UNIVERSITY OF LJUBLJANA
BIOTECHNICAL FACULTY

Tina SIMONČIČ

FOREST FUNCTIONS IN MULTI-OBJECTIVE FOREST MANAGEMENT

Doctoral dissertation

Ljubljana, 2016

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FUNKCIJE GOZDA V NAČRTOVANJU VEČNAMENSKE RABE GOZDNEGA PROSTORA

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Tina Simončič

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AB

We studied the importance of forest function areas and other priority areas for multi-objective forest management. The study was divided into three parts. First, we compared priority areas between the Pacific Northwest of the USA (PNW) and Central Europe (CE) by developing a conceptual framework of six dimensions (primary purpose, importance and spatial distribution of objectives, governance, permanency, spatial scale, and management regime). Secondly, we analysed the concept of forest functions in CE with a comprehensive literature overview and in-depth interviews of forestry experts. Thirdly, we evaluated the effectiveness of forest function areas in Slovenia using an on-line survey (n=162) and a participatory workshop (n=66) for forestry experts. Improvements to the concept of forest functions applied in Slovenia were captured in two alternative models (technical, conceptual), which were tested in three case study areas and evaluated by forestry experts (n=65). We confirmed that the importance of priority areas differs among the regions, especially prioritization of management objectives (mainly segregation in PNW; mainly integration in CE). The main differences among CE countries include the types of forest functions, ranking of importance, proportion of designated area and management measures associated with the selected functions. There was strong support for both technical and conceptual improvements of the concept of forest functions in Slovenia, such as fewer forest function types, prioritization of functions in the same area, less area under designation, prioritizing areas for adjusted management regimes, implementation of management measures through projects and contracts and greater participation of the public and forest owners.

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Preučevali smo pomen območij s poudarjenimi funkcijami gozda in drugih prednostnih območij za večnamensko gospodarjenje z gozdovi. Oblikovali smo model za analizo prednostnih območij, ki obsega šest dimenzij (namen določanja, pomen in prostorske prioritete ciljev, upravljanje, prostorsko merilo, trajnost, gospodarjenje), in z njim primerjali prednostna območja v Pacifiškem delu S Amerike (PNW) in Srednji Evropi (SE). S študijem literature in anketiranjem gozdarskih strokovnjakov smo analizirali koncept funkcij gozda v SE. Na ravni Slovenije smo z anketiranjem gozdarskih strokovnjakov preko spleta (n=162) in na delavnici (n=66) evalvirali učinkovitost funkcij gozda za večnamensko gospodarjenje z gozdovi. Izboljšave smo predstavili v dveh alternativnih modelih, ki so jih ovrednotili gozdarski strokovnjaki (n=65), hkrati smo jih testirali na treh testnih območjih. V PNW in SE je pomen prednostnih območij za večnamensko gospodarjenje različen; razlike smo opazili pri vseh šestih dimenzijah, največje so pri prioritizaciji ciljev (pretežno segregacija v PNW; pretežno integracija v SE). Med SE deželami smo ugotovili številne podobnosti v konceptu funkcij, razlike pa so opazne v številu in tipih funkcij, rangiranju pomena funkcij, površini območij s funkcijami in določanju ukrepov za izbrane funkcije. Gozdarski strokovnjaki v Sloveniji podpirajo predlagane tehnične in konceptualne spremembe koncepta funkcij gozda. Za izboljšanje koncepta funkcij predlagamo manj tipov funkcij, poenostavljeno rangiranje, manj prekrivanja, določanje prednosti med funkcijami, določanje prioritetnih območij za prilagojeno ukrepanje, implementacijo ukrepov preko projektov in pogodb, več participacije javnosti in lastnikov gozdov.

Table of contents

Table of scientific papers

I. Simoncic T., Boncina A., Binder F., Cavlovic J., De Meo I., Janos G., Matijasic D., Rosset C., Schneider J., Singer F., Sitko R. 2013. Importance of priority areas for multi-objective forest planning: a Central European perspective. International Forestry Review, 15, 4: 509-523.

II. Simončič T., Spies T.A., Deal R.L., Bončina A. 2015. A conceptual framework for characterizing forest areas with high societal values: experiences from the Pacific Northwest of USA and Central Europe. Environmental Management, 56, 1: 127-143.

III. Simončič T., Bončina A. 2015a. Are forest functions a useful tool for multi-objective forest management? Experiences from Slovenia. Croatian Journal of Forestry Engineering, 36, 2: 293-305.

Index of figures

Index of appendices

Index of annexes

1 INTRODUCTION AND HYPOTHESES

Accommodating the diverse and changing values associated with forests has been one of the central challenges for forest planning and management (Bengston, 1994). The basic task of forest management has always been to manage forest to provide a satisfactory mix of social values (Koch and Kennedy, 1991). In traditional forestry the provision of commodity values, such as the sustainable yield of commercial timber, was the central concern of forest management (Wilkinson and Anderson, 1987; Schmider et al., 1993). Over the years, values related to forest have changed substantially, and forest managers have had to face the challenge of dealing with a much broader range of social and environmental issues (Sayer and Maginnis, 2005; Angelstam et al., 2005; McAfee et al., 2010). Forests have become important for hydrology and amenity, and have become globally important for biodiversity and carbon storage (Sayer and Maginnis, 2005). Forests are increasingly used by urban populations for recreational purposes (Führer, 2000). Given climate change and the increased risk of natural hazards, the soil and water protection functions of forests are becoming increasingly important (Miura et al., 2015). On the other hand, forest remains a usable and productive part of man's environment, and economic preferences are still the main reasons for forest management (Schmithüsen, 2007).

As society's expectations for an array of goods and services (hereafter services) increase, the role of forests as multifunctional landscapes is becoming more important, and the planning and management required for providing these services is becoming more complex (McAfee et al., 2010). Forest management that considers the multiple values and interests of society and provides an array of timber and non-timber services has been denoted as "multi-objective" forest management (Pukkala, 2002; Seely et al., 2004). The term multi-objective forest management is an umbrella term used to describe approaches to forest management that take into account very broad social, economic and ecological interests. Originally, foresters in the United States applied the term multiple-use forestry (Pearson, 1944; Vincent and Binkley, 1992; Klemperer, 1996), whereas in Europe, multipurpose (Glück, 2000) or multifunctional forest management (Führer, 2000; Cubbage et al., 2007) have been common labels for the above-mentioned management approach. Differences in the mentioned terms mainly derive from different focuses and perspectives, and from the scale at which the provision of forest services is considered.

Multi-objective forest management is often described as cross-scale management associated with social, ecological and economic interests that simultaneously combines timber production with non-timber services such as recreation, nature conservation or protection against natural hazards (Piussi and Farrell, 2000; Pukkala, 2002). Multiple-use forestry began to be discussed in the 1930s, but was not seriously considered until the middle of 20th century when demands for recreation, wildlife, water and other non-timber forest resources began to increase (Bengston, 1994). Three main stages in the development of multi-objective forest management can simply be identified (Gašperšič, 1995): 1) the period of monofunctional management when classical forestry was oriented towards

achieving a single management objective – timber production; 2) the period of declarative multi-objective forest management which was based on the "backwash theory" or Ger. "Kielwassertheorie"; during this period, the awareness of social and environmental roles of forests began to strengthen, but the planning concept still focused on management for sustainable timber production by which all other functions should be provided (Rupf, 1960; Gotsch, 1978); 3) the period of multi-objective and sustainable forest management, when forest development planning or Ger. "Waldentwicklungsplannung" in Central Europe (Bachmann, 1999) and ecosystem planning in the United States (Wiersum, 1995) developed, and forest planning as a discipline to enhance multi-objective forest management gained more importance (Andersson et al., 2000; Farcy, 2004).

A number of countries now apply various forms of multi-objective forest management and use a wide variety of tools. On the global level, three groups of forest functions are recognized: productive, protective and socio-economic. Together with biological diversity, they represent the main criteria for sustainable forest management (Glück, 1995; MCPFE, 2003). The productive functions indicate the economic and social utility of forest resources to national economies and forest-dependent local communities; protective functions include protection of soils from wind and water erosion, coastal protection, avalanche control and air pollution mitigation, and other protective effects; socio-economic functions are connected to the value of wood and non-wood forest products, employment in forestry, and various social uses such as recreation, tourism, education, research and the conservation of cultural or spiritual values (Global forest…, 2010).

1.1 THE FRAMEWORK FOR MULTI-OBJECTIVE FOREST MANAGEMENT

The basic task of forest management has been to operationalize social values, demands and interests into forest management practices (Wiersum, 1995). Demands and interests describe what people (society, individuals, forest owners) expect from forests. In the context of multi-objective forest management, the various demands and interests of society are identified and transformed into management objectives (Bončina, 2009). Multiple-use is the result of the decision-making process; it depends on the resource capability, technology of production, relative values of inputs and outputs, laws governing land use practices, etc. (Deltuvas, 1996). Two broad aspects are relevant for practicing multi-objective forest management. The first is political. Forest policy reflects society's objectives regarding the use of forests and defines the means to achieve them (Linddal, 1996). Policy instruments such as forest laws balance land ownership rights against public interests associated with multiple forest uses and determine management standards for private and public tenure (Schmithüsen and Zimmermann, 2000). Forest policy determines the rules on regulating forest land use (e.g. public access to forests), the balance between public and private goods, and the obligations and rights of forest owners, all of which influence state interventions and management practices and define rights, limitations or obligations for the utilization of forests (e.g. Kissling-Näf, 2000). Forest policy is an

important basis for all further planning and decision-making regarding the use of forests (Krott, 2005).

The second aspect is management. Policy mandates create the need for development of management objectives, strategies and tools that facilitate the provision of an array of forest services (Cubbage et al., 2007). In this light, forest management planning plays an important role as a discipline through which forest policy is expressed and management choices are made (Farcy, 2004). It aims to transform the broader policy goals into practical means (Gašperšič et al., 2001). The main challenge for forest management planning is how to organize multi-objective forest management within the existing policy framework in order to provide the desired services to society (Selman, 2002; Brukas and Sallnäs, 2012). Forest planning acts as a coordinator between societal demands, forest owner interests and the ability of forest ecosystems to provide the desired services by forest management (Bachmann, 2005a). Accordingly, it defines targeted services, objectives, priorities and controlling mechanisms with which to ensure both public interests and management of the forest. Management objectives define which forest services will be prioritized by forest management (Bettinger et al., 2009); they are the framework for selecting management strategies and measures that will promote the desired services (Figure 1). Management actions have an impact on all components and functions of forest ecosystems; therefore, it is generally not possible to apply management measures that provide only one ecosystem service (Gašperšič, 1995). Multifunctionality is achieved by a system of harmonized management measures that create forest stands capable of delivering an array of ecosystem services. This is done with different kinds of management measures in the field of silviculture, forest protection, road construction or specific measures (Boncina, 2011). Many services are strongly conditioned by the structure and composition of forest stands, and thus silviculture plays a crucial role by creating structural elements that are able to provide the desired services (Spellmann, 1995; Wagner, 2004). For example, silviculture systems may be used to improve and diversify the habitat for wildlife in general and protect less mobile or less adaptable native species (Matthews, 1989). Besides silviculture, other measures may be needed to provide services. Recreational enjoyment is often connected to specific places, the visual scale of the countryside, panoramas and diverse landscapes (Lacaze, 2000), and requires recreational infrastructure or specific (e.g. seasonal) regimes of forest users and visitor flow regulations (Pröbstl et al., 2009). Similarly, the protection function may be achieved by building new infrastructure or by applying specific silvicultural regimes that create stands with the capacity to protect against natural hazards (e.g. Berger and Ray, 2004). Finally, some services are promoted through restriction of forest management and silviculture activities, such as the establishment of forest reserves or retention of old-growth attributes (Winter et al., 2005; Bauhus et al., 2009).

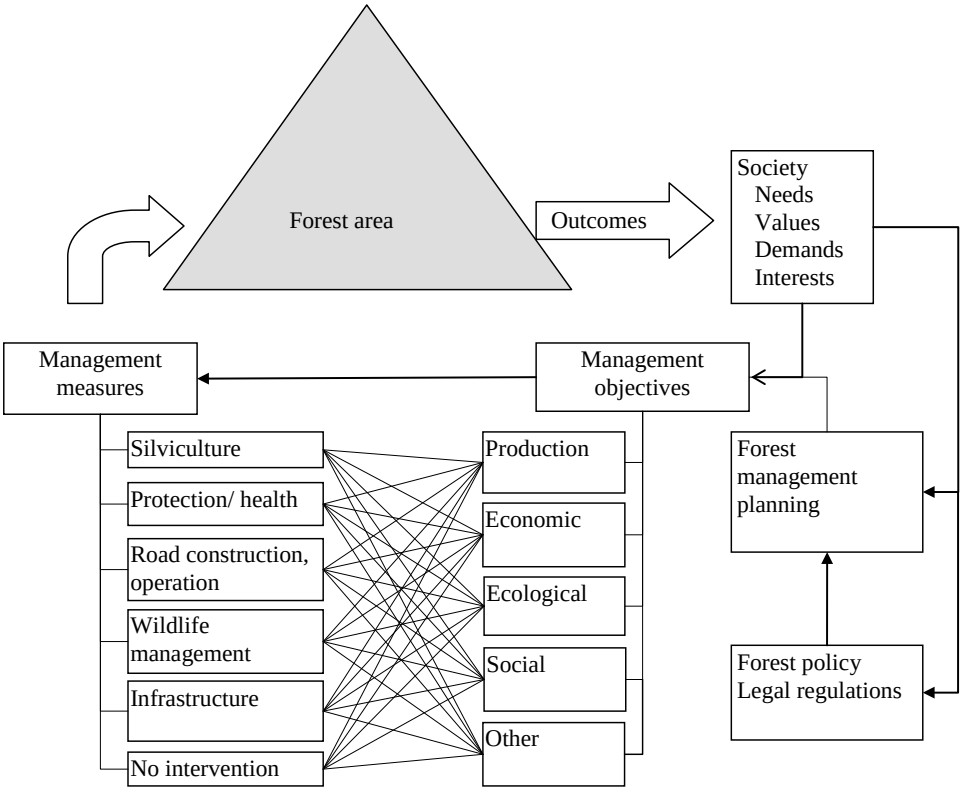

Figure 1: The framework of multi-objective forest management (modified after Boncina, 2011).

Due to the diverse natural and socio-economic conditions, targeted services, management objectives and the measures that promote them vary across forest landscapes. Therefore, it is not desirable or even possible to create a forest ecosystem that fulfils the demands for all forest services equally (Wagner et al., 2013). For practical reasons, spatial classifications of forests have been applied that refer to differences in management goals for different parts of the forest (Haas et al., 1987; Bos, 1993).

1.2 SPATIALLY-BASED APPROACHES TO MULTI-OBJECTIVE FOREST MANAGEMENT

Land classifications for different uses have traditionally been important for managing landscapes (Christian, 1958; Bornes et al., 1982), especially for defining timber-oriented management objectives and activities in space and time (Bettinger et al., 2009). Many spatial classifications in forest management are based on the physical environment and vegetation (e.g. Kimmins, 1997), while some focus on the values, objectives and outcomes of forest management (Boyland et al., 2004; Zhang, 2005). In the framework of multi-objective forest management, forest area is commonly classified into allocations which have been identified as having higher importance for the selected forest services (Behan, 1990; Gustafson, 1996; Neue Wege…, 1996; Führer, 2000; Boyland et al., 2004; Zhang, 2005; Côté et al., 2010). An umbrella term “forest priority areas” has been proposed for all

kinds of allocations that have some legally-based status (i.e. through forest plans or legal regulations) (Simončič et al., 2015). By spatially prioritizing forest lands, some forest areas become more important for nature conservation, some are prioritized for recreation, and others remain as areas for timber production and other commodity services. Such an approach enables clear, specific and effective decision making, helps in reducing conflicts and improves communication with the actors involved (Vos, 1996). It enables the adaptation of forest uses to physical and ecological conditions (Kimmins, 1997) and balanced use that considers multiple demands for forest services (Pukkala, 2002). It can be a powerful tool for preventing forest degradation or even deforestation (Soares-Filho et al., 2009). The value of the spatially-based approach is also the explicit consideration of multiple services and their trade-offs, which provides a basis for decision making and choosing the required management interventions (Wagner et al., 2013).

There are many reasons for such a spatially-based approach to multi-objective forest management. One of them is the fact that demands for services are not equally distributed throughout the forest land (Arnberger and Mann, 2008; Store, 2009). This fact may be the most important argument for spatially-based approaches to multi-objective forest management (e.g. Schuler, 2000). The second reason is related to the potential of the forest to provide the desired services (Vihervaara et al., 2010; Maes et al., 2012), which, too, is not uniform throughout the forest area. Forest ecosystems vary spatially and temporally, providing different services as a result of variation in the physical environment, species, forest stand age and natural disturbance effects (Spies and Johnson, 2003; Kimmins et al., 2008). In addition, road density, the presence of places of special interest and other characteristics of forest land that may be important for providing services differ throughout the forest (Michell et al., 1993). Typically, the third reason – the management possibilities for providing the desired services (Bachmann, 2005a) – plays the decisive role in the designation. Finally, political agreements and social forces can lead to the partitioning of forest land for selected services (Brandon et al., 1998), as it may often be politically easier to provide the desired services by setting different kinds of allocations in forest area (Gustafson, 1996; Noble and Dirzo, 1997).

Judging whether particular forest areas should be managed primarily for timber production, watershed protection, other non-timber values, a combination of some of them, or simply reserved as unmanaged wilderness, is to a large extent a social issue (Kimmins, 1997). Such decisions are normally a consensus on what society values and demands from forests. Priority areas can be established by a set of laws, rules and other political agreements; typical examples are national parks, wildlife reserves, wilderness areas and other legally established protected areas (Parviainen et al., 2000; Parviainen and Frank, 2003; Dudley and Philips, 2006). They are commonly protected for the purposes of conservation of biological diversity, the protection of soil and water resources, or the conservation of cultural heritage (Global forest…, 2010). In addition, priority areas may be designated in the context of forest plans (Gustafson, 1996; Neue Wege…, 1996; Volk and Schirmer, 2003; Special areas…, 2009); as such, they primarily serve as a tool for public forest

administrations for policy implementation, communication with public, and setting management objectives and measures associated with designated areas. Most commonly, landscape scale forest plans elaborated by the public forest administration are used; examples include national forest land and resource management plans (e.g. Forest Service..., 2006, Special areas..., 2009), or forest development plans (WEP, 2006; Pravilnik…, 2010).

The ways in which spatial classification of forests for selected services have been conceptualized and applied in forest management across the world highlights different approaches to multi-objective forest management. Among these, two main approaches can be recognized (Vincent and Binkley, 1992; Koch and Skovsgaard, 1999; Vincent and Potts, 2005; Boncina, 2011). The first, often termed as the segregation approach, divides forest areas according to different forest services or management objectives. The second, also known as the integration approach, promotes various services from the same forest land. In reality, the pure forms of these two approaches of multi-objective forest management rarely exist (e.g. Perley, 2003); instead mixed approaches with elements of the both are applied. In addition, they may differ considerably among regions and countries (and change over time) in the extent to which the elements of both basic approaches are applied. In North America, Canada, Australia and Scandinavia, mixed approaches with predominantly segregative elements prevail, with many different zoning options being proposed or applied (Fries et al., 1998; Boyland et al., 2004; Zhang, 2005; Montigny and MacLean, 2006; McAlpine et al., 2007). For example, A TRIAD (or three zones) approach for public forests distinguishes areas for timber, conservation and "ecosystem management", which combines conservation and production objectives by mimicking natural disturbances (Seymour and Hunter, 1992; Côté et al., 2010). The prevailingly integrative approach with many regional variants prevails in Central Europe (Führer, 2000; Borchers, 2010; Duncker et al., 2012). It promotes various forest services (functions) on the same forest land, although prioritization of management objectives commonly occurs.

1.3 THE CONCEPT OF FOREST FUNCTIONS

In Central Europe (CE), the concept of "forest functions" has been the most widely used planning tool to practice multi-objective forest management (e.g. Volk, 1987; Anko, 1995; Volk and Schirmer, 2003; Riegert and Bader, 2010). The concept of forest functions was developed in the 1950s by Dietrich (1953), who defined a forest function as a social demand placed on forests. The term "function" has been commonly connected to societal demands for various forest services (Führer, 2000). As opposed to "ecosystem functions," which describe the outputs of various ecological processes in the ecosystems (Ansink et al., 2008) and thus the potential for providing services to society (De Groot, 1992), forest functions in the CE commonly reflect societal interests towards forests (Schmider et al., 1993). They are the result of the demands placed on forests, the effects of the forests and the contributions of forest management (Bachmann, 2005a).

In CE multiple-use of the forest can be traced back to a time long before the advent of regular forest management (Hughes, 1983; Johann, 2006). In the Middle Ages, members of local communities agreed on the use of their common land ("adjudications"), which also included allocating areas for specific uses (Mantel, 1990). They were designated mainly for protection against natural hazards (e.g. protection forests, designated even as far back as the 14th century in the Alps (Schuler, 1981)), religious purposes (e.g. "holy groves" in Germany (Bürger-Arndt and Welzholz, 2005)), military purposes (Johann, 2006), nature protection (Johann, 2006), providing fuel and litter supply (Bürgi and Gimmi, 2007), pasturing and hunting (Konijnendijk, 2008). The introduction of "regular" forest management in the 18th century was largely a result of over-harvesting and devastated forests, and increasing demands for timber supply. In some areas a series of large natural catastrophes, mainly landslides and floods, occurred in the 19th century, contributing to greater awareness of the environmental and social importance of forest ecosystems (Farell et al., 2000). In the 19th century forest management became strongly regulated by forest acts. Some of them resulted in the segregation of forest lands into production forests, prevailing over the larger part of the area, and non-production forests, mainly declared as protection forests (Schuler, 1981). In the second half of the 19th century, aesthetic values of forests in some minor areas became important (Konijnendijk, 2008), resulting in strong efforts to maintain or protect nature and natural monuments. The change in perception was partly a consequence of the romanticism affirmed in this period that brought with it a new attitude to nature and forests (Pistorius et al., 2012). At the turn of the 20th century, different societies, social groups and movements expanded these ideas under the paradigms of "nature conservation" and "aesthetics of forestry." These movements were the prevailing drivers behind the establishment of nature protection areas. Forestry societies, individual forest planners and managers, or even forest owners, initiated the establishment of forest reserves, which were the pioneer examples of nature conservation (Parviainen et al., 2000; Frank et al., 2007). Later on, "close-to-nature" forestry was applied in many parts of CE, which was reflected in legal regulations. The clearcutting system was forbidden by law in some countries, such as in Switzerland and Slovenia in 1902 and 1949, respectively, while in other CE countries, there were attempts to drastically curb clear-cutting. In the following decades, forest acts changed considerably. The maintenance of the biodiversity and productivity of forest ecosystems became the integral principle of sustainable forest management, and hence in many CE states nature based silviculture became the standard of forest management (e.g. Schütz, 1997).

The concept of multi-objective forestry was gradually affirmed in the 1960s and 1970s (Blum and Rätz, 1994; Hytönen, 1995). It was primarily based on the assumption that management for sustainable timber production was also beneficial for wildlife, water quality and quantity, and other forest uses. This approach was paraphrased as the "backwash theory" or "wake theory" (Gotsch, 1978; Glück, 1987). This triggered the belief among the public that forest management only takes into account the productive role of forests and neglects non-timber uses and public interests. Later on, modifications to forest management and even new concepts were developed, such as "sustainable forest

management" (Bachmann, 1999). Sustainable forest management expanded from its primary focus on wood production to include a wide range of different combinations of forest uses for meeting economic needs and opportunities as well as addressing dynamically changing social and cultural values (Schmithüsen and Seeland, 2006). In the 1980s and 1990s, the concept of forest functions was officially adopted as a planning tool (e.g. Volk, 1987; Anko, 1995; Volk and Schirmer, 2003). It developed especially to emphasize the public importance of forests, and to address the environmental and social functions of the forest, which, at that time, were not explicitly discussed in forest management (Riegert and Bader, 2010). In the 1990s, when forest planning at a broader spatial scale was introduced in many CE countries (Krott, 2005), forest functions were integrated in forest management through "forest function mapping" (Anko, 1995; Riegert and Bader, 2010).

The concept of forest functions is based on identifying the values, demands and interests of people towards forests and classifying types of forest functions. It investigates the potential of forests to deliver the desired functions and the relationships and possible trade-offs and conflicts among various demands for forest functions (Fallbeispiele..., 1996). The designation or "mapping" of areas (hereafter forest function areas) that are of relatively higher importance for the selected forest services (functions) than the surrounding forest area is an important part of the concept (Blum et al., 1996). In addition, possible effects of management measures on the provision of forest services are studied, and management measures supporting the selected functions are set. Ranking of forest functions is an integral part of the concept; it helps in dealing with conflicting interests and presents the basis for prioritizing management measures (e.g. Fallbeispiele..., 1996; Neue Wege…, 1996).

In CE integration forestry, nearly the whole forest area (except for some strictly protected areas) is multifunctional such that it fulfils, to various degrees, social, ecological and economic functions (Führer, 2000). The designated forest function areas only emphasize the parts of the forests with relatively higher importance of the selected (commonly non-timber) forest functions. Such spatial prioritization has gained multiple meanings for multi-objective forest management. Forest function areas have become an important basis for planning and have contributed to the greater emphasis on the public importance of forests (Bürger-Arndt, 2012). Spatial classification or mapping of forest functions can function as an important basis for defining management objectives (Bachmann, 2005b). The concept has been well accepted among forestry professionals; it has become influential in spatial planning (e.g. Berger and Ray, 2004; Schulzke and Stoll, 2008) and an important instrument for forest policy (Krott, 2005; Schmidt, 2010).

1.4 MOTIVATION FOR WORK

In Slovenia wood and non-wood forest functions gained equal importance with the enforcement of the Forestry Act in 1993 (ZG, 1993), which was an important cornerstone in practicing multi-objective forest management. Three groups of functions – ecological, economic and social – were defined, which has its basis in the state constitution, which recognizes economic, social and environmental functions (Ustava, 1991). In addition, forests are declared as a public good of high national importance. These jurisdictions leave an important footprint on multi-objective forest management: they grant equal importance to all forest functions regardless of ownership of the forest. The concept of forest functions is implemented in practical forest management with several executive acts, by which designation of forest function areas and management measures associated with the designations are prescribed (Pravilnik…, 1998, 2010; Posodobitev…, 2011). In addition, forest areas with environmental or social functions of outstanding public importance are declared as "protected forests" (Uredba…, 2005).

Forest functions have been used in forest management planning for nearly three decades. However, with the exception of recent research (e.g. Anko, 2005; Pirnat, 2007; Bončina and Matijašić, 2010; Bončina and Simončič, 2010; Planinšek, 2010; Planinšek and Pirnat, 2012a, 2012b; Simončič and Bončina, 2012; Mavsar et al., 2013), they have not been a popular topic of interest among scientists. According to experiences to date, the designation of forest function areas has contributed to emphasizing the public importance of forests and has thus become an important tool for forest policy (Veselič et al., 2003; Bončina, 2005). In addition, forest function areas have become influential in spatial planning by becoming an important basis for environmental impact assessment in forest areas (Pogačnik, 1996). They have also contributed to better communication between forestry practitioners and stakeholders. Nevertheless, recent practice has raised a number of concerns regarding the effectiveness of the concept of forest functions. Many such concerns have also been reported from other CE countries. The application of the concept in Slovenia and in several other CE countries has often been criticized for being ineffective for promoting the desired services on the ground (e.g. Weiss et al., 2002; Simončič and Bončina, 2012; Winter et al., 2014). Spatial designation and ranking of forest functions has often failed to prevent conflicts among forest users, which is likely also due to poorly defined criteria for prioritization (Pogačnik, 1996; Pirnat, 2007; Planinšek and Pirnat, 2012b; Bürger-Arndt, 2013). In addition, limited options for participation in the designation process and ignorance of social aspects may have led to tensions between forest planners and forest users (Stiptizov and Duerr, 2005; Ruppert-Winkel and Winkel, 2009; Kangas et al., 2010).

The accumulated experience in the implementation of the concept during the last decades and new regulations regarding multi-objective forest management underscore the need to evaluate the effectiveness of forest functions as a tool in the practice of multi-objective forest management. In our study, we aimed to address the following questions: 1) Can we

speak of a uniform concept of forest functions across CE countries or are there many regional variants? 2) How and why does the concept of forest functions differ with multi-objective forest management approaches used around the globe? 3) How effective are forest function areas in Slovenia in achieving their goals? 4) What are the alternatives or possible improvements of forest function areas in the practice of multi-objective forest management in Slovenia?

1.5 RESEARCH OBJECTIVES AND HYPOTHESES

The main objectives of our research were:

- to overview and explore the concept of forest functions and reveal similarities and divergences among various CE countries,
- to compare and contrast the integrative forestry in CE with other approaches of multi-objective forest management in order to understand the role and function of spatially-based approaches in different socio-economic settings,
- to evaluate the effectiveness of the concept of forest functions in practicing multi-objective forest management in Slovenia, and
- to propose improvements to the concept of forest functions in Slovenia.

We hypothesized that:

H1) The characteristics of priority areas as well as their importance for multi-objective forest management differ significantly between regions around the globe.

H2) In CE the concept of forest function areas is an important tool to practice integrative multi-objective forest management, but its application differs between countries, with the main divergences being the classification system (e.g. the number and types of forest functions), the designation process (i.e. criteria and area under designation) and their importance for forest management.

H3) The concept of forest functions in Slovenia needs to be improved; advancements in the classification of forest functions and the designation process are needed, and stronger integration of forest functions in forest management is essential.

1.6 STRUCTURE OF DISSERTATION

The dissertation starts with a general introduction that describes the theoretical background, the problem and motivation for the work, the main objectives and research hypotheses. The research work is methodologically and thematically divided into four main parts (scientific papers) that successively follow the four research objectives (Figure 2).

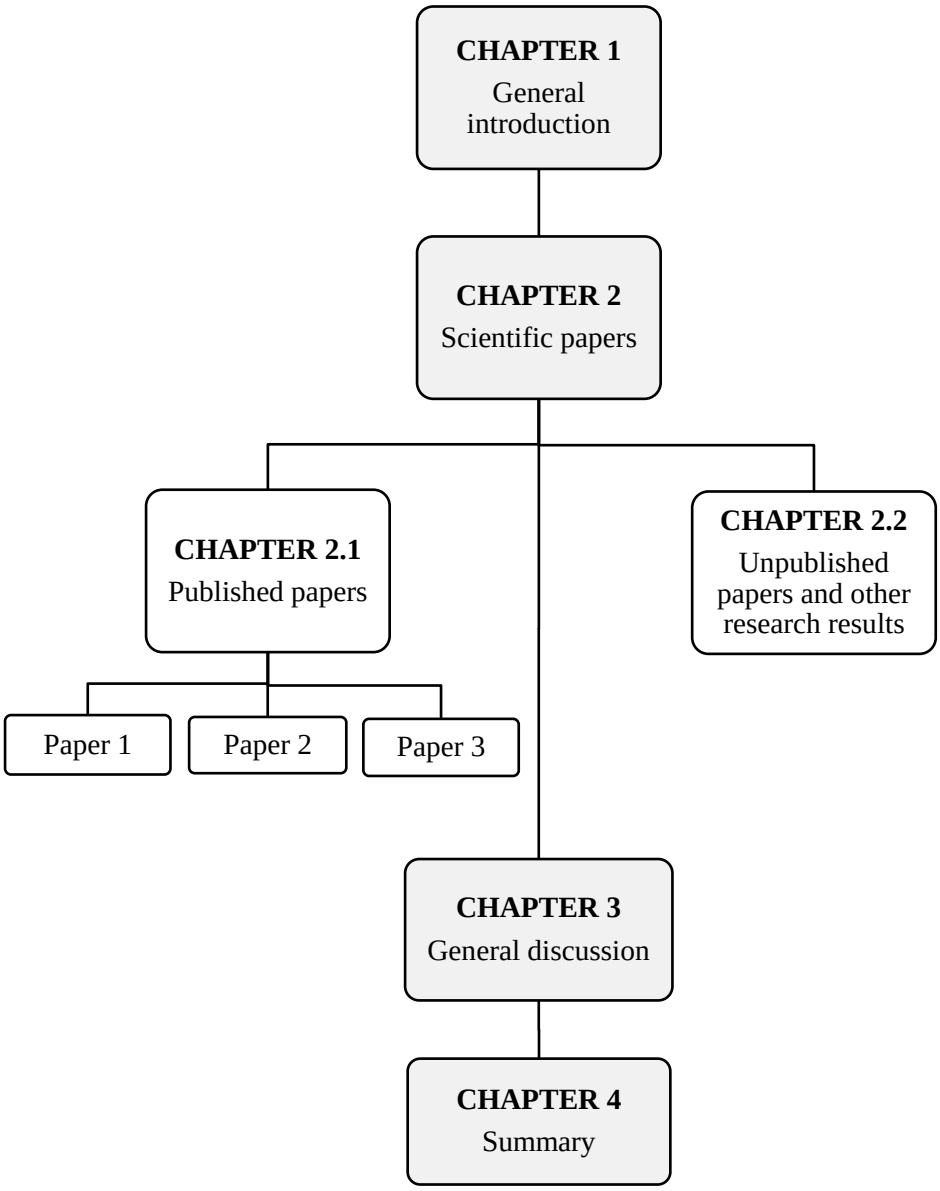

Figure 2: The structure of the dissertation.

2 SCIENTIFIC PAPERS

2.1 PUBLISHED PAPERS

2.1.1 Importance of priority areas for multi-objective forest planning: a Central European perspective

Simoncic T., Boncina A., Binder F., Cavlovic J., De Meo I., Janos G., Matijasic D., Rosset C., Schneider J., Singer F., Sitko R. 2013. Importance of priority areas for multi-objective forest planning: a Central European perspective = [Pomen prednostnih območij pri večnamenskem gospodarjenju z gozdovi: Srednjeevropski vidik]. International Forestry Review, 15, 4: 509-523.

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In the framework of multi-objective forest management, “priority areas” which are relatively more important for the selected management objectives are commonly designated. Using a comparative analysis of guided interviews, we examined the use and importance of priority areas in forest planning in nine Central European countries. In all countries priority areas have been widely used, forest function areas and protected areas being the most common. According to management objectives, more than 20 types of priority areas have been recognized, with priority areas for protection against natural hazards, nature conservation, recreation, welfare, and production being the most prevalent. Criteria for the designation differ among the countries; however, site conditions and infrastructure facilities are most often used. The scale of designation ranges from 1:10 000–1:50 000, and the size of priority areas varies from 0.1 ha to several hundreds of ha. The level of participation of stakeholders involved in the designation of priority areas differs among and within the countries. The effectiveness of priority areas for forest management can be improved by transparent designation criteria, objective oriented management measures, and efficient financial instruments.

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Importance of priority areas for multi-objective forest planning: a Central European perspective

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SUMMARY

In the framework of multi-objective forest management, 'priority areas' which are relatively more important for the selected management objectives are commonly designated. Using a comparative analysis of guided interviews, we examined the use and importance of priority areas in forest planning in nine Central European countries. In all countries, priority areas have been widely used, forest function areas and protected areas being the most common. According to management objectives, more than 20 types of priority areas were recognised, with priority areas for protection against natural hazards, nature conservation, recreation, welfare, and production being the most prevalent. Criteria for the designation differ among the countries; however, site conditions and infrastructure facilities are most often used. The scale of designation ranges from 1:10 000–1:50 000, and the size of priority areas varies from 0.1 ha to several hundreds of ha. The level of participation of stakeholders involved in the designation of priority areas differs among and within the countries. The effectiveness of priority areas for forest management can be improved by transparent designation criteria, objective oriented management measures, and efficient financial instruments.

Keywords: multi-objective forest management, forest goods and services, integration, forest functions, protected forest areas

Importance des zones prioritaires dans le cadre de la planification forestière à objectifs multiples en Europe centrale

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Dans le cadre d'une gestion forestière à objectifs multiples, il est fréquent d'assigner aux objectifs de gestion donnés des "zones prioritaires», d'une importance relativement plus élevée. À l'aide d'une analyse comparée d'entretiens semi-directifs, nous avons examiné l'usage et l'importance des zones prioritaires dans la planification forestière de neuf pays d'Europe centrale. Dans tous les pays, les zones prioritaires ont été largement employées, celles de protection et celles à fonction forestière étant les plus courantes. Selon les objectifs de gestion, plus de 20 types de zones prioritaires ont été identifiés, les plus fréquentes étant les zones prioritaires pour la protection contre les dangers naturels, pour la protection de la nature, la récréation, le bien-être et la production. Les critères de désignation diffèrent selon les pays, mais les conditions stationnelles et les infrastructures sont le plus souvent retenues. Les échelles utilisées pour la détermination vont du 1:10 000 au 1:50 000 et la taille des zones prioritaires de 0,1 ha à plusieurs centaines d'ha. Le niveau de participation des acteurs au processus de désignation de ces zones prioritaires varie selon les pays et au sein de ces derniers. L'efficacité des zones prioritaires pour la gestion forestière peut être améliorée grâce à des critères de détermination transparents, des mesures ciblées par rapport aux objectifs de gestion et des instruments financiers efficaces.

La importancia de las áreas prioritarias en el sistema de la gestión forestal multi-objetivo: una prospectiva de la Europa Central

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En el sistema de la gestión forestal multi-objetivo, se designan comúnemente unas "áreas prioritarias» que son relativamente más importantes para los objetivos de manejo seleccionados. El uso de un análisis comparativo de las entrevistas guiadas, se analizó el uso y la importancia de las áreas prioritarias en la planificación forestal en nueve países de la Europa Central. En todos los países las áreas prioritarias han sido ampliamente utilizadas y, entre ellas, las áreas importantes para las varias funciones forestales y las áreas protegidas que son las más comunes. De acuerdo con los objetivos de gestión, fueron reconocidos más de 20 tipos de áreas prioritarias. Entre ellas las mas prevalentes son las áreas para la protección contra los riesgos naturales, la conservación de la naturaleza, la recreación y la producción. Los criterios para la designación difieren entre los países; sin embargo, las condiciones del sitio y las instalaciones de infraestructura son las que se utilizan más a menudo. La escala de designación va de 1:10 000 a 1:50 000, y el tamaño de las áreas prioritarias varía de 0,1 ha a varios cientos de hectáreas. El nivel de participación de los actores involucrados en la designación de áreas prioritarias difiere entre (y dentro) de los países. La efectividad de las áreas prioritarias para el manejo forestal puede ser mejorada mediante criterios transparentes de designación, medidas de gestión orientadas a objetivos y instrumentos financieros eficientes.

INTRODUCTION

Forest planning is an important tool for organising sustainable and objective-oriented forest management. The basic task of forest planning has always been the same: definition of management objectives and provision of appropriate methods, techniques, and procedures for attaining them (Farcy 2004, Bettinger *et al*. 2009). Planning techniques can be focused on achieving a single management objective (usually timber production) or multiple management objectives. The latter is more challenging since optimisation of forest management measures is needed for different fields of forest management to achieve multiple objectives.

Multi-objective (also multiple-use, multiple-resource, multi-purpose, or multi-functional) forest management is focused on satisfying the demands and needs of society by providing a variety of forest goods and services (Brown and Harris 1992, Klemperer 1996, Glück 2000, Pukkala 2002, Bachmann 2005). Spatial classification of forest land for important management objectives has been commonly used to practice multi-objective forest management (e.g. Riegert and Bader 2010, Parviainen *et al*. 2010). In addition, tools from different fields such as landscape ecology or operations research (e.g. multi-criteria decision analysis) have often been applied to support forest planning and decisions on forest land use (Diaz-Balteiro and Romero 2008, Mendoza and Martins 2006, Pukkala 2002, Wolfslehner and Seidl 2009).

Although multi-objective forest planning has gained in importance in recent decades, multiple forest use is not new (e.g. Farrell *et al*. 2000). Even before regular forest management began in Central Europe, locals divided forests for different purposes. As early as in Greek and Roman times, forests were used for pasture, timber, and hunting (Johann 2006), and some examples of protection and military forests date to the Middle Ages (Hughes 1983). In Europe, regular forest management started in the 18th century. Timber harvest or a sustained maximum income yield became the main or even the single management objective in nearly the whole forest area, although management systems for implementation of this single objective differed greatly (Boncina 2011). However, some forests in mountainous or isolated regions of Central Europe were set aside from timber production due to their distance to settlements, difficult conditions for timber harvesting and transport, and harsh site conditions. This was the origin of the distinctive division (segregation) of forests into 'production' and 'non-productive' forests. In some mountainous areas, the capacity of the forest to protect settlements and infrastructure from natural hazards was endangered due to overexploitation of timber. Therefore, conservation of the protective capacity of the site gained importance, and some forests were declared by law as protection forests (Shuler 2000).

The social and economic development of the 19th and 20th centuries brought new demands on forests (Pistorious *et al*. 2012). Hence, many concerns about single-objective forest planning began to arise. In the second half of the 20th century, conservationists were particularly critical and requested participation in forest management planning (Gamborg and Larsen 2003, Ruppert-Winkel and Winkel 2009). In the 1960s and 1970s, the concept of multi-objective forestry was gradually affirmed (Blum and Rätz 1994, Hytönen 1995). Multi-objective forest planning was primarily based on the assumption that management for sustainable timber production ensures ecological and social objectives at the same time. This approach was paraphrased as 'backwash theory' or 'wake theory' (Glück 1987 and Gotsch 1978). Decisions on forest management were generally made by forestry professionals, while the social aspects of forest planning and the participation of stakeholders in decision making were mainly ignored. This triggered the belief among the public that forest management only takes into account the productive role of forests and neglects non-timber uses and public interests. Demands for environmental services significantly increased, and their integration into forest planning and management were constantly debated (e.g. Mantel 1990). Hence, modifications of forest management or new concepts were developed, such as

'sustainable' (Bachmann 1999 and Johann 2006) and 'close-to-nature' forest management (Mlinsek 1968 and Schütz 1999). New concepts were similar in that there was a shift from the stand level to the broader landscape or regional level, and the importance of nature conservation significantly increased. Decisions on sustainable forest management were no longer just a professional or scientific issue but to a large extent derived from the views of society (Wiersum 1995). Since then multi-objective forest management has continually evolved to meet increasing and changing demands of society for ecological, economic, and social values (Pistorious *et al.* 2012, Riegert and Bader 2010). Forest acts changed considerably; maintenance of the biodiversity and productivity of the forest ecosystem became an integral principle of sustainable forest management, and hence nature based silviculture became the main orientation of forest management in many Central European states. New policy documents regarding forest management planning (e.g. MCPFE 2000) and the rapid development of ecology and landscape ecology (Andersson *et al.* 2000) additionally contributed to the affirmation of the new concepts.

On the global scale, differences in forestry tradition; legal systems; and natural, social, and economic conditions have led to the development of different approaches to multi-objective forest planning. For clarity, they can be classified into two main approaches: the segregation and the integration approach (Boncina 2011, Borchers 2010, Koch and Skoovsgaard 1999). Between them, numerous intermediate forms exist (e.g. Montigny and MacLean 2006). Within the segregation approach, forests are divided into areas for single but different uses, thus multiple uses are achieved on a larger scale (e.g. Vincent and Binkley 1993). The segregation approach developed mainly in countries with a low population density, large and continuous forest areas, and a higher share of public or large private forest land (e.g. Canada, Russia). In the integration approach, multiple management objectives are considered and implemented by considering and promoting different forest uses in the same forest area; still, the importance of particular management objectives can be different depending on the demands of forest owners, society, or natural conditions (Bachmann 2005). These demands are first identified and then transformed into a set of management objectives (e.g. production, economic, social, environmental) and ranked according to their importance. The integration approach has mainly been used in countries with high population density, limited natural resources leading to strong competition for land among land users, a scattered structure of private forest holdings, and a high level of public interest (e.g. Central Europe) (e.g. Duncker *et al.* 2012).

In Central Europe, the integration approach has been the most widely used and has been strongly supported by legal regulations (Fürst *et al.* 2004). Forests are generally managed for a variety of ecological, economic, and social functions (Führer 2000). However, the importance of various forest functions is not equal throughout the forest area, mainly because of differences in natural conditions, the spatial distribution of demands for goods and services in the forest area, and the management possibilities for providing the desired functions. An important part of the integration approach is therefore the designation of 'priority areas', which are relatively more important for the selected management objectives than forests outside of these areas. Some elements of segregation are present in the designation of priority areas within the integration approach. However, priority areas for the most important management objectives do not exclude other objectives; these are only given lower priority when making decisions regarding forest management. Priority areas have been an important part of both the segregation and integration approach; in fact, they may be even more relevant for the segregation approach since forest management differs substantially among priority areas (e.g. Zhang 2005).

In Central Europe, areas important for various forest functions (hereafter forest functions) are the most frequently used type of priority area (Führer 2000, Vyscot *et al.* 2003). The integration of forest functions into multi-objective forest planning appeared in the 1960s and 1970s, although some examples can be found even earlier (Notaro *et al.* 2008). In the last three decades, an enthusiastic period of 'forest function mapping' (e.g. Anko 1985 and Volk 1987) has occurred as part of forest planning. Often, designation of forest functions was based on natural conditions, while ignoring the importance of social demands and management possibilities for providing the desired functions (e.g. Pistorious *et al.* 2012, Weiss *et al.* 2002). Differing understanding of forest functions and limited options for participation in their designation have often caused tension between forest planners and other forest users (De Meo *et al.* 2011). Thus, there have been frequent warnings about the urgent need for participatory decision-making in the designation of forest functions (e.g. Loikkanen 1995). In some countries, forest function mapping has led to detailed spatial division of forest areas for prioritised management objectives. A criticism that has been repeatedly expressed is that the designation of forest functions overemphasizes the classification and spatial division of forest area. As a consequence, the relationship between designated forest functions and management measures to implement the desired objectives in these areas has often been missing.

To our knowledge, a comprehensive study of the importance and use of priority areas for multi-objective forest planning in Central Europe has not yet been done. Therefore, the aim of our study is (1) to analyse the current main types of priority areas and the criteria and procedures for their designation and (2) to assess their current and prospective importance for multi-objective forest planning in Central European countries.

STUDY AREA AND METHODS

The study area encompassed nine Central European countries (Fig. 1). However, due to the administrative division and regionally organised forest planning systems in Italy, Germany, and Switzerland, only one of the administrative regions in each of these countries was selected. The regions were

FIGURE 1 *Map of study area (AU, Austria; BAV, Federal state of Bavaria; CRO, Croatia; CZ, Czech; H, Hungary; SI, Slovenia; SLK, Slovakia; TRE, Trentino Province; ZH, Canton Zürich)*

picked based on the co-authors. In addition, traditional use and importance of multi-objective forest management was an important selection criterion. For simplicity, the common expression of 'country' is used in the paper for all nine cases.

In the selected countries, the surface area of forests ranges from about 50 000 ha (ZH) to 4 million ha (AU), while the share of forests in the total area ranges from 20% in Hungary to almost 60% in Slovenia (Table 1). The majority of forest is privately owned, with the exception of the Province of Trento (Trentino region), Croatia, and the Czech Republic. Private forest property is normally scattered and small-scale; the average private property measures around 2–3 ha, and a minority of forest properties exceed 100 ha. Austria serves as an illustration: there are nearly 120 000 private owners with property measuring 0.5–20 ha, while only 1 538 private owners have more than 200 ha of property. In some countries (e.g. TRE, ZH), local communities own a substantial part of the whole forest area.

TABLE 1 *Basic data on forest area in the analysed countries*

Country	Forest area (1 000 ha)	Share of forest in total area (%)	Share of private forest in total forest area (%)
AU	3 991	48	74
BAV	2 550	36	58
CRO	2 581	46	23
CZ	2 647	34	23
H	1 913	21	44
SI	1 185	59	74
SLK	2 009	44	59
TRE	389	56	28
ZH	50	30	47

The organisation of forest planning is regulated by either national (AU, CRO, CZ, H, SI, and SLK) and/or federal/regional/cantonal legislation (BAV, TRE and ZH). Forest planning is generally organised at the strategic and operative levels. Strategic planning defines objectives, priorities, and controlling mechanisms with which to ensure public interests and management of the forest. It is mostly done at the regional level and rarely at the state (CRO), federal (BAV), or cantonal level (ZH). Strategic plans typically cover the entire forest area regardless of ownership, namely large and small private and public lands. They are an important basis for the elaboration of operational management plans. Operational planning is aimed at achieving the desired management objectives by setting detailed measures. Operational plans are designed either at the local forest administration level (CRO, CZ, H, SI, and SLK) or at the level of forest owner (AU, BAV, TRE, and ZH). In the first case, they are prepared for all forest

areas regardless of ownership, while in the second case they are mainly compulsory for state and corporate forests (BAV) and for large property owners (usually more than 50 ha; AU, TRE, ZH). Forest owners' plans have to comply with the strategic plans, but they focus on owners' objectives and strategies (e.g. Bachmann 2005).

The research is based on comparative analysis of questionnaires completed during guided interviews of experts in the field of forest planning. One expert – a co-author of this article – was interviewed from each of the selected countries. The questionnaire was structured in four sections: (1) classification and general characteristics of the main types of priority areas, (2) criteria and procedures for their designation, (3) management measures on priority areas, and (4) evaluation of the effectiveness of priority areas for multi-objective forest planning. Some analyses were done by comparison and clustering of the answers and by using standard statistical methods. In each country, one priority area was selected to serve as an illustration of the approach used in the country. Priority areas were selected by co-authors, usually in areas where various forest functions important for a vast array of stakeholders were considered in forest management. These priority areas were surveyed in the field, the plans and other relevant literature were overviewed, and local forest authorities were consulted.

RESULTS

Classification of priority areas

There are two main types of priority areas widely used in Central European forestry: forest functions and 'protected' forest areas. They can be further classified according to (1) legal regulations and competences for declaration, (2) the spatial scale of the designation, and (3) the management objectives.

Legal regulations and competences for declaration of priority areas

Forest functions are spatial planning units that are designated in the forest planning process, usually in the frame of strategic planning, and exceptionally in planning at the forest management unit level (e.g. SI, SLK). The rules for designation of forest functions are defined by legal regulations and often additionally prescribed by professional directions (e.g. Volk and Schrimer 2003). Non-forestry institutions (i.e. institutions responsible for nature protection, water management, and natural hazards) may significantly influence the designation of forest functions. Guidelines set forth by these institutions must be considered when forest functions are designated or their experts must directly participate in the designation of priority areas.

Protected forest areas (hereafter protected areas) are priority areas that are declared by legislative regulations at the state, regional, canton, or municipality level. Typical examples of protected areas are protection forests, urban forests, and forests protected for biodiversity and nature conservation commonly termed as protected forests (e.g. Parviainen and Frank 2003). The reason for the declaration of protected areas lies in their much higher interest to the public compared to forest functions. By their declaration the most important objectives of forest management are defined in advance. In general, forest planners can significantly influence the process of designation of protected areas by preparing documents for declaration or even by proposing their designation. Declaration of protected areas is made outside of the planning process, but mostly still under the competences of the forestry sector. However, some protected forests are mainly designated and declared by institutions in the non-forestry sector. This is especially common when forests are a part of broader protected areas, such as national and regional parks or Natura 2000 sites, a network of areas established to preserve the most important habitats and species in the European Union (EC 2004). In some countries (e.g. CRO, H), designation of protected forests falls almost completely outside of the competence of foresters.

Spatial scale of designation

Priority areas are designated at different spatial scales. The regional scale (app. 1:100 000) is rarely used for priority area designation. This scale is appropriate when the importance of priority areas can be recognised on the large spatial scale only. The size of designated areas can be several hundreds or thousands of hectares; forest habitat types (Natura 2000 sites), watershed areas, and wildlife habitats are typical examples. Forest functions and many protected areas are mainly defined at the landscape scale (1:25 000 to 1:50 000). The size of these priority areas usually ranges from 0.5 ha to over 100 ha. Priority areas of smaller size are designated at the stand scale (1:10 000, 1:5 000, or even 1:1 000); areas where habitat trees or buildings of cultural heritage are located or areas around caves, water sources, or bear dens are some typical examples.

Management objectives

In the analysed countries, the questionnaires revealed more than 20 types of priority areas according to management objectives (Table 2). These were then classified into the following five main types:

A. *Priority areas for protection (against natural hazards)* are important for protection against erosion, rock falls, flood, and avalanches. In some of the analysed countries, this type of priority area is further divided into two sub-types: forests which indirectly protect sites, usually in extreme site conditions, and forests which directly protect settlements and infrastructure (e.g. 'Wälder mit Objektschutzwirkung'). Priority areas for protection occupy large areas in many countries; in the Bavarian Alps, 60% of mountain forests (about 150 000 ha) are classified as priority areas for protection, and in Austria they cover 20.5% (800 000 ha) of the total forest area, among which approximately half (420 000 ha) are direct protection forests. The area of direct protection forests is commonly much smaller

than the area of indirect protection forests. In most of the analysed countries, a large part of priority areas for protection are declared as protected.

B. *Priority areas for nature conservation* include rare forest communities, important habitats, many forests within Natura 2000 sites, and other areas important for conservation of nature and landscape. The size of priority areas for nature conservation differs substantially, from a few square meters (e.g. protected tree species) to several thousands of hectares (e.g. forest habitat types, national parks). This type of priority area may, in aggregate, occupy the greatest area relative to other types of priority areas. In Slovenia more than 67% of forests are designated for nature conservation. Many priority areas for nature conservation are declared as protected (e.g. forest reserves, forests within national parks). In some countries, forests important for nature conservation are in general not designated as a priority area by forestry legislation. However, they may be classified as protected under various nature protection categories.

C. *Priority areas for recreation* were clustered from areas for recreation, tourism, leisure, research, and education. The total area of priority areas for recreation is small in comparison to the other types of priority areas. In some analysed countries (e.g. CRO, SI, SLK), some parts of these areas – especially in the vicinity of big cities – may be declared by cantons or municipalities as protected and are usually termed 'forests of special importance' or 'urban forests'.

TABLE 2 *Main types of priority areas (PA) according to management objectives*

PA type	PA subtype	Country								
		AU	BAV	CRO	CZ	H	SI	SLK	TRE	ZH
A	direct protection	■		■		■	■		■	■
	indirect protection	■	■	■	■	■	■	■	■	■
B	nature protection			■	■	■		■		
	biotope		■		■		■			■
	biodiversity protection		■	■	■					■
	landscape protection		■	■	■	■				■
C	recreation	■	■	■	■	■	■	■		■
	education		■	■	■	■	■	■		
	research		■	■	■	■	■	■		
	natural heritage		■	■		■	■			
	cultural heritage		■			■	■			
	scenery and aesthetics		■	■			■			
D	water protection	■	■	■	■	■	■	■		
	climate protection	■	■		■		■			
E	timber	■	■	■	■	■	■	■	■	■
	non-wood					■	■			
	game				■	■	■	■		
	propagation material					■				
*	military			■		■	■			
	seed			■		■	■	■		
	water health				■	■		■		

*Other types not included into A–E

D. *Priority areas for welfare* encompass priority areas for climate and pollution control or for provision of drinking water. In the neighbourhood of large settlements, forests may be declared by municipalities as protected because of their benefit to the local population. Forests important for water protection are often classified as an extra type of priority area, which may even be declared as protected (e.g. forests around Vienna and Munich).
E. *Priority areas for production* are mainly designated for timber production, and in some cases for firewood, game, or non-timber goods such as mushrooms and chestnut. In the majority of the analysed countries, they are designated in all forest areas that are not classified into the A-D types. Therefore, they occupy the largest part of the total forest area.

Criteria for designation

In the analysed countries, numerous methods and criteria for the 'objective' designation of priority areas have been described and have often been supported by field research, different models of spatial analysis, and expert knowledge. Both the criteria for the designation of priority areas and the variables that describe them differ greatly among Central European countries. For clarity and feasibility of further comparison, we classified all variables used into seven groups of criteria (Table 3). Each type of priority area is characterised by variables referring to one criterion or a combination of several criteria. However, two groups of criteria are mainly used for the designation of priority areas: site conditions and infrastructure facilities (Table 4).

Priority areas for protection (A) are mainly defined by site variables (e.g. slope, aspect, altitude) for which threshold values such as minimum altitude belts or slope inclinations are often determined. Stand variables are of minor importance for the designation of this type of priority area (3% of all criteria used); however, they are often important in monitoring and assessing the suitability and effectiveness of stand structure for providing protection. Different variables are used for designating forests important for indirect protection and those important for direct protection (e.g. Bozic *et al.* 2006). In some countries, the first subtype is generally designated in regard to the altitude belt or to the accessibility of the area. The potential of natural hazards to damage roads, railways, and settlements is the most frequently used criteria

TABLE 3 *Main criteria and variables for designation of priority areas*

Criteria	Variables	Evaluation method
site conditions	orographic, hydrological, geological, and pedological conditions	land registry, topographic map, aerial photo, field survey
stand and forest community conditions	stand structure, species and structural diversity, vegetation types, rare and threatened animal and plant species, presence of special habitats	field survey, expert knowledge, expertise and report
potential risk	hydro-geological risk, risk of natural hazards, endangered infrastructure, water and air pollution	GIS model, map of hydrological risk, topographic map, risk zones for floods, expert knowledge
landscape value	special forest landscapes, forests in regions with low forest cover	aerial photo, field survey, expert knowledge
economic value	timber production income, non-timber production income	field survey, expert knowledge, model
social use	number of visitors, organized activities	field survey, expert knowledge, interview, questionnaire
infrastructure facilities	proximity to traffic infrastructure, density of walking paths, parking places, trails for horseback riding, motorbikes, and bicycles	aerial photo, field survey, expert knowledge

TABLE 4 *Relative frequencies of criteria for designation of the main types of priority areas*

Criteria	A	B	C	D	E	Average
site conditions	0.74	0.11	0.00	0.45	0.20	0.30
stand and community conditions	0.03	0.56	0.00	0.00	0.13	0.14
potential risk	0.20	0.00	0.00	0.22	0.08	0.10
landscape characteristics	0.00	0.33	0.00	0.00	0.13	0.09
economic income	0.03	0.00	0.00	0.00	0.13	0.03
actual social use	0.00	0.00	0.50	0.00	0.13	0.13
infrastructure facilities	0.00	0.00	0.50	0.33	0.20	0.21

for the designation of the second subtype. Therefore, infrastructure facilities are crucial for designation of this type of priority area. Data on variables used for designation of priority areas for protection are collected in forest inventories, inventories from other institutions (e.g. geological or hydro geological), or other types of terrestrial surveys, and subsequently analysed with GIS models (e.g. Berger and Ray 2004). Different simulation models are often used to assess the suitability of forest stands for providing protection structure (e.g. Stoffel *et al.* 2006).

Designation of priority areas for nature conservation (B) is mainly based on stand and forest community variables (56% of all criteria used). Some of these include the presence of plant or animal species with special nature conservation status, stand characteristics, and the type of forest communities. At the landscape level, landscape characteristics such as forest edges, the pattern of forest patches, and the presence of hedgerows or riparian trees may be relevant. Lists of variables and their threshold values are defined in forest management or nature conservation regulations. Changes in the selected variables such as conditions of microhabitats or naturalness in terms of tree species, stand structure, or natural regeneration are usually monitored by forest inventories (e.g. on permanent sampling plots) (e.g. Döns-Breuss *et al.* 2004, Winter and Müller 2008). In addition, other types of terrestrial surveys carried out by forest or nature conservation institutions may be performed.

Variables describing infrastructure facilities and actual social use are the most important for designation of priority areas for recreation (C). Among the first, the vicinity to settlements or the density of forest paths are often used. The recreational use of forests is commonly described by the number of visitors or organised activities in the forest area. In some areas, forest planners interview visitors to determine the importance of forests for recreational use (e.g. Scrinzi *et al.* 1996).

Priority areas for welfare (D) are most commonly defined by site conditions (45% of all criteria). However, infrastructure facilities are also important, especially for designation of areas important for protecting settlements against noise or pollution. Variables such as the presence of noise, distance to roads, and aesthetic considerations are used. For the designation of water protection areas, natural (site) characteristics such as the presence of water sources are crucial. Variables important for designation of water protection areas and their threshold values are usually defined by forest and water management institutions, which are also responsible for monitoring changes to these variables.

Priority areas for production (E) are commonly designated in areas where no other type of priority area is classified. However, thresholds of site productivity are often considered for designating this type of priority area. In some other cases, priority areas for production are described by economic variables, among which income from timber production and the amount of non-wood forest products are often used.

Mapping of priority areas

Priority areas are mapped mainly using GIS techniques; however, almost all GIS layers are checked and improved during field inventories and surveys. A forest function map is the most common spatial presentation of priority areas (Table 5). It is usually elaborated in the scale between 1:10 000–1:50 000. Priority areas can be line (e.g. forest edges as biotopes) or planar shapes. The sizes of priority areas vary significantly (from 0.5 ha to the whole landscape). In some countries a minimum priority area size (e.g. 10 ha in Austria) is prescribed. Priority areas are mainly mapped as a special GIS layer, while in some countries (CRO, SLK) they are designated within traditional forest spatial units such as compartments. Compared to other spatial inventory units, priority areas can also encompass non-forested area (e.g. clearings, scenic views, etc.). Generally, mapping includes the whole forest area, but in rare cases only selected parts of the whole forest area are mapped as priority areas, usually those with higher public interest (e.g. ZH).

Ranking of management objectives

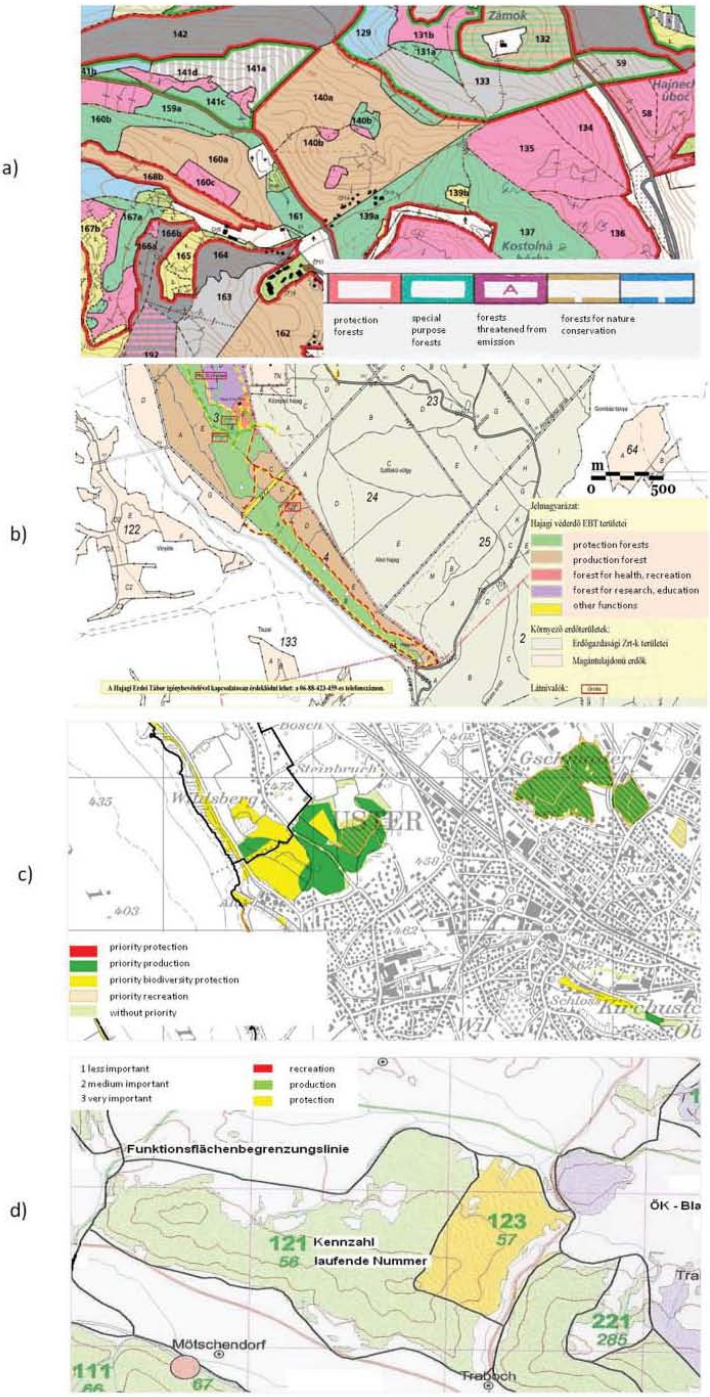
Priority areas are usually important for various management objectives, with a few exceptions where only one objective is considered (e.g. forest reserves or strict water protection

TABLE 5 *Designation and mapping of forest functions*

Country	Ranking	Number of ranks	Minimum mapping area	Scale of mapping	Area under mapping
AU	Yes	4	10 ha	1:50 000	Whole
BAV	Partly	2	*	1:50 000	Whole
CRO	No	-	-	-	-
CZ	No	-	*	1:10 000	Whole
H	No	-	*	1:10 000	Whole
SI	Yes	3	3 ha	1:10 000	Whole
SLK	No	-	*	1:10 000	Part
TRE	No	-	*	1:25 000	Part
ZH	Yes	2	*	1:25 000	Part

*, the same as for designation of forest area, mainly in interval 0.1–0.5 ha; - not used

FIGURE 2 *Sections from the forest function maps: (a) Slovakian example; (b) Hungarian example; (c) Swiss example; (d) Austrian example*



zones). However, management objectives in priority areas are commonly prioritised. In some countries, only one (the main) type of management objective is defined (Fig. 2a and Fig. 2b). In such cases, other objectives are not specified but can be considered in defining the management regime. More commonly, management objectives are ranked according to their importance. Ranking can be based on two methods: (1) defining first and second most important management objective (Fig. 2c) or (2) ranking of each important objective (e.g. 1, 2, 3; Fig. 2d). In both cases the ranks define the importance of management objectives for the forest management regime. In some countries (e.g. BAV) ranking is applied only for certain management objectives (e.g. recreation and water protection).

Stakeholder participation in designation of priority areas

Various stakeholders are involved in the designation of priority areas. Stakeholders fall into two main groups: (1) forest owners and other 'users of forest goods and services' (recreationists, hunters, NGOs) and (2) experts from institutions engaged in the designation of priority areas in accordance with their official competences in the forest area (e.g. geologists, hydrologists). The importance and intensity of participation of both groups in the designation process differs among and within the countries. Generally, the participation of the first group of stakeholders is relatively weak; they are mostly involved in the final stage of the planning process to comment on proposed priority areas and suggested objectives and management measures. However, some protection forests are evidently an exception, as forest owners and other stakeholders may have a strong influence on their designation. The participation of the second group is legally regulated; various experts are usually involved in defining management objectives and guidelines for the management regime in priority areas. However, large differences exist among the countries regarding the competences of the institutions in decision making. In some countries (e.g. AU, ZH), torrent and avalanche control institutions are actively involved in the designation of priority areas for protection, especially for those directly protecting settlements or infrastructure. Collaboration between forestry and nature conservation institutions is generally formal in all the analysed countries. However, the competences of the nature conservation institutions in designating priority areas may vary significantly. In some countries (e.g. H) nature conservation organisations have a dominant influence on designation of priority areas for nature conservation.

Management measures in priority areas

The management regime depends on the type of priority area and its importance for management objectives. Prioritisation of management objectives is the basis for setting management priorities and measures. Generally, three main types of planned activities in priority areas are applied: (1) business as usual, (2) additional measures are needed, (3) limitations for forest management or other uses of the forest area are needed. In the first type, no specific modification of forest management is implemented. In the second type, management objectives are achieved by a suitable selection of additional measures in the fields of silviculture, protection, wildlife management, or other fields of forest management. Among them, silviculture is crucial for most management objectives because it directly influences the structure and composition of forest stands and processes in forest ecosystems and thus also desired outputs (e.g. Dorren *et al*. 2004). In some priority areas for nature conservation, additional silvicultural measures are completely sufficient to meet management objectives (e.g. Motta and Haudemand 2000). However, in some priority areas, especially for protection against natural hazards or recreation, silvicultural measures may need to be supplemented with the construction of infrastructure to sufficiently protect against rock falls and other hazards. In priority areas for recreation, provision of public facilities may be needed to enable recreational use. In some protection and protected forests, the third type of management regime is relevant; management objectives in these areas can only be achieved when there are limitations on forest measures and uses which are otherwise allowed outside of these priority areas (e.g. Neet and Bolliger 2004). Examples include limitations on the size of regeneration units, the period for harvesting operations, or visitor flow.

An essential task of multi-objective forest planning is to set appropriate measures which influence the characteristics of priority areas so as to achieve the management objectives. This can be illustrated in the case of protection forests in Herzogstand /Fahrenberg in the Bavarian Alps, which protect settlements or infrastructure from natural hazards through silviculture interventions that create desirable stand structure defined by tree species composition, vertical and horizontal stand structure, and natural regeneration. In addition, infrastructure is often built to protect against rock fall or other natural hazards and to augment protection capacity. In some parts of the area, limitations such as the maximum allowable density of forest roads and obligatory use of ropeway are prescribed, and some forestry activities (e.g. use of inappropriate harvesting mechanisation) are even prohibited. The management regime in priority areas is usually defined in forest plans; the strategic plans prioritise areas where measures must be implemented in the next planning period, while the operational plans set detailed measures (e.g. silvicultural treatments, technological interventions) and control their implementation. In some countries, special management plans are elaborated for some priority areas. Some protection forests in Austria ('Initiative Schutz durch Wald' subsidy-system and mapping) and Bavaria (e.g. 'Schutzwaldsanierungsplanung') and some priority areas for nature conservation such as Natura 2000 sites (e.g. BAV, CZ) are examples.

DISCUSSION

In all Central European countries, priority areas are commonly used, but there are differences in their importance for multi-objective forestry planning. There are many advantages but also some concerns regarding the adaptation of priority

TABLE 6 *Main advantages, concerns, and potential improvements of priority areas (PA) in multi-objective forest planning*

Advantages	Concerns	Improvements
– spatial identification of public importance	– domination of classification approach	– comprehensive and transparent classification of PA
– recognition of potential conflicts	– ignorance of different spatial scales	– consideration of interconnection between relevant spatial scales
– traditionally accepted system	– time consuming and costly mapping of forest area	– transparent criteria for designation
– basis for setting management regime	– lack of transparency and applicability of PA maps	– improvement of PA maps
– tool for collaboration with stakeholders	– absence of operational planning	– objectives and measures tied to each PA
– basis for spatial planning	– domination of "top-down" system influenced by politicians and non-forestry institutions	– intensification of operative management
– tool for harmonization of public and private demands	– lack of financial instruments	– involvement of stakeholders
– tool for forest policy	– affirmation of segregation approach	– efficient financial support for private forests
		– evaluation of non-timber outputs

areas into the concept of multi-objective forest planning (Table 6). The main concerns are related to (1) terminology, (2) classification and importance for forest planning, (3) criteria for designation and mapping, and (4) the implementation of multi-objective forest management in priority areas.

Terminology

In Central European countries, the term 'forest function' is most often used for priority areas. Despite the common use of this traditional term, there have been frequent doubts about its adequacy (Brun and Giau 2002, De Groot 1992, Weiss *et al.* 2002). The meaning of the term forest functions is often many-sided; it may be used to denote priority areas and also the goods and services in those areas. In addition, the term itself may imply the potential of forest ecosystems to provide benefits to society – and not necessarily the actual services provided. As a result, other terms for the importance of forests for people have been suggested, including 'values', 'tasks', 'benefits', 'uses', and more recently 'services' (Ansink *et al.* 2008, Paterson and Coelho 2009, Pistorius *et al.* 2012). All these terms express the desired benefits from forests to society, but none of them directly imply the 'areas' where these benefits (i.e. functions, services) are promoted. In the paper, we use a general term 'priority area' for all the areas where the functions, goods, services, benefits, etc. are relatively more important for multi-objective forest management. This term has not been used in multi-objective forestry planning, but it is known from nature conservation planning (e.g. Margules and Pressey 2000). Some analogies can be drawn between nature conservation planning and multi-objective forest planning. For example, designating areas for management objectives and setting spatially defined management priorities are an important part of both types of planning. Therefore, in its narrow sense, the term 'priority area' could also be an adequate term for existing 'forest functions' (i.e. priority areas for selected forest functions).

Classification and importance of priority areas for multi-objective forest planning

The benefits of forests to society have been classified in numerous ways (e.g. MEA 2005, Paterson and Coelho 2010). Due to increasing and newly recognised goods and services, there has been a tendency to differentiate forests into an ever-increasing number of types of priority areas. This raises the question of whether it is necessary to convert all new demands to 'new' types of management objectives, reflecting then in the numerous types and subtypes of priority areas. From a management perspective, the most important demands on forests should be classified and then transformed into a practical number of priority areas, leading to a clear link between the priority area and management regime. At the same time, classification of priority area should not lead to a misguided, 'black and white' understanding of management objectives, which may also be important outside of priority areas.

There are at least three crucial reasons that priority areas are used in forest planning: (1) Priority areas are an important tool to differentiate objectives and measures within large forest areas (e.g. Bettinger *et al.* 2009); (2) Priority areas are important for public participation (e.g. Kangas *et al.* 2010) and forestry sector cooperation in spatial planning (Bettelini *et al.* 2000) and can serve as a basis for environmental impact assessment and even as an argument for the conservation of forest land, which might be important in areas where deforestation pressure is high (Schulzke and Stoll 2008); (3) Priority areas provide a spatial framework for possible financial compensations and subsidies and can therefore be a useful tool for the implementation of forestry policy (e.g. Cubbage *et al.* 2007, Dönz-Breuss *et al.* 2004). Of the reasons listed above, the first is the most significant. However, defining management objectives to set a basis for management priorities and to contribute to the prevention of conflicts of forest use is a challenging task. Conflicts may appear if only the main objective is taken into account. Priority areas for protection of habitats and species in mountain forests can serve as an example; protection of species may demand open forests with an abundance of canopy gaps, which, in turn, may seriously reduce natural hazard protection. On the other hand, if management objectives are given equal importance, this can be a hindrance for applying financial instruments since the sources of financial support for management measures are usually related to the specific type of priority area. Ranking may help in this case; however, it may also blur the actual importance

of forest area since a vast array of objectives with different ranks can overlap. Prioritisation of management objectives could be more efficient for management by defining only the most important objective and ranking overlapping objectives only if significant changes in management regime are needed and hence also the application of financial instruments. Sometimes conflicts between forest uses cannot be mitigated and one of the forest uses needs to be relocated. This may be easier for uses that do not depend so much on the natural characteristics but are closely tied to the infrastructure in the forest.

Criteria for designation and mapping of priority areas

Due to new possibilities in data collection and processing, designation and mapping of priority areas is becoming more diverse and detailed, which also raises some concerns:

- Criteria for designation are often too vague and not based on different spatial scales, leading to an oversimplified understanding of priority areas. Ignoring the spatial context may blur the actual need for designating priority areas and may reflect in inappropriate decisions on the management. The eligibility of criteria could be improved by considering relevant spatial scales (e.g. Lindenmayer *et al*. 2000) and by intensifying research activities (e.g. Brang *et al*. 2006, Phua and Minowa 2005). Lastly, the criteria and variables for the designation should be transparent, understandable, and acceptable to stakeholders.
- Often, a muddle in the designation criteria can be observed in terms of assessing the 'supply' of forest goods and services, the 'potential' of forests to provide them, or 'delivery', e.g. the actual benefits provided. Assessment of the supply, which is commonly based on natural characteristics, should be regarded only as a preliminary stage of designation (Bastian 2000). In addition, forest zoning carried out by non-forestry institutions (e.g. water protection zones or areas of natural and cultural heritage) should also be understood as one of the preliminary bases for the designation of priority areas.
- Mapping of priority areas should not be the focal aim of designation process. Setting management regime to promote the desired goods and services and monitoring the efficiency of the implemented measures should receive more attention.

Implementation of multi-objective forest management in priority areas

Designation of priority areas at the strategic level is a good way to show the public importance of forests and possible conflict areas. At the operative level, attention should be directed to specific parts of the defined priority areas in which appropriate management measures should be set and applied. The selection of management regime depends on the type of priority area. However, measures for the same type of priority area may differ, which can be considered only by operational planning. Therefore, operational plans should be elaborated at a detailed scale (e.g. 1:5 000; ZH). In addition, public participation in the designation of priority areas can improve the efficiency of multi-objective forest management (e.g. De Meo *et al*. 2011, Kangas *et al*. 2010, Stiptizov and Duerr 2005). Participation of stakeholders is still insufficiently integrated into multi-objective forest planning; however, it varies among the countries, both in the procedures and in the level of public involvement. Top-down decision making still prevails in most of the countries, which results in low identification of stakeholders with the defined priority areas and management objectives. Some improvements can be made by promoting a bottom-up approach, which includes identification of crucial stakeholders and their involvement in the designation of priority areas. This also ensures that the forest service in charge of the planning is better integrated in the community. Stakeholder perceptions and values could be identified with surveys and multiple-choice questionnaires or by elaboration of priority areas maps (e.g. Kearney *et al*. 1999). Successful examples of participation have been reported more often from countries with traditionally developed (political) participation (e.g. Switzerland; Bettelini *et al*. 2000).

Due to the high proportion of private forests in Central European countries, the management objectives and practices of forest owners have had a significant influence on the effectiveness of multi-objective forest management (e.g. Ficko and Boncina 2013). Forest owners are often not included in the priority area designation, which may lead to a low level of implementation of planned measures in these areas. Hence, legal, financial, and informational instruments should be applied to increase the effectiveness of multi-objective forest management in private forests (e.g. Cubbage *et al*. 2007). In some countries (e.g. Dönz-Breuss *et al*. 2004), measures in priority areas within private forests are subsidized; often, protected areas are a spatial framework for implementation of financial instruments, since they are legally declared and funded by state or community budgets. Recently, the question of the (economic) efficiency of the integration model of multi-objective forest management has received more attention (e.g. Borchers 2010). It is believed by some that, due to the optimisation of management objectives and consequent limitation of some management measures, integrative multi-objective forest planning leads to a lower economic efficiency in comparison to the segregation model. However, the evaluation of forest management efficiency is often still incomplete as many non-timber goods and services are not included in the economic evaluation (Brun 2002, Notaro *et al*. 2008).

CONCLUSIONS

The integration model was developed to increase the effectiveness of forest management in areas with overlapping demands, which are very common in Central European countries. Due to increasing demands on forests, the question of designation of forest areas for various management objectives

is becoming increasingly relevant; therefore, planning appropriate forest land use will be of utmost importance for the forestry profession.

We believe that the integration model of multi-objective forest planning is the most appropriate for Central European conditions. However, current praxis has raised a number concerns regarding the suitability of priority areas in multi-objective forest planning. Such concerns and unexpectedly large differences in the importance of priority areas in forest planning among the observed Central European countries underscore the need for improvement of the concept of multi-objective forest planning and for additional research work in this field. This research should support knowledge on management regimes providing various ecosystem services. It may reveal relations between different management objectives in multi-objective forest management and can also be supported by multi-criteria decision analysis models; it can contribute to adequate and transparent systems of criteria for designation on the micro and macro scale; and it may foster knowledge on the relative management effectiveness of different approaches to multi-objective forest management, including the economic evaluation of all forest ecosystem services.

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2.1.2 A Conceptual Framework for Characterizing Forest Areas with High Societal Values: Experiences from the Pacific Northwest of the USA and Central Europe

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In recent decades much work has been invested to describe forest allocations with high societal values. Yet, few comparative analyses have been conducted on their importance and differences across the regions of the globe. This paper introduces a conceptual framework to characterize forest priority areas defined as areas with identified higher importance of societal values in the context of multi-objective forest management. The six dimensions of the framework (primary purpose, importance and spatial distribution of objectives, governance, permanency, spatial scale, and management regime) characterize the general approach (integrative vs. segregative) to multi-objective forest management and explain the form and role of priority areas for providing forest services. The framework was applied in two case study regions – the Pacific Northwest of the USA (PNW) and Central Europe (CE). Differences between the regions exist in all dimensions. Late succession and riparian reserves are specific to PNW, while protection against natural hazards is specific to CE. In PNW priority areas are mainly focused on public lands whereas in CE they include public and private lands. Priority areas in PNW are designated in a much larger spatial context and have longer time commitments. In CE integration of management objectives on priority areas prevails, whereas in PNW priority areas tend to be designated for single objectives. In CE greater tolerance of timber management within priority areas compared to PNW is allowed. Convergent trends in the application of priority areas between the regions indicate mixing of segregation and integration approaches to forest management.

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A Conceptual Framework for Characterizing Forest Areas with High Societal Values: Experiences from the Pacific Northwest of USA and Central Europe

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Abstract In recent decades, much work has been invested to describe forest allocations with high societal values. Yet, few comparative analyses have been conducted on their importance and differences across the regions of the globe. This paper introduces a conceptual framework to characterize forest priority areas defined as areas with identified higher importance of societal values in the context of multi-objective forest management. The six dimensions of the framework (designation objective, prioritization of objectives, governance, permanency, spatial scale, and management regime) characterize the general approach (integrative vs. segregative) to multi-objective forest management and explain the form and role of priority areas for providing forest services. The framework was applied in two case study regions—Pacific Northwest of USA (PNW) and Central Europe (CE). Differences between the regions exist in all dimensions. Late-successional and riparian reserves are specific to the PNW, while protection against natural hazards is specific to CE. In PNW, priority areas are mainly focused on public lands whereas in CE they include public and private lands. Priority areas in PNW are designated in a much larger spatial context and have longer time commitments. In CE, integration of management objectives on priority areas prevails, whereas in PNW priority areas tend to be designated for single objectives. In CE, greater tolerance of timber management within priority areas compared to PNW is allowed. Convergent trends in application of priority areas between the regions indicate mixing of segregation and integration approaches to forest management.

Keywords Priority area · Allocation · Forest planning · Ecosystem services · Spatially explicit approaches · Segregation versus integration forest management

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Introduction

Accommodating the diverse societal values of forests has been a long-standing challenge in forest planning and management. One way to address this challenge has been to spatially classify forest areas according to priority management objectives. Management objectives are strongly connected to forest goods and services or ecosystem services (MEA 2005); they define which services will be favored by forestry activities. A rough global overview (FAO 2010) showed that 24 % of the total forest area is classified as "multiple use", 30 % is primarily intended for production of timber and non-wood forest products, while 12, 8, and 4 % of the whole forest area are primarily designated for conservation of biodiversity, protection of soil and water, and social services (recreation, tourism, education or cultural and spiritual heritage),

respectively. However, under closer examination, the services provided by these designations vary in their exclusivity and the application of the categories differs among regions, states, and countries (MCPFE 2007).

Spatially explicit approaches to multi-objective forest management have been widely applied in forest planning and management. Plans or political agreements typically classify forest land among various allocations (e.g., Gustafson 1996). This is done through two main allocation approaches—either through mutually exclusive uses of land, or through integration of multiple uses across the land (Borchers 2010; Bončina 2011). The first approach, often termed segregation, divides or zones forests according to single or dominant use, and multiple uses are achieved by a mosaic of different zones on a larger landscape. The second approach, known as integration, designates forest areas for multiple uses, although in practice prioritization of objectives commonly occurs. In reality, completely exclusive approaches rarely exist and mixed approaches with elements of both are common. In addition, the extent to which the elements of both approaches are applied differs among regions (e.g., Koch and Skovsgaard 1999; Angelstam et al. 2005). The relative merits of the effectiveness of the two approaches have frequently been debated. The segregation approach is thought to successfully provide multiple uses at the landscape scale (Nitschke and Innes 2005; Zhang 2005); however, it may not adequately integrate multiple uses within each management area (Behan 1990). The integration of management objectives may be suitable for areas with diverse and overlapping demands (Bollmann and Braunisch 2013), but it may be economically, ecologically, or socially ineffective (Vincent and Binkley 1992). However, the effectiveness of allocations is not only a function of the mix of objectives but also the size and distribution of the allocations (Gustafson 1996; Lindenmayer and Franklin 2002) and their persistence (Stamper et al. 2013). Moreover, the management activities allowed in allocations (either for commodity or other objectives) can play important part in the success of their implementation (Kaeser et al. 2013; Macura et al. 2013). Finally, public participation and community involvement can be essential for successful establishment of allocations by generating understanding and building trust in designation and management process (Bettelini et al. 2000; Cheng and Mattor 2010; Niedzialkowski et al. 2012).

In recent decades, much work has been invested to describe specific types of allocations or factors that affect their designations (e.g., McIntosh 1995; Fries et al. 1998; Führer 2000; Soules 2002; Boyland et al. 2004; Montigny and MacLean 2006; Thomas et al. 2006; Côté et al. 2010; Riegert and Bader 2010; Kaeser and Zimmermann 2014). Allocation approaches appear to differ considerably among regions and countries. However, few comparative analyses have been conducted on their importance and differences across the regions. Global overviews of forest areas with high societal values have been performed (e.g., MCPFE 2007; Jennings et al. 2003), and some detailed analyses have focused on areas with specific protection status and longer time commitments (>20 years) on global (e.g., Dudley and Phillips 2006; Konijnendijk et al. 2006) and regional levels (e.g., Parviainen et al. 2000; Brang et al. 2006; Frank et al. 2007; McAlpine et al. 2007). Despite this work, we lack understanding of how allocations are developed, defined, and applied in specific landscapes across the globe. For example, what are the dimensions of forest areas with high societal values in different countries and how and why does the relative importance of allocation approaches (e.g., segregation vs. integration) differ? Also, social and ecological trends (e.g., Angelstam et al. 2005) suggest it is time to reexamine the role of established allocations as spatial expressions of the multiple societal values of forests. Ecological changes as a result of past land use or climate change may require rethinking of how allocations are identified and managed (Spies et al. 2010). Socio-economic dynamics, in the form of urbanization, depopulation of rural areas, and global redistribution of forest production pose challenges to forest planning and management based on land allocations (e.g., Kline et al. 2013; Cullotta et al. 2014). In addition, governance in natural resource planning is shifting from top-down to a more cooperative approach (e.g., Kearney et al. 1999; Kaeser et al. 2013; Niemela et al. 2005), which may have both stimulating (Asah et al. 2012; Stern 2008) and counterproductive results for establishing forest allocations (Wells and McShane 2004). It is also not clear how allocation approaches affect the accounting and supply of forest ecosystem services (e.g., Verkerk et al. 2014).

We seek to advance our understanding of forest allocation approaches in multi-objective forest management by developing a conceptual framework and then using it to characterize forest allocations in two case study regions: Central Europe (CE) and Pacific Northwest region of USA (PNW). These regions represent quite different but relatively widespread approaches of multi-objective forest management and provide a good opportunity to explore the development and use of forest areas with high societal values in contrasting settings.

Conceptual Framework

The institutional basis of forest allocations includes the legal frameworks, process for designation with involved institutions, and subsequent management. In order to develop a framework, common terms and definition for forest areas with high societal values are needed.

Terminology for allocations varies regionally and globally, e.g., special areas (USDA 2009), forest function areas (Riegert and Bader 2010), allocations (Thomas et al. 2006), allocation zones (Côté et al. 2010), multiple use zones (Boyland et al. 2004), land use allocations (Soules 2002), set-aside areas (Store 2009). We propose to use an umbrella term "forest priority areas" for all kinds of above-mentioned allocations. We define forest priority area as "an area in the forest with identified higher importance values for selected goods and services compared to the general forest land which is designated within the framework of forest planning or by higher level legal regulations". General forest land is understood as the area where forest management does not explicitly favor any services although timber production is commonly the main management objective on these lands. To characterize priority areas and to compare them between the different regions, the framework includes six main dimensions: (1) designation objective, (2) prioritization of objectives, (3) governance, (4) permanency, (5) spatial scale, and (6) management regime.

Designation objective includes the main initial purpose for priority area designation. Categorization of priority areas according to objectives has been widely applied, with almost each country developing its own system. In addition, some general categorizations have been proposed in the frame of international activities to be able to report on the global importance of forest services (e.g., FAO 2010). These efforts have recently been accompanied with the emerging concept of ecosystem services (MEA 2005) which has achieved quite high level of success in developing a shared language to classify forest services. Based on some existing classifications (e.g., FAO 2010; Simončič et al. 2013), we stratified designation objectives into six main categories, each providing specific set of forest ecosystem services (Table 1).

Prioritization of management objectives was classified as (1) segregation of objectives, that is when multiple objectives are spatially segregated, and (2) integration of objectives, that is when multiple objectives are integrated within the same forest area. In the latter case, ranking of objectives' importance can be applied (e.g., Riegert and Bader 2010). Moreover, there may be overlap between priority areas—when new designations are layered on top of the existing ones without removal or nullification of previous priority areas.

Governance defines the institutional framework for designation and for management of priority areas (Secco et al. 2011; Lawrence et al. 2013). Accordingly, we described governance of priority areas by several sub-dimensions. The first is the designation authority; numerous institutions and individuals can be involved in designation of priority areas, some of them having formal authority for designation or for recommending potential priority areas whereas some only informally participate in the designation. The second is the management arrangements; forest management in priority areas can be carried out by public agencies, non-governmental organizations, or private sector. The third is the policy and legal documents; governance arrangements for priority areas can be enforced through various governmental legal acts including presidential, congressional, or national designations, or through management authorities mainly in the form of forest plans. The fourth is the land tenure; it includes the ownership of priority areas as well as the rights on the use and interactions between social institutions.

Permanency refers to the temporal commitment or intended duration of the priority areas. Designated priority areas remain relatively stable over time or can rapidly change mainly due to socio-economic and political demands. We measured permanency of priority areas through three broad categories (adapted after USDA 2006b): (1)

Table 1 The main categories of management objectives and ecosystem services delivered

Groups of management objectives (after FAO 2010; Simončič et al. 2013)	Important ecosystem services	Groups of ecosystem services (after MEA 2005)
Protection against natural hazards	Protection against erosion, rock falls, flood, and avalanches, control of stream flow regulations, hazardous fuel reduction	Regulating
Nature conservation	Wilderness protection, protection of habitats and species, protection of prominent natural features	Regulating
Environment protection	Climate and pollution control, controlling water quality, provision of drinking water, beauty and free flowing nature of waterways	Regulating
Recreation	Protection of scenic, cultural, natural, and recreation resources, promotion of tourism and leisure activities	Cultural
Science and education	Long-term science and management studies	Cultural
Production	Timber production, firewood, and other non-wood products such as game, mushrooms, chestnut, medicines, fodder	Provisioning

permanent (ad infinitum) and semi-permanent (>20 years) priority areas are those whose legal authorities provide long-term protection, (2) mid-term priority areas can persist administratively over time, but whose legal authority has a finite duration and must be renewed based on periodic governmental or planning reviews (10–20 years), (3) temporary priority areas are designed to address relatively short-term management objectives (<10 years).

Spatial scale has important influences on institutional, management, and ecological characteristics of the priority areas (Spies and Johnson 2003). We defined spatial scale with two measures: (1) the spatial context e.g., the size of the broader planning area and (2) size e.g., the surface of priority areas. Three generic scales were used to describe the spatial context: stand/patch (~0.5–100 ha), landscape (~100–100,000 ha), and regional scale (>100,000 ha). These, of course, are arbitrary size classes and their interpretation will vary across regions. In addition, relationship among priority areas is important; it tells whether they are independently designated or if they are part of a network or have some other connection to each other.

The management regime intended to promote the desired services includes different kinds of measures and activities ranging from complete restrictions to applying measures in the field of silviculture, forest protection, road construction, wildlife management, and other forest activities (Bončina 2011). We assessed the range difference of management of priority areas compared to the general forest management and described the main management adaptations on priority areas. The first was assessed with 5-level scale, class 1 indicating business as usual forest management in terms of no adjustments of timber harvest in reference to general lands, and class 5 as complete restriction of timber harvest. These management classes are arbitrary but closely follow the study objectives because they outline the way forest management is practiced in the whole forest matrix.

Case Studies

CE comprises the area of many states or their parts (hereafter countries); among them our study included Austria, Croatia, Czech Republic, Bavaria (Germany), Hungary, Trentino region (Italy), Slovakia, Slovenia, and Canton, Zurich (Switzerland) (for details see Simončič et al. 2013). The total area of these countries amounts to approximately 80 thousand square kilometers and percentage of area covered by forests ranges from 30 to 60 % (Table 2). CE is characterized by forests of deciduous and coniferous species ranging from lowland and floodplain types up to alti-montane and alpine forests (Ellenberg 1988). The Pacific Northwest (PNW) region of the United States includes the states of Washington and Oregon (our primary focus) but is sometimes more broadly defined to include northern California, northern Idaho, and British Columbia. These forests are dominated by coniferous species and included temperate rainforest types near the coast and dry, fire-prone forest types in the interior environments (Franklin and Dyrness 1973). The area of Oregon and Washington in the PNW region is over 42 thousand square kilometers, with forestland occupying slightly more than 50 % of the total land area (Smith et al. 2009).

Population density and proximity to forests are important drivers of social values associated with forests. CE is characterized by dense population, various nations, and diverse socio-economic background of the countries. Traditionally, CE has been politically divided into small states, regions, and municipalities. Politically, PNW (especially if focused on federal forest lands) is more uniform; it includes forest land of two similar states with similar forestry organizations. A large share of forests in CE is under private ownership, which is characterized by small-scale ownership [average private property ranges from 2 to 30 ha (Schlueter 2008)]. In PNW, the proportion of public forestlands is slightly higher than for privately owned forestlands. Public forests include federal, state and local government lands, among which 82 % is managed by the federal Forest Service—USFS or the Bureau of Land Management—BLM (Smith et al. 2009).

Our framework and analysis is not restricted to public or private land; however, in the PNW region our comparison and discussion emphasize federal forest lands because multi-objective forest management has been the primary goal on these lands and planning for priority areas has been active over the last few decades (Johnson and Swanson 2009).

Data Collection

Characterization of the concept in both regions was based on document review, personal discussions, and interviews with forest planners and managers from various CE countries and PNW, consultations with practitioners and field visits. Document review comprised mainly gray literature such as national acts, forest planning guidelines, and forest development plans and reports. For CE, the most important documents included forest function mapping guidelines (e.g., Volk and Schirmer 2003; SBS 2004), forest development plans and international reports on specific priority area types (e.g., Konijnendijk 1997; Frank et al. 2007). In PNW, document review comprised Forest Service national forest land and resource management plans, planning documents required by the National Environmental Policy Act and other regulations (e.g., USDA

Table 2 Basic data on forest area in the Pacific Northwest (PNW) and Central Europe (CE)

Basic data	PNW	CE
Area (1000 ha)	42,450	80,000
Forest area (1000 ha)	21,225	17,300
Share of forest in total area (%)	50.5	30–60
Share of public forest in total forest area (%)	47.5 federal, 12.1 state, 0.4 local government	23–74 (avg. 48)
Share of private forest in total forest area (%)	40	23–74 (avg. 52)
Population density (million)	10.7	~160
Population density (n/km^2)	24	80–230
Forestry in GDP (%)	1.6 (OFRI 2012)	0.1–0.6 (Forest Europe, UNECE and FAO 2011)

2012), USDA Forest Service Handbooks (USDA 2006a, 2009, 2015), and reports (e.g. FEMAT 1993; Smith et al. 2011). In addition, we used the information conducted from structured in-depth interviews with experts in forestry planning from nine CE countries (one representative per country) (Simončič et al. 2013). The respondents collaborated with forestry practitioners who provided insights into the implementation of the concept of priority areas. Moreover, field visits in each of the studied country were carried out with interviewed experts and on the ground practitioners to check responses gathered during the interviews. In PNW, our assessment was based on several years of research and observation of national forest planning including recent application of ecosystem services approach and collaborative efforts (e.g., Smith et al. 2011). In addition, several open interviews were carried out for the purpose of this research including forest planners and managers from various Forest Service units of the PNW Region, and representatives of forest collaboratives.

Priority Areas in Central Europe and Pacific Northwest Region of the United States

Designation Objective

Most priority area types in both regions are classified according to main designation objective (Table 3). In CE, general term "forest function areas" is often used for priority areas, where "function" can be understood as a designation objective. While the diversity of objectives may appear to be higher in PNW given the larger number of priority area types, some CE countries distinguish up to 20 different objectives (see Simončič et al. 2013 for country level information). Recreation, naturalness protection, research, water protection, and conservation of habitats and species are common designation objectives for both regions. In PNW, recreation areas are broken down in many different types encompassing more than 420,000 ha and together with other priority areas with recreation as a sub objective they cover more than 10 % of the whole forest area (Smith et al. 2009). In CE, almost all forests are open for recreation. However, recreation as a stated goal is mainly limited to smaller areas around trails, paths, or the surroundings of scenic views; some larger blocks of this priority area type can be found around cities (Konijnendijk 1997). In CE, priority areas for protection against natural hazards occupy large areas, in some mountainous regions containing more than 50 % of the whole area (Brang et al. 2006) whereas this objective is not important in PNW, except perhaps in the wildland–urban interface, a zone around developed areas where federal managers emphasize wildfire hazard reduction through fuel treatments.

A large part of the land base within priority areas is occupied by nature conservation areas. In recent decades, extensive forest areas in CE have been designated for nature conservation purposes, with national and regional parks and Natura 2000 sites being typical examples (EEA 2005). In PNW, specific nature conservation objectives (outside of wilderness areas which have general goal to preserve "natural" conditions) have recently become relevant with the enactment of the Northwest Forest Plan (NWFP) which focused on conserving and restoring old-growth forests and their associated species (USDA 1994). Late-successional and riparian reserves are specific to the PNW encompassing more than 3 million ha of forest land. Wilderness protection has been much more important in PNW compared to CE, wilderness areas encompassing approximately 1.8 million ha of federal forest land, and together with national parks they contain more than 13 % of the total forest area (Smith et al. 2009). In CE, wilderness protection is mostly limited to strict natural reserves, covering approximately 0.1–1 % of the total forest area of the countries (Parviainen et al. 2000) or to forests within core zones of national parks. While the surrounding zones of the parks can be much larger, they commonly include multiple objectives including timber production.

Table 3 Dimensions of priority areas for a) federal lands in the Pacific Northwest (PNW) and b) all lands in Central Europe (CE)

Designation objective	Major priority area types	Prioritization of objectives		Governance			Permanency[b]	Spatial scale		Management regime[d]	Main references
		Integration vs. segregation[a]	Overlap	Designation authority	Management arrangements	Legal documents		Context[c]	Size of PA		
(a) PNW											
Nature conservation	Wilderness areas	S	Yes	Congress	Government	Congressional acts	P	L	>2000–10,000 s ha	5	WA (1964), Bratton (1985)
	National monuments	I	No	President	Government	Presidential act	P	R/L	Avg. 130–260 ha	5	AAA (1906), Bratton (1985)
	Late successional reserves	I	No	President	Government	NWFP	SP	R	5000–>50,000 ha	3–5	USDA (1994)
	Riparian reserves and key watersheds	I	No	President	Government	NWFP	SP	R	~50,000 ha	4–5	USDA (1994)
Environment protection	Wild and scenic rivers	S	No	Congress	Government	Congressional acts	P	R	100 s km²	4–5	WSRA (1968)
Recreation	National recreational areas	I	No	Congress	Government	Congressional acts	P	R/L	"Spacious"	4	WA (1964), Bratton (1985)
	National scenic areas	I	No	Congress	Government	Congressional acts	P	L	Size not defined	3–4	NSAA (2003)
	National scenic and historic trails	S	Yes	Congress	Government	Congressional acts	P	L	1000 s km²	3–4	NTSA (1968)
	National natural and historic landmarks	S	No	Secretary of interior	Government	Local plans	P	R	Few ha–1000 s ha	5	HSA (1935), Bratton (1985)
	Special interest areas	S	Yes	Secretary of agriculture	Government	Local plans	P	L	<ha–1000 s ha	4	Bratton (1985)
	Special management areas	S	No	Forest supervisor	Government	Forest plans	T	L/S	>20,000 ha	3	USDA (1994)
Science, education, learning	Research natural areas	S	No	Secretary of interior	Government	Local plans	P	L/R	>120 ha	3–5	OA (1897), Bratton (1985)
	Experimental forests or ranges	I	No	Secretary of agriculture	Government	Local plans	P	L	0.5–225 km²	3	USDA (2014)
	Adaptive management areas and matrix	I	Yes	President	Government	NWFP	SP	R	Size not defined	2	USDA (1994)
Production	General forests	I	No	Forest supervisor	Government	Forest plans	T	L/S	>20,000 ha	1–3	USDA (1994)
Fire hazard reduction near human settlement	Wildland-urban interface	I	Yes	Forest supervisor	Government	Local plans	T	L/S	Variable	2–3	USDA (1994)

Table 3 continued

Designation objective	Major priority area types	Prioritization of objectives: Integration vs. segregation[a]	Prioritization of objectives: Overlap	Governance: Designation authority	Governance: Management arrangements	Governance: Legal documents	Governance: Ownership type	Permanency[b]	Spatial scale: Context[c]	Spatial scale: Size of PA	Management regime[d]	Main references
(b) CE												
Protection against natural hazards	Protection forests	S	No	Government	Mainly government	National acts, contracts	Public, private	P	R/L	Size not defined	4–5	Brang et al. (2006), Bauerhansl et al. (2010)
	Forests with protection function	I	Yes	Ministry	Co-managed	Forest plans	Public, private	T	L/S	>0.5–1000 s ha	2–4	Same as above
Nature conservation	Forest reserves	S	No	Government	Mainly government	National acts, contracts	Mainly public	P	L	1–4000 ha, avg. 40–60 ha	5	Diaci (1998), Parviainen et al. (2000)
	National parks	I/S	Depends on zone	Government	Co-managed	Nature conservation acts	Public, private	P	R/L	>1000 s ha	3–5	Parviainen and Frank (2003)
	National monuments	I	Yes	Government	Mainly government	Nature conservation acts	Public, private	P	L/S	>~10–1000 s ha	4	Same as above
	Natura 2000 sites	I	Yes	Government, ministry	Co-managed	Nature conservation agreements/ forest plans	Public, private	P/T	R	>~10–1000 s ha	2–4	EEA (2005)
	Other areas with nature conservation function[e]	I	Yes	Ministry	Co-managed	Forest plans	Public, private	T/P	L	>0.5–1000 s ha	2–4	Simončič et al. (2013)
Recreation	Urban forests	I	Possible	Government, municipalities	Mainly government	Ordinances, degrees	Mainly public	P/T	L	>~10 ha	4	Konijnendijk (1997)
	Areas with recreational function	I	Yes	Ministry	Co-managed	Forest plans	Public, private	T	L/S	>0.5–1000 s ha	2–4	Pröbstl et al. (2009)
Science and education	Forests with educational or research function	I	Yes	Ministry	Mainly government	Forest plans	Public, private	T	L/S	>0.5–1000 s ha	2–4	Volk and Schirmer (2003)
Environment protection	Forests with function of climate or drinking water control	I	Yes	Ministry	Government or co-managed	Forest plans, water regulations	Public, private	P/T	L/S	>0.5–1000 s ha	2–4	Volk and Schirmer (2003)
Non-timber production function areas	Game, non-timber products	I	Yes	Ministry	Private or community	Forest plans	Public, private	T	L/S	>0.5–1000 s ha	4	Bauer et al. (2004), Simončič et al. (2013)

Table 3 continued

[a] *I* integration, *S* segregation

[b] *P* permanent, *SP* semi-permanent, *T* mid-term, *S* temporal

[c] *R* regional, *L* landscape, *S* stand level

[d] 1 business as usual, 2 low adaptation of measures, 3 middle adaptation of measures, 4 high adaptation of measures, 5 complete restrictions (classes present the degree of adaptation of management measures in reference to non-designated lands)

[e] These include also forests in other protected categories such as regional and landscape parks, biosphere reserves, ecologically important areas, or other forestry designations

Prioritization of Management Objectives

There is a considerable difference between the two regions in how the explicit and non-explicit objectives are promoted within priority areas. In CE, multiple management objectives are often promoted on the same forest area; thus more forest functions are mapped in such area. To avoid potential conflicts, forest functions are prioritized by ranking (e.g., SBS 2004). Commonly non-timber objectives have priority over timber production, but the latter is still considered with lower rank of importance. Ranks (two or three at the most) are defined in planning process or by local forest managers. Overlapping appears where different agencies have competences over forest lands; common cases are overlaps between protection forests and national parks.

In PNW, management objectives on priority areas tend to be segregated, although multiple objectives may still be promoted without specific ranking or prioritization. Adaptive management areas and "matrix" are special cases where agency learning, timber production, and biodiversity conservation are integrated to varying degrees, although these have not been implemented as intended (Stankey et al. 2003) and formal adaptive management activities are rare. In addition, agency planners develop standards and guides that may identify subareas within a priority area where priorities can shift (e.g., USDA 1994). In wilderness areas, zones may be identified where some types of recreation (e.g., camping, snowmobiling) are excluded, or within late-successional reserves where some timber can be produced from existing plantations if it is a by-product of ecological restoration activities. Overlapping of different priority area types is less common; it has occurred as different planning processes have superimposed new plans on top of older ones, without modification of the older ones. For example, late-successional reserves, which were intended to protect old-growth forests, were zoned in some places on top of the existing wilderness and recreation areas. In such cases, the more recent designation or the legislated designation takes priority over the earlier one, though that can be a subject of debate.

Governance

In both regions, governance of priority areas is distributed among diverse social actors, including federal/national and local government, communities, non-governmental organizations, and the private sector. Lower-level authorities (e.g., forest district planners) appear to have more authority and responsibility to decide on designation and management of priority areas in CE compared to PNW. In PNW, the federal government (at multiple organizational scales) makes direct decisions on the designation of majority of

priority areas on its lands through congressional legislation (e.g., wilderness areas), from the executive branch (e.g., late-successional reserves), and through administrative processes in forest plans which layout a broad vision for management over a period of 10 or more years. The authority for the designation of priority areas on federal lands depends also on their administrative unit such as Districts, Forests, or Region (USDA 2006a). Public participation in forest plan development, including designation of priority areas for wildlife and stream habitat production, is a key component of the recently adopted Forest Service Planning Rule (USDA 2012). Participation includes collaboration on particular issues, involvement in workshops, consultations, and basic information sharing through various media. The goals of public participation in plan development include "Increased trust and commitment to the final plan, with reduced potential for litigation" (USDA 2015, p. 19).

In CE, most priority areas (all "forest function areas") are designated in forest plans which are approved by stakeholders through participation process and declared by the government. Only a small proportion of priority areas—mainly those with outstanding public interest such as protection forests or natural reserves—are designated directly by legal acts at state, canton/regional or municipal level. In PNW, the USDA Forest Service can administratively identify non-wilderness priority areas during forest planning and recommend some other priority area types which are then designated on higher governance levels. In addition, state and non-governmental designations include collaborative protection efforts on private lands as well as state trusts and recreation lands (Stamper et al. 2013). In both regions, non-management agency institutions (governmental or NGO's) input must be considered in designation of priority areas through planning or through political processes. In CE, the role of these institutions is relatively high through the whole designation process. Participation of public and forest owners is important especially for approving the proposed priority areas and less for designation process. However, approaches of public participation vary significantly among CE countries. Good practices are known from Switzerland where working groups are used to include stakeholders into the designation and management of priority areas (Bettelini et al. 2000). In PNW, environmental and timber industry groups attempt to influence Congress or the forest planning process regarding designation of new priority areas or management actions within them (Sabatier et al. 1995). In both regions, designation of broader protected areas such as national parks is under the delegated or legislated authority of nature conservation and land management agencies.

Priority areas in public forests in both regions are managed in consultation with environmental regulatory agencies and in PNW in some cases with Native American tribal governments. In PNW, this type of governance is further distributed among several public agencies leading to different management approaches on adjacent or similar publicly owned lands (Spies et al. 2007). In addition, state authorities in PNW are responsible for state forests, parks, and state wildlife reserves. In CE, priority areas can also be designated in private forest, which is very limited on private land in PNW (e.g., riparian protection, threatened and endangered species habitat). Priority areas on private lands in CE are usually co-managed with private owners. Management arrangements on private lands can be defined by contracts with private owners, especially when state funds are intended to support public services on private lands (e.g., Dönz-Breuss et al. 2004). In addition, many forms of voluntary contributions on private lands can be found like short-term contracts for groundwater protection, maintenance of cultural objects, or other points of local importance. In PNW, the state-level forest practice acts set rules for private landowners and state lands regarding protection of riparian areas and wetlands but these are often much less rigorous than on federal lands. However, quite large differences between small forest landowners and large timber industries exist mainly in the form of management intensity, since both are subject to the same state-level forest practices acts. While some landowners voluntarily provide public values, such as recreation, hunting, or habitat for some species, personal choices and legal liability issues often exclude public access to private lands (Wright et al. 2002).

Permanency

Governance arrangements have strong influence on the permanency of priority areas in both regions. The majority of priority areas in PNW have been designated by federal-level processes for which strong political consensus is needed (Loomis 2002); such priority areas have greater permanency than those designated in administrative processes which are subject to revisions of forest plans. In CE, priority areas of mid-term commitment prevail; by renewing the strategic forest plans, usually in the period of 10–15 years their designation is actualized. In both regions, priority areas designated for nature conservation have longer time commitments compared to other priority area types; wilderness areas and forest reserves designated in "perpetuity", or late-successional reserves with permanency of 100 years are such examples although the permanency of late-successional reserves and other designations under the NWFP is still subject to change as forest plans change and as new knowledge from adaptive management, science and monitoring becomes available. Priority areas for recreation may change more frequently, although being much more permanent in PNW than in CE.

Temporary priority areas (i.e., less than 10 years) are quite rare for both regions.

Spatial Scale

The spatial context and size of individual priority areas varies significantly between the regions. In PNW, the size of individual priority areas commonly ranges between 100 s and 10,000 s of ha, whereas in CE their size varies between 10 ha and 100 ha. In PNW, the context for establishing priority areas is typically large, landscapes and regions compared to CE where the size of the designation context is commonly a small landscape ranging between 10 s ha (forest stands/compartments) to small region of about 10,000 s ha (planning regions). In CE, regional spatial scale has rarely been used as the context for identifying and implementing priority areas and various priority areas were mainly designated independent of each other. Some recent exceptions include international agreements such as national parks and Natura 2000 sites (EEA 2005), or national networks of forest reserves (Parviainen et al. 2000). In PNW, the regional scale has become more common with the NWFP which encompasses an area of more than 10 million ha and consists of a network of large reserves designed to facilitate maintenance of populations of species, especially the northern spotted owl. However, the spatial context for planning in PNW may be shifting back down to the level of individual national forests as new forest plans are developed and overlaid on top of the older NWFP.

Management Regime

Forest management activities in priority areas differ between PNW and CE in both inside and outside priority areas. In PNW, management practices in priority areas can include timber production (though most ecological priority areas do not include it or limit it in some way), reducing fire risk through mechanical treatment and prescribed fire, and restoration of forest structure and composition through silvicultural practices. Additional activities can include fire suppression, road building and maintenance, and campsite creation (Appendix Table 4). Most of these activities are subject to limitations based on location and forest conditions. In CE, management objectives are promoted by combining timber harvesting with specific measures. Protection against natural hazards may be assured by adopting silviculture in a way to augment protection function (Dorren et al. 2004); in addition, protection infrastructure is built, or limitations of timber management are applied such as lower maximum allowable cut, lower density of forest roads, and obligatory use of ropeway. Within protection forests, habitat conservation can be promoted by leaving open spaces with abundance of canopy gaps to create desired habitats (Neet and Bolliger 2004) provided that they do not threat the capacity of stands to protect subjacent objects from natural hazards. Compared to PNW, management regimes without or with minimum interventions are rare and mainly applied in natural and scientific reserves, and core areas of the national parks and of biosphere reserves (MCPFE 2007).

In PNW, forest management practices outside priority areas on federal lands have historically included regeneration harvesting (e.g., clearcutting), green tree retention, thinning, prescribed burning, and road building. However, since the adoption of the NWFP in 1994 for forests in the range of the northern spotted owl, the area of forest dedicated to timber production has nearly disappeared. Continuing social pressure against the logging of old and large trees has meant that allocations in the NWFP that were originally intended for timber production (e.g., "matrix") have essentially become areas to promote old forest development through thinning only (no regeneration harvesting). Timber production, which now comes mainly from thinning, is a secondary but still important objective. On national forests outside of the NWFP area, general forest still typically occupies the majority of the landbase. Although with timber production as the main objective, general forests on federal lands still provide for a range of services. For example, clearcut areas can provide habitat for neotropical bird species and many ungulates and game species use recently cut forests for foraging and nearby forested area for cover. Intensive timber management (e.g., short rotations and vegetation control) as practiced on some private and state forest lands does not occur on federal lands. In CE, management activities outside priority areas (these lands are termed "multifunctional" or "production function areas") have to consider ecological, social, and economic objectives, often leading to quite similar management regimes on priority areas and outside of them.

Discussion

The application of the framework in PNW and CE region demonstrates the dimensions of similarities and differences in the application of priority areas in multi-objective forest management. The differences between the regions stem from ecological (e.g., role of fire), cultural, historical, and political factors. The primary possibilities for designation of priority areas depend strongly on political systems (Glück 2000; Soules 2002) and their effects on property jurisdictions. Probably the most significant difference between the regions is that in PNW, public non-commodity values are primarily represented in federal and state lands whereas in CE those values are applied in both public and

private land settings. Public importance of all lands in CE mainly derived from historically different property jurisdictions in German system versus Anglo-American legal system (Pistorius et al. 2012), long-term tradition in regulations between public and private rights, and early awareness of high public value in all forests, which was especially strengthened after catastrophic events in the Alps due to extreme floods in the end of nineteenth century (Kräuchi et al. 2000). Many CE countries have adopted rules for the private forests similar to those applied for the state lands (Kissling-Näf and Bisang 2001) including free access and practicing "close-to-nature" forest management (Bauer et al. 2004), and thus providing many public services from private lands. However, for some services (e.g., recreation), adjustments of timber management or additional measures are needed, which may be difficult to apply in private forests—due to divergent objectives of forest owners (Ficko and Bončina 2013), or financial burdens to compensate trade-offs between non-public and public services (Cubbage et al. 2007). This is easier for example in protection forests where state funds are available and protection against natural hazards holds legal priority over owners' rights (SAEFL 2004). Even in CE, allocating priority areas in private lands is more challengeable, but it may be inevitable due to limited extension of public forests, or dominance of private lands where public importance of forests is high (e.g., urban or protection forests). In regions with extensive public lands such as PNW, priority areas can largely avoid private lands, but this may change with shifts in public demands or with changes in ownership structures (e.g. Stanfield et al. 2002). Efforts to increase the supply of services from private lands have been slowly increasing also in PNW (Deal et al. 2012), and the evolving use of conservation easements could be seen as a way forward in providing ecological and social benefits on private lands (Merenlender et al. 2004).

We demonstrated how a framework that includes designation objective, prioritization of objectives, and management regime both in priority areas and outside of them is needed to understand differences in approaches to multi-objective forest management (i.e., segregation vs. integration). Integration of objectives within priority areas is emphasized more in CE than in PNW, where the segregation model is dominant. In PNW, management activities strongly depend on the designation objectives, leading to higher diversity of management regimes across the region compared to CE (Fig. 1). In CE defined management objectives serve more as orientation for searching the most appropriate silviculture systems or applying additional measures rather than for defining management regime. Thus, forest management activities on priority areas have been much less restricted compared to general lands than in PNW. Management regimes on priority areas in CE in many cases do not include any adjustments at all. This is often the case when priority areas are designated to protect forests where pressure for land use conversion is strong (Schulzke and Stoll 2008). In addition, uneven-aged silviculture has been sufficient to provide the desired ecological goals in many nature conservation areas (e.g., Diaci et al. 2011). However, in forests with direct protection against natural hazards, strong limitations or modifications of timber management are applied (e.g., Berger and Rey 2004). The results of our study suggest that the segregation of management objectives in priority areas is partly related to a range of management intensities across the region. If non-timber services are an integral part of timber management on the majority of forest land, the need for segregating objectives may be less, especially if timber management intensity can be significantly reduced and still meet ecological, social, and economic goals. Also, in CE timber production has traditionally been a part of priority areas management whereas in PNW intensive forest management is not what much of the public wants for management of federal lands. This along with the stronger environmental controls on forest management on private lands may be the main reason for greater tolerance of timber management within many priority areas in CE compared to PNW.

The possibilities for emphasizing either integration or segregation approach are closely connected to the spatial scale. In PNW, extensive areas are capable of accommodating different forest values and priority area types. While some areas do not supply certain services, the whole forest matrix may have the potential to deliver them to society (Behan 1990). But in smaller regions such as CE, the diversity of forest values must be packed into smaller areas and some intensive commercial timber harvesting types (e.g., industrial plantations) may not be compatible with other values. However, the amount of integration that can happen in both regions is limited. In some priority areas (e.g., old-growth conifer forests of PNW, or other nature conservation goals), it may not be possible to easily integrate timber and ecological values within the same area. Likewise, in some legally protected areas including wilderness-type areas, there is a limit to the amount of integration that can occur (Bollmann and Braunisch 2013). In PNW, integration approaches, such as ecological forestry, may not be trusted by environmental groups to produce beneficial ecological outcomes. Thus, segregation is inevitably needed to prevent conflicts, which may appear due to non-compatible objectives in the same priority areas or intensive and diverse use of the same forest land. Also, integration approach seems to be more demanding, especially in private forests where optimizing desired and sometimes competitive services is a challenging task, accompanied often by longer, and also more expensive

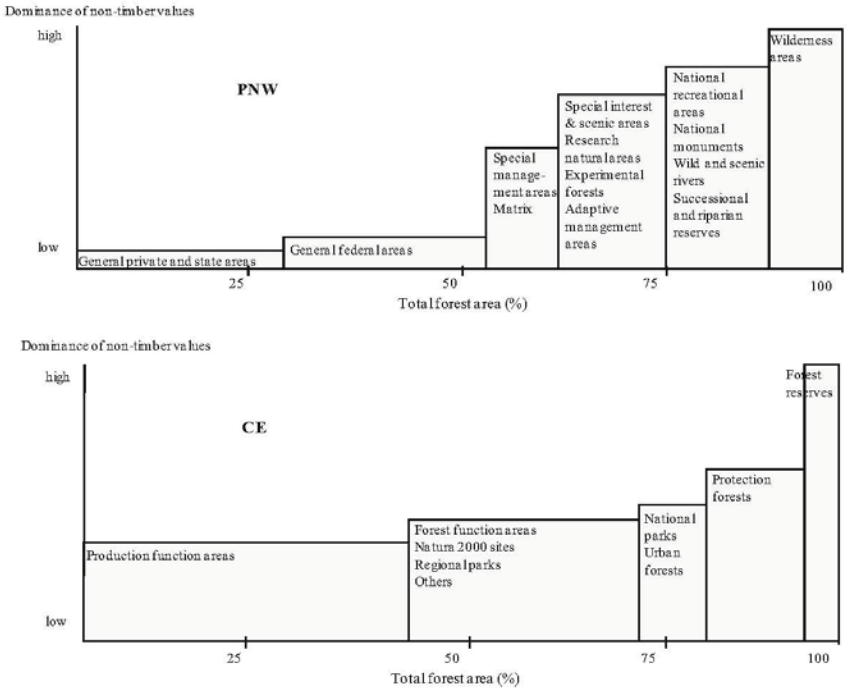

Fig. 1 Relative share of priority areas and general lands in total forest land (*x* axis) and their importance in providing non-timber services (*y* axis) across Pacific Northwest region of the United States (PNW) and Central European region (CE)

participatory planning (Niemela et al. 2005; Cantiani 2012). However, at least in CE, segregating objectives across lands has proved to be difficult to implement due to overlapping demands, traditions, and the mentality of forest owners and ownership structure (Kaeser et al. 2013), leading to recognition that integration of objectives may result in more win–win situations (Kaeser and Zimmermann 2014). In addition, the more segregated the objectives are on priority areas, the greater the economic impact for private owners who depend on forests for their livelihoods. This is probably also the reason for more integration in CE compared to PNW where the federal government is expected to cover the costs of adjusted management. The relative effectiveness of the two approaches for multi-objective forest management is strongly dependent on the ecological and socio-economic context as well as culture and emotions (Vining and Tyler 1999).

Our study showed that priority areas and their persistence is at least partly a result of the history of social forest management conflict and the effects of priority area establishment. The last few decades of the twentieth century were strongly influenced by the social distrust in forest management (Gluck 1987; Wilkinson and Anderson 1987) which led to establishment of many legally protected priority areas. In PNW, intensive timber production on public lands created a crisis that was partially solved through designation of permanent (for 100 years) priority areas by federal policy makers and managers. The designation of large old-growth priority areas on federal forest land has quelled much, but not all, of the controversy and has given the Northwest Forest Plan a status and weight in some environmental community that makes it resistant to any land allocation changes (Spies and Duncan 2009; Kline et al. 2013). There are proposals to use ecological forestry on federal lands (Franklin and Johnson 2012), but presently there is little support from environmental groups that may strongly value forests without evidence of human activity or mistrust the ability of scientific forest management to produce desired ecological outcomes (DellaSala et al. 2013). In the case of PNW, the emergence of forest collaboratives has been a recent way in implementing management objectives and gaining greater public trust

(Wondolleck and Yaffee 2000). However, it seems that given the trust issues and long-term commitments of existing priority areas, it may be more politically possible to modify management objectives and actions within the existing boundaries than to change the boundaries themselves.

The application of the framework showed that priority areas have been crucial in accommodating social values in both regions. However, providing public services is not necessarily limited to priority areas only. There may be areas relevant for providing forest services without explicit spatial delineation. Many examples can be found (e.g., Belin et al. 2005), where forest owners voluntarily or indirectly provide ecological or social services without any special commitments or designations. Some movements like "ecological forestry" (Bončina 2011) are adverse to excessive delineation of forest areas for single management objectives, but on the contrary they try to consider changeable demands (objectives) in time and space. It seems that with the increasing populations and demands for non-commodity services, focus outside of priority areas and across landscapes is needed (Messier and Kneeshaw 1999; Nitschke and Innes 2005).

Despite the differences, some convergent trends can be observed regarding the application of priority areas in both regions. There is a trend to bring active management for restoration into conservation areas that some people see as "no touch" areas in PNW (e.g., interventions in plantations within late-successional reserves or proposals for prescribed fire in wilderness areas to affect landscape-level fire behavior). Some trends toward segregation in CE are observed such as adding conservation areas in terms of "passive management" to promote habitats for certain rare and protected species. Also, dynamic forest planning in both regions seems to result in adding new layers of priority areas rather than through changing management actions within the existing allocations. Changing societal values over time may support the idea for a continual renewal of priority areas. In addition, other factors such as climate change will likely spur change. The need to manage to promote adaptation or resilience may require changing activities within some priority areas and it is not clear if the original intent of some of those priority areas will allow such activities (Spies et al. 2010).

Conclusion

Comparing two countries with advanced economies that differ in a number of social and ecological characteristics provided perspective on the factors influencing the designation and use of priority areas. Our conceptual framework helped us identify some of the major dimensions of differences among very diverse settings. Certainly, other dimensions could be included (e.g., designation criteria) or some could be further anatomized (e.g., land tenure). In addition, although we discussed dimensions with respect to each region, we are unable to address all nuances and details that explain regional differences. However, the proposed framework along with the dichotomy of major approaches (integrative vs. segregative) to multi-objective forest management may be a useful device for understanding the pattern and process of allocating forest areas with high societal values in a broader context. Further use of the framework on case studies is needed to confirm and improve its utility and application.

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Appendix

See Table 4.

Table 4 Main management adaptations in priority areas compared to general lands for federal lands in the Pacific Northwest (PNW) and all lands in Central Europe (CE)

Main priority areas	Main management adaptations
(a) PNW	
Wilderness Areas	No management intervention, wilderness recreation, wildlife management
National monuments	General recreation and public use facilities, wildlife management, hunting, grazing, limited mining
Late-successional reserves	Silviculture for older forest structure, wildlife habitat
Riparian reserves and key watersheds	Watershed and aquatic habitat management, limited timber management
Wild and scenic rivers	Recreation esp. fishing and boating facilities, limited timber management, and road building
National recreational areas	General recreation and public use facilities, limited timber management
National scenic areas	General recreation and public use facilities, limited timber management
National scenic and historic trails	Wilderness recreation, limited timber management and road building, limited access to trailheads only
National natural and historic landmarks	General recreation and public use facilities
Special interest areas	General education and public use facilities
Special management areas	Management for special use, wildlife, recreation, forest management related to special use
Research natural areas	Research with restrictive management, limited timber management, and recreation
Experimental forests or ranges	Research, adaptive management, silvicultural and watershed research, timber management as research
Adaptive management areas and matrix	Timber management, recreation facilities and wildlife management
Wildland–urban interface	Adaptive timber management to reduce fire hazard or restore forest structure and composition
(b) CE	
Protection forests	Protection infrastructure, limited timber management, limited road construction
Forests with protection function	Adapted silviculture
Natural forest reserves	No management interventions
National parks	Adapted silviculture, adapted wildlife management, recreation and touristic facilities, temporal and spatial limitations for harvesting
National monuments	Limited timber management, temporal limitations for harvesting
Natura 2000 sites	Adapted silviculture, adapted wildlife management, temporal and spatial limitations for harvesting
Other areas with nature conservation function	Adapted silviculture, adapted wildlife management, temporal and spatial limitations for harvesting
Urban forests	Recreation facilities, temporal and spatial limitations for harvesting, limited hunting management, visitor management
Areas with recreational function	Temporal and spatial limitations for harvesting, recreation facilities
Forests with educational or research function	Education and research facilities, adapted silviculture, limited timber management
Forests with function of climate or drinking water control	Drinking water control with limited access and occasional silviculture interventions; no specific activities for climate control
Firewood, game, non-timber products	Limited access, adapted silviculture, game management (e.g., fencing, feeding)

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2.1.3 Are forest functions a useful tool for multi-objective forest management? Experiences from Slovenia

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The concept of forest functions evolved in Central Europe as an important tool in the practice of multi-objective forest management. It is based on designating forest function areas that are relatively more important for the selected services. Recent praxis has raised a number of concerns regarding the suitability and effectiveness of the concept of forest functions in satisfying increasing social demands on forests. This paper presents the main results of a survey on the forest functions in Slovenia as seen by forestry experts (n = 162). There was broad agreement among respondents that there are too many forest function types, and that at most two ranks of importance should be applied. Principal component analysis identified four main purposes for designating forest function areas: 1) harmonization of forest uses, identification of conflict areas, and argumentation for land use planning; 2) setting management priorities and strategies such as limitations for harvesting and skidding; 3) providing a framework for financial subsidies for adjusted forest management; and 4) guiding forest road planning and construction. Respondents identified designation of forest function areas in both public and private forests and their high importance for land use planning as the major strengths of the concept. Major weaknesses were an insufficient monitoring and planning system, and complicated forest function mapping. It seems that forest functions have remained an important tool in the practice of multi-objective forest management. However, improved planning methods, increased public participation and greater integration of forest functions in forest policy are needed.

Original scientific paper

Are Forest Functions a Useful Tool for Multi-objective Forest Management Planning? Experiences from Slovenia

Tina Simončič, Andrej Bončina

Abstract

The concept of forest functions evolved in Central Europe as an important tool in the practice of multi-objective forest management. It is based on designating forest function areas that are relatively more important for the selected services. Recent practice has raised a number of concerns regarding the suitability and effectiveness of the concept of forest functions in satisfying increasing social demands on forests. This paper presents the main results of a survey of forest functions in Slovenia as seen by forestry experts (n=162). There was broad agreement among respondents that there are too many forest function types, and that at most two levels of importance should be applied. Principal component analysis identified four main purposes for designating forest function areas: harmonisation of forest uses, identification of conflict areas, and argumentation for land use planning; setting management priorities and strategies such as limitations for harvesting and skidding; providing a framework for financial subsidies for adjusted forest management; guiding forest road planning and construction.

Respondents identified designation of forest function areas in both public and private forests, and their high importance for land use planning as the major strengths of the concept. Major weaknesses were an insufficient monitoring and planning system, and complicated forest function mapping. It seems that forest functions have remained an important tool in the practice of multi-objective forest management. However, improved planning methods, increased public participation and greater integration of forest functions in forest policy are needed.

Keywords: multiple forest use, integration model, concept of forest functions, services, forestry experts, survey

1. Introduction

In Central Europe, the integration model of multi-objective forest management prevails. This management approach considers all forest functions at the same place and time, although their importance can differ (Borchers 2010). The pillar of the integration model is the »concept of forest functions«, which is based on the designation of areas with important forest functions (hereafter forest function areas) that are of relatively higher importance for the selected forest services (functions) than the surrounding forest area (Blum et al. 1996). The concept was developed in the 1950s by Dietrich (1953), who defined a forest function as a social demand imposed on forests. Most of the variants and definitions that followed relied on Dietrich's work (e.g. Rupf 1960, Hasel 1971). Multifunctional forest management was developed due to increasing demands for environmental services (e.g. Mantel 1990). It first came into use through the wake water paradigm, which is based on the assumption that management for sustainable timber production ensures ecological and social functions at the same time (Glück 1982). Later, »forest function mapping« was integrated into multifunctional forest management (Riegert and Bader 2010). The concept of forest functions was gradually affirmed in the practical forestry of Central European countries (especially in

Switzerland, Germany, Austria and Slovenia) in the 1980s and 1990s (Volk 1987, Anko 1995) and has remained an important tool in multi-objective forest management.

Three groups of forest functions are commonly defined by forestry legislation: production, ecological (or also protective) and social functions (e.g. Forst Act 1975, ZG 1993). The production function refers to the use of timber and other wood and non-wood products. Ecological functions include protection against natural hazards; the protection of soil, water and climate; and the conservation of natural habitats and biological diversity. Social functions are mainly connected to recreation and other cultural and educational values, and the protection of natural and cultural heritage. Detailed classifications of forest functions differ significantly among Central European countries (Simončič et al. 2013). For example, in Germany approx. 20 forest function types are classified, although the number may differ among federal states (e.g. Volk and Schirmer 2003). In Austria and Switzerland, the classification systems are simpler. In Austria, protective, protection, social and welfare functions are distinguished (Fürst and Schaeffer 2000), whereas in Switzerland, protective, protection, social and nature conservation functions are commonly defined (BUWAL 1996). Forest development plans (Ger. Waldentwicklungspläne) are the main tools for designating forest function areas and for prescribing management guidelines to promote the selected functions.

The concept of forest function areas has contributed greatly in emphasizing the public importance of forests (Bachmann 2005, Bürger-Arndt 2012) and mitigating conflicts between forest uses (Hanewinkel 2011). In addition, forest function areas have become influential in spatial planning as an important argument for environmental impact assessment in forest areas (e.g. Berger and Ray 2004, Schulzke and Stoll 2008). They have also led to better communication between forestry practitioners and stakeholders (Krott 1985). Nevertheless, a number of concerns have been raised regarding the suitability and effectiveness of the concept of forest functions in practicing multi-objective forest management. Applying fine scale mapping, overlapping and ranking of forest function areas has often failed to meet the diverse demands on forests, mainly due to poorly defined management measures associated with the forest function areas (Weiss et al. 2002), the lack of financial support for adjusted forest management (Buttoud 2002) or limited options for the participation of forest owners and public in the designation process (Ruppert-Winkel and Winkel 2009). In addition, the concept has often been criticized for being too general and prescriptive (e.g. Krott 1985). Another point of concern is that the discourse has not considered an effective reward system for social services provided by forest enterprises (Pistorius et al. 2012). However, there are significant differences among CE countries in how the concept has been applied (Simončič et al. 2013).

In Slovenia, forest functions have been used in forest management planning for nearly three decades. However, with the exception of recent research (e.g. Bončina and Matijašić 2010, Planinšek and Pimat 2012, Simončič and Bončina 2012, Mavsar et al. 2013, Simončič et al. 2013, 2015), they have not been a popular topic of interest among scientists. Accumulated experience in the implementation of the concept during the last decades and new regulations regarding multi-objective forest management underscore the need to evaluate the effectiveness of forest functions as a tool in the practice of multi-objective forest management. We used a survey among forestry experts in Slovenia to explore:

- ⇒ their perceptions on the designation of forest function areas, including the importance of forest function areas in practicing multi-objective forest management;
- ⇒ whether these perceptions differ among different groups of forestry experts.

2. The concept of forest functions in Slovenia

In Slovenia, wood and non-wood forest functions gained equal importance with the enforcement of the Forestry Act in 1993 (ZG 1993). In the last three decades, the classification of forest function types has been developed (Anko 1995), and detailed criteria and procedures for designation of forest function areas have been elaborated (Pravilnik 1998, 2010). The forestry act classifies three main groups of forest functions (social, ecological and economic) and further defines 17 forest function types (Table 1).

Forest function areas are designated in the regional forest plans, which are the strategic plans made at the level of forest management regions (14 in Slovenia). Regional forest plans are aimed at defining objectives, priorities and controlling mechanisms for ensuring public interests and management of the forest. They are approved by the government. In addition, forest function areas are supplemented in the forest management unit plans, in which operational and frame planning is combined (Bončina 2001). Forest function areas are updated every 10 years in the frame-

work of regional forest plan revisions. This is a multi-step process consisting of:

- ⇒ collecting information about forest functions from various institutions (e.g. water protection zones, Natura 2000 sites, hiking trails, natural hazard potential);
- ⇒ checking and harmonizing information about forest functions with forest management unit plans;
- ⇒ GIS analyses and preparation of forest function maps;
- ⇒ setting management guidelines associated with the forest function areas;
- ⇒ harmonizing the maps and associated management prescriptions with other institutions, the public and forest owners.

Forest function mapping in Slovenia is partly similar to the methodology used in Germany and Austria. The forest function map is elaborated on a 1:25,000 scale. The minimum mapping area has the same threshold as for the designation of forest area, which is 0.25 ha. To avoid multiple overlapping that often occurs between 17 types of functions, a synthesis map of the four main categories of forest functions is produced in the regional forest plan, although the database enables the presentation of individual functions on any spatial level (Fig. 1). The importance of each function is ranked according to three levels:

- ⇒ first level – function determines management regime;
- ⇒ second level – function influences management regime;
- ⇒ third level – function has no significant influence on management regime.

Each forest area is designated with a function; if no function is explicitly important, wood production is automatically ranked as primary (first or second level of importance). Due to overlapping, the sum of forest function areas is greater than the surface of the forest area (Fig. 2).

In private forests, financial support is available if additional measures are needed when there are trade-offs between owners' objectives and public demands. The main benefits available for private owners for providing non-timber functions are the right to full or partial financial support of silvicultural and protective measures. The amount of subsidies partly depends on the importance of social and ecological forest functions. In the case of the first or second level of importance, the basic amount of subsidies available for management is increased by 20% and 10%, respectively.

Table 1 Distribution of forest function areas in Slovenia according to the first and the second level of importance (source: SFS 2012). Total forest area amounts to 1.2 million hectares

Function	Percentage of the whole forest area	
	First level, %	Second level, %
Protection	15.4	24.9
Hydrologic	5.1	44.6
Habitat protection	5.0	59.6
Climatic	2.9	3.5
Protective	2.2	0.4
Hygienic-health	2.3	6.0
Recreational	2.4	5.0
Touristic	2.5	2.4
Educational	0.6	0.4
Research	0.8	0.0
Protection of natural heritage	3.0	14.6
Protection of cultural heritage	0.4	13.3
Aesthetic	2.8	7.0
Defence	1.1	1.3
Timber production	59.6	24.4
Non-wood products	1.4	20.1
Game management	2.8	0.0

3. Methods

3.1 Survey methodology

A web based questionnaire (implemented with SurveyMonkey; www.surveymonkey.com) was conducted during February and June 2013 among different groups of forestry experts (Table 2). The questionnaire was first pilot tested through face-to-face interviews with the scientists of the study and further refined. Before data collection, it was additionally tested on six representatives (two local foresters, two scientists, and two planners). The survey lasted 25 minutes on average. Invitations to respond to the questionnaire were distributed by email. Each questionnaire was enclosed with a cover letter identifying the general purpose of the study and key contact person.

The questions were conducted based on our previous research (e.g. Simončič and Bončina 2012), a literature review, analyses of existing legal documents, personal discussions and interviews with forest plan-

ners and local foresters, and consultations with on-the-ground practitioners. For the purpose of the paper, only one part of the questionnaire is presented. The questionnaire contained structured questions. The socio demographic characteristics included information about the respondents' sex, age, education, work location and work position. The questions about types and ranking of forest functions were the multiple response type. Before the interviews, we prepared a list of 16 purposes that we hypothesized forestry experts might consider as the main reasons for designating forest function areas. The respondents were then asked to express the degree of importance of forest function areas to the pre listed purposes with a grading scale. The grading scale was a five point ordinal Likert type scale (Likert 1932):

⇒ (1) not at all important;
⇒ (2) rather unimportant;
⇒ (3) not important and not unimportant;
⇒ (4) rather important;
⇒ (5) very important.

The questions consisted of individual Likert items. For a general evaluation of the concept of forest functions, we prepared a list of 17 statements associated with the designation of forest function areas and subsequent management. Answers to each question were given as a reflection of choices from the strongest agreement (1) to the strongest disagreement (5). We used affirmative and negative statements to encourage respondents to carefully consider each statement and to decrease automatic responses. We then applied cross dating to get parallel statements and to be able to perform statistical tests.

3.2 Respondent profile

The survey population consisted of forestry experts from three institutions. A total of 162 responses were analyzed out of approximately 800 people, representing about 25% of the population. The respondents were then classified into three main groups according to their work positions. For the total sample, scientists represented 30% and practitioners (local foresters and planners) about 22% of the population. The average age of

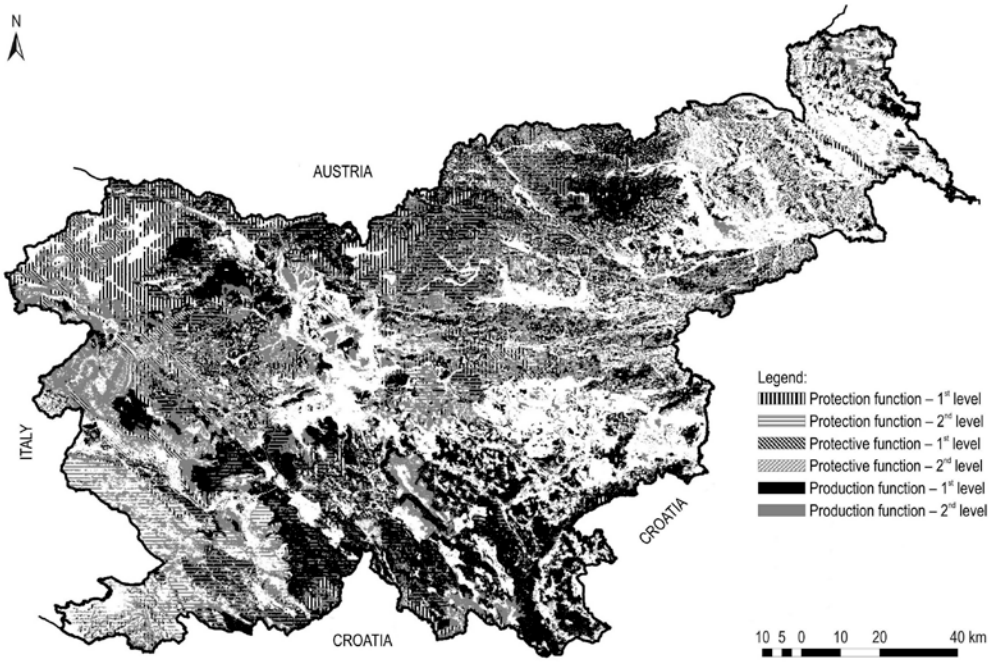

Fig. 1 Map of selected forest function areas at the national level with the first and second level of importance (source: SFS 2014). Protection refers to indirect protection; protective means direct protection of objects; production refers to the timber production

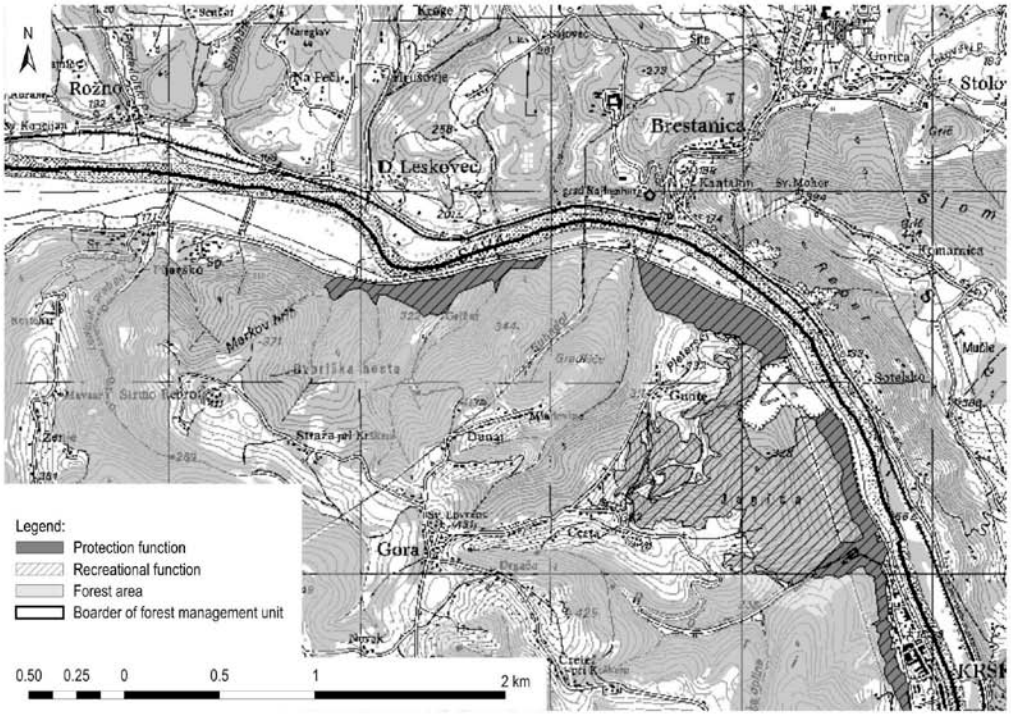

Fig. 2 Section from forest function map at the landscape spatial scale. Only protection and recreational functions of first level of importance are shown

Table 2 Respondents included in the survey

Group	Organization*	Working position	Number of responses, *n*
Local foresters	SFS	District forester	71
	SFS	Head of local unit	24
Planners	SFS	Forest planner at local or regional unit	29
	SFS	Other employee of regional unit	19
	SFS	Employee of central unit	4
Scientists	BF	Researcher	14
	SFI	Researcher	1

* SFS – Slovenia Forest Service; SFI – Slovenian Forestry Institute; BF – Biotechnical Faculty, Department of Forestry

the interviewees was 45 years. Men (88%) prevailed in the survey. The majority of interviewees had university education (43%), followed by higher professional school (37%), a master's or PhD degree (16%) and high school (4%). The respondents mainly work in the forest or forested landscape (74%), followed by agriculture (14%) and the suburban and urban landscape (12%).

3.3 Statistical data analysis

The results were analyzed using Excel and SPSS (IBM 2011). Mean, standard deviation and frequency distribution were used as the basic statistics in the data analysis. The differences between different groups of forestry experts were tested using the χ^2 test. Due to the sample size, the Likert grades were joined into the following categories:

⇒ strongly disagree and disagree;
⇒ neutral;
⇒ agree and strongly agree.

Table 3 Respondent opinions on the number of forest functions

The Forestry Act and planning regulations define 17 forest functions. What is your opinion on the number of forest functions?	Local foresters, %	Planners, %	Scientists, %	All, %
Number of forest functions is adequate	49.5	21.2	13.3	37.0
Number of forest functions is too high	44.2	78.8	86.7	59.3
Number of forest functions is too low	0.0	0.0	0.0	0.0
Undecided	6.3	0.0	0.0	3.7

The number of responses allowed us to only test differences between local foresters and planners, whereas differences with scientists were analyzed by comparing the frequency distribution of responses.

The factors influencing the perceived importance and general evaluation of the concept were analyzed by bivariate Spearman correlation coefficient (r) between the respondents' socio-demographic variables and their opinions, which is commonly used to analyze Likert scale data (Norman 2010). In our case, we compared independent categorical variables such as gender, age, working position, etc. with dependent variables consisting of ordinal data (Likert grades).

We applied principal component analysis (*PCA*; Hill and Lewicki 2007) in SPSS to identify the major categories of importance of forest function areas from the list of 16 statements. *PCA* is a type of exploratory factor analysis that explains the maximum amount of common variance in a correlation matrix using the smallest number of explanatory factors (Field 2000). We chose this approach because the correlation analysis found a degree of interdependence of the data, estimated by Pearson correlation coefficient, at 0.05 and 0.01 significance levels. The reliability of the *PCA* was evaluated using the Kaiser-Meyer-Olkin measure of sampling adequacy (*KMO*). *KMO* greater than 0.7 is considered as an acceptable reliability coefficient. Also, we applied Bartlett's test of sphericity to check the suitability of our data for data reduction. The significant value for this analysis (P=0.00) led us to reject the null hypothesis and conclude that there are correlations in the data set that are appropriate for factor analysis. Based on the Kaiser criterion, only components with an eigenvalue greater than one were considered. Thus, the first four principal components (PCs) were extracted (controlling for 68.7% of the variance) and subsequently rotated with varimax rotation to increase their interpretability.

4. Results

4.1 Number and types of forest functions

The majority (59.3%) of the survey respondents indicated that the number of forest functions is too high (Table 3). We found a statistically significant difference between different groups of forestry experts

Table 4 Respondent opinions on the types of forest functions

Which (if any) forest functions would you no longer designate?	Local foresters, %	Planners, %	Scientists, %	All, %
Defence	28.4	42.3	46.7	34.6
Hygienic-health	23.2	38.5	13.3	27.2
Touristic	12.6	38.5	13.3	21.0
Climatic	12.6	30.8	20.0	19.1
Aesthetic	8.4	32.7	26.7	17.9
Educational	8.4	26.9	0.0	13.6
Protective	10.5	11.5	0.0	9.9
Non-wood products	8.4	7.7	6.7	8.0
Research	5.3	9.6	0.0	6.2
Protection of cultural heritage	4.2	11.5	0.0	6.2
Protection of natural heritage	2.1	11.5	0.0	4.9
Recreational	1.1	3.8	0.0	1.9
Hydrologic	0.0	3.8	0.0	1.2
Wood production	1.1	1.9	0.0	1.2
Protection	0.0	0.0	6.7	0.6
Game management	0.0	1.9	0.0	0.6
Habitat protection	0.0	0.0	0.0	0.0

(P<0.001). The frequency distribution of the responses showed that the number of forest functions is adequate for about half of local foresters, whereas there is broad agreement among planners and scientists that there are too many types of forest functions.

Most respondents would no longer designate areas with the defence, hygienic and health, touristic, climate and aesthetic functions (Table 4). There is a statistically significant difference between different groups of forestry experts regarding the touristic (P=0.001), educational (P=0.002) and aesthetic functions (P=0.001). The frequency distribution of responses shows that a higher share of planners compared to the other two groups would no longer designate touristic, educational and aesthetic functions, the latter also being the case for scientists.

We asked the respondents if they would combine any forest functions. The most common combinations of functions were the following: recreational and touristic (58.6%), protection and protective (38.3%), educational and research (38.3%), protection of cultural and natural heritage (32.7%), and climatic and hygienic–health (27.8%). We found statistically significant differences among forestry experts in combining climatic (P=0.000), recreational (P=0.005) and educational functions (P=0.007). Most (86.3%) local foresters would not combine the climatic function with any of the other functions, whereas about half of scientists and planners would combine the climatic function with other functions. About half (51.6%) of local foresters would not combine the recreational function with other functions, whereas the majority of planners (75.0%) and scientists (60.0%) would combine the recreational function with other functions.

4.2. Ranking of importance of forest functions

The majority (58.7%) of respondents would change the current ranking system and most would apply the first and second level of importance (Table 5). We found statistically significant differences among different groups of forestry experts (P=0.001). The frequency distribution of the responses points to the largest differences among local foresters and the other two groups, with local foresters being less critical of the current ranking system.

4.3 Perceived importance of forest function areas

The lowest importance of forest function areas was given to the following purposes: financial subsidies for management restrictions, financing additional works, planning silviculture and protection works and selection of trees to be cut (Table 6). The highest importance was given to arguments against deforestation of forestland, basis for environmental impact assessment and influence on forest road construction. A higher share of planners (69.2%) compared to local foresters (51.6%) pointed to the importance of forest function areas for environmental impact assessment (P=0.015), whereas a higher share of local foresters (60.0% and 74.7%, respectively) compared to planners (34.6% and 53.8%, respectively) pointed to the importance of forest road planning (P=0.009) and the implementation of harvesting and skidding (P=0.034).

PCA analysis revealed four major categories of importance among the 16 designation purposes, which explained 68.7% of the variability in decision making (Table 7). The highest importance of designating forest function areas (*PC* 1), accounting for 23.2% of the total variability, was for planning forestland use and broader land use planning. *PC* 1 had the highest loadings of factors (six factors with factor loadings higher than 0.70). The second category (*PC* 2) represented the importance of forest function areas for planning and implementing management measures and explained 21.5% of the variance. We identified a third *PC* as the importance of financial subsidies. It additionally explained 14.9% of the variability. *PC* 4, which describes the importance for forest road construction, additionally explained 9.1%.

Respondent's age and forest management region had no significant correlations with perceived importance of forest function areas, whereas working posi-

Table 5 Respondent opinions on ranking the importance of forest functions

Which levels of importance would you use?	Local foresters, %	Planners, %	Scientists, %	All, %
Current system of three levels of importance	53.7	19.2	20.0	39.5
First and second level of importance	27.4	46.2	33.3	34.0
First level of importance	7.4	23.1	20.0	13.6
First level of importance or second where the areas overlap	9.5	9.6	26.7	11.1
Undecided	2.1	1.9	0.0	1.9

Table 6 Respondent perceptions of the importance of forest function areas (the frequency distribution of the responses in %)

Statement	Likert scale*					
	1	2	3	4	5	*Avg.±st. dev.*
Assessment of deforestation of forestland	0.6	1.9	12.3	45.1	40.1	4.22±0.78
Environmental impact assessment	0.6	3.7	15.4	39.5	40.7	4.16±0.86
Forest road construction	/	3.7	19.1	39.5	37.7	4.11±0.84
Planning road construction	0.6	2.5	22.2	43.2	31.5	4.02±0.83
Participation in elaboration of land use plans	1.2	6.8	24.7	47.5	19.8	3.78±0.88
Identification of conflict areas	2.5	5.6	25.9	44.4	21.6	3.77±0.93
Harvesting and skidding implementation	0.6	11.1	22.2	48.1	17.9	3.72±0.91
Harmonization of multiple forestland uses	1.2	6.2	34.6	40.7	17.3	3.67±0.88
Participation with forestland users	2.5	10.5	34.0	40.1	13.0	3.51±0.93
Maximum allowable cut	1.9	9.9	39.5	34.6	14.2	3.49±0.92
Subsidies for silviculture works	2.5	15.4	32.1	34.6	15.4	3.45±1.01
Planning additional works	4.9	9.9	38.9	34.6	11.7	3.38±0.99
Selection of trees to be cut	/	19.8	38.3	32.7	9.3	3.31±0.89
Planning silviculture and protection works	1.9	18.5	36.4	36.4	6.8	3.28±0.91
Financing additional works	5.6	19.8	32.1	30.9	11.7	3.23±1.07
Financial subsidies for management restrictions	10.5	21.0	27.8	25.9	14.8	3.14±1.21

* 1 – unimportant; 2 – rather unimportant; 3 – not important and not unimportant; 4 – rather important; 5 – very important

tion had the strongest. Local foresters and local planners acknowledge forest function areas as more important for the selection of trees to be cut (r=–0.21, P<0.01), maximum allowable cut (r=–0.29, P<0.01) and harvesting and skidding implementation (r=–0.23, P<0.01), whereas higher officials and scientists find forest function areas more important for identification of conflict areas (r=0.17, P<0.05), harmonization of multiple forestland uses (r=0.22, P<0.01), environmental impact assessment (r=0.20, P<0.05) and assessment of deforestation of forestland (r=0.18, P<0.05). Men find forest function areas more important for the selection of trees to be cut (r=–0.17, P<0.05) and maximum allowable cut (r=–0.19, P<0.05), whereas women perceive environmental impact assessment as more important (r=0.18, P<0.05), although this may be related to the higher share of women among forest planners and scientists compared to the share of women among local foresters.

4.4 General evaluation of the concept of forest functions

Respondent opinions point to the following greatest weaknesses of the concept of forest functions (p[rating<3]>0.50): the lack of financial instruments, complicated forest function mapping, poor monitoring of the effectiveness of management measures and insufficient participation of stakeholders, especially forest owners in the designation process (Table 8). The main advantages of the concept (p [rating>3]>0.50) were designation of forest function areas in public and private forests, ranking of the importance of functions and usefulness of forest function maps for spatial planning. Five statements showed statistically significant differences among forestry experts. The frequency distribution of responses indicated that planners are more critical of forest function maps (p [rating>3]=0.35) compared to local foresters (p [rating>3]=0.13) and of the system of financial instruments (planners p [rating>3]=0.885; local foresters p [rating>3]=0.632). Significant differences were also found regarding ownership focus. For example, 1.9% of planners support the designation of forest functions only in agreement with the owners, whereas the proportion of local foresters is higher in this regard (16.8%).

The strongest correlations were found between the general evaluation of the concept and respondent

Table 7 Factor loadings in the *PCA* analysis of respondent perceptions of the importance of forest function areas (N=162, KMO=0.841)

Importance	Categories of importance*			
	PC1	*PC2*	*PC3*	*PC4*
Harmonization of multiple forestland uses	0.82	–	–	–
Environmental impact assessment	0.76	–	–	0.43
Participation in elaboration of land use plans	0.76	–	–	–
Identification of conflict areas	0.75	–	–	–
Participation with forestland users	0.73	0.31	–	–
Assessment of deforestation of forestland	0.71	–	–	0.47
Selection of trees to be cut	–	0.85	–	–
Maximum allowable cut	–	0.80	–	–
Planning silviculture and protection works	–	0.78	–	–
Harvesting and skidding implementation	–	0.72	–	–
Financing additional works	–	–	0.85	–
Financial subsidies for management restrictions	–	–	0.80	–
Subsidies for silviculture works	–	–	0.74	0.32
Planning additional works	0.31	0.35	0.55	–
Forest road construction	–	0.54	–	0.62
Planning road construction	–	0.58	–	0.62

Extraction Method: *PCA* with varimax rotation and Kaiser normalization.
Bolded loading indicates a value greater than 0.50, loadings below 0.25 are not shown.
*Main principal components (*PC*):
PC1 – planning forest land use and broader land use planning;
PC2 – planning and implementing management measures;
PC3 – financial subsidies;
PC4 – road construction.

working position. Negative correlations point to the conclusion that local foresters and forest planners at local and regional units are more critical of unclear forest function maps (r=–0.18, P<0.01), designation of forest functions areas without owner agreement (r=–0.24, P<0.01) or in private forests in general (r=–0.26, P<0.01), whereas higher officials and scientists are more critical of the system of financial instruments (r=0.16, P<0.05) and monitoring of management measures (r=0.33, P<0.01). Men tend to be more critical of financial instruments (r=–0.20, P<0.01) and the monitoring system (r=–0.17, P<0.01) than women, whereas women are more critical of forest function maps (r=–0.18, P<0.01) and the complicated description of forest functions in management plans (r=–0.17, P<0.01).

5. Discussion

Our study addressed several topics regarding the concept of forest functions in Slovenia. The first was the classification system (i.e. number, types and ranking of forest functions). There was broad agreement among respondents (although less for local foresters) that the current number of forest functions is too high. The respondents would either combine many of the existing forest functions, or would not designate some of them. One of the reasons for such a response could be that some forest function types are designated for similar reasons (e.g. recreational and touristic functions) or with regard to rather vague designation criteria (e.g. hygienic–health function). Other CE countries, such as federal states in Germany (e.g. Gross 2007) or in the eastern part of Central Europe, even have more detailed classification of forest function types (Simončič et al. 2013), whereas Austria and Switzerland classify only four to five main functions (BUWAL 1996, Fürst and Schaeffer 2000). The latter approach seems to be more appropriate for forest management given that differentiating and mapping a high number of functions is not practical for collaboration with stakeholders or for implementing forest management (Bončina et al. 2014). In addition, some of the existing forest functions (e.g. climatic function) are not dependent on forest management and can be provided without spatial designations.

Most of the respondents in our survey would apply only the first and second level of importance. The current ranking system of the importance of forest functions used in Slovenia is similar to the Austrian system, which applies four ranks (WEP 2006). In Germany, only recreational (two levels according to the intensity of recreation) and hydrological functions (two levels according to water regulations) are commonly ranked (Waldfunktionen Kartierung 2004). In Switzerland, most cantons apply one level – the priority function (Ger. *Vorrangfunktion*, Kantonale Waldplanung 2007), and some also a second level – the secondary function (Ger. *Nebenfunktion*). Forest functions are ranked between each other, which differs from the Slovenian approach, where multiple functions can have the first level of importance in the same forest area. The approach used in Switzerland clearly defines priorities between functions, which is important for prescribing management regimes, since management regimes associated with each function might not be completely compatible.

Respondents identified several reasons why forest function areas are an important tool in the practice of multi-objective forest management, from identifying conflict areas and setting management priorities to collaboration with stakeholders and argumentation in spatial planning. The diverse importance of forest functions should show in the designation process; the designation criteria should be simple enough to articulate various demands on forests, but also clear and transparent, especially if state funds are available for adjustments of forest management to support public services. In such cases, the participation of forest owners and other relevant stakeholders becomes even more important. Good examples are protection forests in Switzerland that are strongly supported by cantonal or even national budgets (Schmidt 2010).

Surprisingly, respondents placed the highest importance on the influence of forest function areas on spatial planning, which is probably connected to the dramatic land use changes during the last decade triggered by European Union subsidies for agricultural lands. Forest planners decide if small scale conversions from forest to agricultural lands are admissible, and in such cases forest function areas become important arguments against deforestation (Bončina and Matijašić 2010). The respondents assigned relatively low importance to forest function areas for implementing forest management, despite the mandate from the state that forest function areas of first level of importance should determine forest management regimes (ZG 1993). This could be connected to the lack of state funds to support adjusted management in both public and private forests, which is a weakness identified by foresters in this and other surveys (e.g. Bončina et al. 2014). In addition, many respondents criticized complicated forest function maps containing a large number of overlapping forest functions, which could be another reason for the relatively small management importance of forest function areas. Furthermore, large forest areas are ranked with the second level of importance, which has very little or even no influence on forest management regimes (Simončič and Bončina 2012). Experiences show that clear prioritization of forest function areas, which are not determined for the entire forest area but focused on areas with specific importance for multi-objective forest management, provides a much better basis for setting management measures, and at the same time significantly contributes to mitigating conflicts between forest uses (e.g. Hanewinkel 2011).

Recently, the evolving concept of »ecosystem services« (EUSTAFOR and Patterson 2011) has been seen as a way forward to overcome some of the shortcomings of the concept of forest functions (Bürger-Arndt 2013), as it improves communication with the public, evaluates non-monetary functions (services) and consequently establishes a reward system for those providing public services (Weiss et al. 2011). However, important conceptual differences between the two concepts exist (e.g. Pistorius et al. 2012) and should be considered when adopting the language of ecosystem services in the concept of forest functions.

We partly confirmed that forestry experts have different perceptions of the concept of forest functions. Planners and scientists were more critical of classification and mapping compared to local foresters. This seems to be the result of the great deal of time planners need to spend in elaborating forest function maps. On the other hand, local foresters were more critical of the designation of forest function areas without the participation of private owners. Provision of public forest services may be more difficult to apply in private forests due to the divergent objectives of forest owners (Ficko and Bončina 2013) or the need to compensate for trade-offs between private and public demands (Cubbage et al. 2007), and local foresters directly involved with private owners may be much more aware of these issues.

6. Conclusion

Forest functions remain an important tool in the practice of multi-objective forest management in Slovenia; they are the basis for presenting the public importance of forests, they play a large role in preventing deforestation of forestland, and are to some degree important for spatial differentiation of management measures and for financial support for providing public services. Improving the classification scheme and mapping of forest functions is a relevant task; however, changing the focus from »mapping« to management activities, which are necessary for providing the desired services, might be even more important. Nevertheless, the importance of forest function areas for multi-objective forest management will strongly depend on their overall integration into forest and environmental policy, especially the available financial support of the state.

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Appendix

Table 8 General evaluation of the current concept of forest functions

Statement	Likert scale*						
	1	2	3	4	5	*Avg. ± st. dev.*	*P* value
The system of financial instruments for adjusted forest management on forest function areas is sufficient	29.6	42.0	24.7	3.7	0.0	2.02 ± 0.83	0.003
Forest function map is too complicated due to a large number of forest functions**	27.8	37.7	25.9	8.6	0.0	2.15 ± 0.93	0.000
Forest function map is clear due to overlapping of forest function areas	21.6	40.7	27.8	8.6	1.2	2.27 ± 0.94	–
Monitoring of management measures supporting forest functions is sufficient	13.6	45.7	30.2	9.3	1.2	2.39 ± 0.88	–
Participation of forest owners in the designation of forest function areas is not sufficient**	8.6	42.6	32.7	14.8	1.2	2.57 ± 0.89	–
Stakeholders' participation in the designation of forest function areas is sufficient	4.9	39.5	43.2	12.3	0.0	2.63 ± 0.76	–
Forest function areas are uncritically adopted from other institutions (e.g. Natura 2000 sites)**	11.7	25.3	45.7	14.2	3.1	2.72 ± 0.96	–
Descriptions of forest functions in forest plans are too extensive**	8.0	27.2	42.0	22.2	0.6	2.80 ± 0.90	–
Descriptions of forest functions in forest plans are too general**	11.1	21.0	35.8	30.2	1.9	2.91 ± 1.01	–
Forest function map is not useful for planning management measures**	6.8	13.6	47.5	29.0	3.1	2.92 ± 0.91	–
Management measures on forest function areas are clearly defined in management plans	3.1	22.2	51.2	21.0	2.5	2.98 ± 0.81	0.007
Information on forest function areas is not readily accessible to the public**	2.5	17.9	40.1	29.0	10.5	3.27 ± 0.96	–
Forestry experts have enough/sufficient competences in designating forest function areas	3.1	13.6	37.7	35.2	10.5	3.36 ± 0.95	–
Forest function map is useful for collaboration in spatial planning	1.2	8.6	38.3	45.7	6.2	3.47 ± 0.79	–
The ranking levels of importance of forest functions are important for setting management priorities	1.2	8.6	33.3	48.8	8.0	3.54 ± 0.81	–
Forest function areas should be designated only in agreement with forest owners**	1.2	9.3	24.7	37.7	27.2	3.80 ± 0.98	0.018
Forest function areas should not be designated in private forests**	0.6	2.5	10.5	42.6	43.8	4.27 ± 0.79	0.001

* 1 – complete dissatisfaction with the system; 5 – complete satisfaction with the system
**Reverse coding applied

2.2 UNPUBLISHED PAPERS AND OTHER RESEARCH RESULTS

2.2.1 Improvements of the concept of forest functions in Slovenia

Simončič T., Bončina A. 2015b. Improvements of the concept of forest functions in Slovenia = [Predlogi izboljšav koncepta funkcij gozda v Sloveniji]. An unpublished manuscript.

We elaborated possible improvements of the concept of forest functions in Slovenia based on a comprehensive literature overview, an examination of the approaches used abroad and an exhaustive evaluation of the effectiveness of the concept of forest functions as seen by professional foresters and other experts in the field of multi-objective forest management in Slovenia using a questionnaire (n=162) and participatory workshop (n=66). Two alternative models to the current concept (Model A) were elaborated: Model B ("technical") and Model C ("conceptual"). The first deals with improvements to the technical part of the designation: fewer forest function types and their ranks, simplified overlapping and clearer maps. Model C is conceptually different – it emphasizes identification of (potential) conflict areas, prioritization of forest functions and clear definition of management measures to promote the desired forest functions. Both models were evaluated by a group of forestry planners (n=65) and final improvements were suggested. In addition, the models were illustrated with three case studies representing forest, agrarian and urban landscapes. The research findings provide a basis for improving the legal framework of multi-objective forest management in Slovenia.

1 INTRODUCTION

In Slovenia forest management has been based on the principles of sustainability, the close-to-nature approach and multifunctionality (Gašperšič et al., 2001). Close-to-nature silviculture has been an important tool for the practice of multi-objective forest management. Close-to-nature forestry has been seen as a land management strategy that combines economic necessities with multiple social and environmental requirements by contributing to the maintenance of biodiversity, ecosystems and diversified landscapes; offering attractive areas for recreation and leisure activities; and leaving options for future uses and developments (Schmithüsen, 2007). The multi-objective approach has also been supported by the development of landscape-level planning (i.e. forest development planning) (Anko, 2005), by a participatory planning approach that allows for public collaboration in forest management decisions (Bončina, 2004), and by several institutional (public forest service) and financial instruments that help in combining private management goals with public interests (ZG, 1993). The so called "concept of forest functions" has been developed as one of the main policy and planning tools for practicing multi-objective forest management (ZG, 1993; Anko, 1995). The importance of forest functions is spatially recognized with the elaboration of forest function maps; in the

designation process forest functional units are delineated, and forest functions are ranked according to their importance for forest management given prescribed criteria (Anko, 1995; Pravilnik…, 1998). The functional units are created by overlapping different forest function layers; a functional unit has a specific combination of forest functions and their ranks, and if the combination changes, a new unit is delineated. The approach is partly based on methodology from Germany and Austria where maps of forest function areas have been an important tool for planning forest land use and mediating land use conflicts (e.g. Volk and Schirmer, 2003; WEP, 2006; Kuhn, 2011).

There are three fundamental bases for implementing the concept of forest functions in forest management. Firstly, integrative multi-objective forest management is legally accepted in Slovenia. The Slovenian constitution legally acknowledges the social, ecological and economic function of property (Ustava, 1991). This is reflected in the Forest Act, which equalizes the social, economic and ecological functions of forests regardless of their ownership (ZG, 1993; Pucelj Vidović, 2015). Secondly, not all forest areas are important for all forest functions to the same extent, even under the integration model. The importance of a particular function varies in space given the demands towards forests, potential of forest to deliver desired functions and management possibilities for their provision (Bachmann, 2005; Bončina, 2005). Therefore, forest functions are ranked according to the degree to which they are important (Pravilnik…, 2010). Prioritization of forest functions does not mean that functions are spatially segregated; in decision making all forest functions must be taken into consideration, but those with higher priorities are primarily promoted by forest management. Thirdly, the importance of forest functions changes in time given the demands and interests of society. Therefore, the designation of forest function areas is a dynamic process marked by the constant search for harmonization between societal demands, forest ecosystems and their ability to provide the desired services influenced by forest management.

The Forestry Act (ZG, 1993) describes functions as social, ecological and economic, and further divides them into 17 forest function types. Spatial prioritization of forest functions is a matter of forest planning regulations and internal planning directions (e.g. Pravilnik…, 1998; Posodobitev…, 2011). The Slovenia Forest Service (SFS) has the discretion to designate specific places in forests (i.e. forest function areas) that are of outstanding importance for their unique natural or cultural values, provide protection against natural hazards and provide drinking water or other forest services. This process was affirmed with a great deal of enthusiasm (Anko, 1995). Much time and effort was invested in the mapping procedures and harmonization of databases and maps between regional units of the SFS across Slovenia, with numerous institutions and individuals involved (e.g. Veselič et al., 2003). The designation of forest function areas has contributed to emphasizing the public importance of forests and has thus become an important tool for forest policy (ReNGP, 2007). It has also fostered better collaboration with the public, forest owners and other institutions (Bončina et al., 2014). In addition, forest function areas have become

influential in spatial planning by becoming an important basis for environmental impact assessment in forest areas (Bončina and Matijašić, 2010; Nastran et al., 2013).

Since its origins, the concept of forest functions has remained relatively unchanged, with only a few modifications having been made (Pravilnik…, 2010; Posodobitev…, 2011). Recent practice has raised a number of concerns regarding the effectiveness of the concept of forest functions. The main ones are connected to complicated classification systems (e.g. Planinšek, 2010; Planinšek and Pirnat, 2012a; Simončič and Bončina, 2012); unclear or duplicated criteria for designation (Pogačnik, 1996; Pirnat, 2007; Bončina and Simončič, 2010; Planinšek and Pirnat, 2012b); a complicated overlapping system of different forest function areas, long mapping procedures, their weak importance for management and poorly defined management measures for the promotion of designated forest functions (Planinšek and Pirnat, 2012a; Simončič and Bončina, 2012); the lack of financial instruments for supporting forest functions, particularly on private lands; inadequate designation of conflict areas and the lack of monitoring protocols for management effectiveness (e.g. Planinšek and Pirnat, 2012b; Simončič and Bončina, 2012). Given the lack of research in this area, accumulated experiences and identified shortcomings of the implementation of the concept on the ground, the concept needs to be revised, evaluated and improved. The objectives of our research were to 1) assess the advantages and weaknesses of the current approach to the concept of forest functions in the practice of multi-objective forest management, 2) elaborate improvements of the concept, and 3) evaluate the proposed improvements and recommend the main direction of changes.

2. ACTION PLAN

The research project was elaborated in the period 2009–2015. An action plan was divided into five phases (Figure 1):

1) Assessment of the current model (2009–2013),
2) Elaboration of alternative models (2013–2014),
3) Evaluation of the models (spring 2015),
4) Case study implementation (2014–2015),
5) Final management recommendations (on-going).

Phase 5 was not a part of this dissertation work; therefore, it is only briefly addressed at the end of the thesis (Chapter 5).

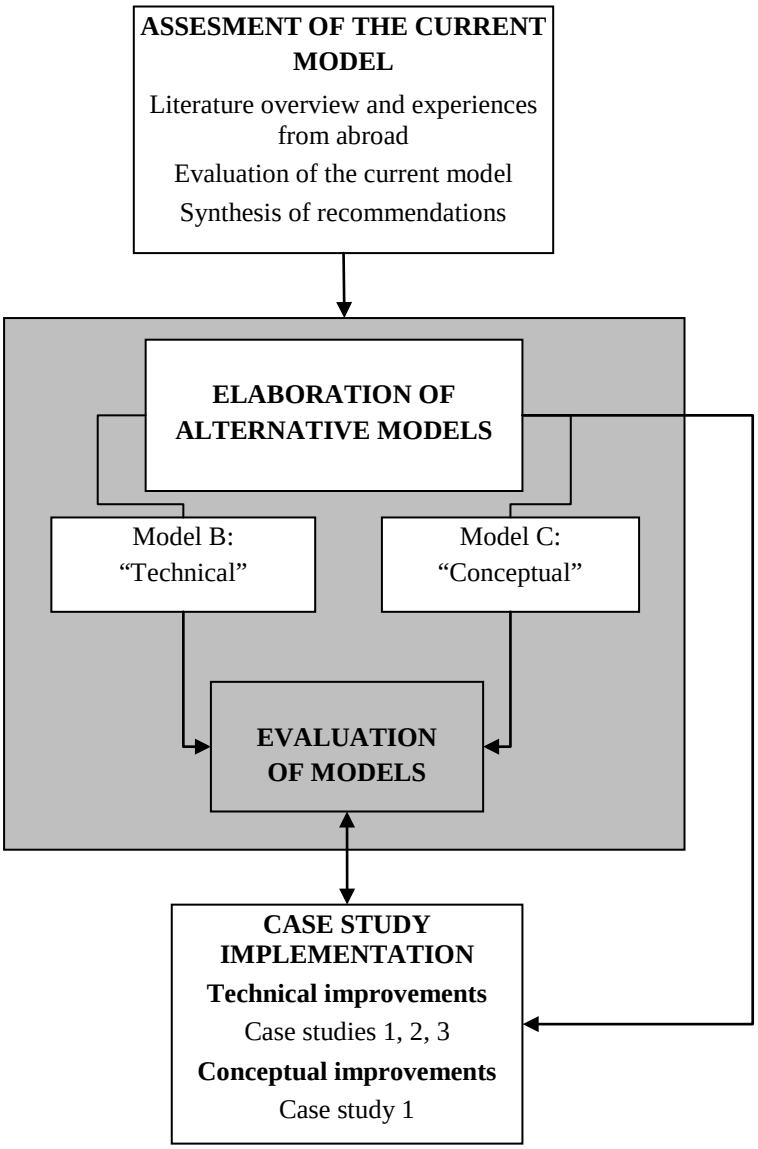

Figure 1: Action plan for improvements of the concept of forest functions.

2.1 ASSESSMENT OF THE CURRENT MODEL

The assessment of the current model (A) consisted of two main steps: 1) literature overview and analysis of approaches abroad and 2) evaluation of the concept of forest functions in Slovenia. The first was conducted on two levels:

Analysis of the concept of forest functions in CE

A detailed comparative analysis of the concept of forest functions was carried out. We conducted structured in-depth interviews with experts in forestry planning from 9 CE countries (1 representative per country). The respondents were selected based on their

professional background; the prerequisite was that the interviewees were among the main experts in the field of forest planning in each of the selected countries. The selected respondents came from universities, research institutions (leading researchers from forest management planning departments) or governmental bodies (ministries). All interviewed experts have rich experience in the fields of forest planning, forest functions and multi-objective forest management. After the interviews were conducted, the respondents collaborated with forestry practitioners who provided essential insights into the implementation of the concept of forest functions and supplemented and validated their answers. Moreover, site visits for a first-hand impression of the implementation of the concept in each of the studied countries were conducted with interviewed experts and practitioners on the ground to verify the responses gathered during the interviews. The sites in each country were selected by the interviewed experts and practitioners based on the following criteria: the case studies represented forest sites where multiple functions are designated; forestry maps were elaborated for the selected sites; conflicts in promoting multiple forest functions were likely to appear and thus multi-objective forest management was of paramount importance. The methods and results of this part of the research are presented in greater detail in the Chapter 2.1 of the dissertation (Simoncic et al., 2013). In addition, open interviews with forest planners from various cantons in Switzerland (e.g. Jura, Graubünden, Zug) were carried out to discuss the implementation of the concept of forest functions on the ground.

Analysis of other spatially-based approaches to multi-objective forest management

We compared multi-objective forest management approaches in CE and the Pacific Northwest region of the USA (PNW). We selected PNW as representative of the relatively widespread approach of multi-objective forest management that is at the same time quite different to the CE approach. The aim was to study how spatially-based approaches function under different socio-economic settings. First, a comprehensive literature overview was done on the spatially-based approaches to multi-objective forest management used around the globe. Based on selected key words (priority area, allocation, forest functions, ecosystem services, spatially explicit approaches, segregation vs. integration forest management), more than 100 references were found and compared. Then we elaborated a conceptual framework drawn up of a limited number of key characteristics or "dimensions," which enabled us to describe the fundamental characteristics of forest function areas and other types of priorities areas, as well as to understand their importance for multi-objective forest management. We applied the framework to the selected case study regions. For CE one part of the information used was gathered from the above-mentioned interviews. In addition, we carried out a comprehensive overview and comparative research of scientific papers (e.g. Kräuchi et al., 2000; Dorren et al., 2004; Brang et al., 2006; Konijnendijk et al., 2006; Bauerhansl et al., 2010; Riegert and Bader, 2010; Pistorius et al., 2012; Kaeser and Zimmermann, 2014) and grey literature such as national legislation (constitutions, acts, degrees), forest function mapping guidelines (e.g. Volk and Schirmer, 2003; Swiss National…, 2004), forest development plans (e.g. Regionaler …, 1999; Waldfunktionen Kartierung..., 2010) and international and national

reports (e.g. Konijnendijk, 1997; Parviainen et al., 2000; Parviainen and Frank, 2003; EEA, 2005; Frank et al., 2007; MCPFE, 2007; Pröbstl et al., 2009). In the PNW the document review comprised Forest Service national forest land and resource management plans, planning documents required by the National Environmental Policy Act and other laws, USDA Forest Service Handbooks (Forest Service…, 2006; Special areas…, 2009), and reports (e.g. Forest ecosystem…, 1993; Smith et al., 2011). The assessment was also based on several years of research and observation of national forest planning including the recent application of the ecosystem services approach and collaborative efforts (e.g. Smith et al., 2011). In addition, nine comprehensive interviews were conducted for the purpose of this research. The interviewees included forest planners and managers from various forest service units of the PNW region, and representatives of forest collaboratives. Specifically, we conducted open interviews with forest planners and local experts in two regional forest service units (together 5 respondents), representatives of forest collaboratives (1 respondent), and researchers with regional and national level experience in the field of forest planning and natural resource management (3 respondents). In addition, several short interviews with forest managers from State of Oregon (1 representative) and representatives of private forest management (2 big private forest owners, 3 respondents from extension programme) were carried out. In addition, we visited several field sites and attended meetings with forest collaboratives, conferences and workshops. The presented results of this phase were limited to those relevant for elaboration of the alternative models. The detailed methods and results of this part of the research are presented in Chapter 2.2 of the dissertation (Simončič et al., 2015).

The second step – evaluation of the concept of forest functions in Slovenia – included five phases:

Phase 1: Literature overview
We carried out a comprehensive literature overview that included scientific research papers, reports and critical reviews. In addition, we analysed existing legal regulations regarding multi-objective forest management with specific emphasis on the Forestry Act, regulations on forest management planning and internal guidelines for designating forest function areas.

Phase 2: Individual survey of forestry experts
We used a survey among forestry experts (n=162) in Slovenia to explore their perceptions on the designation of forest function areas, including the importance and effectiveness of forest function areas in practicing multi-objective forest management (for details, see Simončič and Bončina, 2015; Chapter 2.3 of the dissertation).

Phase 3: 1st workshop
The 1st workshop entitled “Development of the concept of multi-objective forest management: forest functions, ecosystem services and priority areas” was organized on December 17, 2013 on Pokljuka. Sixty-six representatives of various stakeholders,

including the Slovenia Forest Service, Biotechnical Faculty, Department of Forestry and Renewable Forest Resources, Triglav National Park, Slovenian Forestry Institute, Ministry for Agriculture and Environment, Institute of RS for Nature Conservation, Bern University of Applied Sciences and non-governmental agencies, attended the workshop. Selection of the participants was based on their professional background; the participants most strongly engaged with the implementation of the concept of forest functions, or those with strong scientific interests in the topic, were selected.

In the workshop the results of the individual questionnaire (*Phase 2*) were presented to the participants. The effectiveness of the concept of forest functions was evaluated with the *World Cafe method*, which is a simple process for bringing people together around questions that matter (Brown and Isaacs, 2005). It is a conversational process that helps groups to engage in constructive dialogue around critical questions, to build personal relationships and to foster collaborative learning (Fouché and Light, 2010). Through a constructive dialogue, the World Cafe enables relationship building, collective discoveries and collaborative learning. Using several rounds of dialogue, where multiple groups discuss the same topics, important innovative approaches can be developed. Participants were divided into 10 groups and worked on 9 pre-selected topics (Appendix 1). The topics were selected in regard to the main weaknesses and challenges in implementing the concept of forest functions in Slovenia as identified by the literature overview (*Phase 1*) and individual questionnaire (*Phase 2*). At the end of the workshop, suggestions for improving the concept of forest functions were proposed (for details, see Bončina et al., 2014).

Phase 4: 2nd workshop

The 2nd workshop addressed the "Development of the concept of forest functions in Slovenia" and was organized on April 2, 2015 on Pokljuka. Sixty-five participants from SFS offices across Slovenia (the prevailing group), the Department of Forestry of the Biotechnical Faculty (University of Ljubljana), the Slovenian Forestry Institute, Triglav National Park and others were in attendance. About 90 % of the participants had also taken part in the first workshop. The aim of the workshop was to briefly verify the results of the previous two participatory methods (*Phases 2-3*), present proposed improvements of the concept of forest functions and evaluate them. The workshop was organized into three main sessions (for details see Bončina et al., 2015):

- verification and confirmation of the previous findings,
- evaluation of the alternative models,
- final management recommendations on improvements of the concept of forest functions.

The verification and confirmation of previous findings was done to ensure that the results of both *Phase 2* and *Phase 3* were accurate and credible. Each participant was given two questionnaires; the first contained a list of 23 statements to estimate the effectiveness of the current concept of forest functions in Slovenia (Appendix 2); a 9-point Likert scale was

used for estimating participant disagreement (1) or agreement (9) with the statement. Many of the issues were similar to the questions from the first questionnaire (*Phase 2*) and to the topics of the World Cafe method (*Phase 3*). The second questionnaire referred to the purpose of designating forest function areas; participants evaluated with the 9-point Likert scale (1 unimportant, 9 very important) the importance of designating forest function areas (Appendix 3).

Phase 5: Consultation with case study experts
This phase was parallel with *Phase 4*. It was intended to identify the main weaknesses and advantages of implementation of the concept of forest functions on the ground. A questionnaire (Appendix 4) on the assessment of the concept of forest functions was sent to forest planners and local foresters from three case study areas. The issues raised in the questionnaire were also personally discussed with local foresters later on during the case study implementation of the models.

2.2 ELABORATION OF ALTERNATIVE MODELS

We elaborated two alternative models (B and C) to the current model (A), which enabled us to compare and contrast alternative changes (smaller vs. significant changes, technical vs. conceptual improvements), foster thinking among the participants that evaluated both models and generate more ideas for improvements:

- Model B: "technical" includes technical improvements (i.e. classification and mapping procedures) of the designation of forest function areas,
- Model C: "conceptual" includes both technical and conceptual improvements.

Each model was characterized by 18 dimensions, which in a simple way enabled us to describe different concepts of forest functions. The first 9 dimensions describe the technical part of the model, and the next 9 the conceptual part (Table 6).

2.3 EVALUATION OF MODELS

The models were evaluated at the workshop of forest planners (*Phase 4*). The evaluation followed two procedures:

- A modified *H-method* was applied to compare alternative Models B and C to the current Model A, to identify the main weaknesses and advantages of both alternative models and recommend suggestions for their improvement. The H-method is a tool to establish the individual attitude of each participant towards a certain problem, their negative and positive opinions and to find solutions to improve the situation (H-diagram, 2011). The participants were divided into 10 groups of 4-5 people. A moderator was randomly selected at the workshop for each group. Participants first graded the effectiveness of the model compared to the current model with a grade from 1 (not suitable) to 10 (very suitable). The estimation was an agreement among all the people in the group, and final estimation was calculated as the arithmetic mean of the

10 groups. In the next step, participants were asked to list up to 5 main weaknesses and advantages, and 5 suggestions on how to move the grade towards the number 10.

- The World Cafe method was applied later on to elaborate final recommendations for improving the concept of forest functions and to discuss them with all participants. Ten topics were selected; the topics addressed the dimensions from the models, but some dimensions were joined to fit to the number of participants. Each of the topics was discussed by all 10 groups. The moderator was the same as for the first part of the workshop, but was assigned to the topic and not to the group. The moderators were briefly acquainted with the context at the workshop. The questionnaire and the results of the World Cafe method can be obtained from the author of this work.

2.4 CASE STUDY IMPLEMENTATION

To illustrate the suggested changes and their reflection in practice, three case studies were used. Case study design is a common approach to examine concepts and theories and to propose changes for management and policy (e.g. Yin, 1981). We selected three case studies because we assumed that the alternative models would reflect differently in different socio-economic and ecological contexts. The case studies represented three forest management units: Pokljuka, Ljubljana and Krško (Table 1). The cases differed in 1) natural conditions; 2) spatial context (e.g. the size and the spatial structure of forests); and 3) the importance of forests for the public, local communities and forest owners.

2.4.1 Description of case studies

Pokljuka is representative of forest landscape. It lies in the northwestern part of Slovenia, on the Pokljuka Plateau in the Bled forest region. The population density is extremely low; the infrastructure includes mainly forest roads and roads for touristic purposes, local farms and a few tourist accommodations and sports facilities. Large forest owners (church, state) own 81 % of the land, whereas 19 % is owned by small private landowners. The area is characterized by productive high value spruce forests. Large blocks of relatively well preserved forests have significant wilderness characteristics and represent habitat for many wildlife species. Pokljuka is in Triglav National Park and is among the Natura 2000 sites and ecologically important sites. Therefore, nature conservation is a high priority in these forests. A significant proportion of the forest is declared as protection forest due to the extreme terrain conditions (high slopes, upper tree line). The area is an important location for a variety of outdoor activities, in particular cross-country skiing, mountaineering and mountain biking. Due to the specific cultural landscape characterized by forest and pasture land, the area is attractive for tourism.

Ljubljana is representative of urban landscape. It covers the western and central most populated part of the Municipality of Ljubljana. Agriculture and built-up land prevail, the latter especially in the central part where the city of Ljubljana lies. Forests are abundant mainly in the northern and western periphery; two larger blocks of forest – 1) Šišenski

hrib, Rožnik and Mostec and 2) Golovec – are in direct proximity to the city. The majority (86 %) of forest land is privately owned by small land owners, and the average property size is extremely small (0.4 ha). The forests near the city are very popular among residents of Ljubljana for recreation and leisure activities. For this reason, Šišenski hrib, Rožnik, Mostec and Golovec are declared as urban forests. Forest remnants in agricultural land represent important habitats for rare species and are protected by law as habitat forests. Riparian forests, especially in the northern part along the river Sava, are of high importance for preserving water resources in the region.

Krško is representative of agrarian landscape. It lies in the central part of the Brežice forest region in the southeastern part of Slovenia. The area is characterized by a flat agricultural landscape in the southern part and a hilly landscape of scattered forests, meadows and vineyards in the northern and northwestern parts. The northernmost part towards the river Sava is steeper and rockier. The majority of forests (96 %) are privately owned, with an average property size of about 2 ha. The primary importance of forests is for production of wood for domestic needs. Forest remnants and strips in agricultural areas are important for habitats and for protecting water resources. Forests in the northern part above the main road connecting two towns are protected by law due to their role in protecting against rock falls and landslides. A couple of large water protection zones are declared by municipal order. Social functions are limited to the surroundings of the city of Krško. The scattered landscape of vineyards, forests and meadows forms an important cultural identity for the broader region.

Table 1: Land uses in the selected case studies. The data were calculated using data for the whole of Slovenia (MKGP, 2015)

	Pokljuka		Ljubljana		Krško	
Land use type	Surface (ha)	Surface (%)	Surface (ha)	Surface (%)	Surface (ha)	Surface (%)
Agricultural land	245.4	4.8	7228.3	38.5	3989.6	49.5
Forest land	4790.0	93.6	4794.4	25.6	3292.4	40.9
Built-up areas	36.3	0.7	6456.1	34.4	670.4	8.3
Wetland	23.2	0.5	6.2	0.0	0.6	0.0
Other open spaces	24.7	0.5	22.6	0.1	0.0	0.0
Water	0.5	0.0	252.5	1.3	102.4	1.3
All	5120.1	100.0	18760.2	100.0	8055.1	100.0

2.4.2 Main data sources

The data collection procedure for the case study implementation included face-to-face interviews with local experts, SFS records and documents, illustrative material (reports and other publications), on-site observations and the participatory workshop (for Pokljuka only). In each case study, two meetings were organized with local foresters that are most

strongly engaged with forest management in the case study unit: the head of the department for forest planning from the regional office, the forest planner from the regional office responsible for elaboration of the forest plan, the head of the local forest management unit, and the district forester. The goal of the first meeting was to present the aim of the research and identify the main advantages and weaknesses of the implementation of the current model. After the meeting, a questionnaire was sent to the same group of experts containing questions on the main advantages, weaknesses and possible improvements of the concept of forest functions as seen from the point of view of the forest management unit (Appendix 4). The second meeting was organized during implementation of models; its purpose was to get more detailed insight into the implementation of forest function areas in each case study. Before the meeting, a questionnaire on the importance of forest functions and their implementation in forest management was sent to the same team of forest planners and field foresters in each case study (Appendix 5).

The document review comprised analysis of existing forest management plans, forest function maps, reports, and supporting material in the preparation of forest management plans (e.g. guidelines from other institutions). The main spatial data sources included a database on forest function areas from the SFS: FUNK_POV, FUNK_T and FUNK_L (SFS, 2014a). In addition, we used the spatial information from other data holders which is stored in the SFS database or available online. For Pokljuka, we obtained some data from Triglav National Park headquarters and organized a participatory workshop.

2.4.3 Data analysis

The analysis of the data was done in the ArcGIS program. The main steps included:

- breaking the existing database of forest functional units into individual layers of forest functions,
- merging forest functions into new function types (Table 7),
- breaking new layers of forest functional units into individual polygons,
- merging smaller polygons within the larger one with the same designation criteria (the list from the planning regulations, seen from the attribute part),
- elaboration of new forest function maps,
- analysing the attribute part of the forest function maps.

The preparation of Model C followed the same steps as that for Model B, with the exception of different forest function types (Table 8). Additional steps included:

- overlapping layers of individual functions and defining priority and secondary functions,
- analysing the attribute part of the new spatial layers,
- designation of conflict areas and priority objects for management (for Pokljuka only).

Priority functions in Model C were defined based on the existing forest function areas of 1st level of importance. Prioritization was done following general rules (see Chapter 4, dimension 11), and was slightly adapted according to local conditions recognized by consultations with local foresters and on-site observations. For Pokljuka, the information from the participatory workshop was also relevant for defining priority functions.

2.4.4 Testing parameters and dimensions

The implementation of case study units was mainly oriented towards technical dimensions, which were tested with the selected parameters (Table 2); some of them were tested only for Pokljuka.

Table 2: Testing parameters

Testing parameters
Area of forests with important forest functions of different levels
Overall area proportion of forest function areas with different levels of importance
Number of spatial units (n), average area (S), standard deviation (sd)
List of ranking of forest functions, map of forest functions with argumentation
Total designated area (union) of forest functions with different levels of importance
List of functional units with apparent management measures*
The proportion of conflict areas, map of conflict areas with argumentation*

* only for Pokljuka; see Appendix 6

2.4.5 Participatory workshop of stakeholders in Pokljuka

In April 2015 a participatory workshop for local stakeholders was organized in the Pokljuka region with the collaboration of the Forest Service (Bled Regional Office) (see Appendix 6 for extended results). Thirty-one stakeholders came from Triglav National Park, various local tourism and sport organizations, representatives of forest owners and harvesting companies, grazing communities and individuals. The aim of the workshop was to test the participatory approach (Model C) and its importance for identifying conflict areas and improving the management part of the designation. Pokljuka was appropriate for implementing the participatory approach for several reasons: 1) there are diverse and increasing demands towards forests, 2) conflicts among land uses are increasing, 3) the designated forest function areas do not capture the whole complexity of multiple use in the area, and 4) the forest plan is currently under revision. The workshop was divided into four parts:

Ranking of management objectives
Participants were given a list of management objectives (Appendix 6a) that was based on the list from 10 years ago when ranking of objectives with slightly different methodology

was applied within the context of the forest plan revision (SFS, 2005a). The participants were asked to allocate hypothetical sum of 100 points among pre-defined management objectives. SFS employees also ranked the objectives.

Identification of conflicts

Participants individually listed the main conflicts they see regarding forest uses on the Pokljuka Plateau. The identified conflicts were then summarized and ranked according to their importance (the weight was the number of times an individual conflict was mentioned by different stakeholders) (Appendix 6b).

Identification of conflict areas

Participants were divided into four groups: 1) "recreationalists," 2) "environmentalists," 3) representatives of grazing communities and 4) representatives of forest owners and harvesting companies. The employees of the SFS worked as coordinators. Each of the interest groups put their preferences for forest functions on the map. Four thematic maps with background information on forest functions were prepared in advance by forest planners: 1) a map of areas with recreational and touristic functions including existing hiking and biking trails, 2) a map of habitat protection areas, 3) a map of ecological (protection against natural hazards and hydrologic) function areas and 4) a map of wood production function areas with existing forest roads. The latter was intended for stakeholders (mainly forest owners) to mark where they plan to make new roads and locate harvesting operations. This would later help planners to identify where major forestry activities will take place and whether they will conflict with other land uses. All participants were given an opportunity to identify their interests on all maps, although the groups mainly focused on their preferred interests. The employees of the SFS overlaid the thematic maps to identify major conflict areas (Figure 2).

Figure 2: Identification of conflict areas on the Pokljuka Plateau (Participatory workshop, Pokljuka, April 1, 2015).

Finding solutions for the spatially-explicit conflicts

The H-method was used to present conflict areas and to find solutions for mitigating conflicts. Participants continued working in the groups on each of the identified conflict areas (Appendix 6c). Each participant in the group estimated his perception about the magnitude of the conflict on a scale from 0 (large conflict) to 10 (minor conflict) and provided three arguments why his estimation was not 0 or 10. The final estimation of the group was an average of all estimations, and the arguments were summarized within the group. At the end, the whole group suggested how to move the estimation towards 10.

3. FINDINGS OF THE ASSESSMENT PHASE

3.1 LITERATURE OVERVIEW AND EXPERIENCES FROM ABROAD

The literature overview and analysis of the concept of forest functions in CE based on detailed comparison of nine countries revealed both the weaknesses and advantages of this tool in practicing multi-objective forest management (Table 3; for details, see Simoncic et al., 2013).

Table 3: The main importance and weaknesses of the concept of forest functions in nine CE countries (after Simoncic et al., 2013)

Importance
- Forest function areas enable spatial identification of areas of public importance.
- The designation process can lead to recognition of potential conflicts.
- Forest functions are a traditionally accepted tool by forestry professionals and other institutions with competences in forest land.
- Forest functions have been used as an important tool for promoting the interests of forestry in land-use planning.
- Forest functions have been a basis for setting strategic management objectives and strategies.
- In some countries forest function areas have been an important framework for operational planning – for setting the management regime and applying operational measures.
- Forest function areas have been a framework for financial subsidies if trade-offs between public and private objectives occur, and thus a tool for mitigating conflicts between public and private demands.
- As such, forest functions have been an important tool for political decision making.
Weaknesses
- A prescriptive approach with pre-described designation criteria has been dominant in the designation process.
- Forest function areas have mainly been designated on uniform spatial scales.
- Forest function maps lack clarity and applicability due to numerous forest function types and overlapping of layers of forest functions with different levels of importance.
- A lack of public participation and strong influence of non-forestry institutions is recognized in the designation of forest function areas in some CE countries.
- Designation of forest function areas often ignores demands of forest owners, which causes conflicts, especially given the lack of financial instruments for management restrictions on private lands.
- Forest function areas occasionally fail to provide firm arguments in land-use planning due to poorly defined arguments for designation.

According to experiences from CE, the following weaknesses of the concept of forest functions in Slovenia can be recognized and resulting suggestions for improving them might be relevant:

- Interconnection between relevant spatial scales should be considered in the designation process.
- Criteria for designation should be more transparent; the level of prescription should depend on the type of forest functions (e.g. more standardized for designation of areas protecting against natural hazards, more locally-adopted for designation of areas for recreation and leisure activities).

- Forest function maps should be simplified by fewer forest function types, a simpler ranking system, less overlapping of forest function areas and less area under designation of priority functions.
- The management part of the concept should be improved. Two level planning should be more clearly promoted: strategic planning to define objectives and measures and operational planning for defining locations for management priorities, setting concrete management measures and tools to implement them. The participatory process should be improved with stronger involvement of stakeholders, such as the public, forest owners and local communities.
- A stable financial system for private forests should be established.

Comparison of forest function areas and other priority areas between CE and the PNW revealed important differences and convergent trends in spatially-based approaches to multi-objective forest management (Table 4) (for details, see Simončič et al., 2015).

Table 4: Comparison of the concept of forest function areas and other types of priority areas in Central Europe and the Pacific Northwest of the USA (after Simončič et al., 2015)

Characteristics	Central Europe	Pacific Northwest of USA
Main designation objectives	protection against natural hazards, recreation, water protection, nature protection, environment protection, education and research	habitats of late successional species and processes, recreation, water protection, nature protection, education and research
Terminology	forest function areas, special purpose forests	allocations, special use areas
Importance of objectives	multiple objectives on the same forest land	one management objective prevails, others are exclusive or of significantly less importance
Overlapping	yes	no; possibilities to designate sub-areas within the designated areas
Designation competences	mainly in the frame of forest planning	mainly president, congress
Management competences	public forest service	various public services
Ownership	public and private forests	public forests
Permanency	mainly mid-term	mainly permanent or long-term
Scale	some 10 ha (stands) up to a few 10,000 ha (forest management units)	some 100 ha (small landscape) to some 100,000 ha (region)
Management	relatively small differences among designated areas and other forest areas	large differences among designated areas and other forest areas

Several findings might be relevant for supplementing the concept of forest functions in Slovenia:

- Social acceptability of designated areas is important; therefore, public and other stakeholders should be actively included in the designation process.
- The designation is only the first step; active forest management associated with selected functions on the designated areas should be promoted.
- Scale matters; some forest services can only be provided on a broader spatial scale, with consideration of interconnection between various priority areas.
- Priority areas should fit in the local setting; only then can the effectiveness of planned measures on priority areas be assured.
- Monitoring protocols should be developed; therefore, clear and measurable designation criteria (e.g. threshold values, expert opinions) are needed.
- Transparent and clear classification of forest services on priority areas would help in informing the public and politicians about the diverse effects of forest management.
- Economic evaluation of forest services is important; it provides a basis for financial subsidies if trade-offs between public and private objectives appear.

3.2 EVALUATION OF THE CURRENT MODEL OF FOREST FUNCTIONS

The current model of forest functions in Slovenia was evaluated with several procedures (Table 5).

Table 5: The main importance and weaknesses of the current model of forest functions as identified by 1) individual survey of forestry professionals (*Phase 1*; n = 162), 2) workshop of experts in the field of multi-objective forest management (*Phase 2*; n = 66) and 3) interviews and surveys of foresters from case studies (*Phase 5*; n ≈ 15)

Individual survey of forestry professionals
Importance - Forest functions enable harmonization of forest uses, identification of conflict areas, and argumentation for land use planning. - Forest function areas are the basis for setting management priorities and strategies such as limitations for harvesting and skidding and forest road planning and construction. - Forest function areas provide a framework for financial subsidies for adjusted forest management.
Weaknesses - The map of forest functions is complicated due to too many functions, complicated ranking and overlapping of layers of forest function areas. - Financial instruments for implementation of management measures are not sufficiently developed. - Forest function areas have weak importance for management planning and implementing measures. - Participation with other forest users in the designation process is not sufficient. - Monitoring of management effectiveness is too general.

1st workshop
Importance
- Forest function areas are a useful tool for forest land use planning. - Forest function maps are a useful communication tool for stakeholders. - The concept of forest functions considers the entire forest area regardless of ownership. - The designation process enables an overview of conflicts in the forest area.
Weaknesses
- Some criteria for designation are not well-founded. - Too many forest function types are classified. - Forest function maps are too complicated. - Cooperation with other sectors, public and forest owners is insufficient. - Connection between forest function areas and management measures promoting selected functions is weak. - There is asymmetry between invested time in mapping procedures and its utility for forest management. - Definition and understanding of the concept of forest functions are unclear.
Case studies
Importance
- Forest function areas are a basis for subsidies for tending in young forest. - Forest function areas are the most important tool in preventing deforestation of forest land. - Forest function areas are a collaboration tool for other forest users. - Forest functions can be a binding basis for forest management (e.g. preventing forest devastation, limitations for harvesting or skidding operations). - Forest function areas are a professional basis for establishment of protected forest areas.
Weaknesses
- Mapping procedures are outdated and too complicated; maps are not useful for the public. - Ranking of forest functions is not suitable: 1st level is crucial, 2nd is rather vague, 3rd is unimportant. - Competences of some institutions in the designation process are too high. - Forest owner are not supported sufficiently by financial instruments for providing public services. - Criteria for some forest functions are too vague (e.g. climatic, hygienic-health, aesthetic, touristic). - Forest function areas are not integrated in operational planning (e.g. silviculture plans).

These findings were verified with an additional questionnaire of forestry experts in the 2nd workshop using a Likert scale (1-9) (Appendix 2). There was broad agreement among forestry experts (standard deviation, $sd < 2$) that the synthesis map of forest functions should be simplified (P (probability) [rating>8] = 0.84), if conflicts appear, stakeholders should be included in the designation of forest function areas (P [rating>8] = 0.71), and that the number of forest functions should be decreased (P [rating>8] = 0.91). There were divergent opinions among forestry experts regarding the statements that regulations for designating forest function areas are too detailed and prescriptive (sd = 2.50), that a maximum of two or three functions can be defined on the same land (sd = 2.25), and that forest functions do not have generally accepted societal value (sd = 2.29).

The revealed purposes for designating forest function areas were mainly in accordance with the findings from the evaluation phase; participants identified the following main purposes of forest function areas: 1) a tool for collaboration in spatial planning; 2) a tool for collaboration with other institutions and the public; 3) importance for forest development and land use planning; and 4) importance for planning management objectives and measures (Appendix 3).

4. ALTERNATIVE MODELS

The recommended changes were presented in two conceptual models built up of 18 dimensions (Table 6). In Model B the technical part of the designation is improved and simplified. Model C is conceptually different – it emphasizes identification of conflict areas, prioritization among functions and management effectiveness of the designated areas.

Table 6: Main characteristics of models of forest functions

TECHNICAL PART			
Dimension	Model A "Current"	Model B "Technical"	Model C "Conceptual"
1) Types of forest functions	1. protection 2. hydrologic 3. habitat protection 4. climatic 5. protective 6. hygienic-health 7. recreation 8. touristic 9. education 10. research 11. natural heritage 12. cultural heritage 13. aesthetic 14. defence 15. wood production 16. non-wood products 17. game management	1. hydrologic 2. habitat protection 3. protection (direct, indirect) 4. education 5. recreation 6. cultural heritage 7. climatic 8. non-wood products 9. wood production	1. protection (direct, indirect) 2. recreation 3. nature protection 4. hydrologic 5. environment protection 6. wood production
2) Ranking of importance	3 levels of importance	1 or 2 levels of importance	Priority and side function

3) Designation level	Forest management region (FMR) and Forest management unit (FMU)	FMU	FMR for designation of forest function areas FMU for operational planning and detailed designations
4) Designation scale	1 : 25.000	1 : 25.000 or 1 : 10.000	≈1 : 25.000 for designation, more detailed for operational planning
5) Overlapping	<17 functions	Max. 3 functions	Max. 2 functions
6) Point/line objects	Transformed into the "system of functions"	Register of objects	Register of objects
7) Minimum designation area	0.25 ha	0.25 ha	Variable
8) Spatial units	Functional units	Layers of individual functions	Layers of individual functions
9) Data availability	Map of forest function areas, list of functional units	Digital layers of individual functions	Interactive map

CONCEPTUAL PART

Dimension	Model A (and B)	Model C
10) Designation focus	Emphasis on inventory and GIS analysis	Inventory as a basis, emphasis on designation and management
11) Priorities among functions	No	Yes
12) Area under designation	Entire forest area	Large part of forest is without priority function
13) Standardization of criteria	Uniform across Slovenia	Partly standardized
14) Definition of management measures	In FMR and FMU plans, on the level of functional units	In FMU plans, on the level of operational objects with priorities for management
15) Implementation of management measures	Formal management decisions	Management decisions, projects, contracts
16) Evaluation of management effectiveness	On the level of FMR and FMU	On the level of operational objects
17) Identification of conflict areas	Where areas of social and environmental functions overlap	In the participatory process
18) Participation approach	Rather passive, top-down prevalence	Collaborative approach

Argumentation for proposed changes:

1) Types of forest functions. Currently, 17 different forest function types are designated. Main weaknesses:

- large number – hard to follow,
- impossible to spatially present all of them,
- poor basis for management implementation.

According to the individual survey results (for details see Simončič and Bončina, 2015), we have simplified the classification system. We assumed that those functions that the majority of respondents would no longer designate should be excluded from designation, joined with each other or attached to those functions that the respondents would keep in the classification system. Accordingly, we classified 9 main functions (Model B; Table 7). The protection function is further divided into indirect and direct protect function.

Table 7: Forest function types in Model B

Function types (Model B)		Function types (Model A)
1	Protection	Protection, protective
2	Hydrologic	Hydrologic
3	Habitat protection	Habitat, protection of natural heritage
4	Climatic	Climatic, hygienic-health
5	Cultural heritage	Protection of cultural heritage
6	Recreation	Recreation, touristic, aesthetic
7	Education	Research, education
8	Non-wood forest products	Non-wood forest products, game management
9	Wood production	Wood production

The simplification of forest function types in model C was based on the survey results, but additionally considered the international classifications and classification systems used in other CE countries. FAO classification (e.g. Global forest…, 2010) distinguishes five main forest function types: production, protection of soil and water, conservation of biodiversity, social services and multiple uses. The main references from CE were the Swiss and Austrian systems due to their clarity and transparency. They commonly distinguish 4-5 types of forest functions: wood production, protective, recreation, nature conservation (not in Austria) and welfare function including hydrologic function (only in Austria and in some cantons of Switzerland) (WEP, 2006; WEP Greifensee..., 2007; WEP Kanton Zürich, 2010a; Plan directeur…, 2013). Accordingly, we classified 6 main forest functions (Table 8), with protection function further divided into indirect and direct protection function. Our classification additionally distinguishes the hydrologic function because of high relevance of water protection in Slovenia. Some forest functions from the current model (e.g. non-wood forest products, objects of cultural heritage, areas with defence objects, game management areas, and research objects) are not classified as forest function types in model C. Instead, they are designated as other areas of specific importance and presented

in a separate map. A similar approach is used in some cantons in Switzerland for water protection zones or areas of cultural heritage (e.g. WEP Greifensee..., 2007), or in Austria for nature protection zones that are considered in a separate chapter of the plan as special forest sites (WEP, 2006).

Table 8: Function types in Model C

Function types (Model C)		Function types (Model A)
1	Protection	Protection, protective
2	Environment protection	Climatic
3	Nature protection	Habitat, protection of natural heritage
4	Hydrologic	Hydrologic
5	Recreation	Recreation, touristic, aesthetic, education
6	Wood production	Wood production

2) Ranking of importance of forest functions. In the current model the importance of forest functions is designated with three levels: 1st level – determines management regime, 2nd level – influences management regime, 3rd level – not important for management regime. There are a few exceptions: for the protective function, protection of natural heritage, protection of cultural heritage, aesthetic and defence functions, the 3rd level of importance is not defined, and for research, non-wood forest products and game management functions, only the 1st level is determined (Pravilnik…, 2010). The ranking system is similar to the one in Austria (WEP, 2006), whereas other CE countries use fewer ranks (e.g. Volk and Schirmer, 2003; Waldfunktionen Kartierung, 2010; WEP Kanton Zürich, 2010a). Main weaknesses:

- 3rd level of importance has no influence on management,
- criteria for 2nd level of importance are vague,
- no prioritization in the case of overlapping of several function layers.

In Model B we suggest defining the 1st and 2nd rank of importance because there were divergent opinions on these in both the survey and participatory workshop. Model C adopts the system used in several cantons in Switzerland; forest functions are not ranked with levels of importance, but are prioritized between each other (e.g. WEP Kanton Zürich, 2010a). One function is designated as a priority function and one can be designated as a side function. Wood production is the exception that was only ranked as a priority if ecological or social functions were not defined as priority functions.

3) Spatial designation level. Forest function areas are designated on two spatial levels – in the frame of FMR and in the frame of FMU plans – and the designation criteria are the same for both levels. Main weaknesses:

- no conceptual difference among the two spatial scales,
- repetition of work and time consuming.

In Model B forest function areas are designated on one planning level – the FMU. In Model C they are designated in FMR plans. Such an approach is typical for CE where

forest development plans are the main tools for guiding multi-objective forest management. On the level of the FMU, priority objects should be allocated where management measures and activities are needed in the next planning period. The FMU is also the appropriate spatial scale for areas with high public importance (e.g. urban forests or forests in national parks).

4) Mapping scale. In the current model forest function areas are designated at the 1:25,000 scale. Main weaknesses:

- too small for some functions (loss of spatial information),
- ignorance of certain stand level information (e.g. for operational planning).

In Model B two mapping scales are possible – a broader one of 1:25,000 and a detailed one of 1:10,000. A similar approach is proposed by Model C; however, multiple designation scales are possible. To exemplify on nature conservation areas: forest function areas that follow broader designation criteria (e.g. Natura 2000 sites, national parks) are designated in regional (1:50,000) or landscape scale (1:25,000). Forest function areas of local importance (e.g. special forest structures, rare habitat trees, natural cells, rare habitats for animal species, islands of dead wood etc.) are designated in a 1:10,000 or 1:5000 scale.

5) Point or line objects. In the current model different point or line objects are transformed into the system of forest function areas by classifying them into a single layer (e.g. recreational objects). In addition, buffer zones are often built around line objects (e.g. trails) to create polygons and calculate the "surface" of forest function areas. Main weaknesses:

- additional work with transferring databases,
- basic information "hidden",
- hindered data exchange with other users.

In both Models B and C, we suggest that a register of objects is created. The register would first classify its listing by various types of properties. In the next step, it would divide the same types of objects according to whether they are line, point or planar objects. The register would be developed gradually, in collaboration with relevant data holders. The register would allow different users to view basic information, and it would enable exchange of information between institutions and also easier data management (updates, further classifications, spatial analysis and presentations). The following types of objects could be included in the register:

a) points: caves, bear dens, bee pasture locations, water springs, hiking cabins, unique trees, objects of cultural heritage,
b) lines: hiking, running, cross-country skiing, downhill skiing, mountain-biking, riding trails, streams, rivers,
c) planar objects: objects of cultural heritage, seed forests, water protection zones.

6) Minimum designation area. In the current model the minimum designation area is not explicitly defined; it is conditioned by the minimum size of forest area (0.25 ha). Main weaknesses:

- no minimal area could mean very detailed spatial configuration of forest function areas.

In Model C we suggest a minimum designation area for some forest functions; for example, a minimum of 2-3 ha could be an option for designation of protection function areas (e.g. Guček, 2015).

7) Type of spatial units and 8) their overlapping. In the current model functional units are the main spatial units presented on the map and in the attribute part (Figure 4). Main weaknesses:

- too much "fragmentation" of designated area into functional units,
- information on an individual function layer is not easily available from the database,
- the map of functional units is unclear since 17 different forest function areas can theoretically overlap on the same land and even more combinations are possible considering the three levels of importance,
- there is no prioritization among functions on the overlapping areas,
- long and unclear attribute part for one FMU (Figure 3).

In Models B and C we suggest designating forest functions in individual layers. In spatial displays a maximum of three (Model B) or two (Model C) functions are presented. In the latter case, priorities are set among the two (for details, see dimension 11).

Slo_FunkP_2011_KK

FID	Shape *	ZAPSTEVIL	GGO	GGE	EKOLOSKA	SOCIALNA	PROIZVODNA	SIFRA	POVRSINA	DOLZINA	POLMER	VSTOP	HSTOP	BSTOP	KSTOP	ZSTOP	GSTOP
0	Polygon	05001	08	05	1	1	3	v"h"z"e"	15,411607	0	0	1	1	3	3	1	3
1	Polygon	05002	08	05	1	1	3	v"hz"e"	32,133271	0	0	1	2	3	3	1	3
2	Polygon	05003	08	05	1	1	3	v"h"z"rg"e"c	11,816635	0	0	1	1	3	3	1	1
3	Polygon	05004	08	05	2	1	2	hbr"tg"e"	19,441892	0	0	3	2	2	3		1
4	Polygon	05005	08	05	1	3	1	h"	111,323547	0	0	3	1	3	3		3
5	Polygon	05006	08	05	2	1	2	hr"tg"e"	1,658857	0	0	3	2	3	3		1
6	Polygon	05007	08	05	1	3	1	h"	8,428126	0	0	3	1	3	3		3
7	Polygon	05011	08	05	1	3	2	b"	1,068501	0	0	3	3	1	3		3
8	Polygon	05012	08	05	1	2	2	b"d	6,377808	0	0	3	3	1	3		3
9	Polygon	05013	08	05	1	2	2	b"d	12,39455	0	0	3	3	1	3		3
10	Polygon	05014	08	05	1	2	2	b"d	12,600212	0	0	3	3	1	3		3
11	Polygon	05016	08	05	2	1	2	hr"tg"e"b	22,746624	0	0	3	2	2	3		1
12	Polygon	05017	08	05	2	1	2	hr"tg"e"c	3,480775	0	0	3	2	3	3		1
13	Polygon	05018	08	05	1	1	2	h"g"r"	72,24888	0	0	3	1	3	3		1
14	Polygon	05019	08	05	1	3	1	h"b	20,568874	0	0	3	1	3	3		3
15	Polygon	05020	08	05	2	1	2	hbr"tg"e"c	1,059924	0	0	3	2	2	3		1
16	Polygon	05021	08	05	2	1	2	hr"tg"e"c	2,735826	0	0	3	2	3	3		1
17	Polygon	05022	08	05	2	2	1	rgeb	43,567668	0	0	3	3	2	3		2
18	Polygon	05023	08	05	2	2	1	hrgelb	144,280496	0	0	3	2	2	3		2
19	Polygon	05024	08	05	2	3	1	hl"	122,879545	0	0	3	2	3	3		3
20	Polygon	05025	08	05	2	2	2	hrgel	28,493309	0	0	3	2	3	3		2
21	Polygon	05034	08	05	2	3	1	hl"b	34,430366	0	0	3	2	2	3		3
22	Polygon	05041	08	05	1	3	1	h"l"	39,996244	0	0	3	1	3	3		3
23	Polygon	05042	08	05	2	3	1	hl"	309,154625	0	0	3	2	3	3		3
24	Polygon	05044	08	05	1	3	1	b"l"	90,208844	0	0	3	3	1	3		3
25	Polygon	05050	08	05	2	3	1	b	328,435579	0	0	3	3	2	3		3
26	Polygon	05051	08	05	2	3	1	b	759,089655	0	0	3	3	2	3		3
27	Polygon	05052	08	05	1	1	3	v"h"z"e"b	7,521756	0	0	1	1	2	3	1	3
28	Polygon	05053	08	05	2	3	1	hb	186,262005	0	0	3	2	2	3		3
29	Polygon	05054	08	05	2	2	1	hc	29,890124	0	0	3	2	3	3		3
30	Polygon	05055	08	05	2	2	1	rgeb	12,782903	0	0	3	3	2	3		2
31	Polygon	05056	08	05	2	2	1	rgeb	20,086799	0	0	3	3	2	3		2
32	Polygon	05057	08	05	2	2	1	hrgelb	2,410173	0	0	3	2	2	3		2
33	Polygon	05058	08	05	1	1	3	v"hz"e"c	2,431977	0	0	1	2	3	3	1	3
34	Polygon	05060	08	05	2	3	1	hbd	18,621963	0	0	3	2	2	3		3
35	Polygon	05061	08	05	2	3	1	hbd	4,225827	0	0	3	2	2	3		3
36	Polygon	05065	08	05	2	2	1	hbd	1,238617	0	0	3	2	2	3		3
37	Polygon	05067	08	05	2	2	1	bcd	57,097489	0	0	3	3	2	3		3
38	Polygon	05068	08	05	2	1	2	hr"tg"e"	9,08065	0	0	3	2	3	3		1
39	Polygon	05070	08	05	2	2	1	bd	517,891019	0	0	3	3	2	3		3
40	Polygon	05071	08	05	2	2	1	bd	21,287572	0	0	3	3	2	3		3
41	Polygon	05072	08	05	2	2	1	rgebd	31,314314	0	0	3	3	2	3		2
42	Polygon	05073	08	05	2	2	1	bdc	8,437062	0	0	3	3	2	3		3
43	Polygon	05074	08	05	1	3	1	b"h"	17,141658	0	0	3	1	1	3		3
44	Polygon	05075	08	05	2	3	1	h	3,520238	0	0	3	2	3	3		3
45	Polygon	05076	08	05	2	2	1	rgebdh	4,231856	0	0	3	2	2	3		2

Figure 3: An example of the attribute part of the database on forest function areas from the current model (SFS, 2014a); ecological, social and production functions are firstly ranked with three levels of importance, followed by the identification of functional units (column SIFRA) where all existing functions are listed, followed by their surface and the ranking of individual functions.

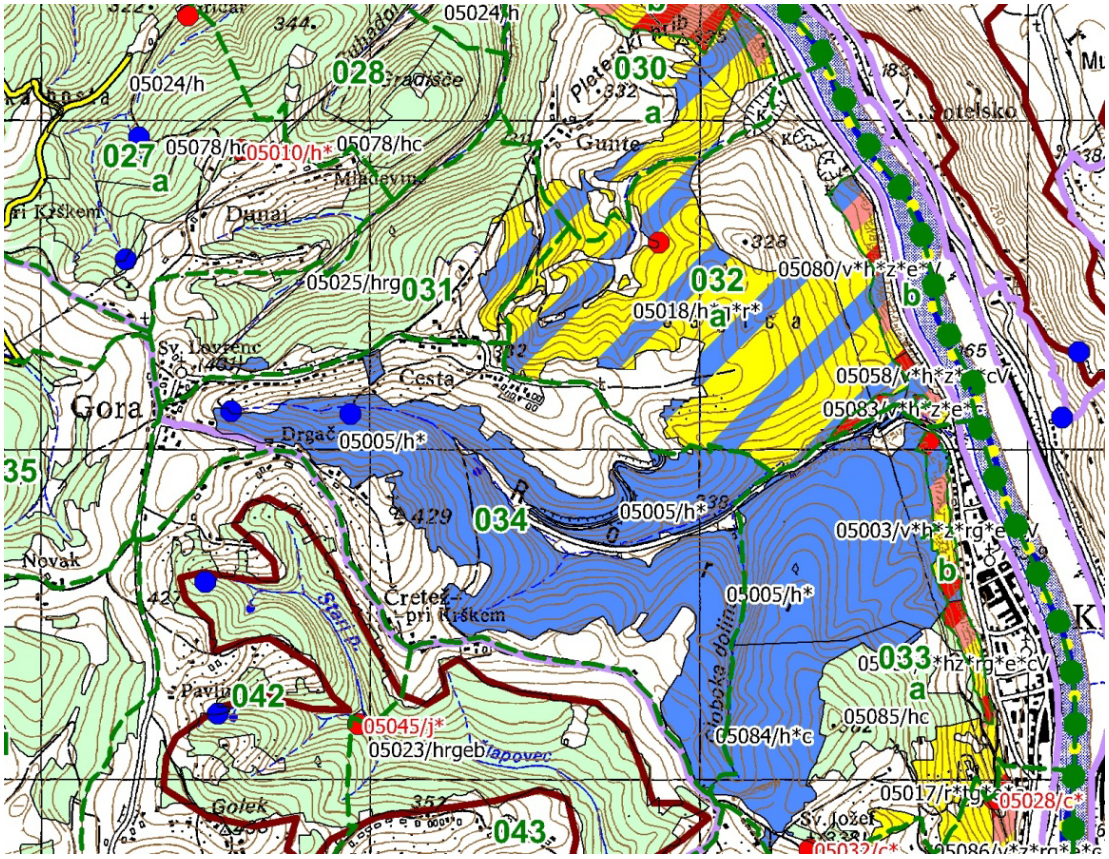

Figure 4: A part of the forest function map where the identification of functional units can be seen (SFS, 2014c). Example: 05018/v*h*z*e* denote the number of functional unit where protection (v), hydrologic (h), protective (z) and aesthetic (e) functions are ranked with the first level.

9) Data availability. Current information on forest functions is available from FMR and FMU plans where a map of forest function areas which is a synthesis map of the main groups of forest functions (ecological, social, economic), and their description is available. In addition, some specific information can be obtained from stand descriptions from forest silvicultural plans. Main weaknesses:

- functional units are not understandable to non-forestry users,
- exchange of information with other institutions is hindered.

In Model B individual layers of forest functions can be exchanged with other institutions and presented to the users. In Model C an interactive map is suggested where all the information on forest function areas is available online. The map would combine the data from different sources and with different contexts. Such maps have been common for example in Switzerland (see WEP Kanton Zürich, 2010b). In Slovenia some steps have already been taken in this direction with a recently published online database (SFS, 2014b) where basic information on forest functions can be accessed.

10) Designation focus. In the current model designation of forest function areas is strongly focused on mapping procedures; a great deal of time is spent for inventory and data management in the office, e.g. gathering, organizing, digitalization, and transforming layers and basis of other data holders in the system of forest function areas. Often, the map of forest functions is an automated aggregate of these procedures. Main weaknesses:

- the next step after inventory, i.e. identifying conflicts and spatial prioritization, is weak;
- strong competences of other institutions (automatic adaptation of other designations).

In Model C the designation (and not mapping as a technical procedure) is central to the concept; it aims to identify (potential) conflict areas, set priorities among functions and plan adequate land use that leads to minimum conflicts. Forest function areas are designated considering the following criteria: 1) there are societal demands for forest functions; 2) additional measures are needed; or 3) potential conflicts are expected among land uses.

11) Priorities among functions. In the current model no priorities are set where different forest function layers overlap. Forest functions are not ranked between each other, but evaluated with degrees of importance according to pre-defined criteria. Main weaknesses:

- overlapping of multiple forest functions with the same priorities can lead to conflicts,
- no clear priorities for management.

In model C we suggest prioritising forest functions according to some general rules. A similar approach is applied in Switzerland's planning guidelines, where priorities are made according to the public interests for forest functions (see Fallbeispiele..., 1996, for example): forest reserves > protection forests > nature conservation function > hydrological function > recreation > environment protection > wood production function. These rules could be adjusted to local conditions if there are good arguments for different public priorities.

12) Area under designation. In Model A forest function areas define the total forest area; therefore, the whole forest area is designated with a function of either 1st, 2nd or 3rd level of importance. Main weaknesses:

- no clear overview on the most important forest function areas in forest land,
- less appropriate for management – forest function areas do not necessarily reflect differences in management goals and associated strategies.

In Model C a large part of forests is defined with either wood production function as the priority function, or as other multifunctional area without a priority function.

13) Standardization of criteria. In the current model designation criteria are prescribed in detail in regulations and are the same for the entire forest area in Slovenia. Altogether, 82 different sub-criteria are identified by regulations on designating forest function areas (Table 9). Main weaknesses:

- excessively prescriptive approach, lack of competences of forest planners,

- no possibility of adapting designation to local conditions,
- time spent on harmonization between regional units.

In Model C we suggest that designation criteria should be standardized only for particular forest functions, namely for ecological functions. For example, for forests with a direct protection function, target values for stand parameters such as tree density, spatial tree distribution, species composition, tree conditions, diameter distribution and basal area are applied for optimizing the protective effects of forests. Designation of areas with important social functions could be less prescriptive and more expert-based, including the opinion of stakeholders and on-site observations.

Table 9: The classification of forest functions and their designation criteria according to the current model (After Pravilnik…, 2010)

Function		Sub-criteria
1	Protection	Va, Vb, Vc, Vd, Ve, Vf, Vg, Vh, Vi, Vj, Vz
2	Hydrologic	Ha, Hb, Hc, Hd, He, Hf
3	Climatic	Ka, Kb, Kc, Kd, Ke, Kf
4	Habitat protection	Ba, Bb, Bc, Bd, Be, Bf
5	Protective	Za, Zb, Zc, Ze, Zf,
6	Hygienic-health	Ga, Gb, Gc
7	Defence	Oa, Ob, Oh
8	Recreation	Ra, Rb, Rc, Rd, Re, Rf, Rg, Rh
9	Touristic	Ta, Tb, Tc, Td, Te, Tf
10	Protection of natural heritage	Da, Db, Dc, De
11	Protection of cultural heritage	Ca, Cb
12	Education	Pa, Pb
13	Research	Ia, Ib, Ic
14	Aesthetic	Ea, Eb, Ec, Ed, Ee, Eg
15	Wood production	La
16	Non-wood forest products	Na, Nb, Nc, Nd, Ne, Nf
17	Game management	Ja, Jb, Jc, Jo, Jk, Jt

14) Definition of management measures. In the current model management measures are listed on the level of functional units. They include the type of measure (a maximum of 5 measures can be defined), an estimation of the ability of forests to provide the function, an estimation of risk and the need to intervene. In addition, more specific measures can also be defined in the process of stand descriptions. Main weaknesses:

- management measures are the same for the particular type of forest function regardless of ecological or socio-economic variability within the regions,
- measures for more functions with the same priorities might not be compatible,
- connection between strategic and operational planning is not assured; management measures from functional units are rarely transferred to the stand scale.

In Model C we suggest creating a list of areas (objects) with priorities for management on the level of the FMU. The list is based on the assessment of areas where measures should be taken in the next planning period to maintain the desired functions.

15) Implementation of management measures. In the current model management measures can be implemented through administrative acts (formal management decisions) which are made on the level of operational forest planning units (compartments, stands). Main weaknesses:

- not explicitly located but defined on the level of the whole compartment,
- not binding for forest owners.

In Model C different management tools are proposed to implement management measures on priority objects, such as existing management decisions, projects and contracts (e.g. Waldfunktionsplanung…, 1994; Regionaler…, 1999; Plan directeur…, 2013).

16) Evaluation of management effectiveness. In the current model management effectiveness is evaluated on the level of the FMR and FMU at the end of the planning period. Main weaknesses:

- evaluation is too general and not linked to concrete objects,
- monitoring protocols for effectiveness of management measures are not adequate.

In Model C the list of priority objects would be a basis to evaluate management effectiveness because of clear and measurable measures.

17) Identification of conflict areas. In the current model conflict areas are assumed where multiple social (recreation) and environmental functions overlap. Main weaknesses:

- schematically anticipates among which types of functions the conflicts appear,
- there are no strategies for mitigating the potential conflicts.

In Model C conflict areas are identified in the participatory process and present an important basis for designation of forest function areas. In the case of non-compatible uses, some of them are relocated during the designation process.

18) Participatory approach. In the current model participation of other institutions is relatively intensive but limited to formal exchange of databases. For other stakeholders, top-down participation still prevails. Main weaknesses:

- lack of recognition of stakeholder (especially public and forest owners) needs,
- limited possibilities to identify (potential) conflict areas,
- poor management effectiveness (e.g. the ability to achieve management goals).

In Model C we suggest a collaborative approach for the identification of potential conflict areas and designation of forest function areas, especially on the areas with multiple demands and more intensive management needs.

5. EVALUATION OF MODELS

Participants evaluated both models as better alternatives compared to the current model. Model C was graded higher than Model B (Table 10).

Table 10: Grading of Models B and C by 10 groups of workshop participants (n=65)

	Model B	Model C
Average estimation	6.7	7.5
Preferred model (number of groups)	3	7

The main advantages of Model B referred to the types of forest functions, ranking of their importance and the concretization of line and point objects (Table 11); whereas the main advantages of Model C related to the designation of (potential) conflict areas, setting priorities among functions and setting and implementing management measures. Model B was criticised for not improving the conceptual part, whereas the disagreement with Model C was due to unclear procedures, the demanding and time consuming approach and the possibilities for designating a maximum of two functions on the same land. Less frequently mentioned advantages of Model B were less overlapping due to merging of some forest function types, less time consuming mapping, comparability of individual layers and greater transparency. Other advantages and weaknesses of both models are listed in the Table 11.

Table 11: The main advantages and weaknesses of alternative models identified by forestry experts (Pokljuka, April 2nd 2015)

	Advantages	Weaknesses
Model B	- Layers instead of functional units - Less forest function types - Register of objects - Designation of forest function areas on the level of FMU - Less degrees of importance - Possibility to designate forest function areas on a smaller scale	- No improvements of the contextual part, too general measures, designation not in accordance with management - Limited number of overlapping functions - Uniform minimum area - Weak participation in designation of conflict areas, too authoritative planning - No priorities among functions - Duality of data: functions + registers - No synthesis, just individual layers - Designation on FMU - lack of strategic view
Model C	- Clear definition of priorities between functions - Only priority function - Adequate number of forest functions	- Supplementation of regulations, professionally demanding, time consuming, complicated ranking system, difficulties in using current data

- Interactive map - Variable minimum area - Designation of conflict areas - Transparent system, simplification, rationalization - Priorities among functions considering local conditions - The list of objects with priorities for management, concretisation of work - Layers of functions - Variable designation scale	- Problematic designation of only two functions, not enough possibilities for overlapping, approach too segregated (single use designation) - Too few function types (lacking research and cultural heritage functions) - High number of unknown processes, unclear concept - FMR planning period does not allow adjustments in-between the plan revisions - Dominance of stronger stakeholders in prioritization of functions

Participants listed suggestions of how to improve both models. We classified the suggested proposals according to the dimension of the model they refer to and joined them for both models (Table 12). Some dilemmas regarding improving of the current concept were also identified by respondents; the main one being prioritization of forest functions and the consideration of other (currently priority) functions.

Table 12: Suggestions for improvement of the conceptual models

Dimension	Final recommendations
1) Number of forest functions	Maximum 6 functions. Dilemma: the designation of wood production is questionable since it is often designated on the entire forest area. Some functions (protection of cultural heritage or non-wood forest products) could be included in the designation as special objects / areas instead forest function types.
2) Ranking	One priority function, one (or more) side functions.
3) Designation level	FMR for designation of forest function areas, FMU for operational planning.
4) Designation scale	Variable scale: general scale 1:25,000 for designation of forest function areas, flexible for other designations.
5) Overlapping	Maximum 2 functions. Dilemma: Many respondents suggested possibilities to overlap more functions.
6) Point/line objects	Register of objects; consensus with data holders on the rights for data management and distribution; possibilities to hide vulnerable information.
7) Minimum designation area	Variable minimum area.
8) Spatial units	Individual functions instead of functional units. Dilemma: it is not clear how to harmonise different forest function layers in case of overlapping (problem of spatial presentation).

9) Data availability	Interactive map in the scale of 1:25,000. Dilemmas: competences of forestry sector in presenting data of other institutions are limited, thus agreement of data holders is needed. In addition, "vulnerable" information (e.g. bear dens) should not be accessible to all users.
10) Designation focus	Focus on designation process and its relevance for management decisions. Larger creativity, expert opinions, consultations. Dilemma: competences of some institutions are already quite strong, and more intensive participation can lead to a longer planning process.
11) Priorities among functions	Setting priorities among functions where forest function areas overlap: one function as priority, one (or more) as a side function; general rules with adaptation to local conditions; information on other functions is maintained in the database. Dilemmas: information on forest functions that are not priority or side can be lost, non-priority functions can be ignored in management decisions.
12) Area under designation	Large part of forests is classified as the wood production function, priority function or other multifunctional area without priority function. Dilemma: in the current forestry legislation, forest function areas define the forest area.
13) Standardization of criteria	The level of standardization connected to the type of function; more expert opinions and on-site assessments, importance of participation.
14) Definition of management measures	General on FMR, detailed in FMU, list of priority objects with management priorities, integration of measures in operational planning (stand spatial scale).
15) Implementation of management measures	Projects, contracts; list of priority objects as basis for subsidies.
16) Evaluation of management effectiveness	On the level of priority objects, elaborate clear monitoring protocols with assessable / measurable criteria.
17) Identification of conflict areas	In the participatory process, conditioned by local settings.
18) Participation approach	Greater participation, especially forest owners and public, in identifying conflict areas, finding solutions for mitigating them, and prioritising management objectives.

6. CASE STUDY IMPLEMENTATION

6.1 TOTAL AREA UNDER DESIGNATION AND OVERLAPPING

The three case studies represent mountain forest landscape under large private and state landowners (Pokljuka), urban and suburban forests mainly under small private ownership

(Ljubljana) and private forests in an agrarian landscape (Krško). Therefore, there are significant differences in the area extent of forest function areas among the case studies (Table 13). The total area under designation is greatest in Ljubljana, followed by Pokljuka and Krško. Even greater differences among the three case studies are revealed if only the area proportions of social and ecological functions of the 1st level of importance are considered; Ljubljana has a much larger area proportion compared to Pokljuka and especially compared to Krško. The biggest difference between the models is in the total area under designation. If confined to the first level of importance of forest functions, the total area under designation is significantly smaller for all three case study units in alternative Model C. This is mainly due to fewer forest function types and less overlapping; both the total designation area and the degree of overlapping noticeably decreased in Model C for all three case studies.

Significant differences in the total designation area (sum) and its overlap (union) point to a large degree of overlapping of forest function areas, which leads to decreased clarity of maps. This observation can be supported by the detailed analysis of functional units under Model A in all three case studies; the average number of functions on one designation area ranges from 2.5 (Krško) up to even 4.3 (Ljubljana). The much smaller degree of overlapping in Model C for all three case study units is one of the largest differences among the three models. In Model C the total designation area (sum) and its overlap (union) separately for functions of 1st or 2nd level of importance is the same for all three case studies. There are differences in the degree of overlapping among Models A and B for all three case studies; however, much greater variation is noticed between Models A and C where the overlapped area is much smaller for all three cases. The biggest difference among the models is identified for Pokljuka, where the area proportion of overlapped functions amounts to only 13.4 % under Model C, whereas for Ljubljana, the biggest difference among Models A and C is in the number of overlapped functions.

The union of designated areas with the 1st level of importance of forest functions is relatively similar in Models A, B and C for all three case study regions, but significantly smaller in Model C if the second level of importance is also considered. This was noticed for all case studies, but was even more obvious for Ljubljana and Pokljuka.

Table 13: Area under designation (% of total forest area) and overlapping of forest function areas

	MODEL A								
	Pokljuka			Ljubljana			Krško		
Forest function	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Forest function area (sum)	141	293	575	355	203	491	116	163	663
Forest area without wood production function (sum)	58	293	570	339	162	457	24	158	661
Forest area (union)	100	100	100	99	99	100	100	91	100
Forest area without wood production function (union)	35	100	100	94	91	100	16	89	100

	MODEL B					
	Pokljuka		Ljubljana		Krško	
Forest function	1st	2nd	1st	2nd	1st	2nd
Forest function area (sum)	149	170	274	247	118	129
Forest area without wood production function (sum)	65	170	232	198	28	124
Forest area (union)	100	100	99	99	100	91
Forest area without wood production function (union)	35	100	94	91	16	89

	MODEL C					
Forest function	Pokljuka		Ljubljana		Krško	
	Priority	Side	Priority	Side	Priority	Side
Forest function area (sum)	100	14	94	21	99	3
Forest area without wood production function (sum)	32	14	85	21	16	3
Forest area (union)	100	14	94	21	99	3
Forest area without wood production function (union)	32	14	85	21	16	3

6.2 FOREST FUNCTION TYPES

There are significant differences in socio-economic and ecological conditions among the three regions. The area proportion of forests with protection and habitat protection functions is therefore the largest in Pokljuka, that with social functions is largest in Ljubljana, and that with the wood production function in Krško. In both Pokljuka and Ljubljana, altogether 15 forest function types were identified in the current model, and in Krško 13 forest function types were identified. In Pokljuka, Ljubljana and in Krško 12, 14 and 8 function types are designated on the 1st level of importance, respectively. In the case of alternative Models B and C, a maximum of 10 and 6 forest function types can be

distinguished, respectively (Table 14). Fewer classified forest function types reflected in relatively less area of forest functions under both alternative models. This was most obvious for the recreational function which joins several currently used social functions (i.e. touristic, educative and aesthetic function), and for the habitat protection function, which also includes the previous protection of natural heritage. This in principle applies to the area of forest functions with the 1st and 2nd level of importance. Some area proportions in Model C differ significantly from the proportion in Models A and B, which was the most obvious in Pokljuka and Ljubljana in the areas where wood production is a priority function. Its area proportion is significantly lower than that in Models A and B.

Table 14: Area proportion of individual forest function types (% of total forest area)

	MODEL A								
	Pokljuka			Ljubljana			Krško		
Forest function	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Protection	18.6	9.6	71.9	1.2	9.0	89.8	1.8	0.0	98.2
Hydrologic	4.4	95.6	0.0	9.3	14.7	76.0	8.5	28.7	62.8
Habitat protection	11.4	88.6	0.0	29.1	17.1	53.8	0.1	72.0	27.9
Climatic	0.0	0.0	100.0	77.6	2.5	19.9	0.0	0.0	100.0
Protective	0.0	0.0	-	0.0	0.0	-	1.8	0.0	-
Hygienic-health	0.0	0.0	100.0	77.4	15.5	7.1	4.3	8.9	86.7
Recreation	1.5	0.0	98.5	57.7	26.8	15.5	4.1	9.2	86.7
Touristic	0.0	0.0	100.0	0.0	0.0	100.0	0.0	1.8	98.2
Education	0.3	0.0	99.7	1.5	3.5	95.0	0.0	0.0	100.0
Research	0.3	-	-	0.0	-	-	0.0	-	-
Protection of natural heritage	0.8	99.2	-	0.5	59.3	-	0.0	23.1	-
Protection of cultural heritage	0.1	0.9	-	3.9	13.3	-	0.0	5.1	-
Aesthetic	16.9	0.0	-	56.4	0.3	-	3.6	8.9	-
Defence	0.3	0.0	-	0.3	0.0	-	0.0	0.0	-
Wood production	83.9	0.0	4.5	15.8	40.6	34.0	92.5	5.4	2.1
Non-wood forest products	2.9	-	-	23.1	-	-	0.0	-	-
Game management	0.0	-	-	0.9	-	-	0.0	-	-

	MODEL B					
	Pokljuka		Ljubljana		Krško	
Forest function	1st	2nd	1st	2nd	1st	2nd
Protection (indirect)	18.6	9.6	2.7	14.6	2.1	0.0
Protection (direct)	0.0	0.0	0.0	0.0	2.1	0.0
Hydrologic	4.4	95.6	9.5	46.1	9.2	28.7
Habitat protection	20.1	64.7	24.7	59.5	4.2	72.0
Climatic	0.0	0.0	82.6	16.5	4.4	8.9
Cultural heritage	0.0	0.0	3.1	17.2	0.0	5.1
Recreation	18.6	0.0	79.5	39.3	6.1	9.2
Education	0.6	0.0	1.6	4.3	0.0	0.0
Non-wood forest products	3.0	0.0	27.9	0.0	0.0	0.0

Wood production	83.9	0.0	42.2	49.2	89.4	5.4

	MODEL C					
	Pokljuka		Ljubljana		Krško	
Forest function	Priority	Side	Priority	Side	Priority	Side
Protection (indirect)	17.8	0.0	1.4	0.0	0.0	0.0
Protection (direct)	0.0	0.0	0.0	0.0	2.2	0.0
Hydrologic	2.7	1.7	9.4	0.0	7.9	0.5
Nature conservation	9.0	12.2	5.7	19.0	4.4	0.0
Environment protection	0.0	0.0	0.0	0.0	0.0	0.0
Recreation	2.3	0.6	66.8	1.6	1.9	2.3
Wood production	68.0	0.0	8.1	0.0	82.8	0.0

6.3 SPATIAL STRUCTURE OF DESIGNATED AREAS

We expected that the spatial structure of designated areas would change with the new Models B and C. Analysis was limited to areas with functions of 1st level of importance in Models A and B or the priority function in the case of Model C. Due to fewer forest function types, and joining spatial units with the same designation criteria, the number of spatial units decreased in the case of Model B for all three case study regions (Table 15). The most obvious difference was for Ljubljana, where the fragmentation of spatial units was the largest under the current model. There were even greater differences in the size and number of spatial units in Model C, which was a function of both fewer forest function types and merging of units with the same criteria, and much less overlapping. The smallest differences in spatial structure among the models were noticed for Krško, where the number of spatial units and the degree of overlapping in the current model were already relatively low. The average size of spatial units was much larger in both Models B and C, particularly for Model C, for all three case study units.

Table 15: Spatial structure of forest function areas (number, average size (ha) and standard deviation of spatial units)

	MODEL A								
	Pokljuka			Ljubljana			Krško		
	n	mean	sd	n	mean	sd	n	mean	sd
All functions	153	51.2	218.8	3082	6.7	17.6	536	7.3	26.3
No wood production	103	34.3	68.6	2929	6.3	16.5	226	4.4	10.5
	MODEL B								
	Pokljuka			Ljubljana			Krško		
	n	mean	sd	n	mean	sd	n	mean	sd
All functions	55	138.5	583.6	1129.0	12.0	61.3	416	9.3	34.1
No wood production	54	61.9	133.4	1107.0	10.3	53.1	181	5.1	12.1

	MODEL C								
	Pokljuka			Ljubljana			Krško		
	n	mean	sd	n	mean	sd	n	mean	sd
All functions	29	176.0	671.1	276	16.9	77.3	277	11.5	39.6
No wood production	28	54.6	155.4	269	15.6	75.1	109	4.8	12.9

6.4 PRIORITIZATION OF FOREST FUNCTIONS

In the current model no prioritization exists among functions that are emphasized on the same area. In Model B prioritization was done only for the purposes of spatial presentation (mapping), and in a way that a maximum of three functions with 1st level of importance are presented on the same forest land. Wood production function areas are not shown in the map. In Model C spatial prioritization was made among functions that had 1st level of importance on the same forest area following selected prioritization rules. Some exceptions were made for Ljubljana; recreation was given priority before nature conservation on Rožnik and Šišenski hrib, where forests are intensively used by city inhabitants for recreation and other activities related to well-being. In addition, around the river Sava, the hydrologic function was defined as priority and nature conservation as side due to the significant importance of these areas for protection of drinking water for city inhabitants. Recreation, which was also designated with 1st level of importance on these areas, was no longer designated due to the higher relevance of the other two ecological functions. Only social or ecological functions were ranked as side functions on the overlapping areas. Therefore, the area extent of wood production function in Ljubljana is much smaller than in the other two models.

In Model C only one side function was designated where two or more priority functions overlapped. For example, for Pokljuka, nature conservation was designated as a side function in the area of forests with protection function due to the high nature conservation importance of the region (wildlife habitats, rare forest communities, TNP, Natura 2000 sites, EPO). In contrast, around Pokljuka bogs, nature conservation was designated as a priority function (national-level relevance as rare habitats), although the protection function was designated as priority in Models A and B. In Ljubljana, prioritization was the most difficult due to the large number of overlapped social and ecological functions on the 1st level of importance. Therefore, the area proportion of the side function is the greatest in this case study (about 20 %). The side function in all case studies was not designated on forests declared as protected categories (protection forests and habitat forests in agriculture land), whereas in Models A and B the same prioritization was done for these areas as for other forest function areas.

The maps show the main differences in the implementation of the alternative models (Figures 5-13): 1) less overlapping in Model C, especially for Pokljuka and Ljubljana; 2) fewer forest function types in Models B and C, especially for Ljubljana; and 3) clearer

overview on priority functions in Model C. There is also a difference between the models regarding the wood production function, which is spatially presented only in Model C. In addition, in Models A and B, only forest function areas with 1st level of importance were included in the forest function map, whereas in Model C, both areas with priority and side functions are shown.

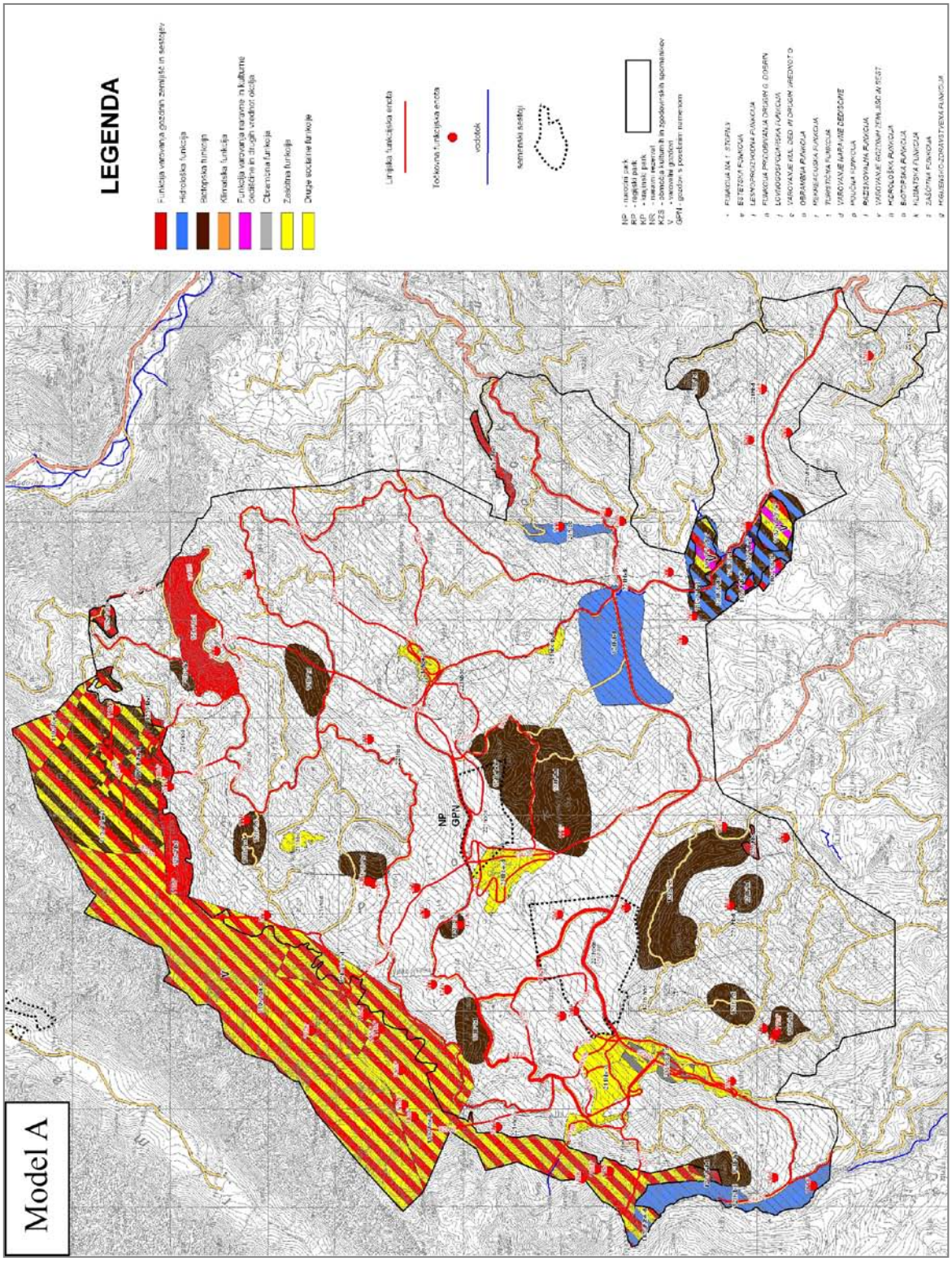

Figure 5: Forest function map in Pokljuka according to the Model A (SFS, 2005b). The original mapping scale was 1:25,000.

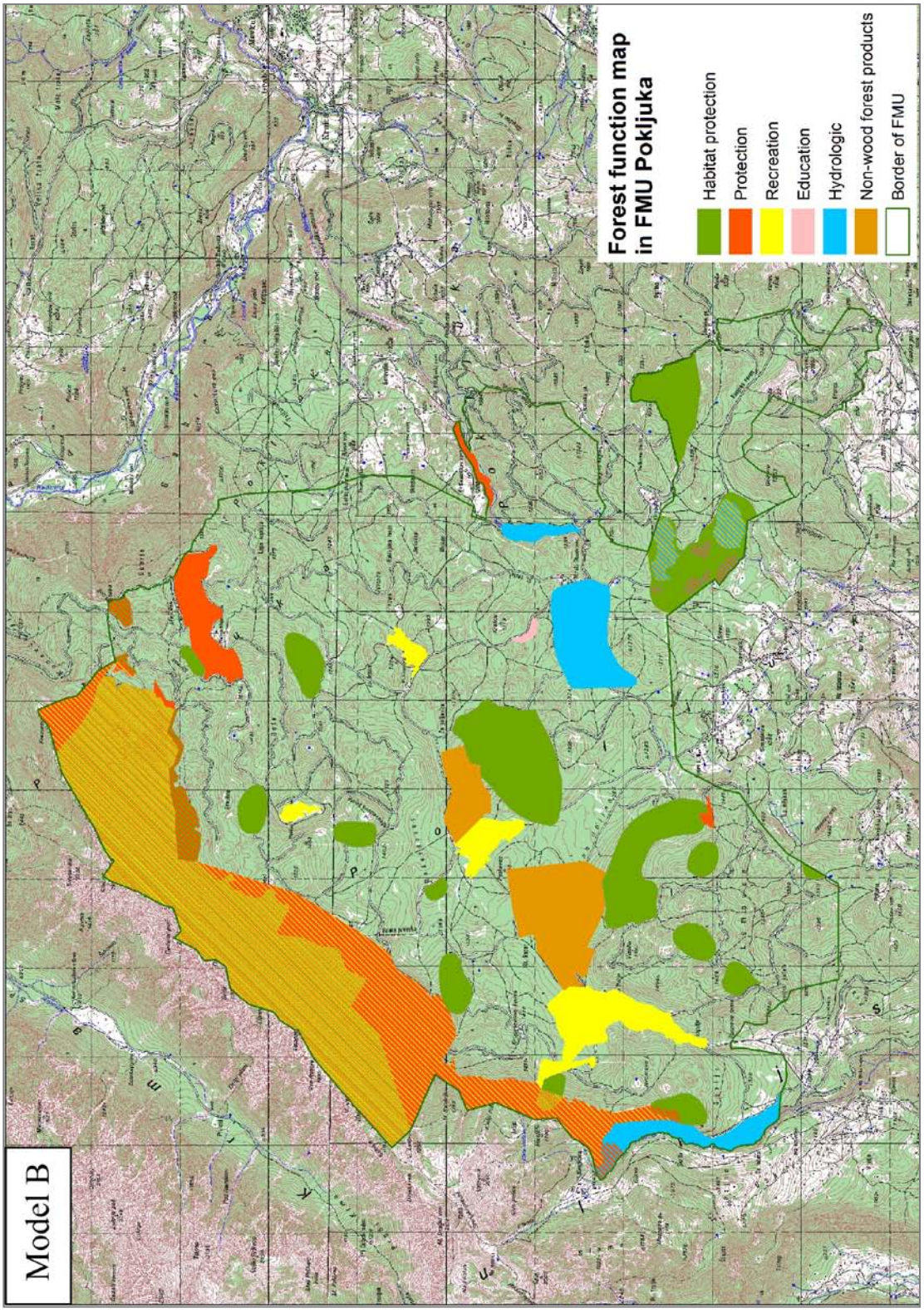

Figure 6: Forest function map in Pokljuka according to the Model B. The original mapping scale was 1:25,000. Protection refers to the indirect protection function.

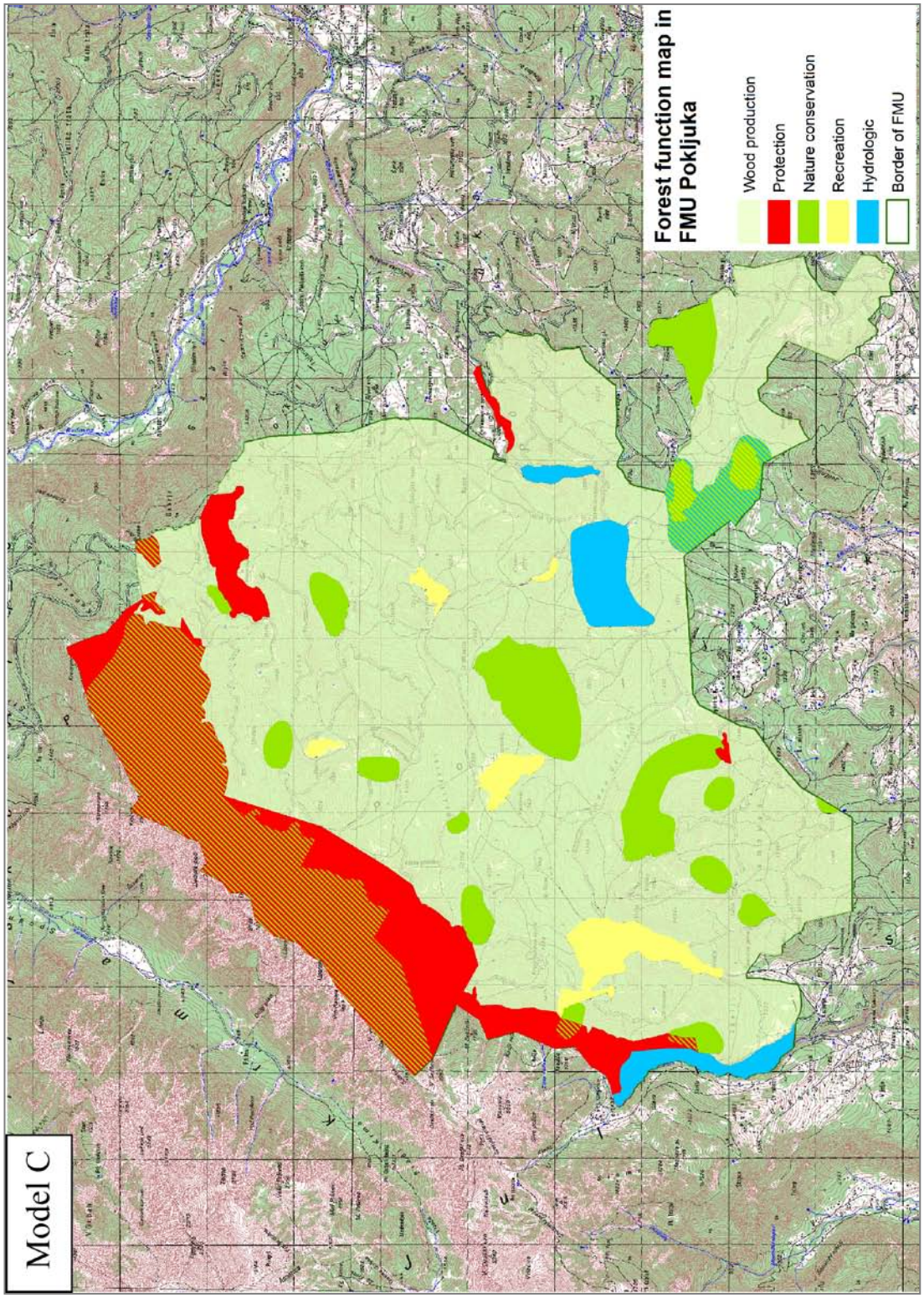

Figure 7: Forest function map in Pokljuka according to the Model C. The original mapping scale was 1:25,000. Protection refers to the indirect protection function.

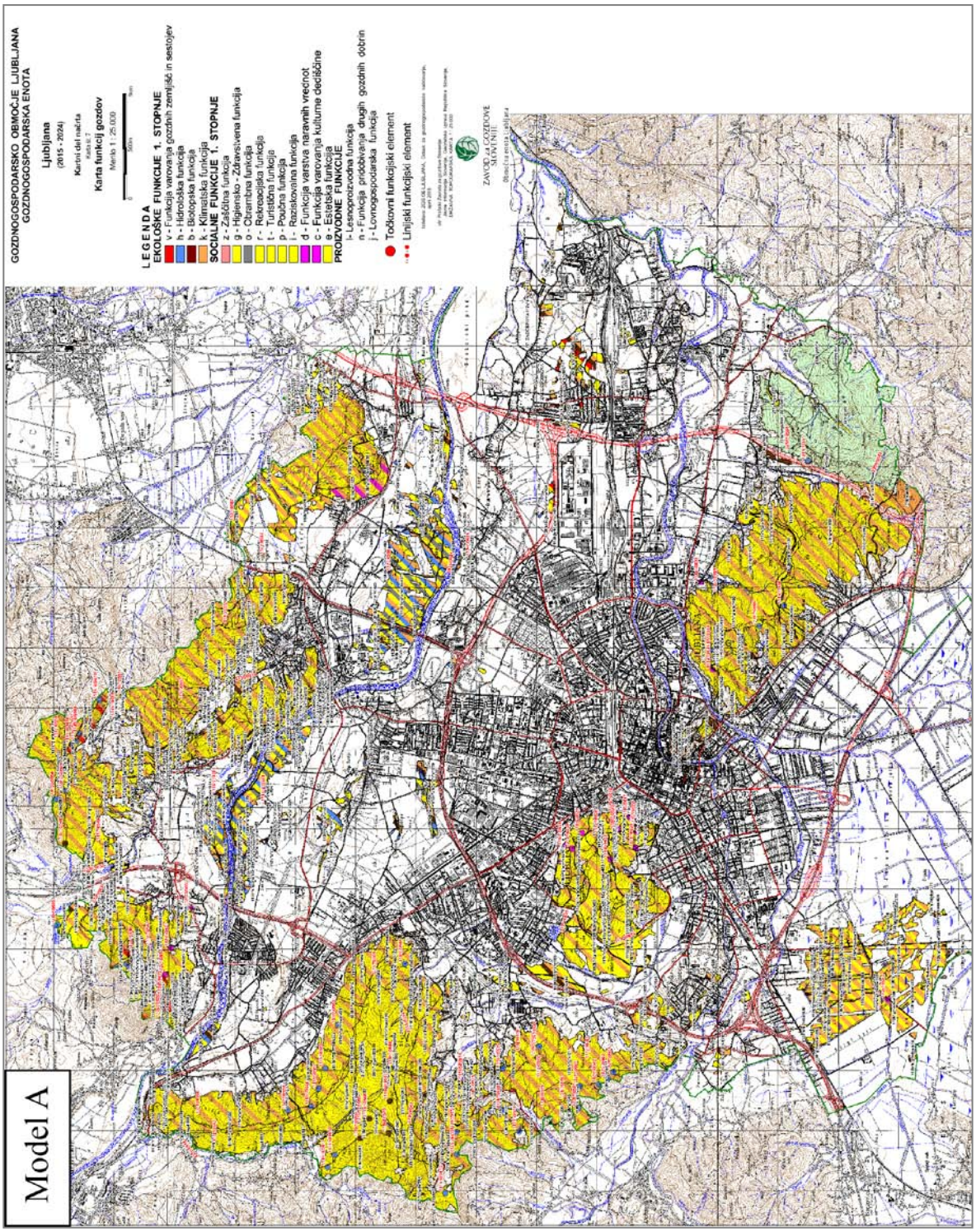

Figure 8: Forest function map in Ljubljana according to the Model A (SFS, 2015). The original mapping scale was 1:25,000.

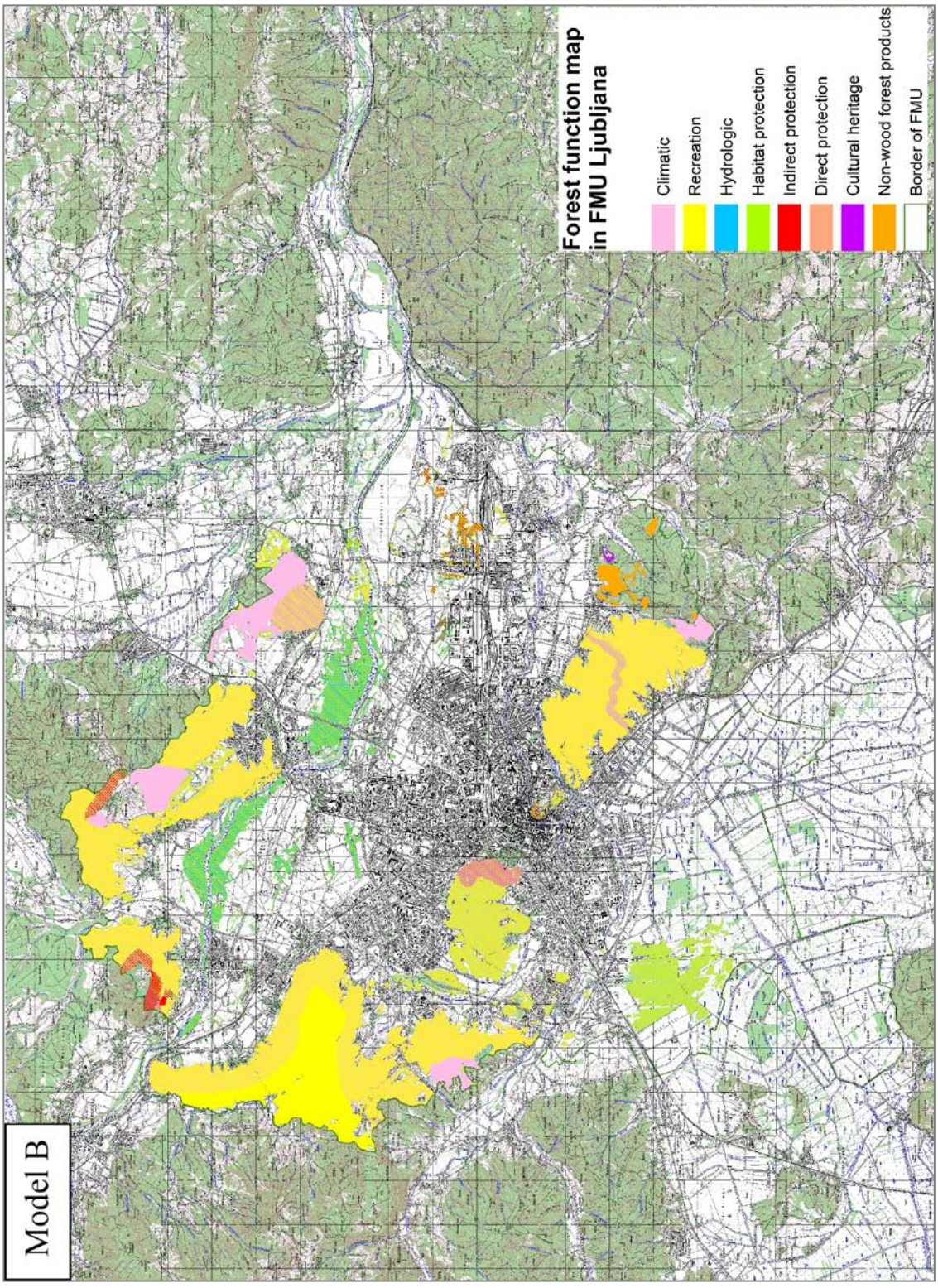

Figure 9: Forest function map in Ljubljana according to the Model B. The original mapping scale was 1:25,000.

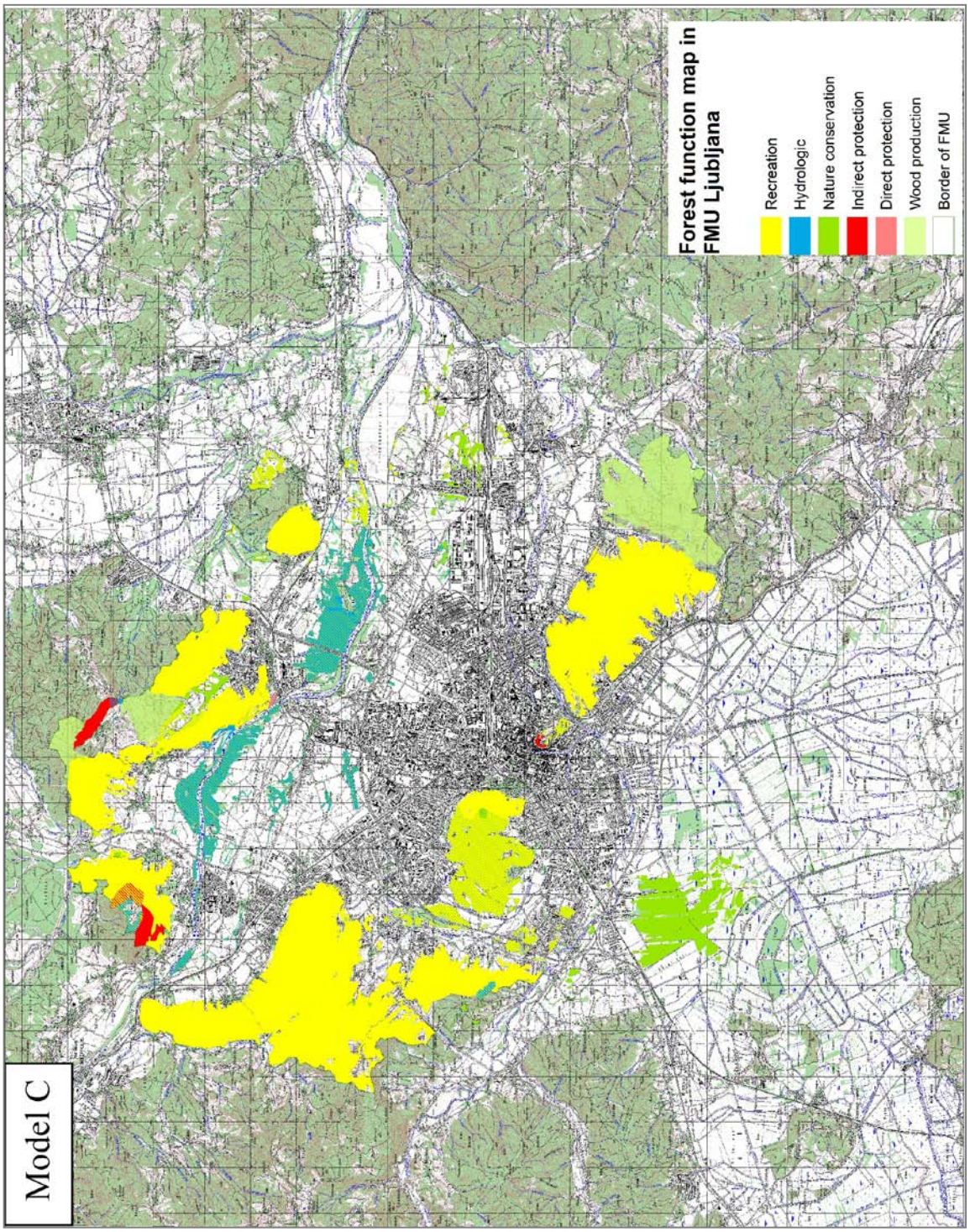

Figure 10: Forest function map in Ljubljana according to the Model C. The original mapping scale was 1:25,000.

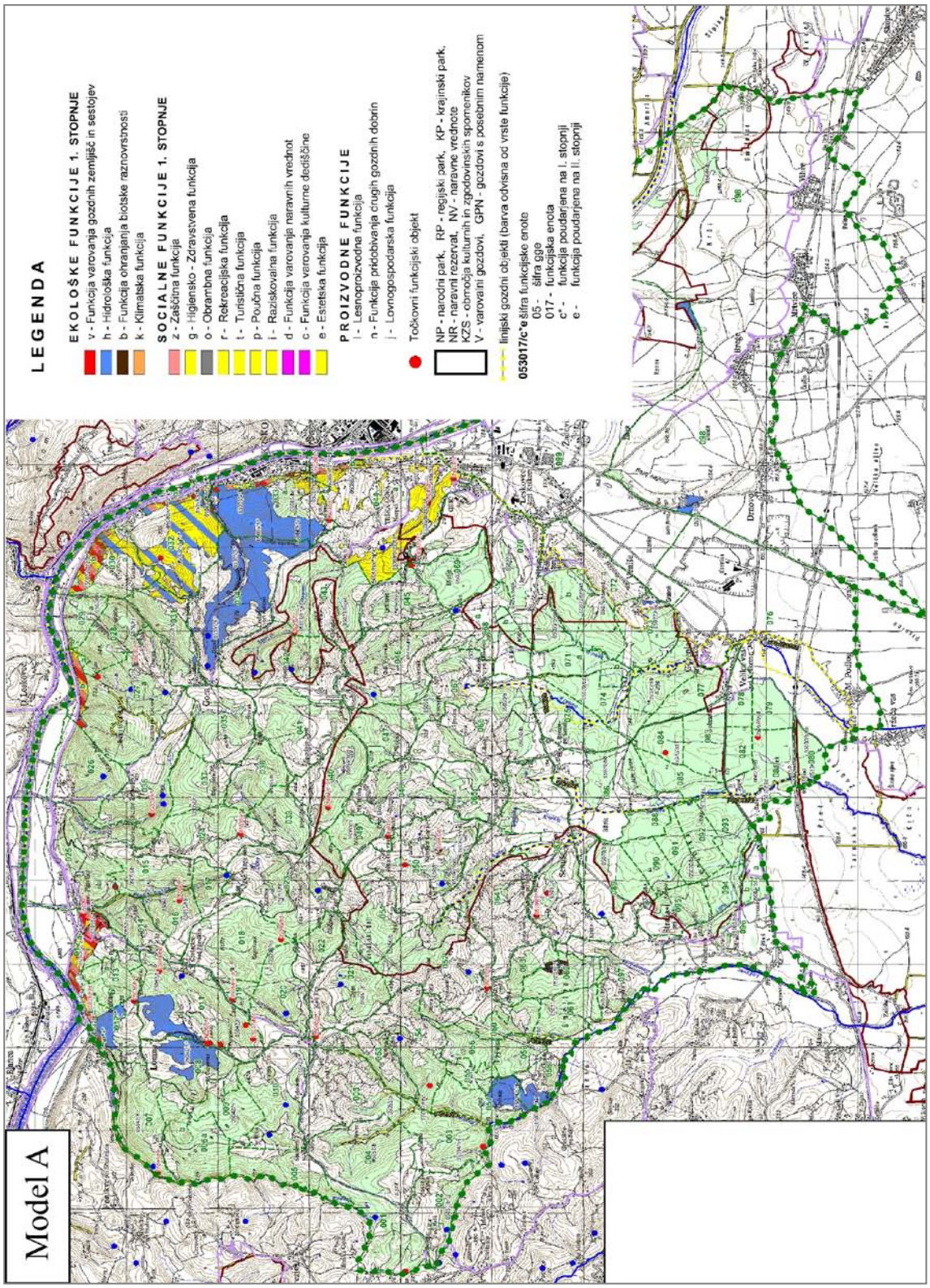

Figure 11: Forest function map in Krško according to the Model A (SFS, 2014c). The original mapping scale was 1:25,000.

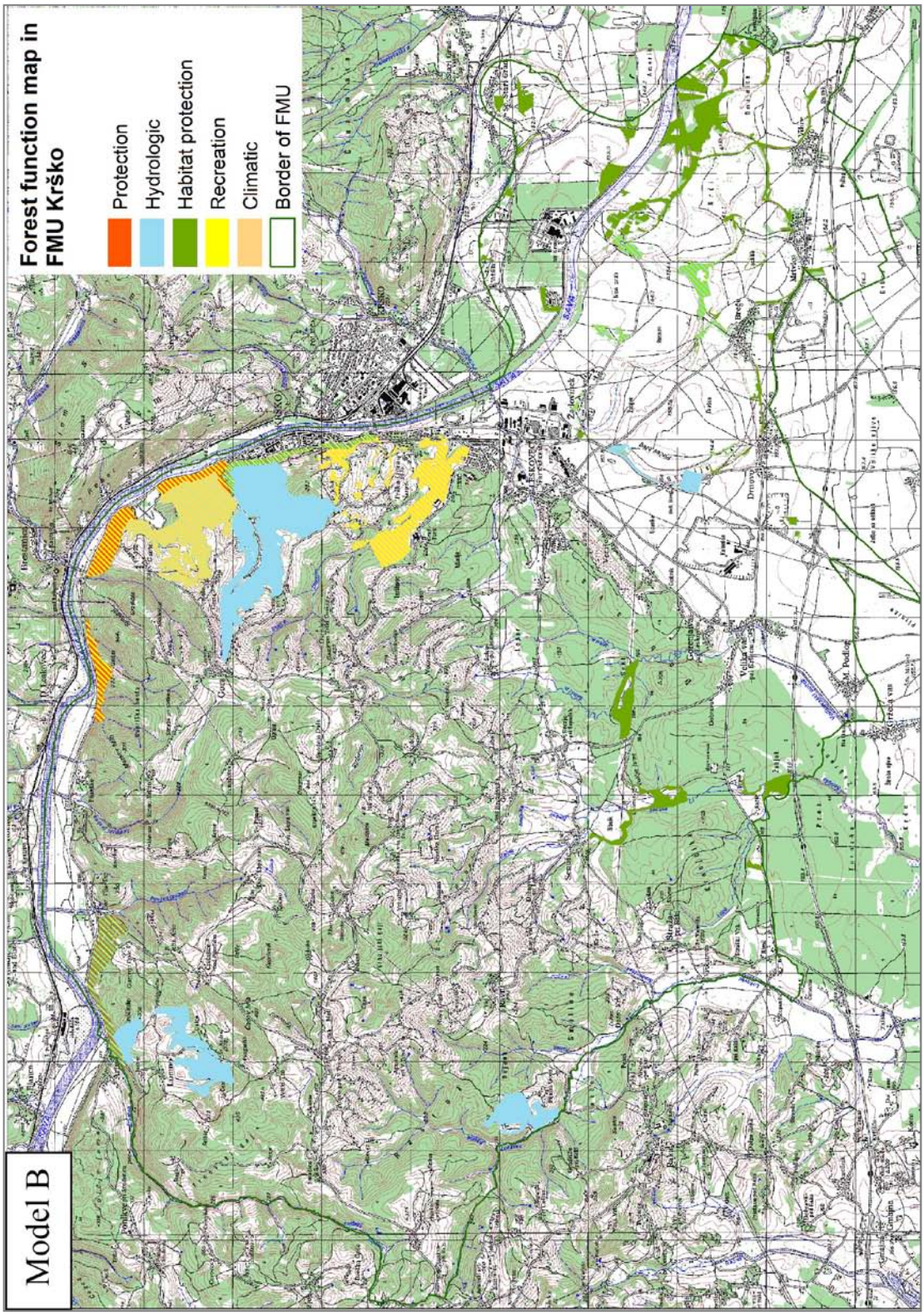

Figure 12: Forest function map in Krško according to the Model B. The original mapping scale was 1:25,000. Protection refers to the direct protection function.

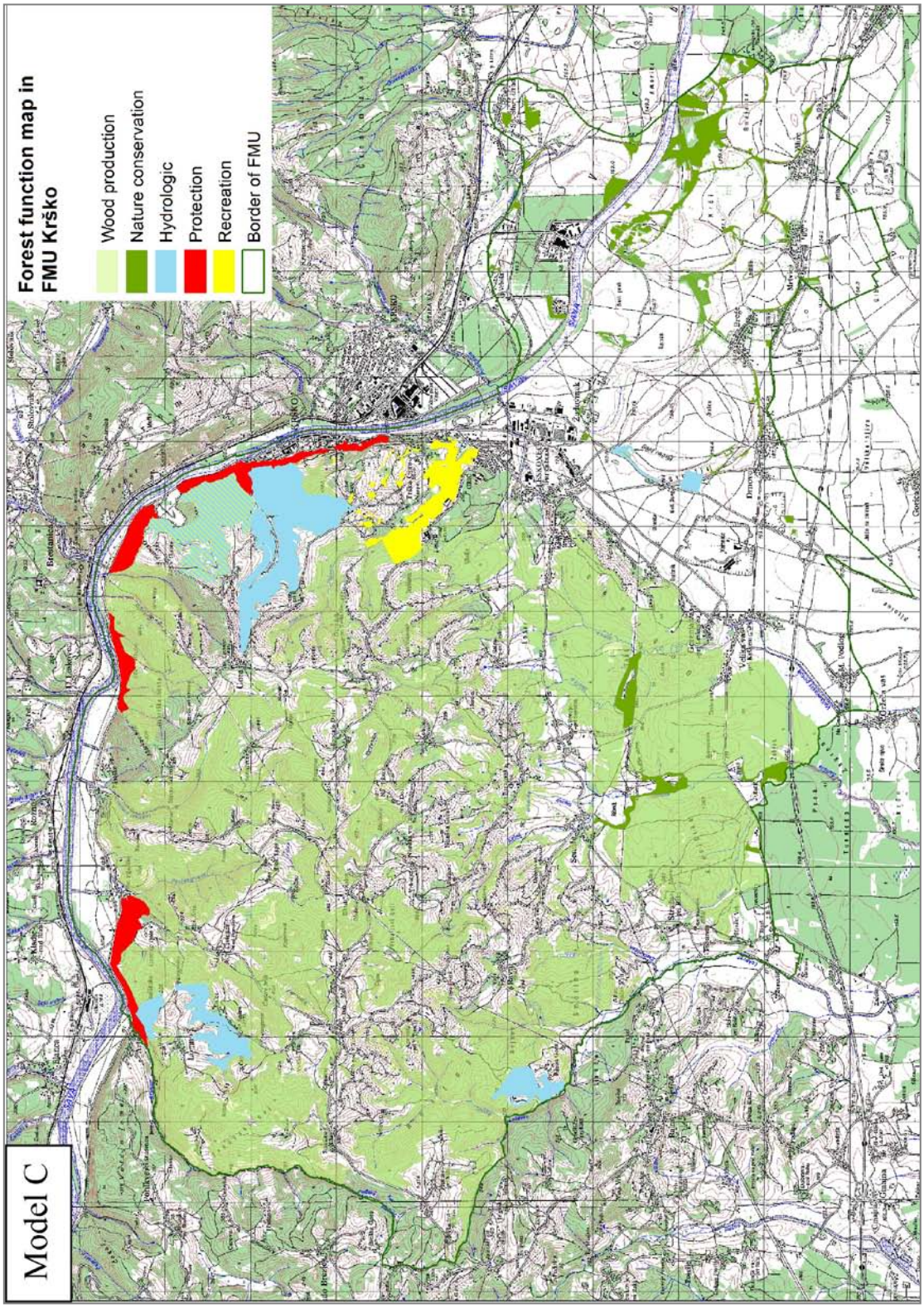

Figure 13: Forest function map in Krško according to the Model C. The original mapping scale was 1:25,000. Protection refers to the direct protection function.

6.5 DESIGNATION OF CONFLICT AREAS

Analysis was limited to Pokljuka, where a participatory approach was used to identify conflict areas in the frame of the model C (Appendix 6). For characterisation of the current model, we used the forest function types from Model B. Analyses showed that according to Model B, in this case study (5119 ha of forest area) conflict areas amount to 913 ha. According to Model C, the area of potential conflicts is much larger (≈1270 ha) (Figure 14). Five main conflict areas were identified by participants:

1. Macesnovec (≈450 ha): conflicts between nature conservation and wood production,
2. Biathlon area (≈260 ha): conflicts between recreation (cross count ry trails) and wood production (skidding trails and harvesting locations),
3. Planina Zajavornik (≈280 ha): conflicts between recreation and wood production (same as above),
4. Pokljuka bogs (≈180 ha): conflicts between nature protection, recreation and wood production (rare habitats, intensive tourism, harvesting and skidding trails),
5. Lipanca (≈110 ha): conflicts between grazing and forestry.

There is significant variation in the designation of conflict areas between the current model and Model C; the majority of conflict areas are completely different between the two models (Figure 14). Partial convergence is seen around the Pokljuka bogs and in the case of forests with the protection function. However, conflicts with recreation are anticipated on the entire area of these forests in the current model (≈ 800 ha), and in Model C conflicts that were listed by stakeholders were recognized only on about 100 ha, but were not related to the recreation and protection functions, but to forestry and grazing (Appendix 6).

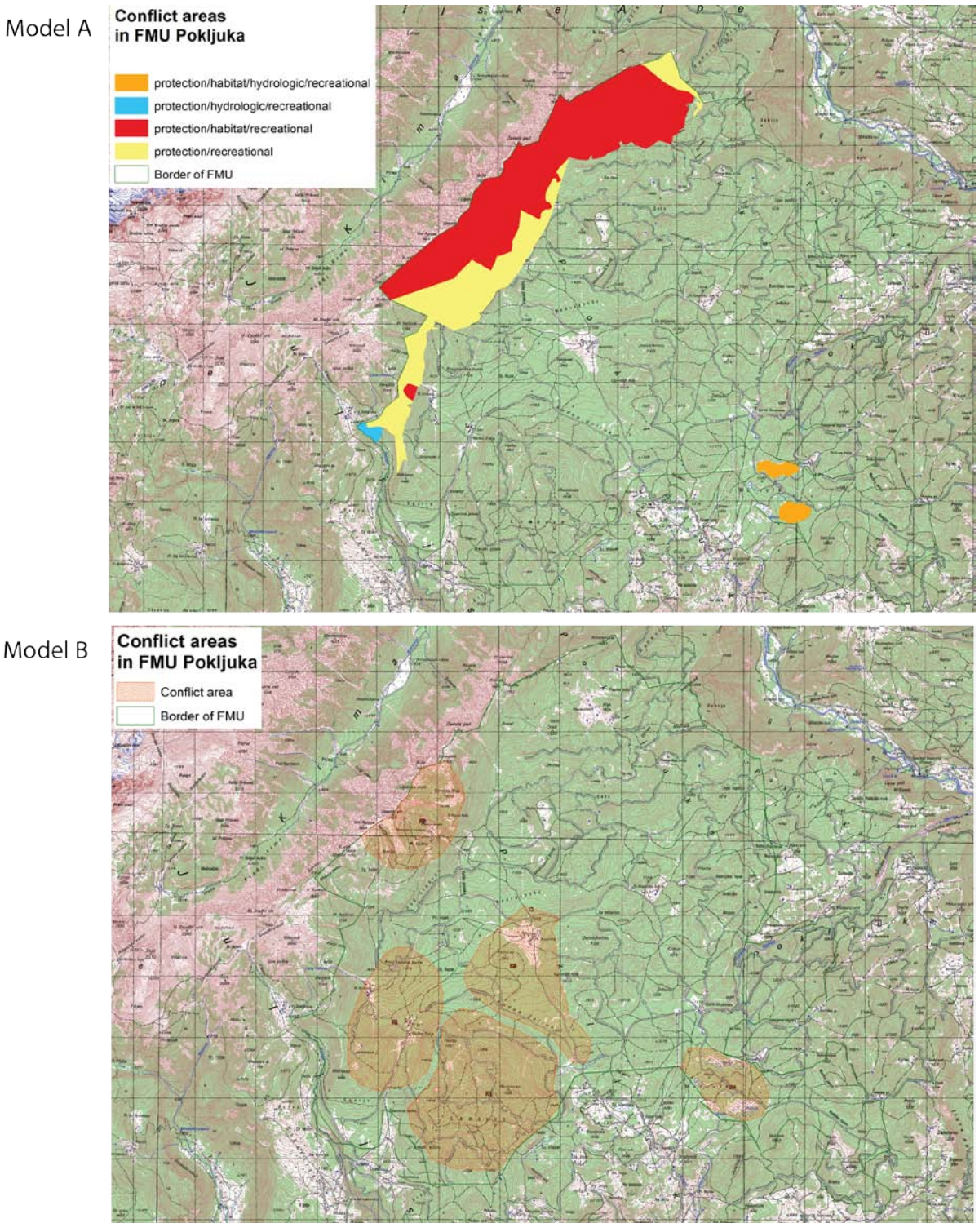

Figure 14: A map of conflict areas in Pokljuka according to Model A and Model C. The original mapping scale was 1:25,000.

6.6 MANAGEMENT ASPECT

The first step in Model C was to identify and rank the main management objectives in order to set the framework for management guidelines and strategies. The ranking done by the participants was compared with the list from 10 years ago, and it was also compared between participants and Forest Service employees (Appendix 6a). The analysis showed increased importance of the recreation and hydrologic functions. The latter was particularly highly ranked by stakeholders, whereas SFS employees placed higher importance on protection of forest sites and non-wood forest products.

For the identified conflict areas, the participants of the workshop listed the main recommendations on how to resolve them (Appendix 6c). We used this information to elaborate the map and list of priority objects for management in the next planning period (Table 16). The area extent of priority objects for management is smaller than that of forest function areas. The exceptions are priority objects for recreation, which were identified by participants on a much larger area if compared to the area extent of the recreational function in the current model. An example of management measures on the level of individual objects is included in Appendix 7.

Table 16: The list of objects with priorities for management

Object	Function	Priority object	Surface (ha)
ZV1	Protection	Lipance	176
R1	Recreation	Biathlon area	275
R2	Recreation	Planina Zajavornik	239
R3	Recreation	Pokljuka Bogs	28
R5	Education	Pokljuška pot	3
R6	Recreation	Hiking and mountain biking trails	111km trails*
VN1	Nature conservation	Pokljuka bogs	87
VN2	Nature conservation	Habitats for *Tetrao urogallus*	388
H2	Hydrologic	Drinking water reservoirs	40
C	Cultural heritage	Two mountain pastures	15

*45 km hiking trails; 18 km horse-back riding trails; 29 cross country skiing trails; 19 downhill skiing trails; 27 km mountain-biking trails

7. DISCUSSION AND CONCLUSION

The analysis of the concept of forest functions in Slovenia revealed important advantages of this tool in practicing multi-objective forest management. At the same time, the assessment clearly highlighted the technical and conceptual weaknesses of the concept. The main improvements needed in the classification system are fewer forest function types, simplified ranking and less overlapping (Simončič and Bončina, 2015a, 2015b). This is in accordance with previous findings (Pirnat, 2007; Bončina and Simončič, 2010;

Planinšek, 2010; Planinšek and Pirnat, 2012a, 2012b; Simončič and Bončina, 2012). In addition, the criteria for designation should be improved by a less prescriptive designation process, increased importance of expert opinions, on-site observations and consultations with stakeholders such as policy decision makers and forest owners (Simončič, 2013; Bončina et al., 2014, 2015). This would improve the clarity of forest function maps and their usable value. In addition, it would provide a better basis for management. Experiences from other CE countries report that fine-scale mapping, overlapping and ranking of forest function areas have often failed to meet the diverse demands on forests, mainly due to poorly defined management measures associated with forest function areas (Weiss et al., 2002; Winkel et al., 2015). In addition, the lack of financial support for adjusted forest management (Buttoud, 2002) or limited options for the participation of forest owners and the public in the designation process (Ruppert-Winkel and Winkel, 2009; Borchers, 2010) were also exposed as reasons for poor management effectiveness. Some authors reported that in many cases little or no change has occurred in the way forest owners manage their forests despite the designations (Winter et al., 2014), which may also be connected to the lack of funding for implementing additional management measures (Pistorius et al., 2012; Winkel et al., 2015).

In our study we have included possible changes into Model B (technical) and Model C (conceptual). With both alternative models, we have simplified the classification system of forest functions and simplified forest function maps. Fewer forest function types and less overlapping of forest function areas reflected in a smaller sum of designation areas in both models, particularly in Model C, compared to the current model. An important consideration in these changes is the implication of the decreased designation area and decreased overlapping area for different fields of forest management. Less area designated with priority functions and less overlapping provides a clearer overview of areas of high public importance. Such an approach is much more appropriate for forest planning and management measures because it produces clear spatially explicit management priorities. However, decreased designation area might have a negative connotation for the public – it can imply that the importance of non-designated areas has decreased. Therefore, collaboration with stakeholders is crucial for social acceptance of changes. The decreased designation area might also have consequences for forest policy and implementation of financial instruments; these may be decreased with area. However, experiences from abroad show that clear prioritization provides a good framework for prioritizing financial instruments (Schmidhauser and Schmithüsen, 1999; Dönz-Breuss et al., 2004; Angst, 2012). By limiting the designation area and overlapping (this mainly considers areas with social and ecological functions), the amount of subsidies on these lands can be increased at the expense of areas no longer under designation. Less area under designation can also impact spatial planning; forest function areas are a relevant tool for promoting forestry interests in land use planning (Pogačnik, 1996; Krott, 2005), which should be considered in the changes of the models. However, in many cases broad designation criteria (especially for areas with functions of 2nd level of importance) have not been sufficient arguments to hold back the pressure for land conversions (Bončina and Matijašić, 2010; Nastran et al.,

2013); therefore, firm arguments for a particular designation are important. The alternative models did decrease the designation area; however, the total (union) area of priority functions remained relatively consistent throughout all three models, which mitigates the above-mentioned consequences of less area under designation. One dilemma which was also identified by respondents and other authors (Planinšek and Pirnat, 2012b) is the consequence of changed designation criteria on the definition of forest area. Under current legislation, the sum of forest function areas defines the overall forest area (ZG, 1993). This would need to be changed under the proposed model C where only a part of forest area is designated with primary or side functions.

With both alternative models, we have decreased the number of forest functions for all three case study areas. By reducing forest function types, we did not intend to decrease the manifold importance of forests but rather to make the system more transparent and usable for forest management and for forest users. We believe that spatially designating and prioritizing 17 forest functions types under the current model is simply not effective for management. Other authors have proposed 9 or 10 forest function types, although they report on 4-5 main forest function types used abroad (Pirnat, 2007; Planinšek and Pirnat, 2012a). Planinšek (2010) suggests defining five main groups of forest functions which are further divided into 10 forest function types. Our final proposal is to distinguish 6 main forest function types. Many spatial characteristics are already stored in the SFS database and likely do not have to be the subject of an additional designation process to be weighted in decision making regarding forest management. Such examples are game management areas, areas for production of non-wood products or objects of cultural heritage. In Switzerland forest planners avoid this duality by including a separate map of important spatial basis in the forest plan (e.g. WEP Greifensee…, 2007). In addition, a list of relevant objects is elaborated in forest plans for those areas (points, lines) that cannot be represented at the forest function spatial scale. Such a “register of objects” was a part of the proposed alternative models. Through fewer forest function types, simplified ranking, joining spatial layers and less overlapping, we have simplified the spatial structure of designated forest function areas. Less delineated spatial units mean a shorter and more simplified attribute part and better basis for setting management measures. Such an attribute part in Models B and C represents a good basis for further classification of spatial units (e.g. for management purposes). Fewer forest function types also means a better framework for spatial planning.

Several respondents pointed out that in the current model, the distinction between the function “defining” management regime (1st level of importance) and function “influencing” management regime (2nd level of importance) is extremely difficult and subjective despite the long list of prescribed criteria. In addition, the criteria for designation of areas with functions of 2nd level have often been vague. Some authors have already proposed supplemented criteria for designating forest function areas (see Pirnat, 2007; Planinšek and Pirnat, 2012b), and proposed to decrease the number of ranks of forest functions. In Model C we have applied only one rank of importance – the priority function,

and side function only in cases where two functions of primary importance overlap. Research results on this topic have also been divergent, proposing only one rank (Planinšek, 2010), or a maximum of two ranks depending on the function type (Pirnat, 2007; Planinšek and Pirnat, 2012a). Our final proposal is to apply two ranks – priority and side function (if needed). Prioritization of forest functions was the largest difference between the models, and also the main dilemma exposed by the respondents. Models A and B do not set any priorities among functions on the same forest land, which can lead to conflicts. The old regulations on forest planning at least included prioritization of management objectives (Pravilnik…, 1987), but ranking was removed after 1991 (Gašperšič et al., 2001). The main dilemma exposed by respondents in the prioritization used in Model C was related to having only one priority function on the same land, leading to the belief of some respondents that such an approach means more segregated planning. On the contrary, by clear prioritization of forest functions and management objectives, and management measures associated with them, potential conflicts are less likely (Bühler, 2011). Such an approach has been common in some CE countries where multifunctionality throughout the whole forest area is strongly emphasized (Hanewinkel, 2011). By defining a priority function, we do not intend to decrease the importance of other functions. The aim of prioritization is to mitigate potential conflicts and to present a basis for additional management measures supporting the priority function. Another dilemma regarding prioritization was in areas where more than one ecological function and also social functions are important on the same forest area. This was the case in a part of Ljubljana, where hydrological, nature conservation and recreational functions all have high relevance. In such cases, it could be useful to set more than one side function, as already indicated by the respondents of the survey.

Promoting multiple functions on the same land can lead to conflicts; therefore, identification of conflict areas is of paramount importance in the designation process. In the current model, conflict areas are defined in advance by overlapping different forest function areas, which has been criticized by respondents. Our participatory workshop on Pokljuka revealed that conflict areas identified by participants are significantly different from those defined by the regulations. Therefore, including stakeholders and their interests in the identification process should be a part of the planning process in the future. To a certain extent, potential conflicts between promoting different forest functions can be anticipated (Pirnat, 2007; Planinšek, 2010), but the participation of stakeholders and identification of their demands, as practiced in several CE countries (e.g. Bettelini et al., 2000; Bürger-Arndt et al., 2012), is crucial for legitimate planning and decision-making. As we have identified on Pokljuka, demands can differ in space and time, and among different stakeholders, which should be considered in forest management strategies and measures. The current model is largely based on an administrative, normative and prescriptive approach where forest planners spend a great deal of time on GIS analysis and "mapping" procedures. This leaves limited time and resources for active collaboration with stakeholders, assessments, field observations and case study trials. Similar trends have also been observed in some other CE countries; in many cases, forest planning procedures

attempt to circumvent potential conflicts among forest uses and only vaguely describe solutions to problems (Winkel et al., 2015). In the second workshop, the respondents pointed out that the competences of some institutions in designating forest function areas are already quite strong, and more intensive participation can lead to a longer planning process. While this may be true, our application of Model C on the Pokljuka study area showed that participation of stakeholders can help in making problems and conflicts explicit and in finding solutions. Potential disapproval of the accepted designations might also be less frequent (e.g. Bernasconi et al., 1991).

On the Pokljuka study area, we have briefly demonstrated how management measures for specific areas could be set and integrated into actual decision making in forest management. Model C suggests the use of various implementation tools used in some other CE countries, such as administrative acts (decisions), projects (e.g. Plan directeur…, 2013) and contracts (e.g. Waldfunktionsplanung…, 1994; Regionaler…, 1999; Angst, 2012). Some of these tools exist in the current model (for example, for habitat trees or habitat cells); however, they have rarely been used. To improve management effectiveness on forest function areas, operational planning should be improved, and sufficient financial funds should be available for management measures that require above-standard works. Finally, monitoring protocols for management effectiveness for each priority function should be developed (e.g. Kovač et al., 2012; Planinšek and Pirnat, 2012b; Guček, 2015). Clear management requirements for designated function areas would be beneficial for the assessment of the actual financial needs.

A question that still remained after the evaluation of the models and case study implementation is why designate areas of the wood production function if it is important on the majority of the land base? Our model implementation showed that the prioritization of the wood production function might be useful only in Ljubljana where wood production is not the priority function, and conflicts between the production and recreational function often appear. Therefore, wood production could be ranked as a side function to recreation in order to identify possible conflict areas. The designation of wood production as a priority might also have relevance in land use planning as a more “protected” category against land conversion, similar to the most productive agricultural land (ZKZ, 2012). Respondents exposed that overlapping of forest function areas such as practiced under the current model is not useful and blurs the clearness and transparency of forest function maps. However, many of them suggested the possibility to overlap more forest function areas, which can lead to the existing state. Planinšek (2010) criticizes overlapping due to difficulties for international reporting and proposes to designate only the priority function; whereas other research on the topic does not explicitly address the issues of overlapping and prioritizing functions. Our proposal is to overlap a maximum of two forest function areas; some information on current priority functions (1st level of importance) will remain the same because it will be joined with priority or side functions, whereas some will be stored in the SFS database. Another dilemma exposed by respondents was regarding the interactive map; despite their high agreement with this tool, they were sceptical on the

rights to use the data of other institutions, and on the public accessibility of "vulnerable" information. This can be solved by formal agreements between data holders on data management and by developing a double database of original data and that available for public users.

According to the comprehensive evaluation of the concept of forest functions in Slovenia, we developed a final checklist for improving the concept of forest functions:

- The concept of forest functions is an important tool and opportunity for the Slovenia Forest Service to communicate a broad array of ecosystem services provided by forest management; the participation approach should be improved with the use of workshops, surveys and an interactive map on relevant information on forest functions.
- Management effectiveness on forest function areas should be improved; some tools exist already, and they should be better integrated in operational planning and supported with sufficient funds. In addition, monitoring protocols should be developed, and the assessment of the actual financial needs for implementing measures should be elaborated.
- Changes of the concept should consider current work as much as possible. This was one of the reasons that we did not change the designation criteria for priority functions – at least for the most part. This was not the subject of our research, although future research should be oriented also in this field.
- Forest function areas are an important tool for collaboration in spatial planning; they should be considered as a land use category (Nastran et al., 2013) and thus interventions in the designated areas would be less frequent. Forest regional plans could gain the status of spatial plans for forest area; for this purpose, the procedure for the preparation of forest management plans should be in accordance with spatial planning (Pogačnik, 1996), and participatory planning procedures should be improved (Golobič, 2010).
- Possible convergence with the concept of ecosystem services should be considered; the concept of ecosystem services has become important in the last few years (e.g. MEA, 2005), partly also because it extends beyond the borders of forest area. It is active in the field of classification of services, their monetary evaluation and mapping. Members of the EU are called to map ecosystem services due to higher political and international agreements. Some states with a traditionally affirmed concept of forest functions (e.g. Germany) are using the designated forest function areas as a basis for forest ecosystem services mapping (e.g. Bürger-Arndt, 2012).
- Finally, it should be constantly repeated that multifunctionality is important on the whole forest area in Slovenia. Designation should be oriented to places where some forest functions evidently have high priorities for society, whereas other lands can be designated as multifunctional forests, which was supported by our research and also indicated by other authors (Pirnat, 2007; Planinšek, 2010). Prioritization means that priority functions have significant influence on the management regime. Therefore,

higher priorities mean a more intensive approach in forest land use planning (Gašperšič et al., 2001).

A great deal of energy was spent on the implementation of the concept of forest function areas; it was an important step forward in the development of multi-objective forest management, and forest function areas were well accepted by stakeholders. Many challenges still remain in making this concept more operational and a stronger tool for forest users; some of them were also approached in our study. However, improvements of the concept will strongly depend on overall policy and the political importance of this tool. Forest function areas can remain primarily a tool for the public forestry administration or can become a binding tool for forest owners, e.g. for mandatory minimal standard works for maintaining public services. For the future, more discussion on public versus private relations in connection to providing ecosystem services from forests is expected (Pucelj Vidović, 2015). This, coupled with the unfavourable status of many forest areas for providing desired services, increasing pressures for land conversions and new emerging concepts (e.g. ecosystem services), only supports the need for a firm, transparent, operational and socially accepted model of forest functions.

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APPENDIX

Appendices are attached at the end of the dissertation.

3 DISCUSSION AND CONCLUSION

3.1 DISCUSSION

3.1.1 Priority areas – an indispensable tool of multi-objective forest management?

In the study we addressed the concept of forest functions and similar spatially-based approaches to multi-objective forest management primarily from a forest management planning perspective. The study was elaborated on three spatial levels: 1) global (comparison of PNW – the Pacific Northwest, USA and CE – Central Europe); 2) regional (comparative analysis of the concept of forest functions in CE); and 3) national (detailed analysis of the implementation of the concept of forest functions in Slovenia).

The findings of the global level comparison support our hypothesis (H1) that spatially-based approaches to multi-objective forest management differ significantly between regions around the globe. We developed a conceptual framework drawn up from a limited number of "dimensions," which enabled us to describe the fundamental characteristics of priority areas, as well as to understand their importance for multi-objective forest management (Simončič et al., 2015). Although allocations designated to promote specific forest functions have been analysed through global-scale and case studies (e.g. Parviainen et al., 2000; Brang et al., 2006; Dudley and Phillips, 2006; Konijnendijk et al., 2006; Frank et al., 2007; McAlpine et al., 2007), we are not aware of comprehensive characterizations of how allocations are developed, defined and applied in specific landscapes across the globe. Our conceptual framework can be used as a device to analyse, compare and understand spatially-based approaches to multi-objective forest management. The application of the framework showed that it works under very different socio-economic, cultural and geographical settings. In addition, this was probably the first comprehensive comparison of priority areas between North America and Central Europe, highlighting differences and convergent trends among the regions. The overview of forest management practices in the two regions can be an important step in improving our understanding of spatially-based approaches used around the globe.

The application of the framework including all six dimensions (primary purpose, importance and spatial distribution of objectives, governance, permanency, spatial scale and management regime) revealed that the importance of priority areas for multi-objective forest management and their dimensions differ significantly between regions. It was confirmed that the diverse ecological, socioeconomic, political, demographic and cultural settings among the regions were reflected in differences in all dimensions. We expected to detect two polar approaches to multi-objective forest management: segregation in PNW, and integration in CE. However, the framework identified that the importance, spatial distribution and mutual exclusiveness of management objectives are much more complex than the types of priority areas might imply. In both analysed regions, we identified some convergent trends and mixing of the segregation and integration approaches to forest

management. There is an evident trend to bring active management for restoration into conservation areas that some people have seen as "no touch" areas in PNW (e.g. interventions in wilderness areas to prevent stand-replacing fires). In addition, alternative silvicultural approaches (e.g. retention forestry) have been seen as important for integrating conservation objectives with timber production (Franklin et al., 2002; Bauhus et al., 2009). Some trends towards segregation in CE are observed, such as adding conservation areas in terms of "passive management" to promote habitats for certain rare and protected species (e.g. Bollman and Braunish, 2013; Kaeser et al., 2013). Our findings on the mixture of spatially-based approaches concur with some other global trends. Forests are increasingly being conserved and managed for multiple uses and values (Global forest…, 2010), and more effort is being made to more finely divide forest land allocations or integrate management objectives within the same allocation (e.g. Rülcker et al., 1994; Fries et al., 1998; Messier and Kneeshaw, 1999; Nitschke and Innes, 2005; Montigny and MacLean, 2006; McAlpine et al., 2007). Even in protected areas, management objectives are becoming more diverse, encompassing much wider ecological, social and economic importance of the designated areas (Watson et al., 2014). In addition, many studies dealing with protected forest areas have emphasized the importance of conservation management within or outside the designated areas (Hanski, 2011; Franklin and Johnson, 2012; Porter-Bolland et al., 2012). However, it is important to consider that many of these cases and our research in PNW as well are biased towards public lands.

We demonstrated that the importance of priority areas for providing goods and services depends on the "standards" of forest management (especially silviculture) applied in general (non-designated) areas. The complexity of silvicultural systems that may have given rise to the differences in the role of priority areas among regions can be captured in two main silviculture concepts (Boncina, 2011). The first, "intensive," also "plantation" or "industrial," forestry leads to a simplification of forest structure and composition by using mainly a clearcutting system or similar silvicultural systems, which have typically ignored or greatly downplayed ecological objectives (Franklin and Forman, 1987; Sedjo and Botkin, 1997; Dargavel et al., 1998; Mönkkönen, 1999). The second, "ecological forestry," is characterized by forms of close-to-nature silviculture, which include a broad range of silvicultural systems (e.g. selection system, irregular shelterwood system); they are based on natural regeneration and emulate natural stand dynamics (e.g. Schütz, 1997; Baker et al., 2013). Close-to-nature forestry indirectly provides many social and ecological services, with nature conservation being considerably integrated into forest management (Schmithüsen, 2007). Close-to-nature forestry has been an important basis for the affirmation of the integration approach to multi-objective forest management (Schütz, 1997; Boncina, 2011). In regions where intensive forestry has prevailed, a mainly segregative approach to multi-objective forest management has developed.

The traditionally applied close-to-nature forestry in CE is likely the reason that management activities in priority areas are often similar to those outside of priority areas, or may be accompanied by some additional activities, whereas entirely divergent strategies

as compared to general lands are rare (i.e. forest reserves, some protection forests). Setting aside areas under the integration model is practiced to a limited extent (e.g. Parviainen et al., 2000; Frank et al., 2007) since silviculture and management practices are important for providing the desired services (Wagner et al., 2013). The complexity of the environmental impact of silviculture used under close-to-nature forestry cannot be downgraded to providing a single ecosystem service (Schütz, 1997; Gašperšič et al., 2001); thus, multiple ecosystem services, such as timber, conservation of wildlife, protection of the water supply and enhancement of cultural values, are all considered together (Matthews, 1989). Still, management measures promoting these services may be different, but the difference is much less if compared to management regimes applied under the segregative model. In segregation, there is a much larger range of management regimes across the landscape attached to individual allocations. In PNW the lower importance of non-timber values on non-designated land is to some extent compensated by the much higher importance of priority areas for these services. The proportion of such areas in the total forest matrix is much greater than that in CE.

The original paradigm of the "wake theory" (Gotsch, 1978) assumed that management for sustainable timber production was also beneficial to wildlife, water quality and quantity, and other uses of the forest. These assertions were false in many cases as the ecological and social aspects were mostly ignored in forest management decisions (Glück, 1987; Glatzel, 1991). However, they may have been justifiable in regions where silvicultural practices such as uneven-aged silviculture co-benefited nature conservation and other non-timber services (Boncina, 2011). Some movements such as ecological forestry are averse to excessive delineation of forest areas for single management objectives, but rather try to consider changeable demands through standard management (e.g. silviculture) practices (Schmithüsen, 2007). Besides the consideration of site conditions, providing desired services is one of the main reasons for the diversification of silvicultural activities across forest land (Matthews, 1989). Therefore, spatial designation of forest services, such as a map of forest functions, might be a helpful tool for determining the most efficient silvicultural activities.

The application of our framework has indicated that social and ecological diversity can influence the development and implementation of priority areas in multi-objective forest management. Due to the diverse socio-economic and political conditions worldwide, large differences in the application of priority areas can be expected to continue. However, three similar trends will probably continue in the next decades: 1) demands towards forests are increasing and becoming more diverse; 2) in the early stages of multi-objective forest management, priority areas were designated in a quite rigid way ("once forever"), but with the development of multi-objective forest management, designations are becoming more flexible and can be more easily changed; 3) in many countries with a primarily segregative approach to multi-objective forest management, the concept of priority areas has changed by adopting elements of the integration approach and also focusing outside of the designated areas.

3.1.2 Common current concepts of forest functions

As our analysis has shown, forest function areas have been a common tool in the practice of multi-objective forest management in CE. This is especially true in Switzerland, Germany, Austria and Slovenia, where they have been an important policy strategy and planning tool for the promotion of multi-objective forest management. We have confirmed our hypothesis that there are many similarities in the application of the concept in forest management among the analysed countries. Six main convergences can be exposed: 1) three groups of forest functions: production, ecological (or sometimes termed protective) and social are declared by law; 2) the term "forest function" has been used in all countries for expressing societal demands towards forests or the potential of the forest to satisfy the demand with or without intervention; 3) a ranking system is applied to forest functions in order to evaluate their importance, mitigate conflicts and prioritize management measures associated with the priority functions; 4) a map of forest functions is elaborated and used as the main information on forest functions; 5) forest function areas and strategies for providing desired services are generally defined in forest development plans and thus the designation exceeds the frames of forest ownership; 6) forest function areas are the main type of priority areas in CE. Only a minor part of priority areas is established by special legal regulations and long-term commitments. Therefore, forest planning has high competences in forest land use planning. In CE many advantages of the spatially-explicit approach to multi-objective forest management via a forest function map are mentioned: it is important for emphasizing the public benefits of forests; it is a strategic tool for forest policy (Hanewinkel, 2011); it is a tool for promoting forestry interests in land use planning (Krott, 2005; Schulzke and Stoll, 2008); it is a basis for setting management objectives (Bachmann, 2005a) and it is a tool for participatory planning and a communication tool for collaboration with other forestry stakeholders (Bürger-Arndt, 2012).

Our comparative assessment also highlights many differences in the application of the concept of forest functions among CE countries and confirms our hypothesis on differentiated spatially-based approaches via forest functions. Two main approaches were pointed out: 1) a detailed and prescriptive approach that defines a large number of forest function types (up to 20) in which ranking is applied to each function, multiple functions can have the same ranks on the same land, and detailed criteria for evaluation of each forest function type are prescribed and 2) a more management oriented approach in which only 4-5 main forest function types are defined, prioritization of functions is applied, only a priority, or in some cases a secondary, function is designated on the same area, and management measures are clearly associated with priority functions. The designation criteria differ significantly among countries (Simoncic et al., 2013), resulting in the area proportion of designated area. In Switzerland, the designation considers potential conflicts, the need for management adjustments or the potential to provide forest services (Fallbeispiele..., 1996). In Slovenia and Germany, designation criteria are much broader, emphasizing ecological variables and accompanied by a highly detailed classification system (Anko, 1995; Volk and Schirmer, 2003). Often, designations from other institutions

(e.g. National Parks, Natura 2000 sites, national monuments, landscape protection areas or water protection areas) are automatically adopted as forest function areas (e.g. Pravilnik…, 1998; Waldfunktionenkartierung…, 2010). In certain CE countries, the competences of non-forestry institutions in the designation of forest function areas are relatively strong; in some cases, they may even have decisive roles in the designation (Mann, 2012). This could be connected to silvicultural developments in recent decades that have likely triggered conflicts between wood production and biodiversity conservation (Weber and Mann, 1997). One way to approach these new challenges could be a highly detailed and multi-faceted concept strongly reflecting cross-sectoral linkage, as is used in some German states (Volk and Schirmer, 2003; Mann, 2012).

A critique of the concept of forest functions which was recognized in almost all the analysed countries was the weak relationship between forest function areas and the specific management requirements needed to promote the desired functions. Many authors have supported this view (e.g. Weiss et al., 2002; Pistorius et al., 2012; Mann, 2012; Winkel et al., 2015). Poor management effectiveness of designated forest function areas has been linked to three main reasons. The first reason is connected to the limited participation in the designation process (Rupert-Winkel and Winkel, 2009). As our comparison has shown, the engagement of the general public and forest owners in forest planning has been relatively poor despite public participation having been formally adopted in the forest planning processes (Public participation…, 2000; Farcy, 2004; Cantiani, 2012). However, collaborative efforts and their success have differed greatly among CE countries. Successful examples can be found in Switzerland, for example, where participation has a long tradition in forest planning. Good practices ensure that working groups of different stakeholders are included in the designation process from the beginning of the planning period (Bettelini et al., 2000). Such a switch to bottom-up participation with public engagement in the early planning stages (when priority areas are being delineated) has been a step forward in conflict management and building consensus among forest users. The second reason is the fact that management requirements are often vague. Conflicts among forest uses are not explicitly approached in forest plans, and further translations of forest functions into practical measures are needed (Winkel et al., 2015). In addition, management measures are often not binding for the forest owners (Winter et al., 2014), which has consequences for management effectiveness in forest function areas. Winter et al. (2014) reported for Natura 2000 sites that little or no changes have occurred in how forest owners are managing forests under these designations. In their view, this is not problematic *per se*, but it could become a challenge if the conservation status of forests becomes unsuitable and additional efforts may be needed. In such cases, public support schemes will need to be developed to compensate forest owners for the additional burden (Knoke and Moog, 2005). A lack of funding can be identified as the third reason for not implementing specific measures for forest functions. An effective financial system will be one of the relevant policy considerations with respect to integrative forest management in the future (Buttoud, 2002; Cubagge et al., 2007; Schmithüsen, 2007). Current examples of

good practices include state funds available for protection against natural hazards (Swiss NFP, 2004).

The concept of forest functions has mainly been a landscape scale issue; some exceptions of a broader spatial context include Natura 2000 sites (Natura 2000…, 2003) or the network of forest reserves. The landscape spatial scale has many advantages: it guarantees the protection of public interests with regard to the forest (Cantiani, 2012), and it enables identification of strategic problems and thus definition of objectives, priorities, and controlling mechanisms with which to ensure public interests and management of the forest (Bachmann, 2005b). Moreover, it can facilitate linkages between forest planning and other land use planning instruments (Krott, 2005). The regional spatial scale also has the potential to consider different forest function areas in a combined matrix and locate them in a way that the fewest trade-offs among forest services are needed and conflicts are mitigated as much as possible. However, as we have revealed by comparing the designation processes in CE, the majority of forest function areas are set up independently without a broader estimation of what they add up to cumulatively. This can have important implications where social and ecological dimensions are concerned, such as natural processes along with disturbance regimes (Rülcker et al., 1994; Bollman and Braunish, 2013). In addition, some services need a large spatial context albeit their relatively small size; an example being forest reserve networks (Diaci, 1999). A broader designation spatial context is likely to gain in importance but will be a challenge in a landscape consisting of multiple administrative units, ownership fragmentation, and diverse land uses with various natural resource agencies with management authorities.

An aspect worth considering regarding scale issues is the connection between the minimum mapping area and the designation scale. In the majority of CE countries, the minimum designation area is not prescribed, with a few exceptions (for example, in Austria 10 ha is the minimum to delineate forest function area). Theoretically, forest function areas are limited only by the minimum area of forest, which is from 0.25 to 0.5 ha on average. However, in the majority of countries, the designated areas are much larger, ranging between 10 ha and 100 ha on average (e.g. Brang et al., 2006; Pröbstl et al., 2009; Bauerhansl et al., 2010; Simoncic et al., 2013). In CE 1:25,000 has been the most common landscape scale reported to designate forest function areas. However, this may be connected to the scale of presentation and not necessarily to the designation scale. A better way for characterizing the designation scale is through measures of the spatial context, e.g. the size of the broader planning area and the size of priority areas, such as proposed by our conceptual framework (Simončič et al., 2015). We believe the scale issue is one of the paramount dimensions for understanding the concept of forest functions and its effectiveness for multi-objective forest management, and should be the focal point of the future research in this field.

Our comprehensive analysis of the concept of forest functions in nine CE countries revealed important commonalities and differences within the region, but also highlighted

some convergent trends. To our knowledge, this is the first comprehensive overview and evaluation of the concept of forest functions in different countries of CE region that helps in understanding the CE approach while also highlighting regional differences. More than 25 researchers, planners and local experts/practitioners were included in the evaluation and provided important insights into the implementation of the concept of forest functions in different countries. This enabled us to generate new perspectives on existing forest function areas, reveal differences among the countries and identify areas where future work and research is needed. We support further work on this topic that would include more research on designation criteria and management, and case study implementations.

We have identified many challenges in the future implementation of the concept of forest functions in CE. One of them is related to the competences regarding planning multiple use in forests. The Forest Service across CE countries still has high influence on multi-objective forest management. However, the competences especially in relation to ecological and social functions can be taken over by environmental institutions if state authorities fail in promoting multi-objective forest management (Krott, 2008). Therefore, forest functions play an important role in promoting forestry competences in forest and broader land use planning. Forest function areas will also represent an opportunity in the implementation of the emerging concept of ecosystem services in the EU (Ecosystem services…, 2011). Mapping ecosystem services in forests could be based on existing maps of forest functions (e.g. Bürger-Arndt, 2013).

3.1.3 Improvements to the concept of forest functions in Slovenia

Our evaluation revealed that the concept of forest functions has been an important tool for forest policy and planners in Slovenia. It has covered the entire forest area including public and private lands; collaboration with stakeholders during the designation process has improved; numerous institutions have been involved in the designation process and thus cross-sectoral collaboration has been strengthened, and to a certain degree, the concept has been useful for planning appropriate forest management to promote various ecosystem services (Simončič and Bončina, 2015b). At the same time, the results of our evaluation largely support our hypothesis (H3) that the concept of forest functions is in need of improvement, confirming the opinions of other authors (Pirnat, 2007; Planinšek, 2010; Planinšek and Pirnat, 2012a; 2012b). The major weaknesses identified by forestry experts included in individual survey and participatory workshops are in accordance with our assumption that the classification of forest functions, the designation process and management aspects are the areas most in need of attention. The main weaknesses identified, many of which also coincided with the above-discussed findings from the regional (CE) evaluation, include complicated mapping procedures, vague and unclear criteria for designation, emphasis on mapping procedures and ignorance of management aspects, an insufficient financial system for promotion of management in support of public benefits, and conceptual and terminological inconsistency (Bončina et al., 2014, 2015;

Simončič and Bončina, 2015b). This is partly in accordance with the findings of other authors; Pirnat (2007) and Planinšek and Pirnat (2012a) reported on too many forest function types, too many levels of importance of forest functions, insufficient designation criteria and inadequate designation scale. Planinšek and Pirnat (2012b) pointed out that designation criteria are to general and subjective, limiting the possibilities for clear monitoring of management effectiveness of designation areas and international reporting on designated areas. In addition, they exposed the weaknesses of terminology and the need to distinguish between the terms forest functions and forest roles, the latter being the consequence of human demands. We believe the term forest function is traditionally applied in CE and it has gained quite high social acceptance. However, a common understanding among managers and researchers, and clear definitions in forestry legislation will be needed.

Our analysis has shown that changes are needed in both the technical and conceptual dimensions of the current model of forest functions. The main suggested changes regarding the designation of forest function areas include:

1. Firstly, a clearer understanding of what forest functions present is needed. Forest functions should reflect public interests. They should be understood as a consensus between societal demands, the ability of forest to provide the desired functions, and the management possibilities for their provision (see also Bachmann, 2005b);
2. Classification should be simplified, and fewer forest function types should be used, as was also suggested by previous research (Pirnat, 2007; Planinšek, 2010; Planinšek and Pirnat, 2012a). We suggest classifying 6 main functions: wood production, recreation, protection, environment protection, nature conservation, and hydrological function. We based our classification on CE countries where forest function planning is well developed (for details see Simončič and Bončina, 2015b). We believe that the proposed 6 main functions present a good basis for spatial prioritization on a landscape and regional scale (e.g. forest management region). On a more detailed scale (e.g. forest management unit), forest functions can further be divided and other areas of specific importance can be presented.
3. Designation criteria should be improved; suggested proposals (e.g. Pirnat, 2007; Planinšek and Pirnat, 2012b), the latest research findings (e.g. Guček, 2015) and examples of good practices from abroad (e.g. Fallbeispiele…, 1996) can be used when supplementing the criteria;
4. Forest functions should be prioritized to decide on the management regime and to avoid potential conflicts. Priority and secondary functions (where multiple functions overlap) should be defined. The prioritisation could be the result of a conflict solving process. We have revealed in the Pokljuka case study that the participatory processes can help in this regard by including stakeholders at the beginning of the planning process when management objectives are prioritized and conflicts are identified. This is typical for land use planning (Golobič, 2010), where identification of values related to land use and their evaluation and coordination are just as important as the professional basis and inputs. Examples of good conflict solving-processes are working groups included in the planning

process in Switzerland (Bettelini et al., 2000; Weiss, 2000). A part of forests without specific demands for forest functions can be classified as multifunctional area, as also supported by others (Bachmann, 2005a; Pirnat, 2007).
5. Designation procedures should be updated. Technological development enables much more user-friendly technical solutions; therefore, the task of improving mapping processes, data management and exchange with other stakeholders, and dissemination of the planning outcomes (i.e. interactive map) should not pose too great a challenge. This would improve the importance and social acceptability of forest function maps for their users.
6. Forest function planning should gain the formal recognition of spatial planning for forest area. The forest function maps in Switzerland can serve as good examples due to their clarity, transparency, up-to-date informational support and high status in land use planning. They have the status of land use plans for forest area and they are accepted in land use plans as a special use category (Forstliche Planung…, 2003).

A transparent and clear designation process supported by objective designation criteria represents the basis for an effective concept of forest functions. However, improving the management aspect may be even more relevant, and at the same time much more demanding. The management aspect (defining measures, implementing them and monitoring their effectiveness) is the core weakness of the current model. Our analysis concurs with other findings in CE countries (e.g. Weiss et al., 2002; Winkel et al., 2015): forest development plans discuss forest functions separately of other strategic issues, whereas forest operational plans avoid making problems explicit, and consider forest functions as "just another chapter" in the plan. As a consequence, forest functions are often not translated into practical measures. We suggest the following pathways to improve the management effectiveness of forest function areas:

1. Clearer management measures associated with forest functions are needed. Monitoring and research can contribute to better knowledge about management approaches and strategies that favour prioritized functions. Research working groups that include experts from different fields should be established, led by the SFS, which could develop improved designation criteria and management measures associated with forest functions.
2. Improved operational planning through more intensive use of existing operational tools, or through the development of new ones (e.g. contracts, projects) is needed. Some other CE countries where complementarity of forest development plans and operational plans is well developed can again serve as good examples (WEP, 2006; WEP Kanton Zürich, 2010). Collaboration with local communities and forest owners is crucial in this step.
3. Protocols for monitoring the effectiveness of management measures should be developed using clear and measurable criteria at different spatial levels. Thresholds for the assessment of goal status must be specified based on scientific knowledge and the current state (e.g. state of forests, demands towards forests). An example for nature conservation areas includes criteria related to the amount of deadwood, patchiness of the stands, the number of habitat trees, the forest continuity or the presence of non-native tree species in forest habitats (Winkel et al., 2015).

4. To increase the management effectiveness of forest function areas, long-term funding is needed. This may be more of a political than a planning issue, yet forest planning can provide an important basis for the prioritization and implementation of financial instruments. For prioritising funds, differentiation of forest areas with respect to management priorities is needed. This could be done in the planning process, in close collaboration with forestry experts, forest owners, local communities and other agencies interested in promoting societal services.

In CE private ownership is common or even the prevailing ownership type. This has several important implications for practicing integrative multi-objective forest management. In Switzerland, for example, fragmentation of private forest property limits the creation of large forest reserves (Angst, 2012). Similarly, the implementation of Natura 2000 sites has been hindered due to the scattered private dominating ownership (Winter et al., 2014). Conflicts are especially pronounced at the local level, where management requirements have to be put into practice (Winkel et al., 2015). Therefore, collaboration with nature conservation agencies and forest owners is crucial for the implementation of conservation objectives (Winkel et al., 2015). In addition, financial instruments have been seen as having promise for implementing management objectives (Horat and Bachmann, 2004). In many CE countries contracts that compensate forest owners for limitations on timber harvesting have been a successful financial instrument for the promotion of nature conservation goals in private forests (Knoke and Moog, 2005; Angst, 2012).

In Slovenia approximately 80 % of forests are privately owned. Therefore, the implementation of management measures associated with designated functions is strongly dependent on private owners. The results of our study showed that participation with private owners in the designation process is insufficient, although it can be crucial for effective implementation of management objectives associated with forest functions (Bettelini et al., 2000; Dönz-Breuss et al., 2004). In addition, forestry experts (especially on-the-ground practitionairs) reported on insufficient financial instruments to implement management measures in private forests, and supported the urgent need to establish sufficient long-term goal-oriented public funding. Public funding can be seen as a means to guarantee the non-timber functions of the forest, particularly protection (protection against floods, avalanches, falling stones, land-slippage, water protection, etc.) and nature conservation benefits (close-to-nature silviculture, forest reserves) (Baur, 2002). Examples of good practice from CE countries could be useful also for Slovenia; some of the most successful ones include:

- State funds available for protection against natural hazards (Swiss NFP, 2004). In Switzerland payments to forest owners and enterprises compensating the costs of forestry measures for protecting houses and infrastructure from natural hazards (public benefits) are assured by confederations, cantons and insurance agencies, and are agreed with forest owners (see Schmidt, 2010, for details).
- Contracts with forest owners for establishment of reserves or for implementing specific nature conservation measures. In Switzerland, they have been used to improve habitats

for prioritized species, preserving traditional forest usage forms or importance of cultural heritage (Angst, 2012). In Austria the national programme successfully generated new forest reserves that are generally not established by decree, but on the basis of private-law contracts (Mantau et al., 2001). The owners commit themselves to abstain from further management of the areas or to manage the areas in a way which is suitable to reach the protection goals (Frank and Müller, 2003).

- Financial subsidies for implementation of management measures in Natura 2000 sites. Although the lack of funding is often given as a reason for not implementing specific management measures (Winkel et al., 2015), especially in private forests (Winter et al., 2014), some examples of good practice exist. For example, in Germany there is financial support for management within Natura 2000 sites (Waldenspuhl et al., 2011), such as subsidies for establishment and conservation of open stands under natural dynamics in private and municipal forests (Mittermeier, 2012).

An effective financial system will be one of the relevant policy considerations with respect to integrative forest management in the future (Buttoud, 2002; Cubagge et al., 2007; Schmithüsen, 2007). Several considerations connected to private-public debates will likely be relevant for effective multi-objective forest management in the future: (1) multifunctionality of forests as an important state priority; (2) state or communal ownership of areas of high public importance as a good basis for incorporating multiple public values into forest management; (3) regulatory, financial and informational instruments for implementation of multi-objective forest management in private forests that will depend on healthy state finances; (4) sound planning that avoids large trade-offs; in times with limited financial injections from the state, trade-offs between forest uses should be mitigated as much as possible. There are several win-win situations between promotion of different forest functions (e.g. Bollmann et al., 2009; Brändli et al., 2011; Angst, 2012), and many options to manoeuvre and avoid the need for restrictions connected to provision of public services that would actually reduce income for private owners. Finally, a careful and conscientious attitude towards nature should be promoted. In CE the trend has been towards more segregation of forest uses and maximization of timber production (e.g. Borchers, 2010). Forest owners are looking for ways to become more profitable (Weiss et al., 2007; Gubsch et al., 2015), occasionally through decreasing the minimum standard of timber management (e.g. Eschmann, 2009), which may have important consequences on the provision of non-timber services.

Difficult economic conditions have led private forest owners to strive for a market economy, as well as with ecosystem services that are not market goods (Moser and Zimmermann, 2011). Who should bear the costs of providing public services from private forests has been a subject of much recent discussion (e.g. Eschmann, 2009). This view has come from the Anglo-Saxon world, where the so-called “payments for ecosystem services” (PES) have become a popular topic of discussion (Pistorius et al., 2012). PES have been seen as an important instrument for providing public goods and conserving forest biodiversity. “The concept of ecosystem services” that generated PES has recently gained

increased importance among researchers and policy makers (MEA, 2005), partly because it goes beyond forest borders. The concept of forest functions and the concept of ecosystem services differ in many dimensions (e.g. Pistorius et al., 2012), but the main difference is in the emphasis of both approaches – forest functions have mainly been the tool for practicing multi-objective forest management, whereas classifying, measuring and monetary evaluation of ecosystem services for better management is the main focus of the ecosystem services concept. Ecosystem services will also be important for Slovenia due to political and international agreements; one of which has already been made at the European level in the form of ‘‘ecosystem services mapping.” By slightly adapting designation criteria, the forestry sector could be included in mapping through forest function maps.

An important dilemma in introducing changes in the concept of forest functions is the consequences for various fields of management. A decrease in the designated area, in the number of forest function types and less overlap can imply that the public importance of forests has been diminished. Also, prioritization of forest functions may lead to the assumption that a more segregative approach will be used in forest management – promotion of single (priority) functions on one area. Our suggested improvements support just the opposite; in Slovenia, an integrative approach that considers all forests as multifunctional should be constantly promoted. However, values associated with forests change in space and time. They are not uniform across the entire forest land base, and quite often they overlap. Therefore, priorities among functions are needed to avoid conflicts, support management requirements and provide clearer assessment of financial needs, especially in private forests. The level of prioritization might be a challenging task for the future and will depend on political, legal and management frames and possibilities.

The research presented has some limitations. The results are based on interviews and workshops with forestry and other natural research managers. The study could have benefited from further interviews with other stakeholders such as private and communal forest owners and public and non-governmental organizations in order to broaden insights into conflict situations and strategies for dealing with multiple-use issues. However, the primary goal of the study in Slovenia has been to examine, evaluate and propose solutions to the concept of forest functions, which is primarily a tool for the public forest administration. Further research could propose methodologies for improving the management effectiveness of forest function areas on an operational scale, which would include identification of stakeholders, especially private owner demands and objectives (e.g. Belin et al., 2005; Ficko and Bončina, 2013).

In Slovenia forest functions have been a sort of neglected topic in the last decades. Still, proposals to improve the concept of forest functions have been outlined in the recent past (e.g. Pirnat, 2007; Planinšek, 2010; Planinšek and Pirnat, 2012a; 2012b; Simončič and Bončina, 2012). The research presented here is the first that provides a comprehensive evaluation of the concept of forest functions from a management planning perspective as seen from the forestry profession. The size of the sample – more than 200 forestry experts

– is large enough to identify the current state, weaknesses and proposals for improving the concept of forest functions. This approach enabled us to 1) generate new perspectives on existing forest function areas; 2) reveal the weaknesses and strengths of the concept, which in turn enabled us to suggest two alternative models; and 3) generate proposals to improve the current model of forest functions. This was the first evaluation that included questionnaires and participatory workshops of participants from different disciplines. Participants were mainly involved with forestry planning, but also included those involved with nature conservation, representatives from the Ministry, University, Forestry Institute and foreign experts. The evaluation blends management and scientific considerations and thus provides a sound foundation for improving the concept of forest functions in Slovenia. The results of our study can provide a basis for changing legislation in the field.

3.2 CONCLUSION

In Slovenia multifunctionality is important in all forests. The future importance of forest function areas will largely depend on how forest management is organized on the majority of the land base. However, forest functions will remain an important tool in promoting multi-objective forest management, especially in areas where public demands are greater and conflicts more likely. Our research has shown that the concept is in urgent need of change, and the forestry profession has been too slow to recognize this fact. The role and implementation of forest functions will likely depend on forest policy and legal formulations, as well as on the planning framework. Improvements of the designation of forest function areas will be a relevant task for forest planners; however, management of these areas to support the desired functions will be of even greater importance, and a bigger challenge. The concept of forest functions interrelates with social and ecological dimensions and acts as a mediator between public and private demands. Therefore, it would be naive to expect that a perfect system for all actors can be established. Nevertheless, constant development and improvements of this tool should be a challenge and motivation for the forestry profession.

4 SUMMARY

4.1 SUMMARY

This work explores the concept of forest functions and other spatially-based approaches to multi-objective forest management. The main challenge of forest planning and management has always been to provide desired services to society. One common way to do that has been to spatially classify forest areas according to the main management objectives. We propose to use an umbrella term “forest priority areas” for all kinds of the above-mentioned classifications. We define priority areas as areas identified as having higher value for the selected forest services, which are established by forest planning or legal regulations. Priority areas have been widely applied in multi-objective forest management. They enable clear, specific and effective decision making; help in reducing conflicts; and improve communication with the involved actors.

The aims of our study were to 1) explore and compare priority areas in multi-objective forest management in different regions across the globe; 2) review and analyse in greater detail the concept of forest functions in Central Europe (CE); and 3) evaluate the effectiveness of the concept of forest functions in practicing multi-objective forest management in Slovenia. Finally, our objective was to elaborate improvements of the concept of forest functions in Slovenia. Our motivation for seeking such improvements stemmed from several weaknesses identified in existing surveys and the accumulated experience of applying forest function areas in Slovenia.

We hypothesized that 1) the characteristics of priority areas as well as their importance for multi-objective forest management differ significantly between regions around the globe (H1); 2) in CE the concept of forest function areas is an important tool to practice integrative multi-objective forest management, but its application differs among countries, with the main divergences being the classification system (the number and type of forest functions), the designation process (criteria and area under designation) and their importance for forest management (H2); 3) the concept of forest functions in Slovenia needs to be improved; advancements in the classification of forest functions and the designation process are needed, and stronger integration of forest functions in forest management is essential (H3).

To test H1, we elaborated a conceptual framework consisting of six dimensions: 1) designation objective, 2) prioritization of objectives, 3) governance, 4) permanency, 5) spatial scale and 6) management regime. We applied the framework to two case study regions: CE and the Pacific Northwest region of the USA (PNW). The regions represent quite different but relatively widespread approaches of multi-objective forest management and enable comparison of the importance of priority areas in contrasting settings. Characterization of the concept in both regions was based on a document review, personal

discussions and interviews with forest planners and managers from various CE countries and PNW, consultations with on the ground practitioners and field visits.

H2 was tested with a comprehensive literature overview and detailed analysis of the concept of forest functions in nine CE countries: Austria, the Federal State of Bavaria, Croatia, the Czech Republic, Hungary, Slovenia, Slovakia, Trentino Province and Kanton Zürich. The study was based on structured in-depth interviews with experts in forestry planning from all countries. The respondents collaborated with forestry practitioners who provided important insights into the implementation of the concept of priority areas. Moreover, site visits in each of the studied countries were conducted with the interviewed experts and practitioners on the ground to verify responses gathered during the interviews.

To test H3, a five stage action plan was developed: 1) assessment of the current model of forest functions in Slovenia, 2) elaboration of alternative models, 3) evaluation of the models, 4) case study implementation and 5) final recommendations. The first stage was performed through a literature overview and analysis of approaches abroad and an evaluation of the concept of forest functions in Slovenia. The second stage included elaboration of two alternative models: Model B ("technical"), which included technical improvements, and Model C ("conceptual"), which included both technical and conceptual improvements. The models were characterized by 18 dimensions that described fundamental characteristics of the concept of forest functions. The third stage – evaluation – was performed through a workshop for forest planners (n=65); it was carried out through the "H-method" and the "World-Café" method. Case study implementation (fourth stage) included an illustration of the proposed models in three forest management units: Pokljuka as representative of forest landscape, Ljubljana as representative of urban landscape and Krško as representative of agrarian landscape. Implementation of the models was based on face-to-face interviews with local experts, data collection of SFS records and documents (forest management plans, forest function maps), on-site observations and a participatory workshop (for Pokljuka only).

Our results on the assessment of priority areas in PNW and CE support hypothesis H1; differences between the regions were revealed in all dimensions. Late succession and riparian reserves are specific to PNW, while protection against natural hazards is specific to CE. In PNW priority areas are mainly focused on public lands, whereas in CE they include public and private lands. Priority areas in PNW are designated in a much larger spatial context and have longer time commitments. In CE integration of management objectives in priority areas prevails, whereas in PNW priority areas tend to be designated for single objectives. In CE there is greater tolerance of timber management within priority areas compared to PNW. In both regions some similarities and convergent trends were also recognized.

The comparative analysis in CE showed that in all countries forest function areas have been the most widely used priority areas. However, several differences among CE

countries were identified, which confirmed our second hypothesis H2. These include the number and type of forest functions, ranging from 5 to more than 20 types; ranking of forest functions; different criteria for the designation; designation scale ranging from 1:10,000–1:50,000; different levels of stakeholder participation; and management implementation. Several weaknesses of the concept of forest functions were recognized, and needed changes in the following fields were exposed: classification system and designation criteria, management importance, participatory approach and financial instruments.

Many disadvantages in the application of forest function areas in Slovenia were recognized. There was strong support among respondents for both technical and conceptual improvements. The results of the evaluation phase and case study implementation pointed to possible improvements of the concept of forest functions in Slovenia, which is in accordance to our third hypothesis H3: fewer forest function types, prioritization of functions in the same area, less area under designation, register of objects, prioritizing areas for management, implementation of management measures through projects and contracts and greater participation with the public and forest owners. Our findings suggest that forest functions will remain an important tool in practicing multi-objective forest management. However, their importance will largely depend on overall policy and legal formulations.

4.2 POVZETEK

Uresničevanje raznovrstnih zahtev do gozdov je bila za gozdnogospodarsko načrtovanje vedno temeljna naloga. Z razvojem družbe so se vrednote in zahteve do gozdov spreminjale (Bengston, 1994), hkrati pa tudi cilji gospodarjenja z gozdovi. Ti so postali raznovrstnejši, upravljavci se ukvarjajo z vse širšo paleto družbenih in okoljskih vprašanjih (Angelstam in sod., 2005; Sayer in Mcginnins, 2005; McAfee in sod., 2010). Gospodarjenje z gozdovi, ki upošteva številne vrednote in interese do gozdov ter zagotavlja družbi raznovrstne dobrine in storitve (od tu naprej storitve), od lesa in lesnih proizvodov, do rekreacije, varstva narave, pitne vode, ohranjanja kulturne krajine, varstva pred naravnimi nesrečami in podobno, se označuje kot večnamensko gospodarjenje (Pukkala, 2002; Seely in sod., 2004). Pri večnamenskem gospodarjenju z gozdovi se različne interese in zahteve družbe preoblikuje v cilje gospodarjenja, ki se dosegajo z izbranim sistemom ukrepov (Bončina, 2009). Za večnamensko gospodarjenje sta pomembna dva vidika; prvi je politični (npr. Cubbage in sod., 2007), ki ureja pravila glede rabe prostora (dostop do gozdov, razmerja med javnim in zasebnim, pravice in obligacije lastnikov idr.) ter postavlja ogrodje za prakso gospodarjenja z gozdovi (npr. Kissling-Näf, 2000). Drug vidik je upravljavski; pomembno vprašanje je, kako znotraj urejenih političnih in pravnih razmerij organizirati gospodarjenje z gozdovi ter uresničevati cilje večnamenskega gospodarjenja (Selman, 2002; Brukas in Sallnäs, 2012).

Pogost način uresničevanja večnamenskega gospodarjenja z gozdovi je delitev gozdne površine na območja z različnimi cilji gospodarjenja (Führer, 2000; Boyland in sod., 2004; Zhang, 2005; Côté in sod., 2010; Riegert in Bader, 2010). Za ta območja predlagamo skupni izraz "prednostna območja" (Simončič in sod., 2013, 2015). Razlogov za prostorsko opredelitev ciljev gospodarjenja je več. Prvič, zahteve do gozdov niso enako pomembne na celotni gozdni površini, razlikujejo se glede na naravne danosti, demografske in kulturne značilnosti prostora in podobno (Arnberger in Mann, 2008; Store, 2009). Drugič, naravne danosti se v gozdnem prostoru razlikujejo (Spies in sod., 2004; Kimmins in sod., 2008), zato se razlikuje tudi pomen gozdov za družbo (npr. varstvo pred naravnimi nesrečami je pomembno predvsem na območjih z velikim škodnim potencialom in veliko nevarnostjo naravnih nesreč). Tretjič, upravljavske možnosti se v gozdnem prostoru razlikujejo, odvisne so od organiziranosti gozdarstva, lastništva gozdov, pravnih predpisov s področja gozdarstva in drugih področij. Določanje prednostnih območij omogoča jasno, diferencirano in učinkovito odločanje o rabi prostora, pomaga pri komunikaciji z različnimi uporabniki in blaženju nesoglasij pri rabi prostora (Vos, 1996; Bachmann, 2005a; Bettinger in sod., 2009).

Način določanja prednostnih območij in njihov pomen za zagotavljanje želenih storitev označujeta dva glavna pristopa večnamenskega gospodarjenja z gozdovi. Pri prvem različne funkcije gozda (cilje gospodarjenja) upoštevamo v istem gozdnem prostoru; takšen način gospodarjenja je opisan kot integracijski model (Borchers, 2010; Boncina, 2011). Razvit je v večini srednjeevropskih dežel, katerih skupne značilnosti so velika gostota naseljenosti, številne prostorske rabe na relativno omejeni površini, razdrobljena zasebna gozdna posest ter velik javni interes v vseh gozdovih. Pri drugem, t.i. segregacijskem pristopu (Vincent in Binkley, 1992; Koch in Skovsgaard, 1999) razdelimo gozdni prostor na območja z enim ciljem gospodarjenja (npr. proizvodnja lesa, ohranjanje narave, rekreacija), večnamensko gospodarjenje pa je zagotovljeno na širšem območju gozdov. Ta pristop je značilen za dežele z nižjo gostoto poseljenosti, večjimi površinami gozdov in večjim deležem velikih zasebnih posesti (npr. Kanada, Skandinavija in ZDA).

V Srednji Evropi (SE) je uveljavljen integracijski način gospodarjenja z gozdovi, njegov sestavni del je tudi t.i. "koncept funkcij gozda" (e.g. Anko, 1985; Volk, 1987; Volk in Schirmer, 2003; Pistorius in sod., 2012). Koncept se ukvarja s študijo pomena gozdov in klasifikacijo funkcij gozda (Riegert in Bader, 2010), z odnosi med funkcijami gozda (Fallbeispiele..., 1996), prostorskim določanjem območij, ki so relativno pomembnejša za izbrane funkcije gozda (od tu naprej območja s poudarjenimi funkcijami), ter z ukrepi za pospeševanje izbranih funkcij (Blum in sod., 1996). Funkcije gozda so pomembno politično orodje za poudarjanje javnega pomena gozdov, orodje za komunikacijo z javnostjo in drugimi sektorji v prostoru (Krott, 2005). Hkrati so pomemben upravljavski instrument – omogočajo diferencirano odločanje o rabi prostora, določanje prednosti pri gospodarjenju in zmanjševanje nesoglasij pri rabi prostora (Bachmann, 2005b; Bončina, 2009).

V Sloveniji se je vključevanje funkcij gozda v gozdnogospodarsko načrtovanje uveljavilo v zadnjih treh desetletjih; izdelana je bila klasifikacija gozdnih funkcij, razviti so bili podrobni kriteriji in postopki določanja območij s poudarjenimi funkcijami pri pripravi območnih gozdnogospodarskih načrtov in načrtov gozdnogospodarskih enot (ZG, 1993; Anko, 1995). Območja s poudarjenimi funkcijami so postala tudi podlaga za dodeljevanje subvencij lastnikom gozdov za opravljena dela, s katerimi so vsaj posredno ugodno vplivali na izbrane, tradicionalno poimenovane "splošnokoristne" funkcije gozda. Koncept funkcij gozda je bil tako kot v drugih srednjeevropskih deželah dobro sprejet v gozdarskih krogih, funkcije gozda so postale pomembna podlaga za presojo posegov v gozdni prostor. Glede na pridobljene izkušnje in tudi zglede iz tujine ugotavljamo, da je koncept funkcij gozda treba preveriti, dopolniti in posodobiti. Z vidika upravljanja se zastavljajo predvsem vprašanja o primernosti sedanjega načina členitve gozdov na območja s poudarjenimi funkcijami (glej Pravilnik…, 1998, 2010; Posodobitev…, 2011), ki med drugim zadevajo poimenovanje, število, stopnje poudarjenosti in merilo prikaza ter kriterije za njihovo določanje (Pirnat, 2007; Bončina in Simončič, 2010; Planinšek, 2010; Planinšek in Pirnat, 2012a; 2012b; Simončič in Bončina, 2012). Zapostavljena sta tudi upravljavski pomen funkcij gozda ter participativni vidik.

V raziskavi smo se ukvarjali z naslednjimi vprašanji: Ali je koncept funkcij gozda znotraj SE enak? Kako se koncept funkcij gozda razlikuje z drugimi prednostnimi območji po svetu? Ali so funkcije gozda učinkovito orodje za uresničevanje večnamenskega gospodarjenja z gozdovi v Sloveniji? Kako je mogoče izboljšati to orodje za večnamensko gospodarjenje z gozdovi v Sloveniji? Opredelili smo tri raziskovalne hipoteze:

- značilnosti prednostnih območij in njihov pomen za večnamensko gospodarjenje z gozdovi se razlikujejo med regijami po svetu (H1);
- koncept funkcij gozda je pomembno orodje za uresničevanje večnamenskega gospodarjenja z gozdovi v SE, ki pa se med deželami pomembno razlikuje (H2);
- koncept funkcij gozda v Sloveniji je potrebno dopolniti predvsem pri klasifikaciji funkcij gozda, postopku določanja in upravljavskem pomenu (H3).

Hipotezo H1 smo preverjali na primeru dveh regij, ki predstavljata različne, vendar relativno razširjene pristope večnamenskega gospodarjenja z gozdovi na globalni ravni: pacifiški del Severne Amerike (PNW) in SE. Koncept prednostnih območij v obeh regijah smo opisovali in primerjali s šestimi temeljnimi značilnostmi, ki smo jih poimenovali dimenzije koncepta: 1) cilji določanja, ki označujejo poglavitni namen določanja prednostnih območij (npr. rekreacija, varstvo narave, zaščita pred naravnimi nesrečami); 2) prioritizacija ciljev, ki pomeni bodisi segregacijo ciljev, ko so ti prostorsko ločeni, bodisi integracijo, ko so cilji integrirani na isti gozdni površini; 3) upravljanje, ki obsega kompetence določanja, odgovorne za upravljanje in vidik lastninske pravice; 4) stalnost, ki se nanaša na časovni okvir oziroma nameravano trajanje prednostnih območij; 5) prostorsko merilo, ki pojasnjuje prostorski kontekst, to je velikost območja načrtovanja in velikost posameznih prednostnih območij; in 6) režim gospodarjenja, ki vključuje različne vrste ukrepov za zagotavljanje želenih storitev gozda, od popolne omejitve do izvajanja

ukrepov na področju gozdarstva, varovanja gozdov, gradnje cest, upravljanja prostoživečih živali in drugih dejavnosti (Boncina, 2011). Karakterizacija koncepta v obeh regijah je temeljila na pregledu dokumentov (zakonski in podzakonski predpisi, navodila, pravilniki, poročila, znanstveni prispevki idr.), osebnih pogovorih in intervjujih z gozdarskimi načrtovalci in upravljavci iz različnih predelov SE in PNW, posvetovanju s praktiki ter terenskih ogledih. Konceptuali model predstavlja novo metodologijo, s katero je mogoče opisati, primerjati in pojasniti značilnosti prednostnih območij v regijah z različnimi socio-ekonomskimi, kulturnimi in naravnimi okvirnimi pogoji gospodarjenja. Hkrati je analiza verjetno prva celovita primerjava prednostnih območij v gozdnem prostoru med PNW in SE.

Hipotezo H2 smo preverjali s primerjalno analizo koncepta funkcij gozda v devetih SE deželah: Avstrija, Bavarska (Nemčija), Hrvaška, Češka, Madžarska, Slovenija, Slovaška, Trentino (Italija), Zürich (Švica). Z vodenimi intervjuji strokovnjakov (po eden iz vsake države) in študijami izbranih primerov smo analizirali obravnavanje funkcij gozda in drugih prednostnih območij v gozdnogospodarskem načrtovanju. V intervjuje smo vključili vprašanja o splošnih značilnostih gozdov in gozdarstva v posameznih državah, splošnih značilnostih funkcij gozda in drugih prednostnih območij (vrsta, status, pomen idr.), značilnostih območij s poudarjenimi funkcijami in načinih presojanja učinkovitosti koncepta funkcij gozda za večnamensko rabo gozdnega prostora. Odgovore smo analizirali po ustaljenih postopkih, uporabili smo tudi klasifikacijske metode. Odgovore na voden vprašalnik smo dodatno pojasnili in preverili s terenskim ogledom izbranih objektov ter pogovori z načrtovalci in lokalnimi eksperti. Kolikor vemo, gre verjetno za prvi obširni pregled in prvo ovrednotenje koncepta funkcij gozda v različnih deležah SE, ki opiše poglavitne značilnosti koncepta, hkrati pa razkriva regionalne razlike ter pojasnjuje glavne prednosti ter slabosti koncepta.

Akcijski načrt za testiranje hipoteze H3 je obsegal pet faz. 1) ovrednotenje sedanjega modela funkcij gozda v Sloveniji (Model A); s študijo domače in tuje literature in analizo pristopov v tujini smo ugotavljali pomen in učinkovitost tega orodja ter izkušnje z njim v tujini (glej H1 in H2). Dodatno smo z anketiranjem strokovnjakov (n=162), ki delujejo na področju načrtovanja in gospodarjenja v gozdnem prostoru (načrtovalci, revirni gozdarji), analizirali učinkovitost sedanjega pristopa obravnavanja funkcij gozda v gozdnogospodarskem načrtovanju v Sloveniji (Simončič in Bončina, 2015). Rezultate smo podprli s participativno delavnico strokovnjakov s področja upravljanja gozdov v Sloveniji (Bončina in sod., 2014), na kateri smo ugotavljali prednosti, slabosti in priložnosti koncepta funkcij gozda v Sloveniji; 2) izdelava alternativnih modelov koncepta funkcij gozda v Sloveniji; možne izboljšave smo združili v dva alternativna modela – Model B "tehnični", ki zajema tehnične poenostavitve (število funkcij, rangiranje, prostorski prikaz), ter Model C – "konceptualni", ki obsega tako tehnične kot konceptualne izboljšave (prioritizacija funkcij, določanje ukrepov, participacija, določanje konfliktnih območij). Modela sestavlja 18 dimenzij, ki opisujejo poglavitne tehnične in konceptualne značilnosti območij s poudarjenimi funkcijami gozda; 3) ovrednotenje modelov; modele so na

delavnici s prilagojeno H metodo ocenili gozdarski načrtovalci (n=66), ki so dodatno po metodi "world café" predlagali izboljšave; 4) na treh testnih območjih smo ilustrirali spremembe koncepta funkcij gozda. Za testna območja smo izbrali tri gozdnogospodarske enote: Pokljuka kot predstavnik gozdne krajine, Ljubljana kot primer urbane krajine in Krško, kjer prevladuje agrarna krajina. Podatke za prikaz modelov smo pridobili iz podatkovne zbirke Zavoda za gozdove Slovenije (ZGS) o funkcijah gozda; analize smo dodatno podprli z intervjuji z lokalnimi eksperti in študijo gozdnogospodarskih načrtov, obstoječih kart funkcij in drugih razpoložljivih virov, ter terenskimi ogledi. V okviru raziskav o funkcijah gozda v zadnjih letih so bili že podani nekateri predlogi za izboljšanje tega koncepta (npr. Pirnat, 2007; Planinšek, 2010; Planinšek in Pirnat, 2012a; 2012b; Simončič in Bončina, 2012). Raziskava, ki smo jo izvedli, je prva, ki obravnava koncept funkcij gozda in njegovo učinkovitost, kot ga vidijo gozdarski strokovnjaki. Novost je tudi v dveh alternativnih modelih, ki lahko skupaj z že obstoječimi predlogi služita kot osnova za spremembe pravnih predpisov na področju funkcij gozda.

S primerjavo SE in PNW smo potrdili H1 o razlikah v aplikaciji koncepta prednostnih območij med regijami po svetu; razlike smo ugotovili v vseh analiziranih dimenzijah. Habitati poznih sukcesijskih vrst in procesov ter obvodni rezervati so specifični tipi prednostnih območij v PNW, varstvo pred naravnimi nesrečami pa pomembno predvsem v SE. V PNW so prednostna območja večinoma določena v javnih gozdovih, medtem ko v SE obsegajo tako javne kot zasebne gozdove. V PNW so prednostna območja določena v bistveno večjem prostorskem merilu - nekaj 100 ha ("manjša krajina") do nekaj 100,000 ha (regije) v primerjavi s SE, kjer je prostorski kontekst določanja običajno nekaj 10 ha (sestoji) do nekaj 10,000 ha (gozdnogospodarska območja). V SE prevladuje integracija ciljev gospodarjenja na istem območju gozda, ti pa so med seboj rangirani po pomembnosti. V PNW so prednostna območja večinoma določena z enim poglavitnim ciljem, lahko se določijo podobmočja znotraj večjih prednostnih območij. Trajnost prednostnih območij je večja v PNW, kjer prevladuje dolgoročno (>30 let) do trajno določanje (>100 let), v primerjavi s SE, kjer so prednostna območja večinoma določena srednjeročno (10-20 let). Razlike v gospodarjenju z gozdovi med prednostnimi območji in ostalo gozdno površino so znatno večje v PNW v primerjavi s SE. Poglavitni razlogi za razlike med regijama izvirajo iz ekoloških (npr. vloga ognja kot ekološkega dejavnika ali potenciali za naravne nesreče), kulturnih, zgodovinskih in političnih dejavnikov. Značilen primer političnih razlik je visok javni pomen vseh gozdov v SE v primerjavi s PNW, kjer je ta omejen na javne gozdove. Ugotovljeno verjetno izhaja iz zgodovinsko različnih jurisdikcij lastnine v nemškem sistemu v primerjavi z angloameriškim pravnim sistemom (npr. Pistorius in sod., 2012), dolgotrajne tradicije v regulaciji razmerij med javnimi in zasebnimi pravicami v SE, in zgodnjega zavedanja velikega javnega pomena v vseh gozdovih (Kräuchli in sod., 2000). Razlike v večji segregaciji v PNW v primerjavi s SE lahko pojasnimo tudi z različnim pomenom ostalih, glede na površino praviloma prevladujočih gozdov, za večnamensko gospodarjenje; ta je veliko manjši v PNW, kjer so za zagotavljanje ekoloških in socialnih storitev pomembna predvsem prednostna območja, medtem ko so v SE te storitve pomembno vgrajene v cilje gospodarjenja na celotni gozdni

površini. S primerjavo prednostnih območij med obema regijama smo prepoznali tudi podobnosti, hkrati pa tudi nekatere skupne trende. Ti med drugim kažejo na več integracije pri ciljih gospodarjenja v PNW (npr. aktivno gospodarjenje v zavarovanih območjih zaradi varstva pred požari ali izboljšanja ohranitvenega statusa gozdov) (npr. Franklin in Johnson, 2012) in na nekaj več elementov segregacije v SE, ki se kažejo v določanju "pasivnih območij" za varovanje habitatov redkih in ogroženih vrst (npr. Bollmann in Braunisch, 2013).

S primerjalno analizo koncepta funkcij gozda med SE deželami smo ugotovili, da so funkcije gozda v vseh deželah pomembno orodje večnamenskega gospodarjenja. Ugotovili smo, da so med deželami številne podobnosti in razlike, ter s tem potrdili hipotezo H2. Poglavitne podobnosti so: 1) pravna opredelitev treh skupin funkcij: proizvodne, ekološke (tudi varovalne) in socialne; 2) izraz "funkcije gozda"; 3) rangiranje pomena funkcij; 4) izdelava karte funkcij; 5) določanje območij s poudarjenimi funkcijami na regionalni ravni (načrti razvoja gozdov), ki presega meje posameznih lastnikov; 6) območja s poudarjenimi funkcijami kot poglavitni tip prednostnih območij. Poglavitne razlike med deželami se kažejo v številu opredeljenih funkcij (5 do >20), rangiranju njihovega pomena ter s tem v prekrivanju območij s poudarjenimi funkcijami (določanje stopenj poudarjenosti proti določanju prioritet med funkcijami), določanju ukrepov za izbrane funkcije ter upravljavskem pomenu opredeljenih območij na sploh. V procesu določanja so poglavitne razlike v prostorskih prikazih (merilo varira med 1:10.000 do 1:50.000), minimalni površini (0,5 ha do 10 ha), prekrivanju območij (nekje dopustno, nekje omejeno na največ dve funkciji) ter površini, ki je opredeljena kot območje s poudarjeno funkcijo; ta je v nekaterih deželah (npr. Švica) znatno manjša in obsega gozdove z visokimi prioritetami za izbrane funkcije, v nekaterih deželah je celotna površina določena kot območje s poudarjeno funkcijo. Z raziskavo smo prepoznali nekatere skupne pomisleke pri aplikaciji funkcij gozda v večnamenskem gospodarjenju. Poglavitne so 1) nekonsistentna uporaba termina "funkcije gozda"; 2) klasifikacija tipov funkcij je prepodrobna, rangiranje pa prezapleteno, kar zmanjšuje uporabno vrednost opredeljenih območij za upravljanje, 3) kriteriji za določanje območij s poudarjenimi funkcijami so pogosto nejasni, določanje ne upošteva različnih prostorskih meril; 4) upravljavski pomen območij s poudarjenimi funkcijami je zapostavljen, povezava med opredeljenimi območji in ukrepi je šibka, kar je skladno z drugimi ugotovitvami (npr. Weiss in sod., 2002; Winkel in sod., 2015); razlog je tudi v zapostavljanju participativnih postopkov, predvsem z javnostjo in lastniki gozdov (npr. Stiptizov in Duerr, 2005; Rupert-Winkel in Winkel, 2009; Kangas in sod., 2010). Zaradi visokega deleža zasebnih gozdov so anketirani opozorili predvsem na pomen sodelovanja z lastniki in izboljšan sistem finančnih nadomestil po zgledu nekaterih SE dežel (npr. Bettelini in sod., 2000; Dönz-Breuss in sod., 2004).

Koncept funkcij gozda v Sloveniji smo ovrednotili z več vsebinsko povezanimi postopki. Z anketo gozdarskih strokovnjakov smo ugotovili naslednje poglavitne slabosti koncepta funkcij gozda: 1) število tipov funkcij gozda je preveliko, številne med njimi, predvsem socialne, je mogoče združiti; podobno predlagajo tudi drugi avtorji (npr. Planinšek in

Pirnat, 2012a); 2) rangiranje pomena funkcij je treba spremeniti, mnenja o eni ali dveh stopnjah so bila deljena; 3) dopolniti je treba raven določanja območij s poudarjenimi funkcijami; 4) prostorski prikazi so zapleteni, funkcijske enote so preživete, zaradi navedenega je zmanjšana uporabna vrednost kart funkcij za upravljanje. S statistično analizo smo prepoznali štiri glavne namene območij s poudarjenimi funkcijami: 1) načrtovanje rabe gozdnega prostora in sodelovanje v prostorskem načrtovanju; 2) diferencirano odločanje o ukrepanju v gozdnem prostoru; 3) okvir za finančna nadomestila; 4) vpliv na gospodarjenje z gozdovi (sečnja, spravilo). Istosmerne poglede smo prepoznali na delavnici gozdarskih strokovnjakov, kjer so udeleženci našteli številne slabosti koncepta funkcij gozda, hkrati pa je bila prevladujoča podpora za znatne spremembe (Bončina in sod., 2014). Izpostavljene so bile naslednje možne izboljšave: 1) razjasnitev in poenotenje terminologije in razumevanja koncepta funkcij gozda, na kar opozarjajo tudi drugi avtorji (npr. Planinšek in Pirnat, 2012a); 2) zmanjšanje števila funkcij gozda (glej tudi Pirnat, 2007; Planinšek in Pirnat, 2012a; 2012b); 3) poenostavitev prikazov območij s poudarjenimi funkcijami; ter 4) izboljšanje povezave med območji s poudarjenimi funkcijami in ukrepi za gospodarjenje. Na podlagi ugotovitev izvedenih postopkov smo potrdili hipotezo H3 o potrebnih izboljšavah koncepta funkcij gozda v Sloveniji.

Udeleženci druge delavnice so podprli tehnične (Model B; ocena 6.5 od 10) in konceptualne spremembe sedanjega modela (Model C; ocena 7.5 od 10). Med tehničnimi so izpostavili predvsem:

- določanje posameznih območij s funkcijami namesto funkcijskih enot,
- manj tipov funkcij,
- register objektov,
- poenostavljeno rangiranje funkcij.

Med konceptualnimi pa:

- jasna definicija prioritet med funkcijami,
- samo ena stopnja poudarjenosti,
- interaktivna karta,
- določanje konfliktnih območij,
- seznam objektov s prioritetami za ukrepanje,
- višja stopnja participacije, predvsem javnosti in lastnikov gozdov.

Udeleženci so pri zaključkih izpostavili nekatere dileme, ki jih obravnavamo v razpravi četrtega neobjavljenega članka. Poglavitne so zadevale določanje samo ene prednostne funkcije na isti gozdni površini, določanje območij s prednostno lesnoproizvodno funkcijo, kompetence nad upravljanjem s podatki pri interaktivni karti ter strokovno, tehnično in časovno zahtevnost predlaganih sprememb.

Z aplikacijo obeh predlaganih modelov na treh testnih enotah smo prikazali nekatere spremembe koncepta funkcij gozda. Zmanjšali smo število funkcij in stopenj poudarjenosti ter tako poenostavili prostorski in atributni del določanja območij s poudarjenimi funkcijami, zmanjšala se je površina prekrivanja posameznih slojev funkcij ter število izločenih prostorskih enot. Pri obeh modelih se je zaradi manjše stopnje prekrivanja preglednost karte funkcij znatno izboljšala. Poglavitna razlika med Modeloma B in C je bila v 1) stopnji prekrivanja med posameznimi območji s poudarjenimi funkcijami in 2) prostorski razporeditvi izločenih območij. V primeru Modela C se je stopnja prekrivanja znatno zmanjšala, število izločenih enot se je prav tako zmanjšalo, povprečna površina izločenih enot se je povečala. Ugotovili smo, da se z nobenim alternativnim modelom skupna površina gozdov s prvo stopnjo poudarjenosti ekoloških in socialnih funkcij bistveno ne spremeni. Aplikacija Modela C na testnem območju GGE Pokljuka je pokazala, da se konfliktna območja, določena s participativnimi metodami, lahko bistveno razlikujejo od območij, določenih po sedanjem načinu, kjer so konfliktna območja določena shematično glede na prekrivanje slojev funkcij. Prikazali smo možnosti vključevanja deležnikov v reševanje nesoglasij ter predlagali opredelitev ukrepov za izbrana območja, kar je lahko podlaga tudi za preverjanje učinkov gospodarjenja.

Funkcije gozda in druga prednostna območja so pomembno orodje za uresničevanje večnamenskega gospodarjenja z gozdovi, ki pa se med deželami razlikuje. V SE so območja s poudarjenimi funkcijami gozda pomembno orodje – za gozdno politiko, sodelovanje v prostorskem načrtovanju in sodelovanje z javnostjo. So pomemben povezovalni člen med zahtevami družbe in zasebnimi interesi in pomagajo pri zmanjševanju nesoglasij pri rabi prostora. So tudi orodje za diferencirano odločanje o ukrepih in okvir za finančna nadomestila lastnikom gozdov v primeru dodatnih obveznosti za zagotavljanje javnih storitev. V Sloveniji so bile funkcije gozda podobno kot v drugih srednjeevropskih deželah med gozdarji in drugimi uporabniki v gozdnem prostoru dobro sprejete, ugotovljene slabosti pa kažejo na to, da so spremembe nujne. Nakazane izboljšave so lahko podlaga za spremembe pravnih predpisov na področju funkcij gozda v Sloveniji.

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APPENDICES

The attached appendices refer to chapter 2.2.

Appendix 1: The 9 topics regarding the effectiveness of the concept of forest functions within the World Cafe method (*phase 2*, 1st Workshop, Pokljuka, December 17, 2013)

Topic	Addressed themes
Definition	Definition of forest functions, designation criteria, importance of spatially-based approach
General understanding	Importance of spatially-based approach, importance of ranking of the importance of forest functions, alternatives to spatial designation of forest function areas
Changeability	Permanency of forest function areas, criteria on different spatial scales, flexibility regarding temporal and spatial designation scale
Ranking of importance	Importance of ranking, involvement of stakeholders in the ranking, improvements of forest function mapping
Objects in forests	Consideration of line and point objects, register of objects
Guidelines for designation	Advantages and disadvantages of prescriptive approach, the role of participation
Participation	The role of participation of public, forest owners, differences in designation between public and private forests, financial instruments to support public functions in private forests
Management effectiveness	Improvement of the effectiveness of forest management, appropriate planning levels, context of forest plans, operational planning
Public importance	The role of forest function areas in promoting public importance of forests

Appendix 2: Respondent opinions on the effectiveness of the concept of forest functions in Slovenia (*phase 3*, 2nd Workshop, Pokljuka, 2nd April 2015)

Statement	Grade
In the frame of forest management unit plan, prioritized areas for management measures should be determined, which would be a subject of co-financing / subsidies.	7.6±1.57
Part of the funds for the promotion of management to provide forest functions (e.g. recreation) should be assured by the local community.	7.3±1.74
Particularly if there are possible conflicts, stakeholders should be included in the designation of priority areas.	8.1±1.17
Funds for financing management measures should not be linked to levels of importance but to concrete areas that would be determined with the FMU plan.	7.2±1.66
A maximum of two or three functions should be determined for the same forest land.	6.4±2.25
The number of forest functions should be smaller.	8.8±0.74
The synthesis map of forest functions should be simplified (less overlapping).	8.2±1.82
Certain forest function areas (e.g. for protective function) should be a binding framework for management measures under the condition that the funds are assured.	7.6±1.41
Criteria for designation of areas with ecological functions should be simplified; more competences should be given to professional judgments in the field.	6.8±2.21
Guidelines for designating forest function areas are too detailed and prescriptive.	5.4±2.48
The state should provide more resources for the promotion of works for the provision of ecological services.	7.6±1.60
The number of levels of importance should be smaller.	7.0±2.49
The designation of forest function areas should be uniform across Slovenia without possibilities to adjust designation criteria to local conditions, or to the stakeholders.	3.1±2.38
Forest owners should be included in the designation of areas with ecological functions.	5.8±2.64
The state should provide more resources for the promotion of works for the provision of social services.	7.3±1.61
An interactive map should be developed that would contain comprehensive information on forest land and forest functions.	7.9±1.71
“Functional units” should be abolished; individual functions should be emphasized.	7.6±1.96
By supplementing and improving the concept of forest functions, foresters will expand competences in forest land.	7.2±1.60
On designated areas (at least for some functions, e.g. protection) it should be possible to determine additional measures which are (co-) financed by the state.	7.6±1.39
Forest functions do not have generally socially acceptable value.	6.5±2.29
The priority function should be defined if areas of multiple functions overlap.	6.9±2.26
Criteria for designation of areas with social functions should be simplified and more competences should be given to professional judgments in the field.	6.6±2.14
Forest owners should be included in the designation of areas with social functions.	7.1±1.86

Grading scale:

1	2	3	4	5	6	7	8	9
Strongly disagree			Slightly disagree	Nor disagree or agree	Slightly agree			Strongly agree
DISAGREEMENT ←				**Undetermined**	**→ AGREEMENT**			

Appendix 3: Perceived importance of forest function areas (0 – unimportant; 9 – very important)

Importance of forest function areas	Mean±S.D.
A tool for collaboration in spatial planning	8.3±1.32
A tool for collaboration with other institutions	8.1±1.47
A tool for collaboration with the public	7.8±1.50
Importance for forest development and land use planning	7.6±1.67
Importance for planning management objectives and measures	7.6±1.61
Overview on the spatial importance of forest	7.5±1.93
A framework for subsidies and payments for ecosystem services	7.1±2.15
A tool for forest policy	6.5±2.04
A basis for forest evaluation	6.5±2.01

Appendix 4: Questionnaire regarding the effectiveness of the concept of forest functions in three case studies (FMU)

1. Are forest functions an important tool for practicing multi-objective forest management in your FMU? (list 3-5 reasons)
2. Which are the main weaknesses of the current approach to designation of forest function areas and associated management? (list 3-5 weaknesses)
3. What should be changed to make this tool more effective for actual forest management? (list up to 5 suggestions)
4. Which management tools are missing for dealing with conflicts regarding forest use in your FMU? (list 3-5 suggestions)

Appendix 5: Questionnaire regarding the importance of forest functions in three case studies (FMU)

1. List the main forest functions in your FMU and estimate their importance by allocating a hypothetical sum of 100 points among the listed functions.
2. For each forest function, list the main management strategies (up to 3) and measures (up to 3) for their promotion.
3. Which are the main conflicts regarding multiple forest use in your FMU? Specify their location if possible.
4. Which spatial information is relevant for designation of forest function areas in your FMU? Which stakeholders should be included in the designation process?
5. Do you suggest some additional tools and analysis for better decision-making process on designation of forest function areas in your FMU?

Appendix 6: Results of participatory workshop in Pokljuka (*phase 5*, Workshop, Pokljuka, 1st April 2015)

Appendix 6a: Ranking of management objectives by stakeholders and employees of the Slovenia Forest Service (SFS)

	Ranks	
Importance of forest function areas	Stakeholders	SFS
Production of wood for market	1	1
Protection of water sources and drinking water	2	8
Nature conservation	3	2
Recreation	4	7
Sport and competitions	5	6
Tourism	6	9
Employment	7	4
Protection of forest sites and stands	8	3
Regulated grazing	9	10
Production of non-wood forest products	10	5
A place for education and research	11	13
Aesthetic look of landscape	12	14
Hunting as economic and recreational activity	13	12
Forest biomass for energetic purposes	14	11
Protection of objects against natural hazards	15	15

Appendix 6b: Ranking of the main conflicts regarding forest land use on the Pokljuka plateau identified by the stakeholders (the ranks represent the number of times an individual conflict was identified)

Conflict	Rank
Regulation of traffic regime	8
Harmonizing different interests	8
Intensive picking	7
Nature conservation requirements and restrictions	6
Conflict between recreation and wood production	6
The stability of forest stands	6
Deficiency of regulating land use	5
Restoration of natural catastrophes	4
Mass events	4
Undirected land use	4
Preservation of cultural landscape	4
Road salting	3
Parking lots	3
Forest road network	3
Implementation of forestry operation	3
The concept of forest management	3
Too high deer densities	2
Public education	2
Utilities, infrastructure	1
The unused potential of plan for forest land use harmonization	1
Unregulated grazing	1

Appendix 6c: The results of the H-method for conflict area 1. The results for other conflict areas can be obtained from the author of the dissertation.

Why not 10	How do you assess the congruity of land uses in **Biatlonski center and Planina Zajavornik?**	Why not 0
Timely mismatch of land uses Traffic and parking Inaccessibility past biathlon centre minimum ½ year Mass events Failure to comply with laws (regulations) Visitors Accessibility (Uskovnica) Ploughed road does not allow cross country skiing Conflict between land uses is not solved systematically No formal yearly agreements Hindered winter production Possibilities for accidents Road block	5	Promotion of forestry Nice aesthetic appearance of Rudno polje and Zajavornik Aesthetic appearance Assuring accessibility Athletes learn about the role of productive forest Multiple use roads Consultations, agreements
	Suggestions Traffic alternatives Timely consistency Active cross country (summer) trails should be relocated from the main roads (safety!) Massive transit of visitors of events	

Appendix 7: Example of management measures implementation on three priority objects in Pokljuka
The results for other objects can be obtained from the author of the dissertation.

ID	**Type**	**R1 - Forests with recreational function**
Description	Localization	R1 – Planina Zajavornik R2 - Biathlon centre R3 - Across the region: cross-country skiing trails, hiking and mountain biking trails
	Starting point	Popular recreation areas with different types of use by forest visitors. Forests enable recreation experiences and are important for tourism for the area. Soft forms of recreation should be promoted due to fragile sites and wilderness characteristics of the area.
	Conflict	Between different user groups (e.g. hikers vs. mountain bikers) (R3) wood production (Biathlon centre, mountain pasture Zajavornik): the same trails are used for cross-country skiing and skidding of wood – problematic during winter, devastated cross country skiing trails, larger potential for accidents
	Objective	The designated areas should be made attractive for recreation and tourists, other activities should be subordinated to recreational needs. Intensive recreation should be concentrated in these areas. Cultural landscape should be maintained for the purposes of tourism. Touristic offer should emphasize quality and authenticity instead of quantity; local products and producers should have priorities. Maintaining user safety, recreational infrastructure, protecting natural resources, and providing high-quality user experiences.
Actions	Management measures	1) visitor density regulations in the wilderness (directing visitors to the designated locations and trails) 3) promote wilderness experiences by promotion, publication and dissemination (awareness concept) 3) build new infrastructure on interesting points 4) zonation of forest area according to the type of recreation (multiple used trails or specialized trails – e.g. for downhill biking) 5) orientation of forest management towards safety and aesthetic appearance of forests – periodical monitoring of forests 6) allowances for sport events provided by competent institutions 7) contracts between the Biathlon and harvesting companies
	Planning implementation	Approval and implementation of management plan for Triglav National Park Agreement with municipality (financing) Operational planning through contracts and projects
	Financing	Municipalities State Triglav National Park Beneficiaries (Touristic agencies and producers, visitors)
	Time frame	2015-2017 Design projects 2017-2023 Implement projects 2023-2025 Monitoring, evaluation of effectiveness
Coordination	Authority	Slovenia Forest Service, Regional Office Bled, District Forest Office Pokljuka, Local Municipalities
	Stakeholders	Touristic office Bled, Touristic office Bohinj, operators, hiking associations, mountain-biking associations, sport clubs, municipalities, forest owners
Basis	Documents, maps	Survey of recreation visitor groups; motivations, user perceptions, preferences and social carrying capacity Forestry Law Manual for the Forest Service Thematic map (map of various forms of recreation on Pokljuka)

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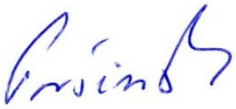

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