ownership of individual features was not easily determined so the attribute was limited to either "public" or "private."

Data tabulations for each feature location area are both qualitative and quantitative. Where feasible, qualitative data related to feature location characteristics were quantified. For example, if no water was present at a feature location, a value of "0" was assigned; whereas a feature location with multiple water sources (e.g., groundwater, pond, and stream) was assigned a higher value indicating the prevalence of water influences at that location.

In addition, feature location characteristics with broad quantitative ranges (e.g., slope lengths and widths) were assigned to defined quantitative categories. Assigning quantitative values to qualitative data and simplifying quantitative data, as appropriate, enhanced the statistical analysis to determine correlations and facilitated data comparison.

The table introduced below in Section 3.4 indicates values assigned to each parameters to facilitate statistical data processing.

3.3 Classification system

As each non-forest woody feature was identified in the field, it was sequentially numbered for data categorization purposes. In total, 233 non-forest woody features were identified in the case study area. A minimum size of $20m^2$ was used for determining which non-forest woody features to classify.

Within this study, the term "attributes" is used to describe the response variables of non-forest woody vegetation. Attributes are parameters such as the physical size measurements (length, width, edge length and area) of each feature. Two other attributes (also response variables) that were documented in the field are structure and composition of the non-forest woody vegetation.

The structure of the non-forest woody features was classified as either linear, patch, or point. For this study, features were classified as "linear" if they generally had length to width ratios greater than 5:1 (e.g. 10m length to 2m width). However, most of them were considerably more linear. Features were classified as "patch" if they did not classify as linear and had total areas greater than 1000 m^2. "Point" features generally had areas of 1000 m^2 or less.

The photographs in Figures 3.3, 3.4 and 3.5 were taken during the data collection stage and indicate the visual difference between the three "structures" of non-forest woody features examined in this study.

Figure 3.3 Linear Feature

Figure 3.4 Patch Feature

Figure 3.5 Point Feature

The study also differentiates between the composition of features. The "composition" was classified using five categories of differentiation – mix, mostly shrub, mostly tree, shrub and tree. Plant species and plant communities were not identified; instead, the classification was based on whether the feature was composed of trees or shrubs as observed in the field.

The photographs in Figures 3.6, 3.7 and 3.8 were also taken during the data collection stage. These three photographs indicate the visual difference between the three of the types of “composition” of non-forest woody features examined in this study.

Figure 3.6 Mixed Feature

Figure 3.7 Shrub Feature

Figure 3.8 Tree Feature

As noted above, in addition to mix, shrub and tree, the study also differentiates between composition of features that are mostly shrub (primarily shrub) and mostly trees (primarily trees).

3.4 Monitored characteristics

Within this study, the term “characteristics” is used to describe collectively the associated parameters that may affect the location or attribute (the response variables) of non-forest woody vegetation. These characteristics (predictor variables) include parameters such as the presence and type of water (groundwater, streams, etc.), presence of rock and the adjacent land management practices.

The full list of feature attributes (response variables) and locational characteristics (predictor variables) is in Table 3.1. The table indicates each parameter, units of measurement, data source and the importance of use in this thesis.

Table 3.1 Parameters used in this study

Attributes of Non-Forest, Woody Features - Response Variables				
Parameter	Sub- Parameter	Units	Data Source	Importance or Usage
Non-Forest, Woody Feature #	N/A	1 - 233	Field Observation / Assigned	Classification System
Structure	N/A	Patch (Pa), Linear (L), Point (Po)	Field Observation	Response Variable
Length (m)	N/A	meters	Field / Map Measurement	Response Variable
Width (m)	N/A	meters	Field / Map Measurement	Response Variable
Area (m^2)	N/A	square meters	Calculation	Response Variable
Edge Length (m)	N/A	meters	ArcGIS	Response Variable
Composition	Fruit	X (Yes)	Field Observation	Characteristic Not Used
Composition	N/A	Tree (T), Mostly Tree (MT), Shrub (S), Mostly Shrub (MS), Mix (M)	Field Observation	Response Variable
Characteristics of Non-Forest, Woody Feature Locations - Predictor Variables				
Parameter	Sub- Parameter	Units	Data Source	Importance or Usage
Ownership	N/A	Public, Private	CUZK inspection of the cadastre and/or vdp.ruian	Predictor Variable
Ownership Name	N/A	Name of Public Owner		
Typology	CENIA	3M2, 3L2	CENIA	Predictor Variable
	Rompt	2Z, 2M	Romportl TPK_D GIS layer	Predictor Variable
Commute Type	N/A	Road (R), Field Road (FR), Path (P), None	Field Observation	Predictor Variable
Water Type (Surface Water Bodies)	N/A	No Water =0.0, GW=1.0, Wetland = 2.0, Stream=3.1, Pond=3.2, GW+Stream=4.1, GW+Pond=4.2, GW+Multiple=4.2	Calculation	Statistical Data Processing
	High Ground Water	X (Yes)	Field Observation	Predictor Variable
	Wetland	X (Yes)	Field Observation/ZABAGED	Predictor Variable
	Stream Tributary	Steady (S), Occasional (Occ)	Field Observation/ZABAGED	Predictor Variable
	Stream Name	Nucicky p. (N.p.), Konojedsky p. (K.p.), Prusicky p. (P.p.), Vyzersky p. (V.p.)	Geoportal WMS - ZM 10	Data documentation
	Pond	X (Yes)	Field Observation	Predictor Variable
	None	X (Yes - None)	Field Observation	Predictor Variable
Bedrock and Soils	Rocks	X (Yes), None	Field Observation	Predictor Variable
	Geology	Pa, Kce	CGS	Predictor Variable
	Soil Type	FG, GF, HA, HL, HM	CGS Soil Map/CENIA	Predictor Variable
	Slope Length	% Slope 1)<5.1, 2)<10.1, 3)<15.1, 4)<20.1, 5)<25.1	Calculation	Statistical Data Processing
	Slope Width	% Slope 1)<5.1, 2)<10.1, 3)<15.1, 4)<20.1, 5)<25.1, 6)<30.1, 7)<35.1…	Calculation	Statistical Data Processing
	Slope Length Measured	% Slope Length	ArcGIS	Predictor Variable
	Slope Width Measured	% Slope Width	ArcGIS	Predictor Variable
Cultural	Architecture	Religious (R), Technical (T)	Field Observation	Predictor Variable
Management	Game	X (Yes)	Field Observation	Predictor Variable
	Local Forest Mgmt.	X (Yes)	Field Observation	Predictor Variable
	Nat. Consrvtn	X (Yes)	CENIA	Predictor Variable
	Other	X (Yes)	Field Observation/CENIA	Predictor Variable
	No	X (Yes - None)	Field Observation	Predictor Variable
Zoning	Nature	X (Yes)	ZABAGED/CENIA	Predictor Variable
	Cultural Heritage	X (Yes)	ZABAGED/CENIA	Predictor Variable
	No	X (Yes - None)	ZABAGED/CENIA	Predictor Variable
Notes:	See Table A.1 Data Table in Appendix A for full data compilation.			
	N/A = Not Aplicable			

3.5 Statistical analysis

Human activities are important factors in shaping the landscape structure. However, these activities are to a great extent limited by natural settings of the landscape. Then, in this study we call the most relevant human activities “cultural parameters” and the natural setting by “natural parameters.”

Predictors (cultural and natural) and response variables (numbers of features, area, edge, structure and composition) were recorded and used in the statistical analysis. With the data tabularized and units assigned to facilitate statistical data processing, several statistical techniques were used to determine whether correlations existed between the cultural and natural characteristics (predictor variables) of the non-forest woody feature location and the attributes (response variables) of non-forest woody features.

Statistical techniques included correlation coefficient, analysis of variance, box plots with whiskers, and contingency tables (Pearson's chi-squared test). As explained in Chapter 4 (Results), the frequency figures (contingency tables) with the chi-square test were the most useful statistical technique for this analysis. The chi-square test compares the observed and expected frequencies to determine whether there is a statistically significant difference.

For this study, the observed frequencies of the "structure" and "composition" of the non-forest woody features and the observed frequencies of "water," "rock" and "land management" were compared to the expected frequencies of occurrence.

4. Results

4.1 Overall distribution of non-forest woody vegetation elements

Within the case study boundaries, 233 non-forest woody features in total were identified. The attributes and characteristics of each are presented in the field data table in Appendix A. The locations of the 233 features are shown in Figure A.1 of Appendix A.

The non-forest woody vegetation (the 233 features) constitutes approximately 5.38 hectares (ha) or 0.17% of the total land area of 3256 ha within the case study boundaries. Forest areas constitute about 31.33% (1020 ha) of the case study area and the remaining 68.5% (2230.6 ha) are other land uses such as agriculture, development and water bodies.

The areal extent of the structure and composition (in hectares) of the 233 features is shown in Table 4.1.

Table 4.1 Areal Extent of Structure and Composition within Case Study Area (in ha)

	Non-Forest Woody Composition					
Structure	Mix	Mostly Shrub	Mostly Tree	Shrub	Tree	Total
Linear	1.38	0.06	1.39	0.04	1.26	4.13
Patch or Point	0.58	0.00	0.60	0.00	0.06	1.24
Total	1.97	0.06	1.99	0.04	1.33	5.38

The following figures graphically depict the compositional make-up of the non-forest woody vegetation. Figure 4.1 is a pie chart showing the percent composition of the 233 non-forest woody features. That is, of the total number of non-forest woody features in the case study area, the chart indicates that percent that were of mixed composition, mostly shrub, mostly tree, shrub and tree. Similarly, Figure 4.2 shows the percent structure of the 233 non-forest woody features. More than three-fourths (77%) of the features have a linear structure and less than one-fourth (23%) of the features have either a patch or point structure.

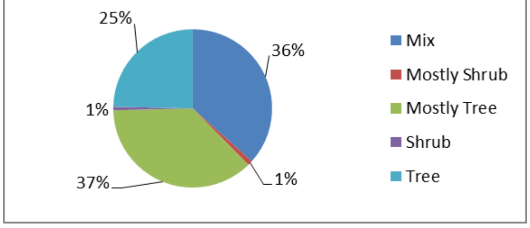


Figure 4.1 Compostion of Non-Forest Woody Vegetation (% Area)

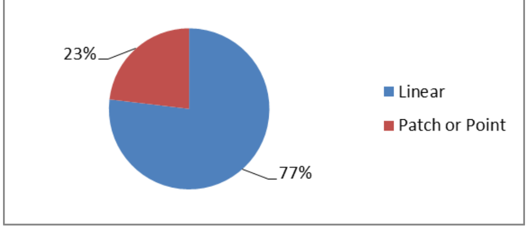


Figure 4.2 Structure of Non-Forest Woody Vegetation (% Area)

In further examining the composition of each of type of structure, it was found that based on area, the linear non-forest woody vegetation is almost equally one-third of mixed composition (33%), about one-third mostly tree (34%) and about one-third tree (31%). The non-forest woody vegetation having a structure as a patch or point were found to have a compositional make-up, based on area, more even divided between just two of the categories. About half of mixed composition (47%) and about half being mostly tree (48%). Figure 4.3 depicts the percentage of area for the various vegetative compositions for the linear structures and Figure 4.4 depicts the percentage of area for the various vegetative compositions for the patch or point structures.

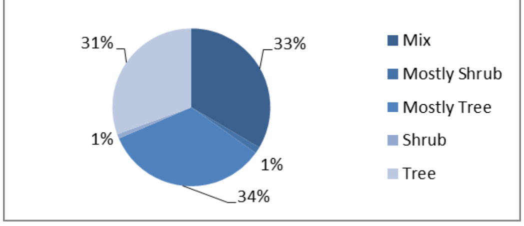


Figure 4.3 Composition of Features Having Linear Structure (% Area)

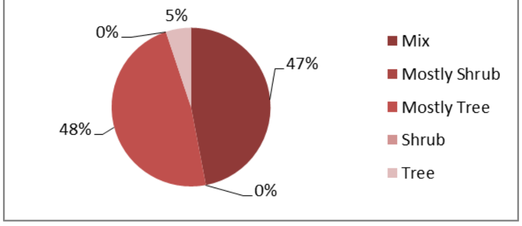


Figure 4.4 Composition of Features Having Patch or Point Structure (% Area)

4.2 Structure and composition

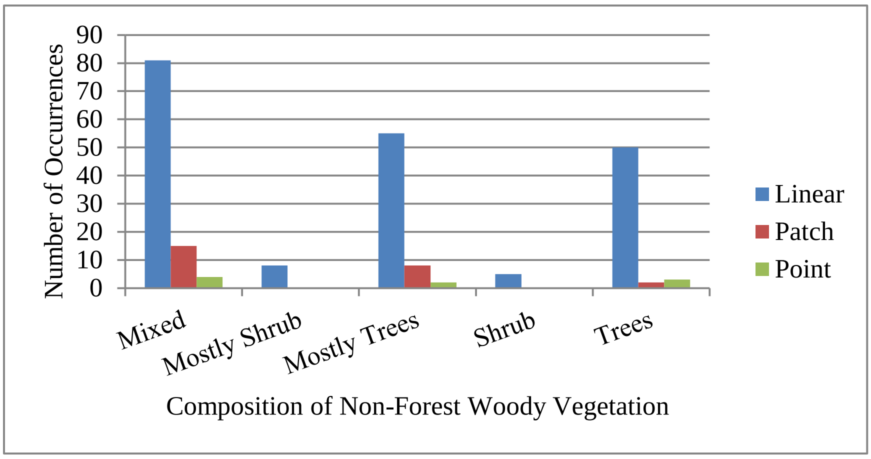
The investigation on the relationships between attributes was primary focused on factors affecting the structure of non-forest woody vegetation (line, patch or point) and those affecting the composition of the non-forest woody vegetation (mix, mostly shrub, shrub, mostly tree, trees). As described below, the relationship between structures and composition of non-forest woody vegetation was found to be not factors affecting the structure of non-forest woody vegetation (line, patch or point) and those affecting the composition of the non-forest woody vegetation (mix, mostly shrub, shrub, mostly tree, trees). As described below, the relationship between structures and composition of non-forest woody vegetation was found to be not significant. Therefore, it lends credence that the results of factors affecting structure of non-forest woody vegetation are unique from the results of factors affecting composition of non-forest woody vegetation. That is, the presence of structure and composition are not influencing the other's results when each is examined for relationships with other parameters.

Focusing on the relationship between Structure and Composition the Contingency Table is shown in Table 4.2 and as a Chart in Figure 4.5.

Table 4.2 Contingency Table: Structure and Composition

	Composition of Vegetation				
Structure	Mixed	Mostly Shrub	Mostly Trees	Shrub	Trees
Linear	81	8	55	5	50
Patch	15	0	8	0	2
Point	4	0	2	0	3

Figure 4.5 Bar Chart: Structure and Composition



The chi-square test for independence was used to determine whether the proportion of times that a structure (linear, point or patch) of non-woody vegetation occurs is the same for all of the composition types (mix, shrub, tree, etc.) of the vegetation. The null hypothesis tested is that the vegetative composition is independent of vegetative structure.

The calculated chi-square was 14.987. With 2 degrees of freedom (df) and selecting a 95% confidence level (0.050), it is noted that a chi-square of 14.978 is less than the critical value of 15.507. Therefore, for structure and composition, we must accept the null hypothesis. There is no statistical difference between the observed and the results happening by chance, That is, there is no relationship between structure and composition.

4.3 Structure and characteristics of features

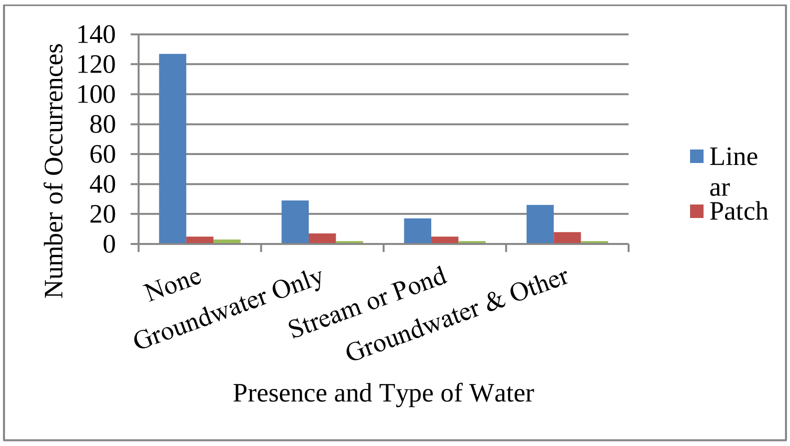
In looking at the potential relationship of the structure of the non-forest woody vegetation, the statistical results found strong relationships between Water and Structure and Rock and Structure. Relationships were also found, though less significant, between Management and Structure and Soil Type and Structure. Commute Type and Structure and Ownership and Structure were both found only marginally significant. Relationship between Typology (Cenia or Rompt.) and Structure and Cultural Architecture and Structure were found to be not significant.

Focusing on the relationship between Water and Structure the Contingency Table is shown in Table 4.3 and as a Chart in Figure 4.6.

Table 4.3 Contingency Table: Structure and Water

	Presence of Water and Type at Feature			
Structure	None	Groundwater Only	Stream or Pond	Groundwater & Other
Linear	127	29	17	26
Patch	5	7	5	8
Point	3	2	2	2

Figure 4.6 Bar Chart: Structure and Water



The chi-square test for independence was used to determine whether the proportion of times that a structure (linear, point or patch) of non-woody vegetation occurs is the same for all of the water parameters. The null hypothesis tested is that the water attribute is independent of vegetative structure.

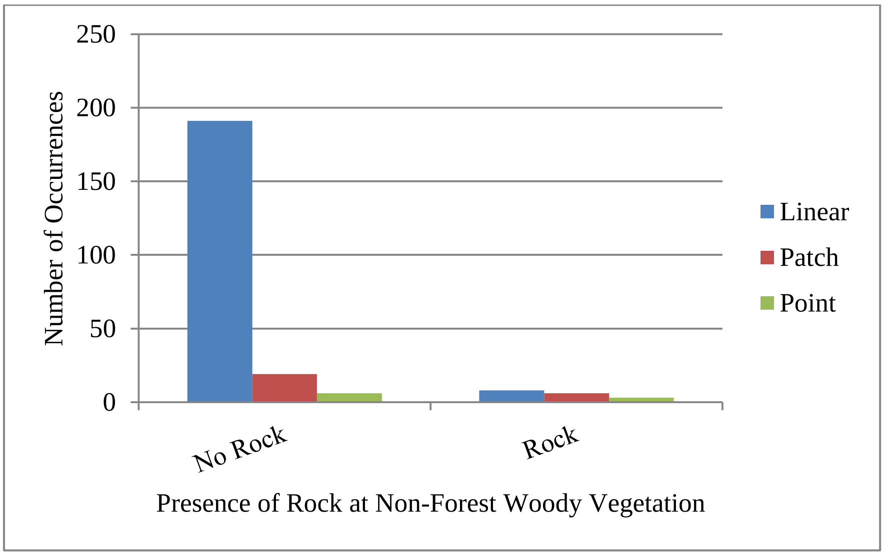
The calculated chi-square was 20.549. With 6 degrees of freedom (df) and selecting a 95% confidence level (0.050), it is noted that a chi-square of 20.549 is greater than the critical value of 12.592. Therefore, for structure and water, we must reject the null hypothesis. There is a statistical difference between the observed and the results happening by chance, That is, there is a relationship between water and structure.

Another significant relationship was found between Rock and Structure. The Contingency Table is shown in Table 4.4 and Chart in Figure 4.7.

Table 4.4 Contingency Table: Structure and Rock

	Presence of Rock at Feature	
Structure	No Rock	Rock
Linear	191	8
Patch	19	6
Point	6	3

Figure 4.7 Bar Chart: Structure and Rock



The chi-square test for independence was used to determine whether the proportion of times that a structure (linear, point or patch) of non-woody vegetation occurs is the same whether rock was present or not. The null hypothesis tested is that the presence of rock is independent of vegetative structure.

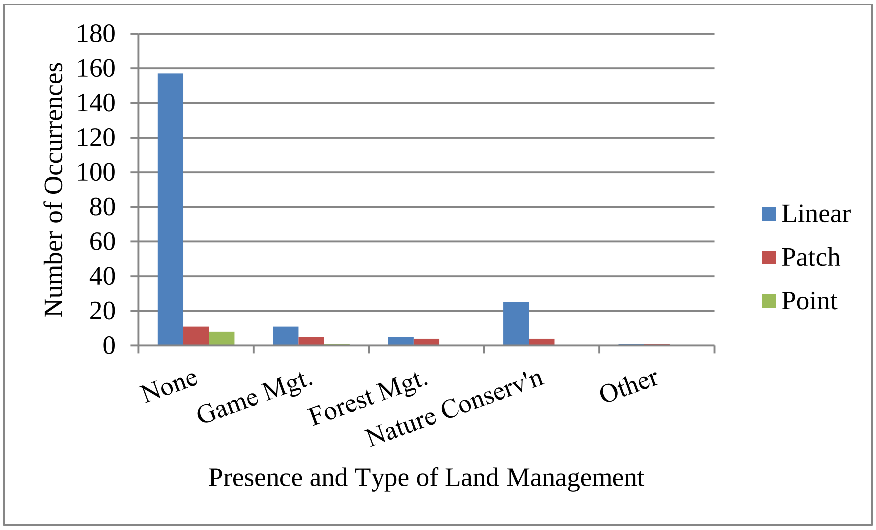
The calculated chi-square was 22.491. With 2 degrees of freedom (df) and selecting a 95% confidence level (0.050), it is noted that a chi-square of 22.491is greater than the critical value of 5.991. Therefore, for s and composition, we must reject the null hypothesis. There is a statistical difference between the observed and the results happening by chance; that is, there is a relationship between rock and structure.

Another significant relationship was found between Land Management and Structure. The Contingency Table is shown in Table 4.5 and Chart in Figure 4.8.

Table 4.5 Contingency Table: Structure and Land Management

	Presence of Land Management and Type at Feature				
Structure	None	Game Mgt.	Forest Mgt.	Nature Conserv'n	Other
Linear	157	11	5	25	1
Patch	11	5	4	4	1
Point	8	1	0	0	0

Figure 4.8 Bar Chart: Structure and Land Management



The chi-square test for independence was used to determine whether the proportion of times that a structure (linear, point or patch) of non-woody vegetation occurs is the same for all land management parameters. The null hypothesis tested is that the land management practice is independent of vegetative structure.

The calculated chi-square was 25.806. With 8 degrees of freedom (df) and selecting a 95% confidence level (0.050), it is noted that a chi-square of 25.806 is greater than the critical value of 15.507. Therefore, for land management and composition, we must reject the null hypothesis. There is a statistical difference between the observed and the results happening by chance, That is, there is a relationship between the land management practice and structure.

4.4 Composition and characteristics of features

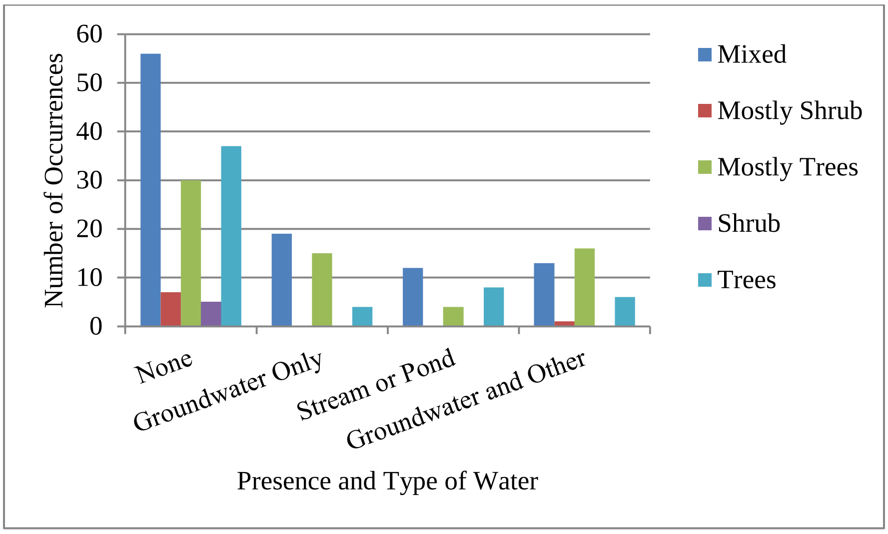
The potential relationships between composition and some of these attributes was also tested. The statistical results found relationships between Water and Composition but no relationship between Rock and Composition or Land Management and composition.

Focusing on the relationship between Water and Composition, the Contingency Table as shown in Table 4.6 and Chart in Figure 4.9.

Table 4.6 Contingency Table: Composition and Water

	Presence of Water and Type at Feature			
Composition	None	Groundwater Only	Stream or Pond	Groundwater and Other
Mixed	56	19	12	13
Mostly Shrub	7	0	0	1
Mostly Trees	30	15	4	16
Shrub	5	0	0	0
Trees	37	4	8	6

Figure 4.9 Bar Chart: Composition and Water



The chi-square test for independence was used to determine whether the proportion of times that the composition (mixed, mostly shrub, mostly trees, shrub or trees) of non-woody vegetation occurs is the same for all of the water parameters. The null hypothesis tested is that the water attribute is independent of vegetation composition.

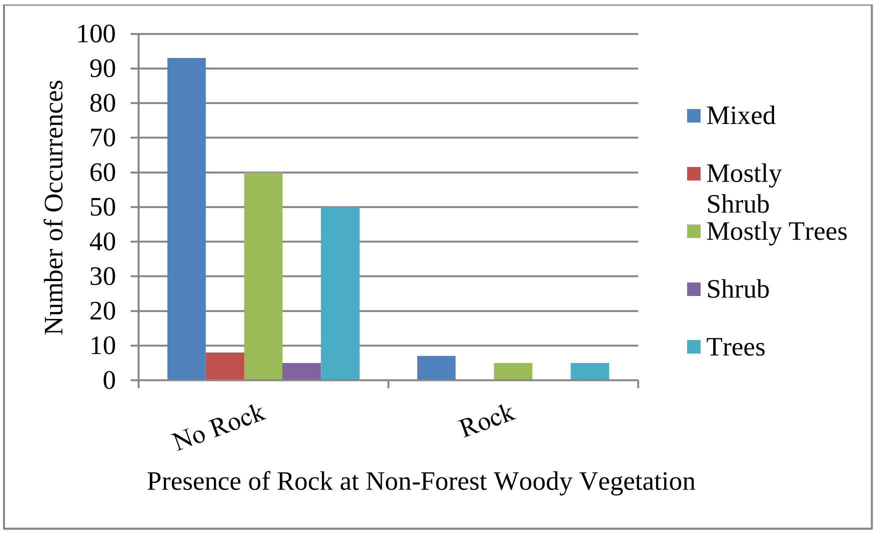
The calculated chi-square was 21.467. With 12 degrees of freedom (df) and selecting a 95% confidence level (0.050), it is noted that the chi-square value of 21.467 is greater than the critical value of 21.026. Therefore, for composition and water, we must reject the null hypothesis. There is a statistical difference between the observed and the results happening by chance, That is, there is a relationship between water and vegetative composition.

As noted above, no relationship was found between Rock and Composition. The Contingency Table is shown in Table 4.7 and Chart in Figure 4.10.

Table 4.7 Contingency Table: Composition and Rock

	Presence of Rock at Feature	
Composition	No Rock	Rock
Mixed	93	7
Mostly Shrub	8	0
Mostly Trees	60	5
Shrub	5	0
Trees	50	5

Figure 4.10 Bar Chart: Composition and Rock



The chi-square test for independence was used to determine whether the proportion of times that the composition (mixed, mostly shrub, mostly trees, shrub or trees) of non-woody vegetation occurs is the same regardless of the presence of rock. The null hypothesis tested is that rock is independent of vegetative composition.

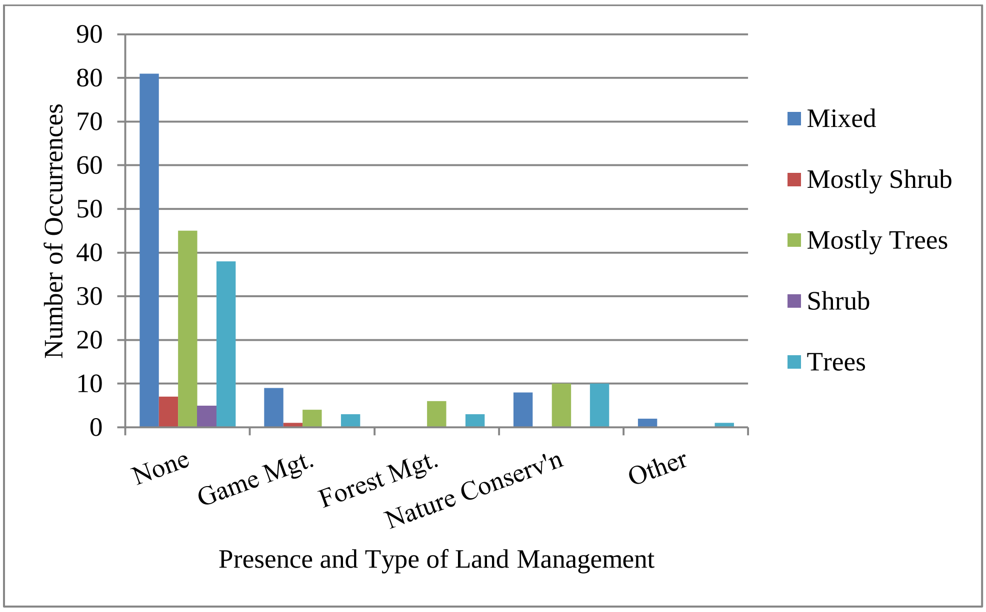
The calculated chi-square was 1.313. With 4 degrees of freedom (df) and selecting a 95% confidence level (0.050), it is noted that a chi-square of 1.313 is less than the critical value of 9.488. Therefore, for rock and composition, we must accept the null hypothesis. There is no statistical difference between the observed and the results happening by chance, That is, there is no relationship between rock and composition.

As noted above, there was also no relationship was found between Land Management and Composition. The Contingency Table is shown in Table 4.8 and Chart in Figure 4.11.

Table 4.8 Contingency Table: Composition and Land Management

	Presence of Land Management and Type at Feature				
Composition	None	Game Mgt.	Forest Mgt.	Nature Conserv'n	Other
Mixed	81	9	0	8	2
Mostly Shrub	7	1	0	0	0
Mostly Trees	45	4	6	10	0
Shrub	5	0	0	0	0
Trees	38	3	3	10	1

Figure 4.11 Bar Chart: Composition and Land Management



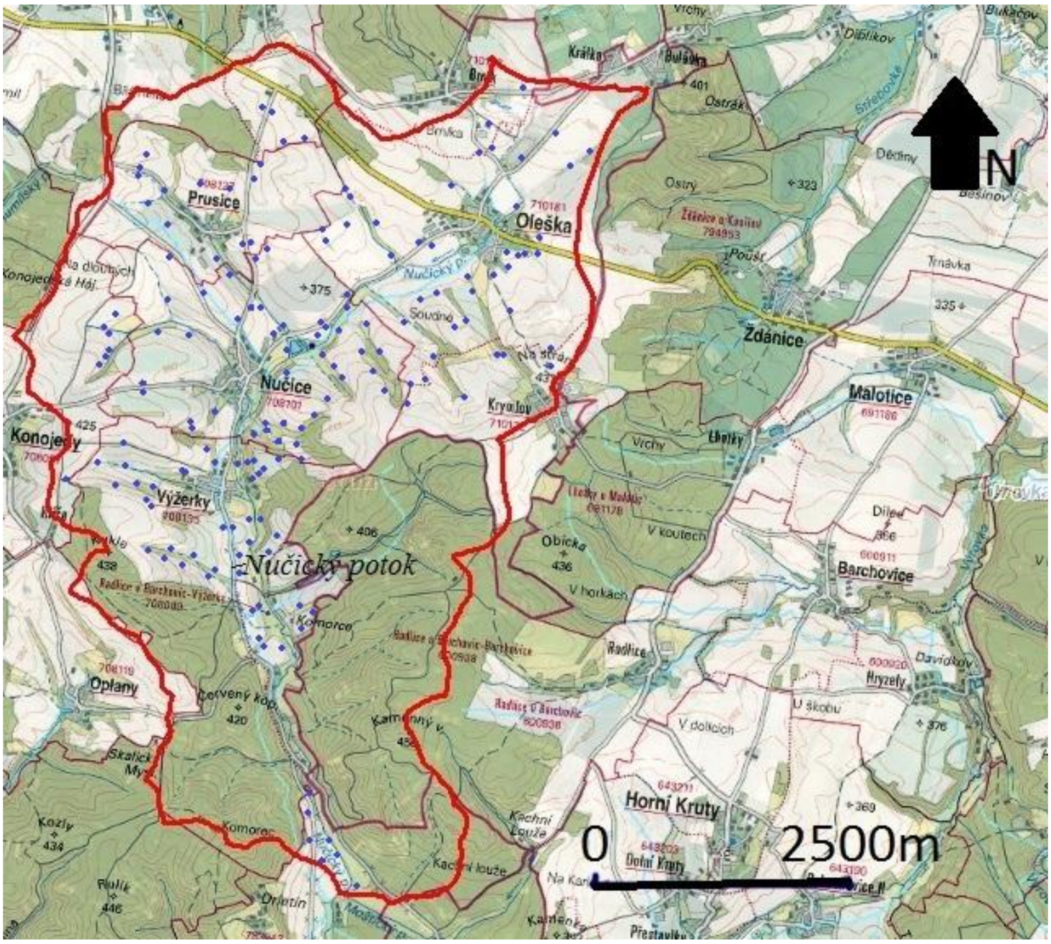
The chi-square test for independence was used to determine whether the proportion of times that the composition (mixed, mostly shrub, mostly trees, shrub or trees) of non-woody vegetation occurs is the same regardless of the presence of rock. The null hypothesis tested is that rock is independent of vegetative composition.

The calculated chi-square was 21.433. With 16 degrees of freedom (df) and selecting a 95% confidence level (0.050), it is noted that a chi-square of 21.433 is less than the critical value of 26.296. Therefore, for land management and composition, we must accept the null hypothesis. There is no statistical difference between the observed and the results happening by chance, That is, there is no relationship between land management practice and composition.

4.5 Summary of results

The approximate locations of the non-forest woody vegetation features identified in the field are shown in Figure 4.12 which is also replicated in Appendix A as Figure A.1.

Figure 4.12 Approximate Locations of the Non-forest Woody Vegetation Features



Note: Figure indicates case study boundary in red and non-forest woody feature approximate locations as blue dots (basemap source: Geoportal INSPIRE, WMS-ZM10).

A summary of the above statistical discussion is presented in Table 4.9. It is particularly interesting to note the calculated *p*-values (or probability value) which reflects the smallest level of significance at which the null hypothesis will be rejected, assuming the null hypothesis is true. Therefore, *p*-values less than the 95% probability, or $p < 0.050$, will reflect rejection of the null hypothesis since we are using the 95% probability threshold for the chi-square test.

Table 4.9 Summary of Statistical Results

Parameters Compared		Statistical Test						
		df	Chi-Square	Critical Value (CV) @ x^2.050	Chi-Square > or < CV	*p* value	Accept or Reject Null Hypothesis[1]	Statistical Difference between O-E
Structure and Composition		**8**	**14.987**	**15.507**	**<**	**0.478876**	**Accept**	**No**
Structure and -								
	Water	6	20.549	12.592	>	0.002211	Reject	Yes
	Rock	2	22.491	5.991	>	0.000013	Reject	Yes
	Land Management	8	25.806	15.507	>	0.001134	Reject	Yes
Composition and -								
	Water	12	21.467	21.026	>	0.043949	Reject	Yes
	Rock	4	1.313	9.488	<	0.859144	Accept	No
	Land Management	16	21.433	26.296	<	0.162475	Accept	No

[1]Null Hypothesis: No statistical difference between the observed (O) and the expected (E) results.

The *p*-values also indicate the strength of significance of the result. *P*-values that are much smaller or much larger than 0.050 will indicate greater significance of the conclusions. As shown on Table 4.9, the relationship between structure and rock is very significant with a calculated *p*-value of 0.000013. The relationship between structure and water and between structure and land management is moderately significant with p- values of 0.002211 and 0.001134, respectively. The relationship between composition and water is marginally significant (p = 0.043949 compared to 0.050).

Chapter 5 presents a discussion of these results.

5. Discussion

5.1 Discussion of results

The results of the study indicate significant relationships between the structure of non-forest woody vegetation elements (i.e. linear, patch or point) and the presence of water, rock and the particular land management technique of the area. The study results also indicate that the composition of the non-forest woody vegetation elements (i.e. mix, mostly tree, tree, mostly shrub, or shrub) has a significant relationship to the presence of water, but no relationship to the presence of rock or the land management techniques of the area.

Comparisons of non-forest woody vegetation structure to the locational characteristic indicate that more of the selected parameters are related to structure of the non-forest woody vegetation features (all three of the characteristics – water, rock and land management technique) than to the composition of those features (one of the three characteristics – only water). This may be a function of which locational characteristics were selected for testing – water, rock and land management practice. However, it may also indicate that environmental and cultural characteristics are more likely to have a relationship to the structure of non-forest woody vegetation features than the composition of the vegetation features.

The significant relationship between the structure of non-forest woody vegetation and water, rock and land management is not surprising. Whether linear, patch or point, the structure may be altered by the influence of landforms (rock), accessibility to water (groundwater, streams, etc.), and by manmade changes to the landscape (such as clearing for agriculture).

Similarly, the significant relationship between the composition of non-forest woody vegetation and water is not surprising. The existence and availability of water is extremely important to the type of vegetation within these areas since different species have varying hydrological requirements. A hydrophyte grows in water or on a substrate that is at least periodically deficient in oxygen as a result of excessive water. By contrast, a mesophyte grows under average moisture conditions. A xerophyte grows in low moisture conditions such as a desert.

Increased non-forest patches, linear features and points may be an indicator of landscape fragmentation and can contribute to the understanding of land cover changes on a local level (Olsen et al., 2007). However, depending on the past and present land use, non-forest woody vegetation may also indicate an increase of heterogeneity in a once homologous landscape area.

The data and results of this study can be used for further investigations of additional relationships between non-forest woody vegetation attributes and locational characteristics. With the addition of other factors such as changes over time (temporal differences), the analysis could also provide insight on how these relationships might evolve over a period of time.

Knowing the possible environmental and cultural relationships in areas of non-forest woody vegetation can be an important step in further understanding which conservation practices and other land management strategies are most desirable in a particular area. Non-forest woody vegetation can provide critical habitat and shelter for animal and bird species and can also provide partial connectivity with larger biocenters and biocorridors (Billeter et al., 2007). Therefore, if managed appropriately, non-forest woody vegetation can have a positive effect on species protection and biodiversity.

5.2 Discussion of methodology

The methodology used in this study had numerous advantages, but also had some shortcomings – both of which are described below.

Location: The study area selected was very homogenous in terms of non-forest woody vegetation and was purposely chosen for this reason. However, study results may not be replicated in areas that are less homogeneous.

Source data: GIS provided a large amount of data that could not be easily collected in the field and is easily repeatable. However, GIS may not provide as much specificity as field data – for example, while general soil types are available from GIS, soil sampling would likely yield more accurate results. Also, only visible rock was noted through field observation – buried rock and depth to bedrock were not evaluated.

Classification system: A generally qualitative, rather than quantitative, decision-making process was used in determining whether an area was a patch or a point - i.e., trees and shrubs were not actually counted in the field. However, results were based on direct observation by the author alone, rather than by multiple study participants, so the classification process was consistent from area to area.

Composition: Tree and shrub species were not recorded; instead, the author used visual field observation to determine general composition. Again, the fact that the author was the sole field observer likely resulted in more consistent determinations. Also, field work was conducted in a relatively short time period so changes in composition were not likely.

Statistics: The chi-square method used in this study was appropriate to readily determine relationships between parameters and provided consistent, uniform results. While contingency tables are most commonly analyzed using the chi-square method, there is a method called the Fisher Exact Test that avoids the concerns associated with small expected values (values <5). However, the Fisher Exact Test is significantly more difficult to apply.

Also, while interesting to note where relationships exist between non-forest woody vegetation attributes and the characteristics of their locations, the chi-square test for independence has its inherent limitations. The chi-square test only indicates if there is a relationship between attributes and characteristics and the strength of that relationship. The statistical analysis does not determine the direction of the relationship, whether there is a causal effect, or whether another factor (related to another parameter) might also be contributing to the relationship.

For example, while the presence of rock is found to be related to the type of non-forest woody vegetation structure, it may be that the presence of rock is representative of some other parameter not measured or tested that could actually be the causal factor. Perhaps the presence or absence of visible rock is an indicator of the existence of adjacent agricultural practices – and those practices may be the parameters actually affecting the structure or composition of the non-forest woody vegetation features. In addition, not all of the relationships between predictor variables and response variables were examined; there may be additional relationships to be explored with these data.

Therefore, this study cannot conclude if or how the locational characteristics directly affect the non-forest woody vegetation elements - only that specific relationships may or may not exist between the non-forest woody vegetation attributes and their locational characteristics.

Further testing of the locational characteristics would be necessary to determine whether these relationships exist and whether they might be affecting the chi-square results presented in this study.

6. Conclusions

Landscape characteristics such as vegetation composition and structure can be used as a tool to analyze human and natural impacts in a particular area, determine the functionality or value of the area from an ecological perspective, and develop the appropriate strategies to manage land.

The results of the study indicate significant relationships between the structure of non-forest woody vegetation (i.e. linear, patch or point) and the presence of water, rock and the particular land management technique of the area. The study also found that the composition of the non-forest woody vegetation (i.e. mix, mostly tree, tree, mostly shrub, or shrub) has a significant relationship to the presence of water, but no significant relationship to the presence of rock or the land management techniques of the area.

Additional conclusions are:

- Field survey combined with GIS mapping and statistical tools provide an appropriate methodology for analyzing structure and composition of non-forest woody vegetation.
- The classification systems that have been applied in this study are relevant for describing and analyzing structures and composition of non-forest woody vegetation.
- More than three-fourths (77%) of the features have a linear structure and less than one-fourth (23%) of the features have either a patch or point structure. The linear structures have compositions that are almost equally "mixed," "mostly tree" or "tree." Non-forest woody linear features are typically associated with roadways or waterways and, as a result, may define land management techniques in these locations.
- Both environmental (water and rock) and cultural (land management) parameters affect whether the structure of non-forest woody vegetation is linear, patch or point. Further, water and rock are often obstacles to agricultural and other development practices. Therefore, it follows that environmental landscape features such as water and rock may dictate the land management practices.

- Water is the most decisive environmental factor affecting both structure and composition of non-forest woody vegetation.
- The study cannot conclude if or how the locational characteristics directly affect the non-forest woody vegetation – only that specific relationships exist between these non-forest woody vegetation attributes and their locational characteristics.
- The rigors of the data collection activities and the analysis methodology presented herein contribute to answering the initial study question. However, the data collected in the field include other parameters (e.g. soil, land slope, adjacency to roads, etc. included in Appendix A) which could be further analyzed. Furthermore, it would be interesting to add a temporal dimension to the study which would examine whether the environmental and cultural parameters affect non-forest woody vegetation over time.

The data and results of this study can be used for further investigations of additional relationships between attributes and locational characteristics of non-forest woody elements. Understanding the underlying natural and human influences within a particular area characterized by non-forest woody features leads to a better understanding of land cover changes on a local level, future landscape trends, and can lead to better land management.

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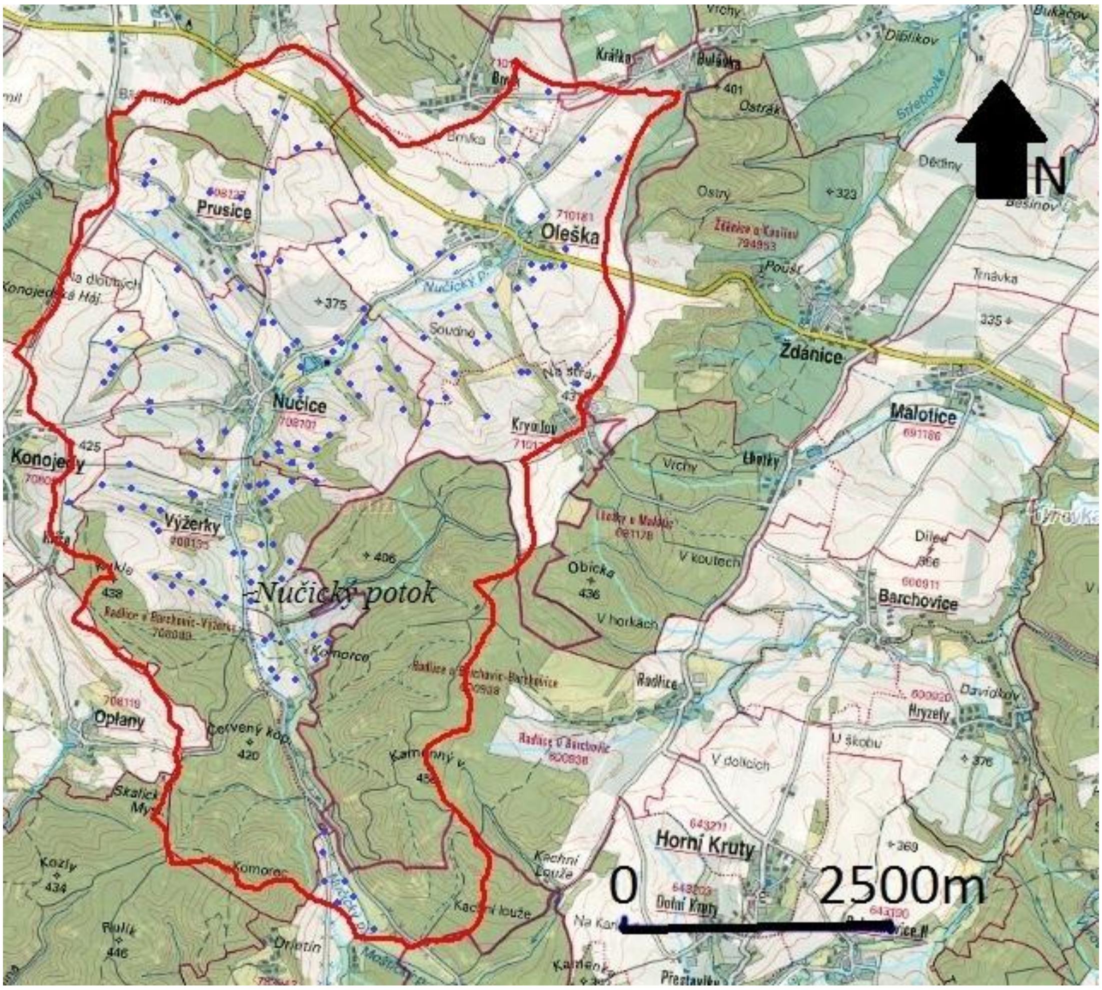
8. Appendix A

The pages which follow constitute Appendix A to this thesis. The locations of the 233 features are shown in Figure A.1. The collected field data is provided in Table A.1. The Excel file of Appendix A, Table A.1 Field Data Table, is also provided as a separate submittal but included as part of this thesis by reference.

Figure A.1 Case Study Area Boundaries and Approximate Locations of the Non-forest Woody Vegetation Features



Note: Figure indicates case study boundary in red and non-forest woody feature approximate locations as blue dots (basemap source: Geoportal INSPIRE, WMS-ZM10).

Table A.1 Field Data Table

NF Feature #	ATTRIBUTES OF NON-FOREST WOODY FEATURES: Structure (Pa, L, Po)	Area (m^2) if Linear	Area (m^2) if Patch or Point	Edge Length (m)	Composition: Tree (T), Mostly Tree (MT), Shrub (S), Mostly Shrub (MS), Mix (M)	CHARACTERISTICS: Reasons Behind the Feature Location — Ownership (Public, Private)	Typology CENIA	Typology Rompt.	Commute Type: Road (R), Field Road (FR), Path (P), None	Water: High Ground Water	Water: Wet-land	Water: Surface Water Bodies — Stream Tributary - Steady (S), Occasional (Occ)	Water: Surface Water Bodies — Stream - Nucicky p. (N.p.), Konojedsky p. (K.p.), Prusicky p. (P.p.), Vyzersky p. (V.p.)	Water: Pond	Water: None (No water adj)	CHARACTERISTICS: Reasons Behind the Feature Location — Bedrock and Soils: Rocks	Geology	Soil Type	Slope Catageory: % Slope Length 1)<5.1, 2)<10.1, 3)<15.1, 4)<20.1, 5)<25.1, 6)<30.1, 7)<35.1...	Slope Catageory: % Slope Width 1)<5.1, 2)<10.1, 3)<15.1, 4)<20.1, 5)<25.1, 6)<30.1, 7)<35.1...	Feature Slope Precise: % Slope Length	Feature Slope Precise: % Slope Width	Cultural Architecture: Religious (R), Technical (T)	CHAR'S: Reasons Behind the Feature Location — Management: Yes — Game	Management: Yes — Local Forest Mgmt.	Management: Yes — Nature Conservation	Management: Yes — Other	Management: No (None)	Zoning: No
1	L	704		358	M	Public	3M2	2Z	FR						X	None	Pa	HA	1	5	4.6	25.0	None					X	X
2	L	1,701		503	M	Public	3M2	2Z	None						X	None	Kce	HA	1	3	3.3	14.0	None	X					X
3	L	5,910		2,374	MT	Public	3M2	2Z	R	X						None	Pa	HA	1	2	2.4	10.0	T					X	X
4	L	9,456		2,380	MT	Public	3M2	2Z	R	X		Occ	P.p.			None	Pa	HA	1	3	2.4	12.5	T					X	X
5	L	1,452		496	M	Public	3M2	2Z	None			Occ	P.p.			None	Pa	HA	1	4	2.9	16.7	T					X	X
6	Pa		11,310	873	M	Public	3M2	2Z	None	X		Occ	P.p.			None	Pa	HA	1	1	2.9	3.1	None					X	X
7	L	2,934		670	MT	Public	3M2	2Z	None						X	None	Pa	HA	1	3	4.9	11.0	None					X	X
8	L	2,744		798	M	Public	3M2	2Z	None						X	None	Kce	HA	1	3	7.6	14.0	None					X	X
9	L	984		262	M	Public	3M2	2Z	None						X	None	Pa	HA	1	5	2.4	25.0	None					X	X
10	Pa		2,248	186	M	Public	3M2	2Z	None				P.p.			None	Pa	HA	1	1	1.3	2.8	T					X	X
11	L	3,760		772	M	Public	3M2	2Z	FR			Occ	P.p.			None	Kce	HM	2	2	6.4	10.0	None					X	X
12	L	1,791		416	M	Public	3M2	2Z	None						X	None	Pa	HA	1	3	3.4	11.0	None					X	X
13	L	273		92	T	Public	3M2	2Z	R						X	None	Pa	HA	1	3	5.0	14.3	None					X	X
14	L	768		208	M	Public	3M2	2Z	None	X						None	Kce	HM	2	3	9.4	12.5	R					X	X
15	L	1,364		690	T	Private	3M2	2Z	R						X	None	Kce	HA	2	5	6.2	25.0	T					X	X
16	L	1,572		792	T	Private	3M2	2Z	R						X	None	Kce	HA	2	5	5.4	25.0	T					X	X
17	L	2,145		412	MT	Private	3M2	2Z	None	X						None	Kce	HA	2	4	7.2	18.0	T		F				X
18	L	252		256	MS	Public	3M2	2Z	None						X	None	Kce	HM	3	10	10.3	50.0	T					X	X
19	L	706		710	MS	Public	3M2	2Z	None						X	None	Pa	HA	1	10	2.3	50.0	T					X	X
20	L	936		630	S	Public	3M2	2Z	R						X	None	Kce	HM	1	1	1.9	0.0	None					X	X
21	L	870		586	S	Public	3M2	2Z	R						X	None	Kce	HM	1	1	1.7	0.0	None					X	X
22	L	500		504	S	Public	3M2	2Z	R						X	None	Pa	HA	2	10	5.2	50.0	T					X	X
23	L	696		470	S	Public	3M2	2Z	R						X	None	Pa	HA	2	7	5.4	33.0	T					X	X
24	L	3,993		748	M	Private	3M2	2Z	None						X	None	Pa	HA	2	2	7.2	9.0	None	X	F				X
25	L	9,160		956	MT	Private	3M2	2Z	None	X						None	Pa	HA	1	1	2.0	5.0	T					X	X
26	L	6,076		896	MT	Public	3M2	2Z	None	X			P.p.			None	Pa	HA	1	2	1.8	7.0	T					X	X
27	L	4,432		1,124	M	Public	3M2	2Z	None	X			P.p.			None	Pa	FG	1	3	1.6	12.5	R					X	X
28	L	1,133		228	M	Public	3M2	2Z	None	X						None	PA	HA	1	2	3.9	9.0	None					X	X
29	L	1,920		652	M	Public	3M2	2Z	None						X	None	Pa	HM	1	7	0.9	33.0	None					X	X
30	L	3,600		740	M	Public	3M2	2Z	R						X	None	Pa	FG	1	4	3.6	20.0	R					X	X
31	L	2,408		702	M	Public	3M2	2Z	R						X	None	Pa	FG	1	3	4.1	14.5	None					X	X
32	L	2,736		924	M	Public	3M2	2Z	R						X	None	Pa	HM	1	4	3.5	16.7	None					X	X
33	L	4,696		1,190	M	Public	3M2	2Z	P						X	None	Pa	FG	1	5	0.5	25.0	None	X					X
34	Pa		2,840	253	M	Public	3M2	2Z	P	X			K.p.			None	Pa	HA	1	1	2.3	2.7	None	X		X			X
35	L	3,720		946	M	Public	3M2	2Z	None	X		Occ	K.p.			None	Pa	HA	1	1	3.7	0.0	None	X		X			X
36	Po		909	123	T	Private	3M2	2Z	R						X	X	Pa	HA	3	1	10.7	4.8	None	X					X
37	Pa		3,067	247	MT	Public	3M2	2Z	R	X			K.p.	X		X	Pa	HA	1	1	2.8	4.1	None	X					X
38	L	24,720		3,326	MT	Public	3M2	2Z	None	X		S	K.p			None	Pa	HA	1	2	1.8	6.7	None			X			X
39	L	168		68	M	Public	3M2	2Z	None	X			K.p			None	Pa	HA	2	4	7.1	16.7	None			X			X
40	L	392		126	M	Public	3M2	2Z	None						X	None	Pa	HM	3	3	10.7	14.3	None					X	X
41	L	2,709		1,555	M	Public	3M2	2Z	None						X	None	Pa	HA	1	12	1.8	57.1	None					X	X
42	L	328		172	M	Private	3M2	2Z	None	X						None	Pa	HA	1	3	4.9	12.5	None					X	X
43	L	948		328	M	Private	3M2	2Z	None						X	None	Pa	HM	2	7	5.1	33.3	None					X	X
44	L	380		198	M	Public	3M2	2Z	None						X	X	Pa	HM	1	5	4.2	25.0	None					X	X
45	Pa		1,618	239	M	Public	3M2	2Z	None						X	X	Pa	HM	2	4	6.3	16.7	None	X					X
46	L	2,015		336	M	Public	3M2	2Z	None	X			K.p.			None	Pa	FG	1	4	2.0	15.4	None					X	X

Table A.1 Field Data Table

ATTRIBUTES OF NON-FOREST WOODY FEATURES						CHARACTERISTICS: Reasons Behind the Feature Location										CHARACTERISTICS: Reasons Behind the Feature Location								CHAR'S: Reasons Behind the Feature Location					
	Structure				Compos-ition	Owner-ship			Commute Type	Water						Bedrock and Soils							Cultural	Management					Zoning
										Surface Water Bodies									Slope Catagoery		Feature Slope Precise		Architecture	Yes					
NF Feature #	Pa, L, Po	Area (m^2) if Linear	Area (m^2) if Patch or Point	Edge Length (m)	Tree (T), Mostly Tree (MT), Shrub (S), Mostly Shrub (MS), Mix (M)	Public, Private	Typology CENIA	Typology Rompt.	Road (R), Field Road (FR), Path (P), None	High Ground Water	Wet-land	Stream Tributary - Steady (S), Occasional (Occ)	Stream - Nucicky p. (N.p.), Konojedsky p. (K.p.), Prusicky p. (P.p.), Vyzersky p. (V.p.)	Pond	None (No water adj)	Rocks	Geology	Soil Type	% Slope Length 1)<5.1, 2)<10.1, 3)<15.1, 4)<20.1, 5)<25.1, 6)<30.1, 7)<35.1…	% Slope Width 1)<5.1, 2)<10.1, 3)<15.1, 4)<20.1, 5)<25.1, 6)<30.1, 7)<35.1…	% Slope Length	% Slope Width	Religious (R), Technical (T)	Game	Local Forest Mgmt.	Nature Conser-vation	Other	No (None)	No
47	L	2,001		1,340	M	Public	3M2	2Z	None						X	None	Pa	FG	1	7	2.4	33.3	None					X	X
48	L	398		323	MS	Private	3M2	2Z	None						X	None	Pa	FG	1	8	3.8	40.0	None					X	X
49	L	1,296		870	MS	Public	3M2	2Z	None						X	None	Pa	HM	1	7	4.6	33.3	None					X	X
50	L	5,127		3,424	T	Public	3M2	2Z	R						X	None	Pa	HM	1	5	3.5	25.0	None					X	X
51	L	3,418		3,422	T	Public	3M2	2Z	R						X	None	Pa	HM	1	5	3.5	25.0	None					X	X
52	L	2,958		998	T	Private	3M2	2Z	None						X	X	Pa	HM	2	5	6.7	25.0	None					X	X
53	L	623		192	MT	Private	3M2	2Z	None	X						X	Pa	HM	1	9	4.5	42.9	None					X	X
54	L	372		136	MT	Private	3M2	2Z	None						X	X	Pa	HM	1	1	0	0	None					X	X
55	L	2,478		382	M	Private	3M2	2Z	None	X						None	Pa	HL	2	6	7.3	28.6	None					X	X
56	L	1,080		286	MT	Public	3M2	2Z	None						X	None	Pa	HL	2	3	6.7	12.5	None					X	X
57	L	1,020		1,024	T	Public	3M2	2Z	R						X	None	Pa	FG	1	10	0.6	50	None					X	X
58	L	1,976		996	MT	Public	3M2	2Z	None	X			N.p.			X	Pa	FG	1	1	0	0	T			X			X
59	L	588		398	M	Public	3M2	2Z	None						X	None	Pa	HL	2	7	8.2	33.0	None					X	X
60	L	639		432	M	Public	3M2	2Z	None	X						None	Pa	HL	1	10	2.4	50.0	None					X	X
61	Po		434	81	MT	Public	3M2	2Z	None						X	X	Pa	HL	3	3	14.9	11.1	None					X	X
62	L	1,033		597	M	Public	3M2	2Z	R						X	None	Pa	HM	2	6	6.0	29.0	None					X	X
63	L	1,033		597	M	Public	3M2	2Z	R						X	None	Pa	HM	2	5	6.0	29.0	None					X	X
64	L	2,706		914	M	Public	3M2	2Z	R	X						None	Pa	HM	1	7	1.8	33.0	None					X	X
65	L	1,266		434	M	Public	3M2	2Z	None			Occ	V.p.			None	Pa	HM	2	2	9.0	8.3	T					X	X
66	L	528		148	MT	Private	3M2	2Z	None						X	None	Pa	HM	1	8	3.0	37.3	None					X	X
67	L	306		210	MS	Public	3M2	2Z	None						X	None	Pa	HM	2	7	5.9	33.0	None					X	X
68	L	1,602		374	MT	Public	3M2	2Z	None						X	None	Pa	HM	1	7	1.7	33.0	None	X					X
69	L	864		210	M	Public	3M2	2Z	FR						X	None	Pa	HM	2	16	5.2	83.0	T					X	X
70	L	1,134		338	T	Public	3M2	2Z	R						X	None	Pa	HL	1	1	1.9	0.0	R					X	X
71	L	2,220		752	MT	Public	3M2	2Z	FR						X	None	Pa	HM	1	4	1.1	16.7	T					X	X
72	L	788		457	MT	Public	3M2	2Z	FR						X	None	Pa	HM	1	6	1.3	28.6	T					X	X
73	L	464		132	T	Public	3M2	2Z	FR						X	None	Pa	HM	1	3	3.5	12.5	T					X	X
74	Pa		320	80	M	Private	3M2	2Z	None	X						None	Pa	HM	1	3	2.5	11.8	T					X	X
75	L	6,050		1,122	MT	Public	3M2	2Z	FR	X			V.p.			None	Pa	HM	1	3	2.4	13.7	None					X	X
76	L	4,640		948	M	Public	3M2	2Z	FR			Occ	V.p.			None	Pa	HA	1	3	4.3	15.0	R					X	X
77	L	987		296	M	Public	3M2	2Z	FR						X	None	Pa	HA	1	1	2.2	0.0	None					X	X
78	L	2,376		420	M	Public	3M2	2Z	R	X						None	Pa	HA	2	2	5.1	8.3	None					X	X
79	L	784		400	M	Public	3M2	2Z	R						X	None	Pa	HM	2	3	5.1	12.5	None					X	X
80	L	4,112		546	T	Private	3M2	2Z	None						X	X	Pa	HM	3	3	13.6	12.5	None		F				X
81	L	616		170	T	Private	3M2	2Z	None						X	None	Pa	HM	5	3	20.8	12.5	None					X	X
82	L	1,840		262	T	Private	3M2	2Z	None						X	None	Pa	HM	4	2	17.4	6.3	None		F				X
83	L	2,885		1,164	M	Public	3M2	2Z	None						X	X	Pa	HM	1	12	0.7	60.0	None					X	X
84	L	801		540	S	Private	3M2	2Z	None						X	None	Pa	HM	1	10	3.4	50.0	None					X	X
85	L	2,040		428	MT	Public	3M2	2Z	FR						X	None	Pa	HM	2	4	8.3	20.0	None	X					X
86	L	712		364	T	Public	3M2	2Z	FR						X	None	Pa	HM	2	5	9.0	25.0	None					X	X
87	L	1,351		400	M	Private	3M2	2Z	None						X	None	Pa	HL	2	3	6.7	14.5	None					X	X
88	L	126		90	M	Private	3M2	2Z	R						X	None	Pa	HL	1	7	4.8	33.0	T					X	X
89	L	190		86	M	Private	3M2	2Z	R						X	None	Pa	HL	1	4	2.6	20.0	T					X	X
90	L	972		976	T	Public	3M2	2Z	R						X	None	Pa	HL	1	5	1.0	25.0	T					X	X
91	L	1,740		1,166	T	Public	3M2	2Z	R						X	None	Pa	HL	1	7	1.0	33.0	T					X	X
92	L	1,084		550	M	Public	3M2	2Z	None						X	None	Pa	HL	1	10	0.7	50.0	None					X	X

Table A.1 Field Data Table

ATTRIBUTES OF NON-FOREST WOODY FEATURES						CHARACTERISTICS: Reasons Behind the Feature Location										CHARACTERISTICS: Reasons Behind the Feature Location								CHAR'S: Reasons Behind the Feature Location					
	Structure				Composition	Ownership			Commute Type	Water						Bedrock and Soils							Cultural	Management					Zoning
										Surface Water Bodies									Slope Catageory		Feature Slope Precise		Architecture	Yes					
NF Feature #	Pa, L, Po	Area (m^2) if Linear	Area (m^2) if Patch or Point	Edge Length (m)	Tree (T), Mostly Tree (MT), Shrub (S), Mostly Shrub (MS), Mix (M)	Public, Private	Typology CENIA	Typology Rompt.	Road (R), Field Road (FR), Path (P), None	High Ground Water	Wetland	Stream Tributary - Steady (S), Occasional (Occ)	Stream - Nucicky p. (N.p.), Konojedsky p. (K.p.), Prusicky p. (P.p.), Vyzersky p. (V.p.)	Pond	None (No water adj)	Rocks	Geology	Soil Type	% Slope Length 1)<5.1, 2)<10.1, 3)<15.1, 4)<20.1, 5)<25.1, 6)<30.1, 7)<35.1...	% Slope Width 1)<5.1, 2)<10.1, 3)<15.1, 4)<20.1, 5)<25.1, 6)<30.1, 7)<35.1...	% Slope Length	% Slope Width	Religious (R), Technical (T)	Game	Local Forest Mgmt.	Nature Conservation	Other	No (None)	No
93	L	3,570		1,438	M	Public	3M2	2Z	FR	X						X	Pa	HM	1	4	4.3	20.0	None	X					X
94	L	428		222	MS	Private	3M2	2Z	None	X		Occ	N.p.			None	Pa	HL	1	1	4.7	0.0	None	X					X
95	L	500		210	T	Public	3M2	2Z	FR						X	None	Pa	HM	3	4	13.0	20.0	T					X	X
96	L	186		190	M	Public	3M2	2Z	None			Occ	N.p.			None	Pa	HM	1	8	2.2	37.0	None					X	X
97	Pa		1,834	216	M	Public	3M2	2Z	None	X		Occ	N.p.			None	Pa	HM	2	2	6.8	6.0	None	X					X
98	Po		302	92	T	Private	3M2	2Z	None						X	X	Pa	HM	4	4	20.0	17.7	None					X	X
99	Pa		2,270	297	T	Private	3M2	2Z	None						X	X	Pa	HM	2	4	7.5	15.4	None	X	F				X
100	Pa		14,644	1,330	M	Public	3M2	2Z	None	X						X	Pa	HM	2	3	9.8	13.3	None	X					X
101	L	448		232	T	Private	3M2	2Z	R			Occ	N.p.			None	Pa	HL	1	5	1.8	25.0	T					X	X
102	L	1,015		304	T	Private	3M2	2Z	R						X	None	Pa	HL	1	3	2.8	14.3	None					X	X
103	L	2,471		720	M	Private	3M2	2Z	None	X		Occ	N.p.			None	Pa	HL	1	5	4.8	21.4	T	X					X
104	L	232		236	M	Public	3M2	2Z	R						X	None	Pa	FG	1	5	4.3	25.0	None					X	X
105	L	435		296	M	Public	3M2	2Z	R						X	None	Pa	FG	1	4	4.8	16.7	None					X	X
106	Po		403	403	T	Private	3M2	2Z	None			S	N.p.			None	Pa	GF	1	1	0.0	0.0	None					X	X
107	L	705		476	M	Private	3M2	2Z	FR						X	None	Pa	HL	2	2	5.1	8.3	None					X	X
108	L	1,896		490	MT	Private	3M2	2Z	R						X	None	Pa	HL	1	14	2.5	66.7	None					X	X
109	L	705		292	MT	rivate/Publ	3M2	2Z	R						X	None	Pa	HL	1	10	2.1	50.0	None					X	X
110	L	330		269	M	rivate/Publ	3L2	2Z	None						X	None	Pa	GF	3	4	12.1	20.0	None					X	X
111	L	1,260		234	T	Public	3M2	2Z	R						X	None	Pa	HL	2	8	5.7	37.5	T					X	X
112	L	660		533	T	Public	3L2	2Z	R						X	None	Pa	GF	1	8	2.7	40.0	None					X	X
113	L	515		417	T	Public	3L2	2Z	R						X	None	Pa	GF	1	8	1.9	40.0	None					X	X
114	L	11,565		2,588	MT	Public	3L2	2M	None	X		S	N.p.			None	Pa	GF	1	3	1.3	11.1	T					X	X
115	L	390		266	M	Public	3L2	2Z	None	X						None	Pa	GF	2	9	8.5	41.7	T					X	X
116	L	268		142	MT	Private	3L2	2Z	None	X						None	Pa	GF	3	5	11.9	25.0	T					X	X
117	L	408		148	M	Private	3L2	2Z	R	X		S	N.p.			None	Pa	GF	1	10	0.0	50.0	T					X	X
118	Pa		3,874	338	M	Private	3L2	2Z	None	X		S	N.p.			None	Pa	GF	3	2	11.4	7.5	None					X	X
119	L	510		214	MT	Private	3L2	2Z	R						X	None	Pa	GF	1	12	4.9	60.0	None					X	X
120	L	1,600		340	MT	Private	3L2	2Z	R	X		Occ	N.p.			None	Pa	GF	1	3	1.9	15.0	None		F				X
121	L	8,942		1,086	T	Private	3L2	2Z	FP	X		S	N.p.			None	Pa	GF	1	3	3.0	11.8	None			X			X
122	L	3,564		670	MT	Private	3L2	2Z	None			Occ	N.p.			None	Pa	GF	1	6	1.2	27.3	None			X			X
123	L	5,544		1,030	T	Private	3L2	2Z	FP	X		S	N.p.			None	Pa	GF	1	11	2.4	54.4	None			X			X
124	L	1,320		206	MT	Private	3L2	2Z	None	X		Occ	N.p.			None	Pa	GF	1	2	0.0	10.0	None			X			X
125	L	945		388	MT	Private	3M2	2Z	None	X		Occ	N.p.			None	Pa	GF	1	1	1.1	0.0	T			X			X
126	L	1,088		552	T	Private	3M2	2Z	P	X						None	Pa	GF	1	12	1.5	60.0	None					X	X
127	Po		480	101	M	Private	3M2	2Z	None	X	X		N.p.			None	Pa	GF	1	1	0.0	5.0	T					X	X
128	L	2,471		720	T	Private	3L2	2Z	FR						X	None	Pa	HM	2	6	8.5	28.6	None					X	X
129	L	6,528		1,648	T	Private	3M2	2Z	None			S	N.p.			None	Pa	GF	1	3	1.4	12.5	None					X	X
130	L	357		244	MT	Private	3L2	2Z	P	X						None	Pa	HM	3	4	11.0	16.7	None					X	X
131	Pa		13,576	680	MT	Private	3M2	2Z	P	X		S	K.p.	X		None	Pa	FG	1	4	5.0	16.0	None		F				X
132	Pa		5,248	342	MT	Public	3M2	2Z	None	X						None	Pa	FG	1	1	0.7	2.3	T			X			X
133	L	628		322	M	Public	3M2	2Z	None						X	None	Pa	FG	1	4	1.3	18.8	None					X	X
134	L	6,080		1,236	T	Private	3M2	2Z	None			S	N.p.			None	Pa	GF	1	11	2.0	55.0	None			X			X
135	L	840		292	T	Private	3L2	2Z	R						X	None	Pa	GF	1	5	2.9	25.0	T		F				X
136	L	960		394	MT	Private	3M2	2Z	None						X	None	Pa	HM	1	1	3.7	4.5	None					X	X
137	L	14,020		2,824	T	Public	3M2	2Z	None			S	N.p.			None	Pa	FG	1	8	0.1	40.0	None			X			X
138	L	14,020		2,824	T	Public	3M2	2Z	None			S	N.p.			None	Pa	FG	1	8	0.1	40.0	None			X			X

Table A.1 Field Data Table

NF Feature #	Structure: Pa, L, Po	Area (m^2) if Linear	Area (m^2) if Patch or Point	Edge Length (m)	Composition: Tree (T), Mostly Tree (MT), Shrub (S), Mostly Shrub (MS), Mix (M)	Ownership: Public, Private	Typology CENIA	Typology Rompt.	Commute Type: Road (R), Field Road (FR), Path (P), None	Water: High Ground Water	Water: Wetland	Surface Water Bodies: Stream Tributary - Steady (S), Occasional (Occ)	Surface Water Bodies: Stream - Nucicky p. (N.p.), Konojedsky p. (K.p.), Prusicky p. (P.p.), Vyzersky p. (V.p.)	Pond	None (No water adj)	Bedrock and Soils: Rocks	Geology	Soil Type	Slope Catageory: % Slope Length 1)<5.1, 2)<10.1, 3)<15.1, 4)<20.1, 5)<25.1, 6)<30.1, 7)<35.1...	Slope Catageory: % Slope Width 1)<5.1, 2)<10.1, 3)<15.1, 4)<20.1, 5)<25.1, 6)<30.1, 7)<35.1...	Feature Slope Precise: % Slope Length	Feature Slope Precise: % Slope Width	Cultural Architecture: Religious (R), Technical (T)	Management Yes: Game	Management Yes: Local Forest Mgmt.	Management Yes: Nature Conservation	Management Yes: Other	Management: No (None)	Zoning: No
139	L	2,670		386	T	Public	3M2	2Z	P						X	None	Pa	FG	2	5	7.3	23.3	None					X	X
140	L	1,128		388	MT	Private	3M2	2Z	None						X	None	Pa	HM	2	12	6.9	58.3	None					X	X
141	L	1,332		456	M	Private	3M2	2Z	P						X	None	Pa	HM	2	14	6.8	66.7	None					X	X
142	L	3,185		924	MT	Private	3M2	2Z	None						X	None	Pa	HM	1	12	2.0	57.0	None					X	X
143	L	960		394	MT	Public	3M2	2Z	None						X	None	Pa	HM	1	10	2.6	50.0	None					X	X
144	L	2,550		862	MT	Public	3M2	2Z	None						X	None	Pa	HM	1	11	1.9	54.2	None					X	X
145	L	5,295		736	T	Public	3M2	2Z	None	X						None	Pa	FG	1	10	2.0	45.7	None			X			X
146	L	2,752		704	M	Private	3M2	2Z	None						X	None	Pa	HM	1	13	2.0	62.5	None					X	X
147	L	1,280		522	M	Private	3M2	2Z	None						X	None	Pa	HM	2	9	5.5	45.0	None					X	X
148	L	1,365		404	MT	Private	3M2	2Z	P						X	None	Pa	HM	3	10	10.3	50.0	None					X	X
149	L	4,230		1,422	MT	Private	3M2	2Z	None	X						None	Pa	HM	1	10	5.0	54.2	None					X	X
150	L	185		84	MT	Private	3M2	2Z	None						X	None	Pa	HM	4	7	16.3	35.0	None					X	X
151	L	2,667		776	T	Public	3M2	2Z	FR	X		Occ	N.p.			None	Pa	FG	1	5	0.8	21.4	T			X			X
152	L	1,043		839	T	Public	3M2	2Z	R						X	None	Pa	FG	1	6	0.7	30.0	T	X					X
153	L	828		558	M	Public	3M2	2Z	None	X						None	Pa	HM	1	8	3.6	40.0	None					X	X
154	L	1,473		988	M	Private	3M2	2Z	None	X						None	Pa	HM	1	7	4.3	33.3	None					X	X
155	L	4,480		1,136	M	Public	3M2	2Z	P						X	None	Pa	HM	1	5	4.8	25.0	None					X	X
156	L	2,344		602	MT	Private	3M2	2Z	None						X	None	Pa	HM	1	9	2.7	43.8	None					X	X
157	L	564		290	MT	Public	3M2	2Z	None						X	None	Pa	HM	1	9	2.1	43.8	None					X	X
158	L	948		482	MS	Public	3M2	2Z	None						X	None	Pa	HM	1	10	2.1	50.0	None					X	X
159	L	2,970		1,198	M	Public	3M2	2Z	None						X	None	Pa	HM	2	9	6.4	45.0	None					X	X
160	L	951		640	M	Public	3M2	2Z	None			Occ	N.p.			None	Pa	HM	2	4	5.1	16.7	None					X	X
161	L	447		304	T	Private	3M2	2Z	R						X	None	Pa	FG	1	7	2.0	33.3	T					X	X
162	L	956		486	T	Public	3M2	2Z	None				P.p.	X		None	Pa	FG	1	1	0.4	0.0	None			X			X
163	L	776		396	T	Public	3M2	2Z	None					X		None	Pa	FG	1	4	1.0	18.8	T			X			X
164	L	1,704		442	M	Public	3M2	2Z	None	X				X		None	Pa	FG	1	3	0.5	12.5	None			X			X
165	Pa		3,984	317	M	Public	3M2	2Z	None				N.p.			None	Pa	FG	1	3	3.9	13.3	None			X			X
166	L	1,218		979	MS	Private	3M2	2Z	None						X	None	Pa	FG	2	14	6.2	70.0	None					X	X
167	L	681		460	MT	Public	3M2	2Z	None	X						None	Pa	FG	1	10	2.6	50.0	None					X	X
168	L	500		258	MT	Private	3M2	2Z	P	X						None	Pa	FG	1	5	2.4	25.0	T					X	X
169	L	773		1,033	T	Public	3M2	2Z	R						X	None	Pa	FG	1	1	0.8	0.0	T					X	X
170	L	2,056		1,036	MT	Public	3M2	2Z	None	X			N.p.			None	Pa	FG	1	1	0.6	0.0	T			X			X
171	Pa		1,676	203	M	Public	3M2	2Z	None						X	X	Pa	FG	1	2	1.2	8.3	None	X					X
172	L	696		931	T	Public	3M2	2Z	R						X	None	Pa	FG	1	1	0.7	0.0	None					X	X
173	L	4,440		1,492	T	Public	3M2	2Z	None	X		Occ	N.p.			None	Pa	FG	1	4	3.7	16.7	T	X					X
174	Pa		1,616	190	M	Public	3M2	2Z	None			Occ	N.p.			X	Pa	FG	1	1	0.0	2.2	None	X	F				X
175	L	262		266	MT	Private	3M2	2Z	None	X						None	Pa	HM	1	10	4.6	50.0	None			X			X
176	L	812		246	MT	Private	3M2	2Z	None	X						None	Pa	HM	2	8	6.0	35.7	None					X	X
177	L	2,064		700	M	Public	3M2	2Z	None						X	None	Pa	HM	2	4	6.1	16.7	None					X	X
178	L	574		178	M	Public	3M2	2Z	None						X	None	Pa	HM	2	3	8.5	14.3	None					X	X
179	L	678		238	M	Private	3M2	2Z	None						X	None	Pa	HM	3	4	14.2	16.7	None			X			X
180	L	1,035		424	M	Private	3M2	2Z	None						X	None	Pa	HM	2	9	5.3	44.4	None					X	X
181	L	3,115		1,256	M	Public	3M2	2Z	P						X	None	Pa	HM	1	7	2.9	33.3	None			X			X
182	L	848		432	M	Private	3M2	2Z	None						X	None	Pa	HM	1	5	2.4	25.0	None					X	X
183	L	1,344		680	MT	Public	3M2	2Z	None						X	None	Pa	HM	2	3	8.3	12.5	None					X	X
184	L	2,410		974	M	Public	3M2	2Z	None						X	None	Pa	HL	1	12	1.0	60.0	None					X	X

Table A.1 Field Data Table

NF Feature #	ATTRIBUTES OF NON-FOREST WOODY FEATURES: Structure: Pa, L, Po	Area (m²) if Linear	Area (m²) if Patch or Point	Edge Length (m)	Composition: Tree (T), Mostly Tree (MT), Shrub (S), Mostly Shrub (MS), Mix (M)	CHARACTERISTICS: Reasons Behind the Feature Location: Ownership: Public, Private	Typology CENIA	Typology Rompt.	Commute Type: Road (R), Field Road (FR), Path (P), None	Water: High Ground Water	Water: Surface Water Bodies: Wetland	Stream Tributary - Steady (S), Occasional (Occ)	Stream - Nucicky p. (N.p.), Konojedsky p. (K.p.), Prusicky p. (P.p.), Vyzersky p. (V.p.)	Pond	None (No water adj)	CHARACTERISTICS: Reasons Behind the Feature Location: Bedrock and Soils: Rocks	Geology	Soil Type	Slope Catageory: % Slope Length 1)<5.1, 2)<10.1, 3)<15.1, 4)<20.1, 5)<25.1, 6)<30.1, 7)<35.1...	Slope Catageory: % Slope Width 1)<5.1, 2)<10.1, 3)<15.1, 4)<20.1, 5)<25.1, 6)<30.1, 7)<35.1...	Feature Slope Precise: % Slope Length	Feature Slope Precise: % Slope Width	Cultural Architecture: Religious (R), Technical (T)	CHAR'S: Reasons Behind the Feature Location: Management: Yes: Game	Management: Yes: Local Forest Mgmt.	Management: Yes: Nature Conservation	Management: Yes: Other	Management: No (None)	Zoning: No
185	Pa		2,900	504	M	Public	3M2	2Z	None				P.p.			None	Pa	FG	1	1	1.4	4.0	T					X	X
186	L	1,916		966	T	Public	3M2	2Z	None	X			N.p.			None	Pa	FG	1	4	0.6	18.8	None			X			X
187	L	363		248	MT	Public	3M2	2Z	None						X	None	Pa	FG	1	2	1.7	8.3	None			X			X
188	L	4,921		1,420	M	Public	3M2	2Z	None			S	N.p.			None	Pa	FG	1	1	1.9	3.6	None			X			X
189	Pa		11,460	661	MT	Public	3M2	2Z	None			S	N.p.			None	Pa	FG	1	1	1.6	1.8	None		F				X
190	Pa		4,452	441	MT	Public	3M2	2Z	None						X	None	Pa	FG	2	1	6.1	0.0	None		F				X
191	L	3,690		1,242	M	Public	3M2	2Z	None						X	None	Pa	HM	1	4	4.1	16.7	None					X	X
192	L	1,086		730	MT	Public	3M2	2Z	None			Occ	N.p.			None	Pa	HM	1	7	1.9	33.3	None			X			X
193	L	438		257	M	Private	3M2	2Z	None						X	None	Pa	HM	1	12	3.2	57.1	None					X	X
194	L	179		109	MT	Private	3M2	2Z	None						X	None	Pa	HM	2	6	5.8	28.6	None					X	X
195	L	2,730		922	MT	Public	3M2	2Z	P						X	None	Pa	HM	1	4	3.6	16.7	None					X	X
196	L	1,180		256	M	Private	3M2	2Z	None	X						None	Pa	HM	2	2	5.1	10.0	None	X					X
197	L	462		166	M	Public	3M2	2Z	None	X						None	Pa	HM	2	4	7.8	16.7	None					X	X
198	Po		411	108	MT	Private	3M2	2Z	None	X						None	Pa	HM	2	2	7.1	10.0	None					X	X
199	L	1,110		382	T	Private	3M2	2Z	P						X	None	Pa	HM	1	4	3.8	16.7	None					X	X
200	L	1,378		238	M	Private	3M2	2Z	None						X	None	Pa	HM	1	2	4.7	7.7	None					X	X
201	L	344		348	T	Public	3M2	2Z	R						X	None	Pa	HM	1	1	3.5	0.0	None					X	X
202	L	398		402	T	Private	3M2	2Z	R						X	None	Pa	HM	1	1	4.0	0.0	None					X	X
203	L	880		362	M	Public	3M2	2Z	None	X						None	Pa	HM	1	6	4.0	30.0	None					X	X
204	L	336		176	M	Public	3M2	2Z	None						X	None	Pa	HM	2	5	9.5	25.0	None					X	X
205	L	1,910		774	MT	Public	3M2	2Z	None	X						None	Pa	HM	1	1	4.5	5.0	None	X					X
206	L	1,785		724	M	Public	3M2	2Z	FR						X	None	Pa	FG	1	4	0.3	20.0	None					X	X
207	L	980		294	MT	Public	3M2	2Z	None	X			N.p.			None	Pa	FG	1	3	0.7	14.3	None					X	X
208	L	1,904		558	MT	Public	3M2	2Z	None	X			N.p.			None	Pa	FG	1	3	1.1	14.3	None					X	X
209	L	1,290		866	T	Public	3M2	2Z	R						X	None	Pa	HL	1	7	2.1	33.3	None					X	X
210	L	1,095		736	MT	Public	3M2	2Z	R						X	None	Pa	HL	1	7	1.9	33.3	None					X	X
211	Pa		15,642	917	MT	Public	3M2	2Z	None	X				X		None	Pa	FG	1	1	2.3	1.7	T					X	X
212	L	3,419		552	MT	Public	3M2	2Z	FR			Occ	N.p.			None	Kce	HL	1	2	4.6	9.6	None					X	X
213	L	1,365		556	M	Public	3M2	2Z	None						X	None	Pa	HM	2	5	5.5	25.0	None					X	X
214	L	4,725		1,900	M	Public	3M2	2Z	FR						X	None	Pa	HM	2	4	5.4	20.0	None					X	X
215	Pa		2,345	295	M	Public	3M2	2Z	None	X						None	Pa	HM	1	1	1.9	4.2	None					X	X
216	Pa		3,199	388	M	Private	3M2	2Z	None	X						None	Pa	HM	1	1	4.1	3.9	None					X	X
217	Pa		3,198	303	MT	Public	3M2	2Z	None	X		Occ	N.p.			None	Pa	HM	1	2	2.8	5.6	None					X	X
218	Po		617	174	M	Private	3M2	2Z	None	X		Occ	N.p.			None	Pa	HA	1	2	0.6	6.2	None					X	X
219	Pa		1,169	187	M	Public	3M2	2Z	None						X	None	Pa	HA	1	1	4.4	3.3	None					X	X
220	L	1,850		750	M	Public	3M2	2Z	None						X	None	Pa	HA	1	4	3.8	20.0	None					X	X
221	Pa		2,501	224	T	Private	3M2	2Z	None	X						None	Pa	FG	1	1	1.2	1.9	T					X	X
222	L	5,401		1,004	T	Public	3M2	2Z	FR	X			N.p.			None	Pa	HL	1	1	0.6	4.5	None					X	X
223	L	2,214		2,218	T	Public	3M2	2Z	R						X	None	Pa	HA	1	3	1.5	12.5	None					X	X
224	L	396		270	T	Public	3M2	2Z	R	X						None	Pa	HL	1	1	0.8	0.0	None					X	X
225	L	632		636	T	Public	3M2	2Z	R						X	None	Kce	HA	1	1	1.6	0.0	T					X	X
226	L	705		292	MT	Public	3M2	2Z	R						X	None	Kce	HA	1	4	1.4	20.0	T					X	X
227	L	1,080		442	M	Public	3M2	2Z	R						X	None	Kce	HA	1	1	1.4	3.0	None					X	X
228	L	336		340	MT	Public	3M2	2Z	R						X	None	Kce	HA	1	2	1.2	7.5	None					X	X
229	L	1,053		847	MT	Public	3M2	2Z	R						X	None	Kce	HL	1	8	1.7	40.0	T					X	X
230	L	1,588		1,275	T	Private	3M2	2Z	R						X	None	Kce	HL	1	8	0.8	40.0	T					X	X

Table A.1 Field Data Table

ATTRIBUTES OF NON-FOREST WOODY FEATURES						CHARACTERISTICS: Reasons Behind the Feature Location										CHARACTERISTICS: Reasons Behind the Feature Location								CHAR'S: Reasons Behind the Feature Location						
	Structure				Compos-ition	Owner-ship			Commute Type	Water						Bedrock and Soils							Cultural	Management					Zoning
										Surface Water Bodies									Slope Catageory		Feature Slope Precise		Architecture	Yes					
NF Feature #	Pa, L, Po	Area (m²) if Linear	Area (m²) if Patch or Point	Edge Length (m)	Tree (T), Mostly Tree (MT), Shrub (S), Mostly Shrub (MS), Mix (M)	Public, Private	Typol-ogy CENIA	Typol-ogy Rompt.	Road (R), Field Road (FR), Path (P), None	High Ground Water	Wet-land	Stream Tribu-tary - Steady (S), Occas-ional (Occ)	Stream - Nucicky p. (N.p.), Konojedsky p. (K.p.), Prusicky p. (P.p.), Vyzersky p. (V.p.)	Pond	None (No water adj)	Rocks	Geology	Soil Type	% Slope Length 1)<5.1, 2)<10.1, 3)<15.1, 4)<20.1, 5)<25.1, 6)<30.1, 7)<35.1...	% Slope Width 1)<5.1, 2)<10.1, 3)<15.1, 4)<20.1, 5)<25.1, 6)<30.1, 7)<35.1...	% Slope Length	% Slope Width	Religious (R), Technical (T)	Game	Local Forest Mgmt.	Nature Conser-vation	Other	No (None)	No
231	Po		957	137	M	Private	3M2	2Z	None	X						None	Kce	HL	1	1	1.6	0.0	None					X	X
232	Po		817	147	M	Public	3M2	2Z	None					X		None	Pa	HA	1	1	2.9	3.3	None					X	X
233	Pa		2,021	195	MT	Public	3M2	2Z	None	X						None	Kce	HA	1	1	1.6	2.6	None		F				X