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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 km^2	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 km^2	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 km^2	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		Governance				Permanency[b]	Spatial scale		Management regime[d]	Main references
		Integration vs. segregation[a]	Overlap	Designation authority	Management arrangements	Legal documents	Ownership type		Context[c]	Size of PA		
(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

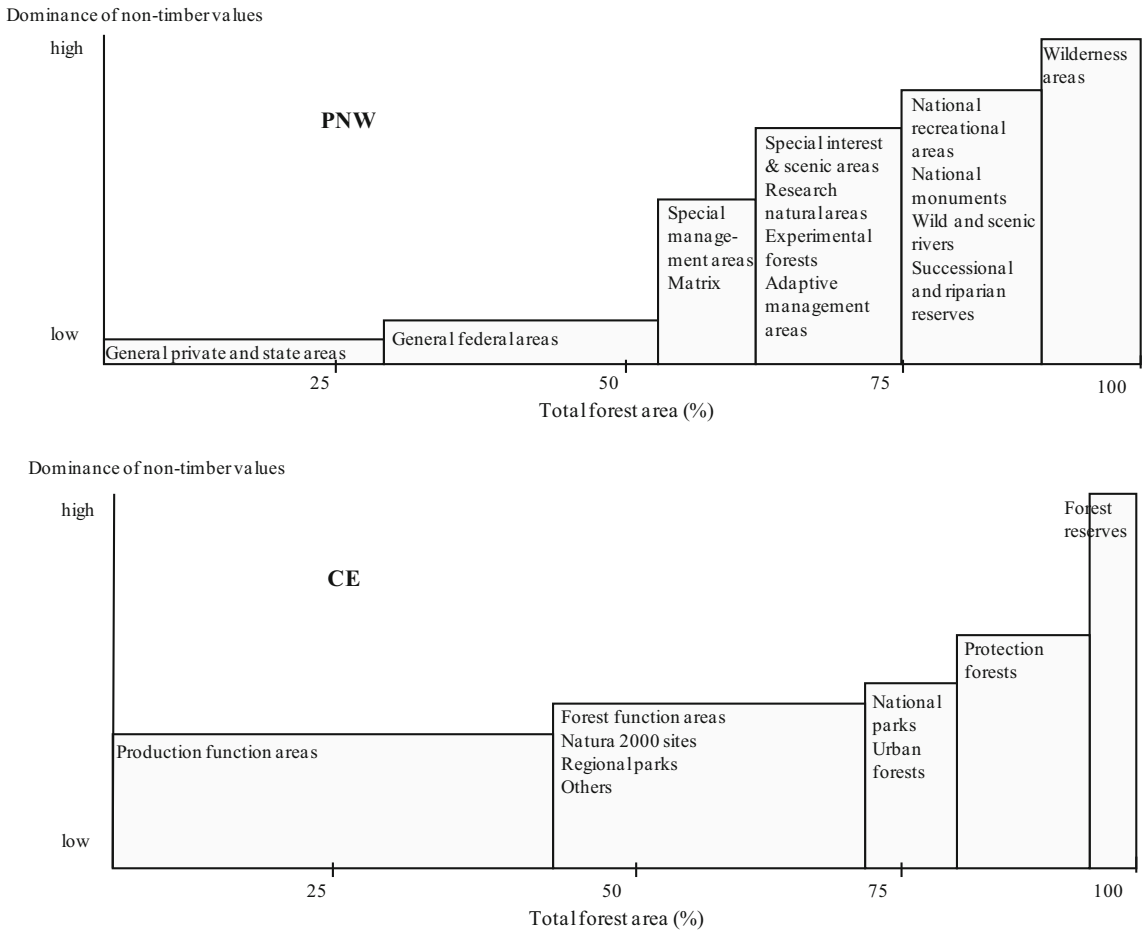

Fig. 1 Relative share of priority areas and general lands in total forest land (*x* axis) and their importance in providing non-timber services (*y* axis) across Pacific Northwest region of the United States (PNW) and Central European region (CE)

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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