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Analysis of institutional and technical adaptation: biodiversity conservation capabilities of forestry organisations responding to social-ecological challenges

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Abstract
We identify two principal foci of contemporary research and policy targeting sustainability. The first is institutions and social demand, more specifically incentives, spurring public-goods producing behaviours and innovations. The second is technology and best management actions; techniques that enhance resource productivity and environmental conservation. We identify a significant gap in our knowledge in that little attention has been paid to what lies between incentives and action. Organizational adaptation and learning in response to environmental change and social demand for ecological integrity have not been adequately studied. By some formal accounts, adaptation is assumed to be frictionless and knowledge is regarded as a public good. Our research takes the friction of adaptation and learning seriously. We study the processes of firms, agencies, territories and sectors developing conservation competencies; capacity to produce environmental conservation benefits while maintaining economic competitiveness and social development. Our empirical research on investments in biodiversity conservation competencies among forestry actors in Finland is illustrative of a situation in which a traditional and highly-institutionalized management system, spanning a variety of spatially distributed socio-economic and social-ecological conditions, is confronting shifting social demand. We combine data from a survey of professional forest managers who delineate habitats to be set aside whilst planning forestry operations with regional ecological and social-economic data. Our analysis focuses on the conservation competencies that organizations, regions, and the sector as a whole, apply when integrating biodiversity conservation to the extractive function of forestry We find that variance in organizations' investments in competency formation do not strongly reflect regional socio-economic and social ecological conditions as analyzed in this study. More generally, we find little support for the notion that a subset of actors in Finnish forestry would have invested heavily to differentiate themselves on the basis of biodiversity conservation competencies. These results reinforce our earlier findings and point to isomorphism, i.e. lack of diversity, in the relevant population and the conservative character of innovation dynamics in Finnish forestry.

Introduction

The complex relationships between social and ecological systems are a major research challenge (Folke et al., 1996; Ezzati, 2001) and much contemporary sustainability policy addresses the uneven spatial distribution of ecosystem services and socio-economic activities (Millennium Ecosystem Assessment 2003). The literature on ecosystem resilience, vulnerability and adaptation addresses the important issues of dynamics of ecosystems and social-ecological systems (Holling 2001, Folke 2006, Folke et al. 2005). Less attention has been paid to actors' (individuals, organizations, sectors and territories) attempts to develop sustainable modes of practice in exploitation of natural resources as a response to the evolving social demand for increased ecological integrity. In these attempts, actors are dependent on the natural resource base, market demand for their services and products and, importantly, on the institutional constraints that they face at different levels.

Rural communities often depend on a single resource, such as forests. In these cases, the different actors' ability to redirect their capabilities in ways that are ecologically informed and, at the same time, continue to generate income, are crucial. Abundant natural resources in rural areas often coincide with low local economic development opportunities (Niskanen and Lin 2001, Stedman et al. 2007) while urban sprawl and economic investment can lead to increasing pressure on land resources and to resource depletion (Konijnendijk 2003). In both settings, the forest sector is struggling to integrate production and conservation of economic and ecological benefit streams.

The theoretical concept of an environmental Kuznets curve suggests that up to a certain point of development, increases in wealth will come at the expense of environment, and only when certain social and economic needs are met does the society start valuing and investing in environmental improvement (Costantini and Monni 2008). This hints at the possibility of a mode of economic development in which enhanced economic wellbeing is coupled with enhanced ecological integrity. The notion, with an emphasis on technical change and innovation, is oftentimes referred to as ecological modernization (Spaargaren and Mol 1992).

The forest sector provides an interesting case for examining sustainable development and processes of creating positive feedbacks between environmental improvements and socio-economic development. The forest sector is dependent on raw material generally available in rural areas but, at the same time, requires modern infrastructure and industry to turn the raw material into marketable products. The institutional support for these functions has typically a long history, and is more or less powerful in the rural administration (Farrell et al. 2000, Lachapelle et al. 2003, Selby et al. 2007). At the same time, forestry confronts the urgent challenge of integrating ecological concerns, biodiversity conservation in particular, into management practices.

In Finland, integration of economic and ecological functions in forestry has been explicitly addressed for some time by the legal requirement to conserve habitats of special significance in connection with commercial forestry operations, i.e. harvesting (Forest Act 1997). In conserving these Forest Act habitats, we assume that organizations and professionals invest in a range of skills and technologies as well information sourced through various networks. While we have found mobilization of competencies to vary extremely little across organizations and across different profiles of specialization (Primmer and Wolf 2007), in this paper we focus our attention on regional differences, and the possible effects that regional conditions have on organizations' resource mobilization in integrated habitat conservation. Our approach

focuses on organizational responses to increased demand for ecological integrity in varied socio-economic and social-ecological circumstances in a particular institutional context. By decomposing and analyzing the resources on which environmental conservation practice and learning rest, we seek to develop knowledge and methodologies to advance sustainable development research (Wolf and Primmer 2006). In particular, in this paper we investigate empirically organizational investments in competencies, and we explore the regional distribution of capacity to conserve habitats and, by extension, biodiversity.

A resource-based view of conservation

The public organizations (the 13 Regional Forestry Centres) have inventoried the various classes of Forest Act habitats, and they control this geo-referenced database which they apply when making forest management plans for non-industrial private forest owners. A proportion of these plans are produced by Local Forest Management Associations, which are local cooperatives focussed on planning and providing operational services to landowners. The third large group of actors that has a direct management role in non-industrial private forests is the large timber buying corporations. Their foresters plan management operations in connection with timber purchases. Although the inventory data are not openly available to all organizations, success in conservation of Forest Act habitats is high, with only 12% having been altered in forestry operations in 2007 (Tapio 2007). The process by which the organizations manage to integrate habitat conservation includes mobilization of various competencies (Primmer and Wolf, 2006). Competencies are defined here as constituent elements of the capabilities that individuals, organizations, sectors and territories employ as they compete and innovate.

Mobilization of competencies is the organizational response to evolving social demand for sustainable development. Forestry organizations interpret social demand for sustainable development in varying ways, depending on their institutional environment, the nature of the social pressure, and the channels through which the demand is expressed (Cashore and Vertinsky 2000). While the Finnish forestry actors are exposed to strong institutionalized policy and guidance (Van Kooten et al. 1999), there is significant regional variation in economic dependence on forests and conservation in the country. The forest sector accounts for up to a fifth of GDP in some regions, while urban areas are almost independent of forest sector income. The spatial distribution of parks and protected areas is similarly heterogeneous. Almost 25% of northern Finland is protected as parkland, while this proportion is barely over 1% in Southern Finland. We take these socio-economic and social-ecological conditions as the point of departure in this analysis of forestry organizations' conservation competency development. In the long-term, we seek to analyze and understand the spatial distribution of forest biodiversity conservation competencies. With this study, we make the initial effort of exploring the relationships between regional conditions and organizations' capabilities.

We address the regional socio-economic and social-ecological conditions in which organizations make their decisions on competency mobilization. Socio-economic conditions reflect the role of forestry as economic activity, and as income provider (Stedman et al. 2007). The development of the proportion of forest sector employment out of all employment, regional added value produced by the forest sector, timber price, and timber removals illustrate the regional dependence on forestry as an economic activity. Removals, that is, the annual cuttings influence also the ecological system, and the proportion of growing stock removed each year is central to the traditional

sustainable yield approach in forest research and policy (Farrell et al. 2000).One traditional way to compensate for the negative impacts of extractive forestry, has been the establishment of nature conservation areas. Conservation in preserves and parks established by law has more recently been supplemented with legally based habitat conservation in the commercially managed landscape, to combine conservation of valuable ecological functions with management for economic purposes. These legal conservation measures reduce somewhat the opportunity for economic gain in timber production (Koskela and Ollikainen 2001).

The assumption (or hypothesis) that we explore is that there are links between economic activity, ecological consciousness, sensitivity to market demands for greening, and conservation capabilities. Formal legal nature conservation requirements are likely to affect the need for competencies among actors. Increasing competencies, in turn, would support expanded ability to conserve habitats in connection with forestry operations, i.e. avoid breaking against legally defined standards. This is the habitat conservation outcome (Figure 1), which in turn influences the ecological conditions. Before describing our empirical analyses, we will elaborate on our conception of organizational competencies.

The competency, or resource, investments of business organizations have been found to indicate their ability to respond to changes in market demand. Also investments environmental competencies have been found to enhance success (Porter and van der Linde 1995; Russo and Fouts, 1997; Sharma and Vredenbug, 1998; Menguc and Ozanne, 2005). The approach that is applied in investigating organizations' idiosyncratic resources and strategies is known under the label of the so called resource-based view of the organization (Barney 1991). This approach is primarily focussed on arrangements within organization, rather than the environmental (market) conditions which on the other hand has dominated economic analyses (Nelson 1991). The resource-based view meets the economic view in institutional analysis of adaptation and technological development (Nelson and Sampat 2001). Technology and human capital are the main resources by which additional economic growth can be generated. Similarly, these resources, coupled with learning and knowledge exchange are keys to ecological modernization. But, investment in these resources is shaped by the institutional environment where actors operate. We have applied the resource based view in our competency analysis of forestry organizations responsible for integrated conservation, and found particularly management resources directed to information sourcing and management to contribute to active habitat conservation. (Primmer and Wolf, 2007).

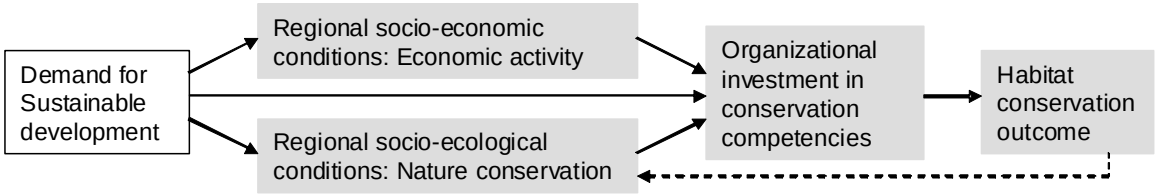


Figure 1. Explored relationships (dashed arrow represents non-analysed feed back)

Our aim here is to evaluate and compare forest sector actors' responses to the increasing challenge to integrate conservation into extractive forestry in a range of socio-economic and social-ecological conditions. In other words, we study the processes by which actors and territories develop conservation competencies; capacity to produce environmental conservation benefits while maintaining economic competitiveness and contributing to social development.

Methods

We conducted a nationwide survey of forest mangers that plan forestry operations to assess the biodiversity conservation competencies which they and their organizations apply in 2006. We drew a random stratified sample from comprehensive sample frames of public and private forest planners. Our statistical analysis is based on 311 valid responses (response rate 58%). These survey data are combined here with forestry and nature conservation statistics (Finnish 2006) and nature quality audit results (Forestry Development Centre Tapio) of the 13 Forestry Centre Regions in Finland.

Table 1. Human resources, organizational resources and information sources.

Human resources Scale 0-4		Years in profession			
Education	Biodiversity training	Experience			
Organizational resources Scale -1 to +2					
1. Procedures	2. Communication	3. Support	4. Data & maps	5. Time & money	6. Certification
Instructions and policies	Involvement of workers in developing org. practices	Guidelines	Field computer or GPS	Time	Forest Certification systems[1]
Guidelines for exceptions/ rare situations	Communication within organization	Co-workers' help	Maps	Financial resources	
Information management	Contact with clients	Assisting staff	GIS data		
Documentation	Contact with stakeholders	0.184	0.169		
Monitoring and auditing					
Continuous improvement of practices					
Information sources Scale 0-1					
1. Public agencies	2. Forestry actors	3. Internal	4. Forest administration		
Regional Environment Centre	Forest owner	Own organization. supervisor	Inventory data		
Land Use Register	Forest plan	Own organization. co-worker	Forest plan		
Municipal zoning	Own organization. subordinates	Own organization. nature specialist	Regional Forestry Centre		
Regional Council	Other forestry professionals				
Forestry Development Centre Tapio	Local Forest Management Association				
Finnish Environment Institute	Timber buyer				
	Logging contractor				

[1]Scale 0-4.

The competencies that we addressed in the survey, included human competencies (Table 1), organizational competencies (current status and development of a list of organizational management systems and practices, Table 1), and information sourcing patterns (frequency of information sourcing from list of actors, Table 1). Organizational resources and information sourcing were reduced through principal component analyses (Factor loadings >0.5) to address five categories of organizational resources: procedures, communication, support, data and maps, and time and money (Table 1). Additionally, certification was measured through a summary of positive responses to membership in four potential certification schemes. Information sourcing was reduced to four categories of information sources: public agencies, forestry actors, internal, and forest administration (Table 1).

The socio-economic variables that we included in our analyses were illustrative indicators of the share of forestry in regional economy on the one hand, and indicators of economic activity on the other. The variables were: timber price, intensity of removals (removals per growing stock), forest sector's share in regional GDP and the change in proportion of forest sector employment out of total employment during the last 15 years. As social-ecological conditions of competency investment, we included the proportion of forests conserved[1] and the proportion of forest land inventoried as Forest Act habitats. These are the legal arrangements to conserve areas and sites which are considered ecologically valuable, and which have been socially (or politically) evaluated as suitable for setting aside from economic use.

As a measure of habitat conservation outcome, we analyzed the regional Forest Act habitat audit results, i.e. the percentage of habitats in original or close to original (as opposed to partly or completely altered) status after the forestry operation.

We first examined the descriptive statistics of the different variables of the 13 regions. We ran Analysis of Variance on the resource variables across the 13 regions, to detect variation across regions. We then proceeded to analyze socio-economic and social-ecological indicators with human resources, organizational resources and information sourcing as well as habitat conservation outcome through correlations. Based on the correlations, we chose a set of competencies for the regression analyses, based on which we built an explorative path illustrating conditions, investments and success in sustainable development. Because the Lapland Regional Forestry Centre (the northernmost region) was an outlier with respect to percentage of land in protected status (23% compared with the second highest 5,30%), we excluded this region from the correlation and regression analyses.

Results

Socio-economic indicators. Regional differences in economic activity were substantial with the share of forestry in GDP ranging between 1.3 and 21 percent (Table 2). The most forest dependent economy was located in South-Eastern Finland, while the economies where the forest sector had a small share were located in Western Finland. These areas had low average timber prices. Forestry activity was intense in terms of removals relative to the growing stock in Southern and Central Finland (Map 1.).

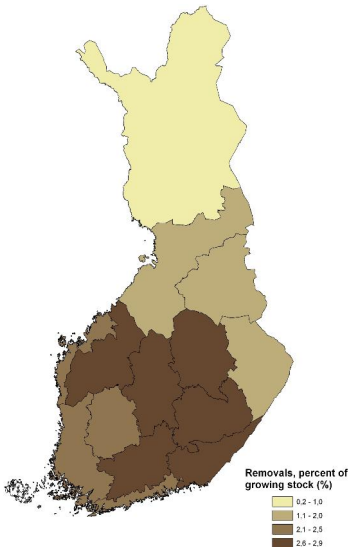
[1] *Protected forest and forests under restricted use,* *percent of forest and scrub land.*

Timber extraction was somewhat related to the development of jobs in forest sector (R 0.395, Sig.0.204 (2-tailed), Appendix 1). Forest sector employment development was almost positive in areas where the largest proportion removals of the forest stock was harvested, with the exception of Lapland, where positive development in forest sectors' share of employment took place, with the lowest proportion of growing stock removed. While the situation of Lapland reflects the special ecological conditions in that growth is slow and ecosystems are sensitive, increase in employment share is largely due to regionally focused conservation and employment policy. Otherwise, it seems that extractive functions dominate in contributing to jobs and economic activity (Appendix 1).

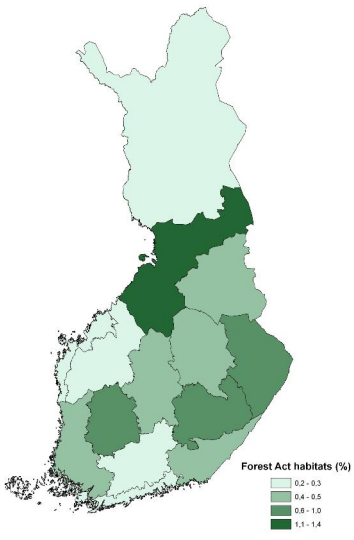
Social-ecological indicators. As we mentioned in the introduction, the distribution of conservation areas is extremely skewed across Finland, with a great majority of all legally established parks and preserves being located in Northern Finland. Lapland had the largest wilderness areas, and 23 percent of forest and scrub land protected (Table 3). With traditionally intense and diverse land use in the privately owned properties in the south, a very low proportion had been conserved in these areas. Addressing this void in conservation is the target of recent policy processes focused on conserving southern Finland's biodiversity (Government 2002). The approach to conservation that is being pursued in Southern Finland is not focused on taking large areas of land out of production. Rather, the focus is on conserving the ecologically most valuable areas. Because it will be economically, socially and politically difficult to create large, interconnected conservation areas (Horne et al. 2006), protecting biodiversity in commercially managed forests becomes even more important.

Table 2. Socio-economic indicators in 13 Forestry Centre regions.

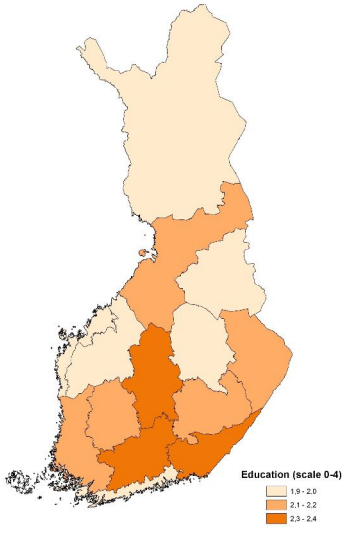
	Min	Max	Mean	Median
Timber price, € per m^3	10.5	12.56	11.78	11.99
Removals, percent of growing stock	0.20	2.91	2.20	2.48
Forest sector's share in GDP	1.3	20.9	9.59	10.1
Change in proportion of forest sector employment out of total employment, 1990-2005, %	-3.1	1.2	-1.12	-1.2



Map 1. Intensity of removals



Map 2. Forest Act habitats



Map 3. Education

Table 3. Social-ecological indicators in 13 Forestry Centre regions.

	Min	Max	Mean	Median
Area protected , percent of forest and scrub land	1	23	4.27	2.3
Forest Act habitats, percent of forestry land	0.2	1.4	0.52	0.4

To this end, conservation of habitats of special significance has been included in the Finnish Forest Act (1997). These habitats were not as unevenly distributed as the parks and preserves (Map 2). The area inventoried as Forest Act habitats represented a share between 0.2 and 1.4 percent of forestry land. Conservation in protected areas and proportion of Forest Act habitats were related, (R 0.550, Sig. 0.064, Appendix 1). The larger proportion of Forest Act habitats in some regions is to a large extent the result of ecological characteristics of the area.

Relationship between socio-economic and social-ecological indicators. The intensity of removals and conservation had a very significant inverse relationship (R -0.927 Sig. 0.000, Figure 2). Conservation was also negatively related to forest sector employment change and GDP (Appendix 1), and the same negative relationships applied between socio-economic indicators and Forest Act habitat proportion, with particularly employment development being inversely related to areas set aside (-0.652 Sig 0.016, Appendix 1). These relationships suggest that there can be a tradeoff between different foci in the use of ecosystem functions in different regions. If this is the case it represents a challenge for the ecological modernization and sustainable development expectations, even if the underlying causes are related to logistics and production conditions (lower cuttings in remote areas with poorer wood production) and general economic conditions (generally lower level of economic activity in sparsely populated regions).

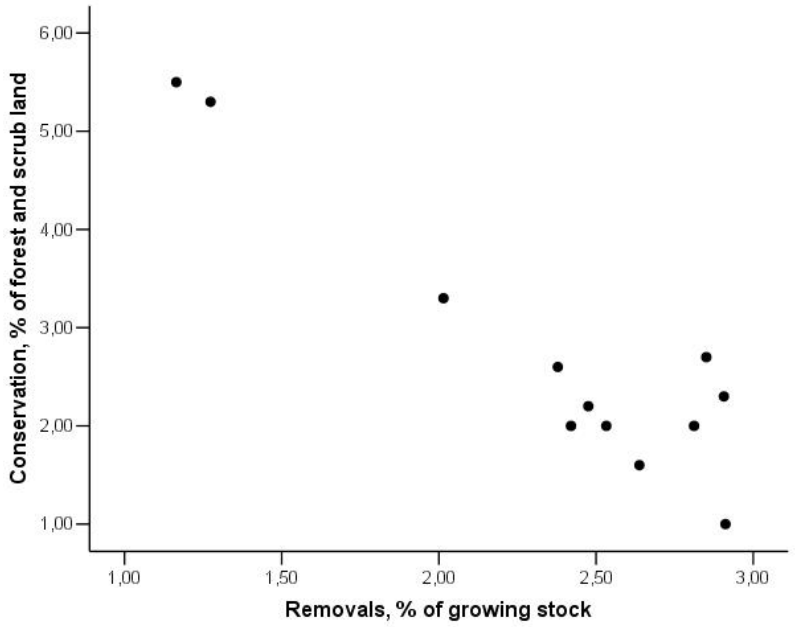


Figure 2. Conservation and removals in 12 Forestry Centre regions. Competencies.

The competencies that the forestry organizations and their forest manager employees held did not vary much across the regions (Table 4). We have found this isomorphism to show also across different organization types and different profiles of specialization among the population of forest mangers (Primmer and Wolf 2007). Foresters had largely the same vocational credentials across the country (college or bachelor level forestry degree) with slightly higher level in southern and central Finland (Map 3, Table 4). Forestry organizations in different areas of Finland applied rather similar levels of organizational resources, with biggest differences in support and communication systems (Table 4). Similarly, information sourcing was also only slightly differentiated geographically. Levels of information sourcing from public agencies and forest administration were very low but varied so that southern and central Finland had a relatively higher level of information sourcing particularly from public agencies than the rest of the country.

With the small differences reflecting the institutional isomorphism and strong policy guidance (Van Kooten et al. 1999), even small differences can be important. Considering the large regional differences in socio-economic and socio-ecological circumstances, it remains interesting whether and how these contexts shape the actors' competencies.

Relationship between socio-economic and socio-ecological indicators and forestry organizations' conservation competencies. The correlations between regional indicators of forestry economic activity and conservation arrangements are listed in Appendix 1. Based on the correlations, a hypothesis that economic activity would trigger investment in conservation skills, management systems and information sourcing is only weakly supported. Intensity of removals, share in GDP and forest sector's proportion of employment development were however all positively related to at least one of the competencies which we measured in each competency category. Out of human resources, education and experience were related to several socio-economic indicators (Appendix 1).

Relationship between regional indicators, conservation competencies and habitat conservation outcome. On average, 88% of Forest Act habitats audited after forestry operations were in original status, i.e. they had not been altered. This regional habitat conservation outcome, i.e. the "success-ratio" varied between 82 and 97%. Regional habitat conservation outcome was not related to Forest Act habitat abundance (R 0.15 Sig. 0.0.486). Out of regional socio-economic conditions, Forest sector's GDP was related to habitat conservation outcome (0.767, Sig. 0.004). Of competencies, organizational support (0.644, Sig. 0.024), and information sourcing from forestry actors (0.626, Sig. 0.029) as well as biodiversity training, and data and maps were related to habitat conservation outcome (Appendix 1).

Table 4. Competencies in 13 Forestry Centre regions: descriptive statistics of all data (a) and for regional averages (b), and significance of analysis of variance of all survey responses in the 13 regions.

		Minimum		Maximum		Mean		SD		ANOVA Sig.
		(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)
Human resources										
Education	Scale 0-4	0	1.88	4	2.36	2.10	2.08	0.72	0.14	0.667
Biodiversity training	Scale 0-4	0	2.52	4	3.13	2.80	2.81	0.90	0.20	0.462
Experience	Years in profession	1	17.44	47	24.50	20.39	20.73	10.02	2.14	0.467
Organizational resources										
Procedures	Scale -1 to +2	-0.83	0.98	2.00	1.25	1.09	1.08	0.44	0.09	0.453
Communication	Scale -1 to +2	-0.50	0.83	2.00	1.25	1.05	1.03	0.48	0.13	0.037
Support	Scale -1 to +2	-0.33	0.88	2.00	1.29	1.03	1.02	0.39	0.11	0.053
Data and maps	Scale -1 to +2	0.00	1.10	2.00	1.41	1.25	1.24	0.47	0.09	0.576
Time and money	Scale -1 to +2	-1.00	0.30	2.00	0.81	0.51	0.53	0.67	0.15	0.569
Certified management system	Scale 0-4	0.00	1.22	4.00	2.00	1.51	1.56	0.93	0.22	0.366
Information sourcing										
public agencies	Scale 0-1	0.00	0.01	0.63	0.14	0.07	0.07	0.11	0.04	0.000
Forestry actors	Scale 0-1	0.00	0.21	0.75	0.38	0.34	0.34	0.18	0.05	0.102
Internallly	Scale 0-1	0.00	0.11	1.00	0.28	0.23	0.22	0.22	0.05	0.423
Forest administration	Scale 0-1	0.00	0.43	1.00	0.65	0.53	0.53	0.26	0.07	0.039

The correlations highlighted the rather weak relationship between broadly varying regional conditions and the rather uniform biodiversity conservation competencies as well as audited habitat conservation outcome. To further investigate the relationship, we used linear regression. We included all human resources as dependent variables in Model 1, due to many of them having a correlation with two-tailed significance below 0.20 with some regional socio-economic and social-ecological indicators. Further dependent variables were: organizational communication, support and certification, and information sourcing from public agencies, forestry actors and within own organization. All regional socio-economic and social-ecological indicators were included as independent variables.

The results of Model 1 are presented in Table 5 and illustrated in Figure 3. Based on the Adjusted R Square, we could see that the socio-economic and socio-ecological drivers usefully explained regional differences in organizational communication systems, i.e. in employer involvement as well as contacts with stakeholders and clients. Also organizational support and references as well as information sourcing within organization were explained by regional differences to some degree. Of human resources, only education was explained by socio-ecological indicators (Table 5, Model 1 in Figure 3).

Employment change implied less organizational communication, but more internal information sourcing. This can signal that a reduction in forestry contacts, stakeholders, and clients shifts communication from sharing through organizational systems, towards searching for information directly from own supervisors, coworkers and subordinates. The proportion of forest area in inventoried Forest Act habitats had the same direction of impacts on these communication and information competencies. This is probably due to competency requirements focusing less on social interaction type communication, more on substance-related information retrieving. Education was explained by Forest Act habitat share of forest land.

In model 2, we found that education and experience and Forest Act habitats as a proportion of forest land substantially explained variance in Forest Act habitat conservation outcomes. Forest Act habitats were included as an independent variable to control for ecological circumstances, and also accuracy of inventory. Forest Act habitats had a negative effect on habitat audited Forest Act habitat conservation. This indicates that where habitats are more abundant, violating conservation requirements is more common. Abundance can be related to unclear boundaries of habitats, and the forest managers can have a tendency to not appreciate the special character of habitats that do not differ from the general landscape. Pykälä (2007) has criticized professionals responsible for habitat inventory for not identifying habitats in areas where habitat types are abundant.

Both education and experience had a negative and significant impact on audited Forest Act habitat conservation in operations (Table 6). This could be interpreted as economic functions dominating at the cost of ecological integration, so that knowledge would be directed at cutting fine the marginal of legal protection, and risking breaking the law, rather than guaranteeing ecological integrity at the cost of income opportunity. The negative impact of experience, which is consistent with our earlier results (Wolf and Primmer 2006, Primmer and Wolf 2007) can be due to outdated habitat delineation capacity among older members of the workforce, or, stated more positively, heightened ability among younger, more recently graduated forest managers.

Model 3 combined Model 1 and Model 2 outcomes by including all those competencies which were explained by regional indicators, together with Forest Act habitat proportion, as independent variables predicting Forest Act habitat conservation outcome. Again, experience had a negative significant impact on habitat conservation. None of the other competencies had a significant effect on habitat conservation (Table 6).

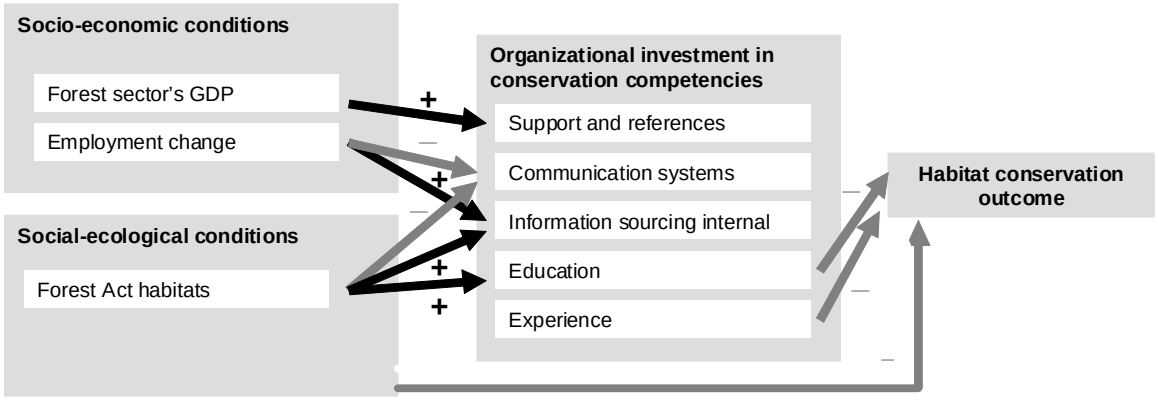


Figure 3. Observed relationships.

Table 5. Model 1. Regression analysis of social-ecological and socio-economic demand factors' effect on competencies

	Human resources						Organizational resources						Information sourcing					
	Education		Biodiversity training		Experience		Communication		Support s		Certification		Public Agencies		Forestry actors		Internal	
	Beta	Sig.	Beta	Sig.	Beta	Sig.	Beta	Sig.	Beta	Sig.	Beta	Sig.	Beta	Sig.	Beta	Sig.	Beta	Sig.
Conservation	-0.169	0.837	0.448	0.678	0.406	0.654	-0.255	0.466	0.249	0.740	-1.120	0.055	-0.814	0.394	-10.134	0.303	0.115	0.876
Forest Act habitats	0.867	0.085	-0.173	0.757	0.013	0.978	-0.414	0.057	0.254	0.523	-1.023	0.020	0.170	0.723	0.314	0.567	0.817	0.076
Timber price	-0.095	0.771	0.055	0.898	0.185	0.607	0.749	0.002	-0.292	0.347	.231	0.360	0.092	0.800	-0.039	0.925	0.149	0.617
Removals	0.256	0.737	0.031	0.975	0.951	0.281	0.530	0.137	0.512	0.472	-1.237	0.036	-0.401	0.640	-0.945	0.348	0.852	0.248
Forest sector's GDP	0.397	0.254	0.560	0.225	-0.352	0.345	-0.188	0.202	0.852	0.029	.098	0.681	-0.287	0.444	0.435	0.317	-0.202	0.501
Employment change	0.919	0.077	0.499	0.400	0.244	0.614	-0.967	0.002	0.276	0.499	-.032	0.933	0.476	0.353	0.338	0.549	0.570	0.189
R	0.815		0.651		0.773		0.971		0.848		.868		0.760		0.677		0.851	
R^2	0.665		0.424		0.597		0.942		0.719		.753		0.578		0.458		0.725	
Adjusted R^2	0.263		-0.268		0.114		0.872		0.382		.505		0.072		-0.191		0.395	

Table 6. Model 2. Regression analysis of competencies' effect on habitat delineation.

	Habitat conservation outcome			
	Model 2 Human resources		*Model 3 Competencies*	
	Beta	*Sig.*	*Beta*	*Sig.*
Forest Act habitats	-0.510	0.017	-0.729	0.036
Human resources				
Education	-0.434	0.028	-0.141	0.694
Experience	-0.687	0.004	-0.762	0.026
Organizational resources				
Communication			0.139	0.518
Support			-0.184	0.508
Information sourcing				
public agencies			-0.394	0.253
Internallly			0.139	0.530
R	0.896		0.940	
R^2	0.803		0.883	
Adjusted R^2	0.729		0.678	

Discussion

With an interest in sustainable development, and demand to combine economic success and ecological integrity, we have investigated the influence of regional conditions on organizational biodiversity conservation competencies. And, we have investigated the contribution of regional competencies to habitat conservation outcome. Despite the vast regional differences in socio-economic conditions in forest sector, and in legal conservation, we do not observe regions differentiating themselves with respect to organizational investment in competencies. The small differences which we identify, point to economic activity contributing to organizing support mechanisms and information exchange within organizations while volume of legal conservation is associated with, in addition to internal information sourcing, relatively higher levels education. Regions differ also more generally in communication and information sourcing. As both education and experience predict low success in habitat conservation, the challenge of integrating economic and ecological targets in operational forestry remains with the educational system. Younger generations of professionals will probably contribute to sustainable development practices.

The uniform competency mobilization of the various organizations in differing socio-economic and social-ecological circumstances reflects a national-scale sectoral convention. This is likely due to both centralized institutional control of the sector and less formal mechanisms of professional cognitive base and routine practice (Primmer and Wolf 2007). These mechanisms, that DiMaggio and Powell (1983) called coercive and normative isomorphism in their seminal work on institutionalization, lead organizations to follow a narrower set of approaches than what they might in a less stable and less historically rooted context. Also DiMaggio and Powell's (ibid.) mimetic institutionalism is possible. According to them, organizations would copy others' approaches to unclear situations where objectives are loose. The population of organizations would utilize technologies and practices already tested to save costs and avoid risks (March 1994, Nelson and Sampat 2001). It is possible the multifunctionality expectations facing the forest sector are insufficiently clear to initiate intensive investment in conservation competencies.

The institutionalization patterns can lead to reduced ability to adapt and innovate. According to Holling (2001), and researchers in economic innovation (Schumpeter 1934, Nelson and Sampat 2001), sudden changes in the system or the operating environment might trigger differentiating behavior to search for innovations and adapt to new circumstances. The biodiversity conservation challenge, so powerfully accentuated in policy and markets, has probably not disrupted the traditional structures and modes of action in Finnish forestry.

This might make the challenge of integrating new ecological objectives seem easy for a designer of a centralized policy, but casts doubts on the ecological modernization capability of the sector. If sustainable development in the sector rests on actors' commitments to competition, innovation and search for solutions, more diversity and targeted investments in conservation competencies are required. As sustainable development is more elusive, complex, and context dependent than what the national (bureaucratic, centralized) system can manage, adaptation can better be advanced through encouraging diversification of actors, practices and networks.

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APPENDIX 1

Correlations between all variables: social ecological indicators, socio-economic indicators, human resources, organizational resources, information sourcing and habitat conservation outcome in 12 Forestry Centre regions (Lapland excluded).

	Conservation	Forest Act habitats	Timber price	Removals	Forest sector's GDP	Employment change	Education	Biodiversity training	Experience	Procedures	Communication	Support	Data and maps	Time and money	Certif management system	Public agencies	Forestry actors	Internally	For admin
Social ecological indicators																			
Conservation	1																		
Forest Act habitats	,550	1																	
Socio- economic indicators																			
Timber price	,205	,275	1																
Removals	-,927(**)	-,506	-,156	1															
Forest sector's GDP	-,138	,046	,270	,105	1														
Employment change	-,474	-,675(*)	-,030	,395	-,231	1													
Human resources																			
Education	-,439	,016	,149	,393	,249	,426	1												
Biodiversity training	,021	-,239	,230	-,049	,393	,285	,046	1											
Experience	-,498	-,375	,021	,599(*)	-,314	,494	,230	-,065	1										
Organizational resources																			
Procedures	-,056	,093	,283	,243	,248	-,421	,001	-,191	,330	1									
Communication	-,336	,028	,478	,457	,309	-,337	,068	-,160	,248	,809(**)	1								
Support	-,394	-,095	-,029	,396	,740(**)	,001	,512	,195	-,028	,346	,295	1							
Data and maps	-,029	,115	,372	,033	,532	-,091	,195	,385	-,226	,314	,329	,700(*)	1						
Time and money	,574	-,029	-,179	-,478	-,311	-,157	-,807(**)	-,086	-,144	-,240	-,425	-,557	-,408	1					
Certified management system	-,009	-,634(*)	,057	-,123	,067	,410	-,427	,607(*)	-,072	-,363	-,261	-,220	-,001	,369	1				
Information sourcing																			
public agencies	-,515	-,384	-,057	,410	-,294	,652(*)	,628(*)	,164	,403	-,205	-,028	,079	-,016	-,634(*)	-,006	1			
Forestry actors	-,314	-,051	,070	,133	,418	,192	,296	,558	,238	-,039	-,012	,431	,339	-,412	,204	,304	1		
Internallly	-,437	,096	,193	,512	-,182	,342	,436	-,252	,319	,004	,198	,189	,295	-,374	-,404	,275	-,109	1	
Forest administration	,225	-,101	-,077	-,169	-,162	,246	,140	,583(*)	-,009	-,239	-,328	,046	,183	-,059	,147	,491	,234	-,164	1
Habitat conservation outcome																			
Forest Act habitats conserved	,008	,223	,132	,005	,767(**)	-,318	,309	,492	-,120	,301	,218	,644(*)	,404	-,374	-,140	-,048	,626(*)	-,350	,289