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Research, part of a Special Feature on Ecological Restoration, Ecosystem Services, and Land Use

Social success of in-stream habitat improvement: from fisheries enhancement to the delivery of multiple ecosystem services

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ABSTRACT. Stream restoration often aims to enhance fisheries by improving stream conditions for target fish species. However, river restoration has a potential impact on a variety of ecosystem services. Among stakeholders, the emerging expectations about restoration attain different priorities. How well these expectations are met influences social perceptions of success or failure. Although public support for restoration is known to have a significant impact on the sustainability and overall success of restoration, social aspects are rarely considered in this context. To address these issues, we conducted a questionnaire study among the residents and fishermen of three recently restored rivers in Finland. Results indicate that both user groups highly supported the restoration goals, but they were not always satisfied with the restoration outcomes. The changes in landscape value and amenity and fish provisioning had the highest influence on the user groups' attitudes. Restoration-induced changes in ecosystem services showed clear variation between the different locations, but the differences in the perceptions of the two user groups were less evident. Comparing perceptions between the user groups and locations and applying the ecosystem services approach are a novel contribution to the debate on restoration success. Our study highlights the importance of perspective, social-ecological context, and adequate communication for success.

Key Words: *benefits; cultural value; evaluation; perception surveys; public satisfaction; restoration; river*

INTRODUCTION

In recent years, ecological-restoration scholars have accepted the idea of considering stakeholder satisfaction as part of the evaluation of restoration success (Woolsey et al. 2007, Shackelford et al. 2013). For example, Palmer et al. (2005) have suggested that ecological, stakeholder, and learning success form the main cornerstones for effective river restoration. Despite increasing interest, ecosystem services and other socioeconomic outcomes have rarely been identified in this context, limiting our understanding of the full benefits and costs of ecological restoration (Acuña et al. 2013, Wortley et al. 2013).

Restoration is a value-driven process in which different expectations about the restored ecosystems provide the societal framework for the restoration project (Bliss and Fischer 2011). Socioeconomic drivers often motivate the decision to start the restoration project (Hagen et al. 2013). According to the social-ecological systems approach (e.g., Ostrom 2009), the support of stakeholders and the efficacy of the socioeconomic and political settings are also reflected in the initial success and long-term sustainability of restoration (Naiman 2013, Petursdottir et al. 2013, Metcalf et al. 2015). To understand the reasons for the (non) acceptance of a restoration project, it is crucial to examine public views (Buijs 2009) and to consider the commonalities and diversity of local experiences (Connelly et al. 2002, Schaich 2009, Barthélémy and Armani 2015).

The ecosystem services approach provides a tool to acknowledge what restored ecosystems can deliver for humans (Schultz et al. 2012, De Groot et al. 2013). In addition to a range of ecosystem functions, rivers provide various social benefits, such as a transport medium or tourist attractions, having thus a high environmental and social value (Perni et al. 2012, Che et al. 2014). The degradation of river ecosystems has influenced the interactions between people and nature, and as a result, the ecosystem goods and services that are provided by rivers to society have declined over time (De Groot et al. 2013, Gilvear et al. 2013).

Ideally, restoration can improve both ecosystem health and important services (Golet et al. 2006, Rey Benayas et al. 2009, Åberg and Tapsell 2013). However, many of these potential benefits and their value to society are generally ignored, largely because the scientific evidence base for these benefits is often lacking (Aronson et al. 2010, Gilvear et al. 2013).

Stream restoration may enhance biodiversity, biodiversity's intrinsic values, and the sustainable use of aquatic and riparian ecosystems by recovering ecosystem services. Although evidence of ecological benefits is often lacking, socioeconomic studies indicate that changes in immaterial services (e.g., aesthetics, sounds, scenery, and landscape) have been perceived as successful (Jähnig et al. 2011, Åberg and Tapsell 2013). Naturalized river ecosystems are preferred and found more attractive for the aesthetic outcome, which may in turn increase the cultural value of the river by affecting user groups' attitudes and actions (Junker and Buchecker 2008, Seidl and Stauffacher 2013, Åberg and Tapsell 2013).

This study identifies the possible effects of stream restoration on river ecosystem services and user groups' satisfaction. We compared the perceptions of restoration outcomes between local residents and recreational fishermen on three recently restored rivers in Northern Finland. To our knowledge, such comparisons have not been conducted under the ecosystem services approach, particularly in river ecosystems.

In Finland, stream restoration has focused on main channels and tributaries that were channelized to facilitate timber floating, mainly between the late 19th century and mid-20th century. Since the 1970s, timber floating was gradually abandoned, and efforts to restore streams closer to their natural state were initiated (Yrjänä 1998). A primary goal of the restoration efforts has been to enhance fishing opportunities by recreating the stream habitat, especially for salmonid fishes. A number of studies evaluating the ecological and hydromorphological restoration success have been carried out (e.g,. Vehanen et al. 2010, Marttila et al. 2015), but

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the systematic evaluation of social, cultural, and economic aspects is generally lacking in this context. Thus far, how the different users of rivers perceive the success of restoration and the changes in ecosystem services is largely unknown. Therefore, our study focused on the following questions: (1) Which ecosystem services are impacted through stream restoration? (2) How do changes in these services affect general satisfaction and river use? (3) Does the degree of satisfaction and perception of changes vary between user groups and study rivers?

METHODS

Study sites

Our study rivers, Kiiminkijoki (170 km in length; 65°19 N, 25°30 E), Kostonjoki (35 km; 65°57 N, 28°18 E), and Simojoki (193 km; 65°62 N, 25°04 E) are located in the northern part of Finland and drain into the Gulf of Bothnia (Kostonjoki via the river Iijoki). All three rivers are protected from hydropower construction, but the river flow in Kostonjoki is regulated for the use of the hydropower stations in the river Iijoki. Although the water quality of the rivers is altered by increased humic substances and nutrient loading originating from local land-use practices, the ecological status of the rivers is classified as good to excellent (the same status given in the evaluations of 2008 and 2014).

The rivers are popular fishing and recreation sites, attracting visitors from afar, and their natural and recreational value is therefore significant. Simojoki is home to one of the two remaining original and naturally reproducing Baltic salmon (*Salmo salar*) stocks in Finland. In Kiiminkijoki, the native Baltic salmon population was lost by the end of the 1970s, and the salmon was later reintroduced to the river. The migration of salmonids to Kostonjoki is currently enabled from the upstream lake area but not from the Baltic Sea, thus excluding the salmon from the expected catch.

By the late 1950s, all of the study rivers were channelized for timber floating. Floating was ended in the 1960s in Kiiminkijoki and Simojoki and in the late 1980s in Kostonjoki. Part of the river channels and salmonid habitats were restored in Kiiminkijoki and Simojoki between the late 1970s and the late 1980s. More comprehensive restoration was conducted on all three rivers in the 21st century (Kiiminkijoki 2003-2004, Kostonjoki 2005-2009, and Simojoki 2002-2006) with the primary aim to improve in-stream habitat conditions for the salmonid populations and the overall ecological state. The restoration measures were conducted considering also canoeing opportunities and local problems related to flow and ice conditions. The restoration measures were implemented fairly recently, allowing us to assume that the prerestoration state was well recalled by the different user groups.

The protocol of in-stream habitat restoration (Roni et al. 2008) applied on the study rivers includes returning large boulders and spawning gravel to the stream channel and reopening the side channels. As a result, channel and hydraulic complexity, channel width, and mean water depths will generally increase, whereas flow velocities will decrease (Marttila et al. 2015). These changes are expected to increase species diversity and the production of the target fish species. Although in-stream restorations have generally overlooked the riparian ecosystems and the river landscape (Nilsson et al. 2005), their effects on ecosystem service delivery reach far beyond the stream banks.

The biological responses to stream restoration have been largely variable (Luhta et al. 2012, Nilsson et al. 2015) or have shown little evidence of ecological success (Louhi et al. 2011). For example, the short-term evaluation of restoration success on the river Kiiminkijoki showed no response of one-year-old salmon to restoration. A significant increase in the amount of suitable habitats under summer conditions was observed, but the improvement of overwintering habitats was only marginal (Koljonen et al. 2012). Detailed biological surveys with a longer timescale have been conducted on our study rivers, but the analyses of these data have not been completed, and the validation of the questionnaire data by biological results was not possible in this paper. Therefore, the study relies largely on views of the stakeholders, which may to some extent be inconsistent with the results concerning ecological success.

Questionnaire

The opinions of the fishermen and residents on the restoration effects were investigated by conducting a questionnaire study in 2013-2014. An informative postcard encouraging the recipient to participate in an Internet survey (Harava template, © Dimenteq Oy, https://www.eharava.fi/en/) was sent to all fishermen (total 1462) that had bought a fishing licence in 2013 to one of our study rivers. A sample of residents (total 719) was compiled by first outlining all the properties in close proximity to the restored river sections; maximum distance from a study stream was 150 m and maximum distance from any restored river section 5 was km. Next, all of the addresses at Kostonjoki, whose total population was smaller than that at the two other rivers, and every third one at Kiiminkijoki and Simojoki received a postal survey. Both user groups were informed that they could answer either on paper or via the Internet. They were reminded about the survey two weeks after the first round. Of all sent questionnaires, the fishermen returned 26% and the residents returned 42% (Table 1; fishermen n = 380, residents n = 302).

Table 1. Sent and returned questionnaires, including the achieved return rate from the three study rivers. The before-after groups include respondents who knew about the restorations and had lived near or visited the river before the restorations.

	Kiiminki	Kosto	Simo	Total
Fishermen				
Sent	735	166	561	1462
Returned (%)	199 (27)	70 (42)	111 (20)	380 (26)
Before-after (%)	51 (26)	57 (79)	41 (37)	149 (39)
Residents				
Sent	465	46	208	719
Returned (%)	167 (37)	25 (54)	110 (53)	302 (42)
Before-after (%)	73 (44)	22 (88)	77 (70)	172 (57)

In the questionnaire, we used a combination of fixed-choice and open questions. The questions for the fishermen focused mainly on restoration-induced changes in fishing habits, opportunities, and the catch, and for the residents on the changes in various social and ecosystem functions and recreational opportunities. We created a block of statements measuring perceived change in, for example, the stream ecosystem, recreation, landscape aesthetics, and the attractiveness of the river after the restoration;

Table 2. Factors revealed in the factor analysis, percentages of explained variance, and loadings of the statements onto the factors. Ecosystem services were derived from the factors for the two user groups separately.

Factors	% of variance	Statements	Loadings
Fishermen			
1. Landscape value and amenity	37.4	River landscape has become more natural	0.759
		River landscape has become more beautiful	0.842
		River sounds have become more pleasant	0.656
2. Fish provisioning	8.6	Fish community has become more diverse	0.779
		Valuable fish species have become more abundant	0.699
3. Habitat structural diversity	7.2	Depth variability is appropriate	0.646
		The amount of boulders is appropriate	0.594
		Boulders are well placed	0.666
4. Fisheries opportunities	6.6	There is a proper amount of spinning and fly-fishing spots	0.708
		Suitability for fishing has improved	0.793
Residents			
1. Landscape value and amenity	41.0	The amount of boulders is appropriate	0.650
		Boulders are well placed	0.565
		Residential amenity has increased	0.504
		River has become more attractive	0.520
		River landscape has become more natural	0.802
		River landscape has become more beautiful	0.873
		River sounds have become more pleasant	0.565
		River and its surroundings have become more suitable for outdoor activities	0.604
		Fishing opportunities have improved	0.558
2. Fish provisioning	8.9	Fish community has become more diverse	0.736
		Fish stocks have increased	0.884
3. Travel on water	7.2	Water levels have improved also during summer low-flow conditions	0.503
		Boating hasn't become more difficult	0.655
		Canoeing has become more interesting	0.635
4. River ice processes	5.7	Formation of ice jams during the ice break up hasn't increased	0.629
		Formation of frazil ice hasn't increased	0.596

there were 24 statements for residents and 18 for fishermen. The respondents had to answer these statements using a five-point Likert scale ranging from completely agree to completely disagree.

Data analysis

The data collected by fixed-choice (questions and answer choice grids) questions were analysed using SPSS version 21 (IBM, Armonk, New York, USA). The fishermen's and residents' answers were analyzed separately. All statements were transformed into a positive form to enable comparisons between the statements.

We created a subsample including the respondents who knew about the restorations and had lived near or visited the river before the restorations. This group was assumed to be able to compare the condition of the river area before and after the restoration (Table 1). General satisfaction and perceived changes in recreational opportunities and the fishermen's catch were quantified for the group before and after. The other analyses were conducted using the data from all respondents.

The answers to the block of statements were fed into a factor analysis (principal axis factoring method using rotation with Varimax with Kaiser normalization), which revealed four factors for the residents and five for the fishermen. The fifth factor of the fishermen was excluded from further analysis because it consisted of only one variable. Other factors contained multiple survey statements (variables) that had similar patterns of responses. Each factor was then associated with an interpretable ecosystem service according to the variables clearly loading onto them (>0.5 at the rotation factor; Table 2). Mean factor scores for the different user groups and study rivers were computed to summarize the perceived changes in the given ecosystem services. Finally, we classified the services using the categories defined by the Millennium Ecosystem Assessment (2005) as cultural, provisioning, regulating, and supporting services.

A qualitative approach was used for the analysis of the open questions. The transcribed answers were clustered by user group, study river, and perceived direction of change to increase the understanding of the reasons for the commonalities and differences between the respondent groups.

RESULTS

Attitudes and general satisfaction

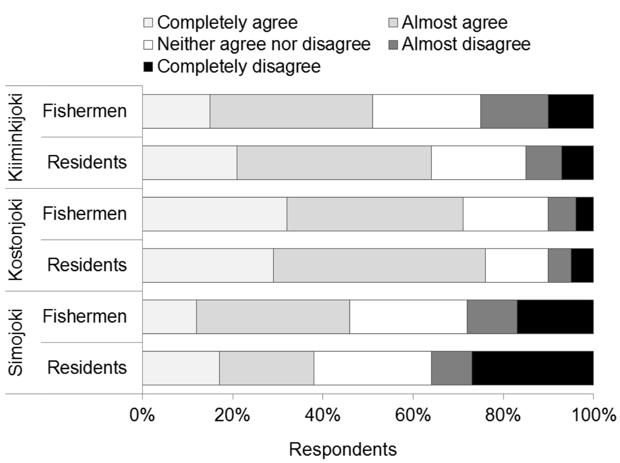
The majority of the respondents perceived the stream restoration as ultimately important for the stream biology (84% of fishermen, 86% of residents), recreational/fisheries opportunities (91% of fishermen, 83% of residents), and residential amenity (76% of residents). However, they were not always satisfied with the restoration outcomes (Fig. 1). Most of the residents (76%) and

Table 3. Mean factor scores of each ecosystem service for the three study rivers and the two user groups. The factor scores indicate the relative position of the respondent's perception on each factor.

		Kiiminki		Kosto		Simo	
Category	Ecosystem service	Fishermen	Residents	Fishermen	Residents	Fishermen	Residents
Cultural	Landscape value and amenity	0.03	0.1	0.15	0.53	-0.15	-0.27
Cultural	Habitat structural diversity	-0.03	-	0.11	-	-0.02	-
Cultural	Fisheries opportunities	0	-	-0.05	-	0.04	-
Cultural	Travel on water	-	0.08	-	-0.16	-	-0.08
Provisioning	Fish provisioning	0.01	0	0.11	0.32	-0.09	-0.07
Regulating	River ice processes	-	-0.05	-	0.04	-	0.06

fishermen (72%) at the river Kostonjoki were satisfied with the restoration, whereas at the river Simojoki fewer than half of the fishermen (46%) and only 39% of the residents were satisfied. At the river Kiiminkijoki, the residents (65%) were more often satisfied than the fishermen (51%).

Fig. 1. Distribution of answers to the statement "I am satisfied with the restorations," comparing the fishermen's (n = 129) and the residents' (n = 158) perceptions about the three study rivers.

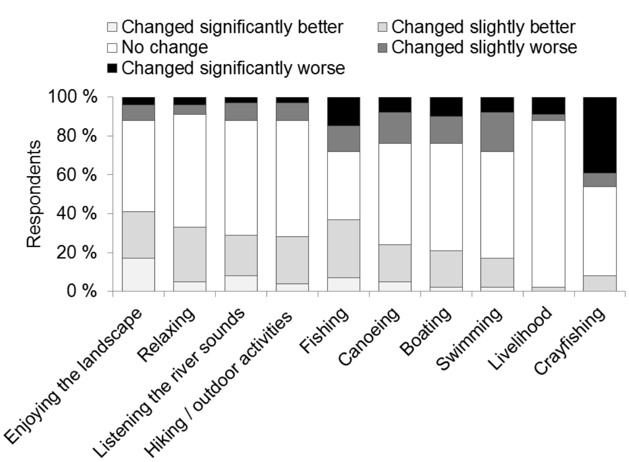


In addition to several comments expressing strong approval, some respondents claimed in the open questions that the restoration effects remained unclear or were negative. At Simojoki and Kiiminkijoki, many considered the in-stream habitat restorations insufficient to improve the river conditions; they thought instead that fishing regulations, water quality, and flow regime should be the main concern. Correspondingly, at Kostonjoki, the strong regulation of water flow and migratory obstructions on the river Iijoki were mentioned. Only if these problems were first mitigated could in-stream restoration show positive responses in the biota and eventually in the fishermen's catch. Sometimes dissatisfaction was related to unrestored sites, and additional restoration measures were demanded. There were also mentions that local opinions had not been taken into account and that information about both the expected and observed outcomes had been insufficient.

Cultural services

The residents perceived that the recreational opportunities had changed relatively little after the restoration, "no change" being the most common answer for almost all of the given activities (Fig. 2). Most positive changes were related to enjoying the landscape, both visually and aurally, and relaxing and hiking on the riverside. Although opportunities for crayfishing seemed to have worsened after the restoration, in the comments this was associated mainly with the land-use impacts and the crayfish plague.

Fig. 2. Changes in recreational opportunities after the restoration that were perceived by the residents (n = 43-136). Recreational activities from left to right are listed from the most satisfying changes to the least satisfying.



The first service derived from the factor analysis explained a significant proportion of the variation among the surveyed variables (Table 3). The service was denoted by landscape value and amenity for both the residents and the fishermen (Table 2); variables included aesthetic appearance and naturalness, and for the residents also the structural diversity of the river and the suitability of the site for recreational purposes. Perceived changes were the most positive at Kostonjoki and the most negative at Simojoki, but the difference was not as notable among the fishermen as it was among the residents.

The fishermen perceived that habitat structural diversity (third service, Table 2) had improved at Kostonjoki, whereas at Kiiminkijoki and Simojoki the changes were seen as slightly negative (Table 3). They saw the changes in the fisheries opportunities (fourth service, Table 2) as slightly positive at Simojoki and slightly negative at Kostonjoki, whereas the opinions from Kiiminkijoki were averagely neutral. The changes in the residents' third service, travel on water, were seen averagely as positive at Kiiminkijoki but negative at Simojoki and Kostonjoki.

Improved naturalness, attractiveness, and access to the river were often mentioned in the answers to the open questions. Especially, the river Kiiminkijoki was currently seen to offer good and family-friendly recreational opportunities, although water quality was partly hindering the use of water from Kiiminkijoki and Simojoki. Although the restorations on all three rivers were generally praised for improving the salmonid habitats and their variability, some of the respondents were disappointed in the current appearance of the restored sites in terms of water depth, flow velocity, and vegetation. A few Simojoki residents criticized the changes in the stream banks and the unnatural appearance of the rapids. These undesired changes were seen as harmful for recreational use, tourism, and fishing. Several residents stated that boating and canoeing had become more difficult after the restoration, and they demanded a clear passage for boating. On the other hand, some residents mentioned that Kiiminkijoki had become more attractive for canoeing. Increased water levels were seen either as a positive or a negative change, depending on the site. Concerns about water levels also extended to issues beyond the stream channel and its restoration, such as ongoing land-use practices and possible drinking water uptake in the future.

Many fishermen perceived fishing as being more interesting after the restorations, and some saw the restoration of Kostonjoki as the most successful of all restoration efforts so far. Some level of dissatisfaction was related to fishing during the summer low flows. There were several mentions that wading had become more difficult after restoration because of unattached and large boulders and unexpectedly deep spots, especially in Kostonjoki, but also in some rapid areas of Simojoki. A desire for additional restoration and the creation of spawning grounds emerged among the comments from Simojoki and Kiiminkijoki.

Provisioning services

For both the fishermen and the residents, the second factor revealed in the factor analysis was fish provisioning (Table 2). The change in this service was perceived as averagely positive at Kostonjoki, somewhat neutral at Kiiminkijoki, and negative at Simojoki (Table 3).

Perceived changes in the catch of the three most desired fish species varied highly among the respondents (Table 4), with more negative changes (28%-37%) than positive changes (16%-22%) reported. Also, the option "no change in the catch" was frequently chosen (one third of the responses). The most evident increase was reported for grayling (*Thymallus thymallus*) catch at Kostonjoki (41% of the responses), although a nearly similar percentage of fishermen (37%) reported no change. On the contrary, half of the respondents at Kiiminkijoki and Simojoki perceived that the grayling catch had decreased after the restoration. Also, brown trout (*Salmo trutta*) and Atlantic salmon (*Salmo salar*) catches at Kiiminkijoki and Simojoki were more often reported to have decreased (16%-50% of the responses) than increased (2%-13%), with many fishermen (16%-39%) perceiving that the catches had remained similar. At Kostonjoki, the perceived change in the brown trout catch was as often positive as negative (27% of the responses), whereas "no change" was the most frequent answer (35%).

Table 4. Perceived changes in the fishermen's catch of the three most desired fish species after the restoration of the study rivers.

	Kiiminki	Kosto	Simo	Total
Brown trout (*Salmo trutta*)				
Increase in catch %	13	27	3	16
No change %	39	35	16	32
Decrease in catch %	35	27	20	28
No catch %	13	11	61	24
N	46	52	31	129
Grayling (*Thymallus thymallus*)				
Increase in catch %	9	41	9	22
No change %	23	37	38	33
Decrease in catch %	49	18	50	37
No catch %	19	4	3	8
N	43	54	34	131
Atlantic salmon (*Salmo salar*)				
Increase in catch %	2	-	9	22
No change %	19	-	38	33
Decrease in catch %	16	-	50	37
No catch %	63	-	3	8
N	43	-	34	131

Although some respondents reported in the open questions an increased abundance of valuable fish species, many fishermen, especially at Simojoki, were disappointed in the restoration outcomes (no change or negative change perceived). Comments from Kiiminkijoki included an approximately similar amount of positive and negative views. According to the respondents at Kostonjoki, graylings had not only increased in amount but also in average size of individuals after the restoration, whereas the respondents at Simojoki perceived that the restoration had caused the most harm to this species. A common concern of the fishermen on both Kostonjoki and Simojoki was the fish community structure with an increased amount of pike, perch, and roach. This was thought to result from the decreased flow velocity that favors these species. On the other hand, many respondents perceived that the restoration had improved the salmonid habitat, even if they had not seen desired changes in the catches. These respondents showed careful optimism and wished to see positive results sometime in the future. Besides the restoration, multiple other factors influencing the fish provisioning service were mentioned, including water quality, fishing and predatory pressure, and fish stockings.

Regulating services

The fourth service revealed for the residents belonged to the regulating services and was related to the formation and fragmentation processes of river ice (river ice processes, Table 2). According to the residents of Kostonjoki and Simojoki, the restorations had not increased the formation of frazil ice and ice jams during the ice breakup, whereas at Kiiminkijoki, restoration effects on ice processes were considered slightly negative (Table 3).

In summary, the respondents at Kiiminkijoki perceived the most positive changes in the landscape value and amenity service, and the most negative changes in habitat structural diversity (fishermen) and river ice processes (residents). Also at Kostonjoki, the most positive changes were perceived in landscape value and amenity, whereas changes in fisheries opportunities (fishermen) and travel on water (residents) were considered the most disappointing. By contrast, the respondents of Simojoki perceived the changes in landscape value and amenity as the most negative and the changes in fisheries opportunities (fishermen) and river ice processes (residents)as the most positive.

DISCUSSION

Among the public, differing judgments of restoration success arise from different expectations regarding the question, “What is the desired end point of restoration?” (Seidl and Stauffacher 2013). Positive or negative perceptions are also rooted in site-specific physical features, management and landscape context, local history of socionatural interactions, and political and economic issues (Schaich 2009, Barthélémy and Armani 2015). In this study, we compared the social perceptions between the different restoration sites and user groups. As expected, our results showed clear variability between the different locations (Tunstall et al. 2000, Seidl and Stauffacher 2013, Barthélémy and Armani 2015). However, the perceptions of restoration outcomes were largely similar between the different user groups, although some differences were seen in general satisfaction.

There is a broad consensus on the importance of public acceptance for long-term restoration success (Naiman 2013, Metcalf et al. 2015). If the restored site is highly approved, it is likely to be treated with special care over the long term (Junker and Buchecker 2008). Similar to our observations, Connelly et al. (2002) noted that ecosystem restoration goals are more generally approved than specific restoration actions. On the other hand, easier access to the river, recreational opportunities, and attractive scenery and wildlife are likely to help to reconnect people with the restoration site (Åberg and Tapsell 2013). According to our analysis, these variables played a key role in creating approval or nonapproval at the study rivers.

We identified a range of services that were impacted by stream restoration, and the respondents perceived that landscape value and amenity was impacted the most. Site-specific variation in this service reflected the opinions on aesthetic appearance and naturalness that are often the public’s main criteria in judging restoration outcomes (Higgs 1997, Tunstall et al. 2000). Radical changes in the river channel and its surroundings can cause long-lasting public discontent (Åberg and Tapsell 2013). Sometimes the aesthetics are also associated with the ecomorphological quality of the river, the satisfaction of human needs, and the suitability of the site for recreational purposes (Junker and Buchecker 2008, Barthélémy and Armani 2015). The residents in our study were possibly following this logic or at least saw similar changes in all these variables because they were included in the first service. Even though the residents did not see much change in the recreational opportunities after the restoration, many of them thought that the restoration sites were providing more enjoyment to the public.

The fishermen, instead, seemed to construe fisheries opportunities and habitat structural variability more independently from the first service, and the same was noted for travel on water for the residents. The site-specific values of fisheries opportunities and travel on water were also inconsistent with the general satisfaction, although the importance of the services was evident among the responses.

Perceived changes in fish provisioning seemed to influence the overall perceptions of restoration benefits (Acuña et al. 2013). Abundance of the target fish species may be an indicator of ecological integrity, but it is also seen as a resource that affects fisheries opportunities, the attractiveness of the river, and local employment (Dufour and Piégay 2009, Schultz et al. 2012). The respondents in our study had not always observed improvements in the abundance of the desired fish species. In general, studies on ecological success have produced conflicting results, with some suggesting positive effects on stream biota and others revealing little or no benefits for lotic organisms (Stewart et al. 2009). Although the perceptions of the respondents are not direct measures of fish abundance and conclusions may be misleading, our findings may at least partly reflect site-specific differences in ecological success.

Many respondents perceived that it was still too early to judge the restoration outcomes. Some of them were positive that the abundance of fish and recreational opportunities would increase over a longer period of time and that more time was needed to allow the ecosystem to recover (Tunstall et al. 2000). The timescale over which restoration will improve different ecosystem services may also vary to a great extent. In the short term, restoration can increase the provision of some ecosystem services while perhaps even causing damage to some others (Gilvear et al. 2013). For example, in our study, the newly restored sections of the river Kostonjoki were sometimes considered too challenging or even dangerous from the users’ perspective, but fish provisioning and attractiveness had improved. However, improvements in these other services and accumulation of the benefits they provide may be achieved in the long term (Gilvear et al. 2013). Consequently, resident support may also improve over time (Purcell et al. 2002, Åberg and Tapsell 2013). In our study, however, the general attitudes were more positive toward the most recent restoration project than toward projects conducted several years ago.

At the rivers Kiiminkijoki and Simojoki, many perceived that the outcomes of stream restoration remained weak because of ineffective fishing regulations and inadequate water quality. Therefore, they demanded larger scale actions, an approach highly supported by other studies (Golet et al. 2006, Bernhardt and Palmer 2011). Nevertheless, ecological improvements are difficult for the public to perceive (Barthélémy and Armani 2015), especially in the case of slow-changing variables (Tuvendal and Elmqvist 2011). Sometimes the stakeholders may be critical of the restoration outcomes because of misconceptions. For example, Gardeström et al. (2014) noted that the stakeholders were concerned about returning boulders into the stream channel because they expected water to disappear and fishing to become difficult. Their results, as well as those of many others (e.g., Marttila et al. 2015), have shown, however, that restoration typically decreases flow velocity and increases water depth.

Providing information on realistic expectations and the obtained results could help to avoid disappointments and to increase the understanding of ecosystem benefit trajectories over time (Tunstall et al. 2000, Åberg and Tapsell 2013). Also, the relevance of specific species or processes needs to be communicated; if it is not, their importance may remain underestimated among the public. This is likely in the case of nonuse values and values related to regulating and supporting services that may benefit human welfare only indirectly (Schultz et al. 2012).

Trade-offs between ecological goals, ecosystem services, competing land uses, and funding are inevitable in restoration (Gilvear et al. 2013). Although ecological constraints set limits on what is possible based on the biophysical realities, societal constraints set limits on the possible extent of restoration activities in terms of what is acceptable and realistically achievable (Miller and Hobbs 2007). Sometimes the interests and opinions of stakeholders are distinct from the scientists' view of what would be ecologically justified (Tunstall et al. 2000, Palmer 2009). For example, safety, improved access, and an attractive riverside with related recreational facilities were perceived as important restoration outcomes in our survey. Typically, river restoration aims to restore a particular ecosystem service but meets societal pressure to deliver other services in addition (Gilvear et al. 2013). According to Hobbs et al. (2004:43), it is challenging to tackle all the societal expectations and "a mix of scientific uncertainty, value-laden decisions, and unrealistic expectations can lead to costly and demoralizing failures." Here, a value-based dialogue about the trade-offs and a clear evaluation of what is possible in particular cases, and at what costs, are critical (Hobbs et al. 2004, Failing et al. 2013).

Bliss and Fischer (2011) have noted that successful ecological restoration requires sound ecological science, but also an understanding of the dynamic interactions among people, as well as between people and the landscapes they inhabit. Integration of social sciences with ecological research in the context of river restoration is clearly needed to increase the understanding of the overall benefits within the larger social-ecological context, as well as the efficacy and sustainability of future restoration projects (Mutz et al. 2013, Naiman 2013, Wortley et al. 2013). Detailed biological surveys have been conducted in our study rivers both before and after the restoration that together with this sociological data will enable the multidisciplinary evaluation of stream restoration success in our future studies.

CONCLUSION

This study aimed to increase the understanding of social perspectives concerning restoration success. The results show that the changes in landscape values and fish provisioning had the highest influence on the user groups' attitudes. By analyzing the ecosystem services and their role in social success, our study helps to identify the underlying reasons for support and opposition that ecological restoration may encounter. It shows that the restoration outcomes were not evaluated separately from the surrounding landscape and society, because opinions about the restoration effects on the ecosystem services differed between the rivers. We argue that the key factors causing these differences are the following: (1) whether the expected benefits are realistic in relation to the local social-ecological constraints, ecosystem benefit trajectories, and the spatial scale of the restoration; (2) whether the social aspects are properly considered; and (3) how well user groups are informed of the restoration effects both before and after the project's implementation. Because of the site-specific patterns of social perceptions, knowledge obtained from comparative studies is significant for future restoration efforts because these studies highlight the local specialities that need to be recognized and discussed with the stakeholders.

Responses to this article can be read online at:
http://www.ecologyandsociety.org/issues/responses.php/8118

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