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Are Socioeconomic Benefits of Restoration Adequately Quantified? A Meta-analysis of Recent Papers (2000–2008) in *Restoration Ecology* and 12 Other Scientific Journals

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Abstract

Many ecosystems have been transformed, or degraded by human use, and restoration offers an opportunity to recover services and benefits, not to mention intrinsic values. We assessed whether restoration scientists and practitioners use their projects to demonstrate the benefits restoration can provide in their peer-reviewed publications. We evaluated a sample of the academic literature to determine whether links are made explicit between ecological restoration, society, and public policy related to natural capital. We analyzed 1,582 peer-reviewed papers dealing with ecological restoration published between 1 January 2000 and 30 September 2008 in 13 leading scientific journals. As selection criterion, we considered papers that contained either "restoration" or "rehabilitation" in their title, abstract, or keywords. Furthermore, as one-third of the papers were published in *Restoration Ecology*, we used that journal as a reference for comparison with all the other journals. We readily acknowledge that aquatic ecosystems are under-represented, and that the largely inaccessible gray literature was ignored. Within these constraints, we found clear evidence that restoration practitioners are failing to signal links between ecological restoration, society, and policy, and are underselling the evidence of benefits of restoration as a worthwhile investment for society. We discuss this assertion and illustrate it with samples of our findings—with regards to (1) the geographical and institutional affiliations of authors; (2) the choice of ecosystems studied, methods employed, monitoring schemes applied, and the spatial scale of studies; and (3) weak links to payments for ecosystem service setups, agriculture, and ramifications for public policy.

Key words: agriculture, ecological–economic interface, payment for ecosystem services, policy implications, restoration of natural capital.

Introduction

Westman (1977) was among the first to call for closer links between ecological and economic systems of thought and public policy in his landmark paper "How much are nature's services worth?" He talked about the importance of evaluating nature's contribution to social welfare in economic terms. Soon after, Ehrlich and Ehrlich (1981) coined the term "ecosystem services," but it took nearly 20 years to establish a real dialog between ecologists and economists (Arrow et al. 1995; Costanza et al. 1997; Daily 1997; De Groot 1992).

In recent years, De Groot et al. (2002) and the Millennium Ecosystem Assessment (MA 2005) have shown how ecosystem services can be used by policymakers and the business community. The logical follow-on is the development of legal mechanisms, financial markets, and direct payments for rewarding the promotion, conservation, or enhancement of ecosystem services (Daily 1997; MA 2005). Examples are watershed protection and water supply subsidy programs, such as those in South Africa (Turpie et al. 2008) and Costa Rica (Morse et al. 2009), not to mention carbon sequestration (Galatowitsch 2009; Pagiola et al. 2005).

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Markets are valuable social constructs providing scientists and decision-makers alike with partial information as to what society wants. Today, the economic evaluation of, and financial payments for, ecosystem services are gaining importance as tools are available to help combat global biodiversity loss and ecosystem service deterioration (Bennett & Balvanera 2007; MA 2005), especially through conservation (Balmford et al. 2002; Costanza & Daly 1992) and mitigation, or offsets. Payments for ecosystem services can and should also be developed in ways that help pay for, and reward, ecological restoration (Aronson et al. 2007; Tallis et al. 2008, among many others).

There are many direct and obvious benefits of ecological restoration for society, such as watershed protection, waste treatment, secondary productivity of use to people, and carbon sequestration to mitigate anthropogenic global warming (Rey Benayas et al. 2009). Ecological restoration can also lead to improvements or enhancements in the supply and quality of ecosystem services to society perceivable in the short term, and locally, such as increased productivity of farmland and rangelands (Geerken & Ilaiwi 2004), reduced soil erosion and mudslides, and greater protection against floods and offshore storms (Clewell & Aronson 2006, 2007). Indeed, some of the best-documented causes for environmental degradation are rangeland overgrazing and the harvesting of fuel wood in those same areas at rates in excess of primary productivity. Deforestation and conversion of native forests into agricultural or urbanized areas are still occurring at high rates. Estimates indicate that in the period between 2000 and 2005 deforestation reached an annual rate of approximately 13 million hectares (FAO 2005). Together, this bundle of ecological symptoms is caused by economic needs and pressures (Ayyad 2003; Duraiappahn 1998; Geerken & Ilaiwi 2004; Mahiri & Howorth 2001; Wessels et al. 2004; Wezel & Bender 2004). Ecological restoration—among other things—is clearly required to repair the damage and to halt or reduce the economic losses and socioeconomic disruptions caused by these abuses of rangelands.

Another important direct benefit of restoration pertains to the socioeconomic impacts of ecological restoration and greater long-term conservation of natural resources, which are now being recognized under the broad concepts of natural capitalism (Hawken et al. 1999) and restoring natural capital (Aronson et al. 2006a, 2006b, 2007; Blignaut et al. 2008; Clewell and Aronson 2006, 2007; Milton et al. 2005). The opportunities for job creation and improved livelihoods are also an important consideration (Woodworth 2006). Other tangible benefits are numerous, as reflected in the growing prospects for developing effective marketplaces and legislation to provide payments for ecosystem services (Bennett & Balvanera 2007; European Communities 2008; Turpie et al. 2008).

Finally, there are many other less concrete, but no less important benefits of restoration (Janzen 2002) that should be taken into account when conducting a holistic return-on-investment assessment of restoration (Goldstein et al. 2008; Jones & Schmitz 2009; inter alia). However, it is uncertain to what extent restoration research actually addresses all these high-level prospects and implications. In this study, we examined the degree of connectedness and integration between the science and practice of ecological restoration, on the one hand, and society at large, on the other, as reflected in a sampling of the peer-reviewed, academic literature. The key questions we asked were: (1) To what extent are the people publishing in the field describing or quantifying the tangible benefits of ecological restoration to society? (2) Has the degree of use of, or reference to, ecosystem services in this context changed as awareness of the "usefulness" of this concept has increased (i.e. for policymakers, finance organisms, and communications)?

We addressed these questions using a sample of the recent papers in 13 leading journals from 1 January 2000 to 30 September 2008. Both Ruiz-Jaen and Aide (2005) and Weiher (2007) have done similar surveys, but focused on fundamental ecology rather than broader socioeconomic links. Similarly, Meli (2003) analyzed 77 tropical forest restoration papers in 22 different journals over varying periods. A recent meta-analysis of 89 projects carried out by Rey Benayas et al. (2009) provides compelling evidence of "enhancement" of biodiversity and of ecosystem services arising from ecological restoration. However, there have been no previous studies on the restoration literature with a focus on linkages to socioeconomic benefits or public policy.

Methods

We began our literature analysis with a pilot study of 528 academic papers published in peer-reviewed journals in the field of restoration ecology and ecological economics from 1 January 2000 to 30 September 2008. These were obtained from the bibliographic databases of five of the senior researchers who participated in this study. We searched these papers for the words "restoration" or "rehabilitation" in their titles, abstracts, or keywords. When a paper was found that contained either of these two words, the paper was classified as a "hit." This left us with 115 papers. After analyzing the list of "hits," we found that most of them were from 13 journals. We decided to focus on those journals (see Appendix) because a general search would be impractical and this set included a broad cross-section of highly rated ecology, conservation, environmental management, and restoration journals, as well as two key journals from the field of economics.

We acknowledge potential bias in the selection of papers. For example, "rehabilitation" sometimes refers to activities closer to ecological engineering or "reclamation" than to ecological restoration, sensu the SER Primer of Ecological Restoration (SER 2004). However, we were attentive to this potential problem when we screened and evaluated papers. Secondly, our pre-selection was biased against aquatic ecosystems as the five established researchers have historically been more involved with restoration in terrestrial than with aquatic systems and only infrequently consult journals specialized in wetland systems issues. Finally, and most importantly, we are well aware that much work in ecological restoration has only

been reported in the "gray" literature, which is not included in this study. Our conclusions therefore must be evaluated in light of these imperfections.

After excluding letters to the editor and book reviews, we screened all 19,547 publications appearing in the 13 journals from 1 January 2000 to 30 September 2008, searching for those that had the words "restoration" and/or "rehabilitation" in the title, abstract, or keywords. All "hits" were subsequently analyzed according to a predetermined list of variables and categories (Table 1) thought likely to provide tangible, measurable links to restoration ecology's current contributions or prospects for *concrete* contribution to human society.

Table 1. List of variables and categories used for analyzing the restoration papers ("hits") in literature review (for many, multiple answers are possible).

Category	*Keywords and Definitions*
Paper descriptors	Author(s), year of publication, title of the article, journal, location of the keyword identification (title, abstract, and/or key words)
Ecosystem types in which the study was conducted	Grasslands, forests, woodlands, shrublands, and savannas, arid (and semiarid) regions, aquatic (rivers, other wetlands, marine, and coastal), urban, human modified and transformed, other, or unclassified
Restoration approach	Active = implies that something was added or removed (e.g. reseeding, fertilizer, irrigation, plants) Passive = area was left to recover by itself Not specified
Restoration method used	Reseeding, planting, succession, others, or not specified
Purpose of restoration; type of ecosystem services affected (as per MA [2005] categories)	Supporting = a service such as pollination or seed dispersal that makes it possible to produce crops Regulating = a service that moderates environmental extremes or stabilizes ecosystem components, dynamics, and functions—e.g. control of floods, erosion, dust storms Provisioning = direct values of goods that can be harvested, e.g. firewood, craft materials, meat Cultural = benefits that people get from visiting wild places—scenery, traditional rituals, relaxation, scientific information
Constituents of well-being addressed or affected	Material = food, wood, fish, and other things, goods or products that people harvest from ecosystems Health = health benefits of natural environments, e.g. water purification, removal of toxins from the air Security = ways in which natural vegetation or functioning ecosystems protect our atmosphere or prevent or minimize disasters such as floods or mudslides Social relations = ways in which natural environments contribute to our cultural and social lives; care for the innate value of biodiversity included here
Well-being impact description	Description of how the restoration improves quality of life for people
Link to agricultural systems or practices	Does the restoration link with agricultural systems or practices? Yes/No. If yes, in what way? For example crop production, forestry, ranching
Monitoring tools used	Yes/No. If yes, description of how restoration was monitored. Instrumental = measuring, e.g. vegetation cover, species abundance, or soil parameters Interviews = asking people by phone or questionnaire about restoration project
Scale of influence and interventions	Level of ecological organization and specific kinds of interactions: Landscape (spatial interactions) = covering many habitats or communities, Ecosystem (trophic interactions) = that the restoration influences plants, herbivores, and predators, Community (interspecific interactions) = restoration affects many organisms, or Population (reintroductions) = restoration focused on a single species
Policy outcome or (research) recommendation	This refers to the effect of the study of the restoration or the restoration itself on policy: none, locally (one town or settlement), regionally, nationally (whole country), or global
Policy intensity (scale of impact)	The number of people directly or indirectly affected by the policy or the importance of the policy for the way in which towns, nations, or the world is run: none, minor, major
Host country	Country where restoration took place
PES (Payment for environmental services)	Yes/No. This describes the ways in which restoring an environment to provide better services can be rewarded, e.g. by tax credits or reductions. If yes, does the market actually exist or is it only perceived? Formed = the reward method is functioning and that farmers, miners, NGO, etc. are actually receiving some payment or other benefits for doing the restoration; Perceived = a possible method of reward has been described

The variables and categories were selected to identify the geography and institutional affiliations of the authors of the studies. The geographical variable used was mean national income as classified by the World Bank (i.e. high, upper-middle, low-middle, and low-income countries) (World Bank 2008). We also examine the focus of the restoration activities—choice of ecosystems, methods employed, monitoring, and the spatial scale. Finally, trends relevant to plausible benefits to society were studied, such as links to agriculture, policy implications, and especially the presence or absence of references or allusions to payments for ecosystem services based on the four categories used in the Millennium Ecosystem Assessment (MA 2005).

We report the results for each of the categories listed in Table 1, but not always in equal detail. As fully one-third of the papers (527) considered as "hits" under our selection criteria appeared in the journal *Restoration Ecology* (hereafter *RE*), we used that journal as a reference for comparison with the other 12 journals (hereafter *OJ*). This particular focus also seemed worthwhile as *RE* is generally considered the world's leading journal in the field of ecological restoration, and it covers aquatic as well as terrestrial ecosystem restoration. This comparison also allowed us to track the trends and development of the restoration literature over the period of the study, 2000–2008.

Results

Trends in Quantity, Geography, and Author Affiliations

During the period 2000–2008, the relative number of "hits" in *RE* remained consistently high, with an average of 88.4% per year (Table 2), and far exceeded those in the *OJ*, which had an average of only 5.6%. Between 6.8 and 17.6% of all "hits" appearing in all 13 journals for a given year were published in *RE*.

A large majority of the papers in *RE* (78%) and in the *OJ* (70%) dealt with projects in high-income countries as classified by the World Bank (Fig. 1). This bias is no doubt due to these countries having sufficient resources to invest in restoration research.

The results of Figure 1 are in sharp contrast to the socioeconomic profile and the geographical distribution of the parts of the world where restoration is most urgently needed. To illustrate this point, Figure 2 indicates the world's "top 20" countries in terms of annual rate of deforestation in recent decades. Not surprisingly, most of these are poor, low-income, economically and institutionally underdeveloped countries in tropical Africa and Asia. Although deforestation is not the only form of degradation requiring restoration, this is, in our view, a clear and compelling indicator of the disjunction between countries with high-level research on ecological restoration—at least as reflected in the journals included in this study (Fig. 1)—and those most in need of restoration (Fig. 2).

An analysis of the institutional distribution (Fig. 3) of the agencies involved in conducting the restoration in *RE* shows that in 65.6% of the cases the restoration was conducted by academics or people based at research institutions, and 19% were from government agency–based researchers. As mentioned already, this statistic does not do justice to restoration efforts in developing countries in general, or to those of nonacademics who often publish only in the gray literature or not at all.

Do Biome Type, Restoration Approach, Monitoring, and Spatial Scale Differ Among Journals?

In all, there are four categories of indicators that reveal priorities and concerns of the people conducting research or projects in ecological restoration.

Biome Types. Between 45 and 60% of all "hits" focus on forest ecosystems and aquatic ecosystems (rivers, other wetlands, marine and coastal systems) combined (Table 3). In sharp contrast, the arid and semiarid areas—which cover 41% of the land surface and are home to almost 3 billion people or circa 38% of the global population (Reynolds et al. 2007)—account for only 5% of the restoration "hits" in *RE* and only 3% in the *OJ*.

Restoration Approach: Active Versus Passive. Active restoration methods (seeding, planting, preparation) were

Table 2. Number and distribution of restoration papers ("hits") in *Restoration Ecology* (*RE*), as compared to the 12 other journals (*OJ*) (see list in Appendix).

	Papers Scrutinized			*Number of "Hits"*			*Percentage of Papers Per Year Dealing with Restoration*		
	RE	*OJ*	*Total*	*RE*	*OJ*	*Total*	*RE (%)*	*OJ (%)*	*Total (%)*
2000	45	1,584	1,629	42	77	119	93.3	4.9	7.3
2001	46	1,640	1,686	36	73	109	78.3	4.5	6.5
2002	73	1,667	1,740	62	71	133	84.9	4.3	7.6
2003	57	2,041	2,098	50	104	154	87.7	5.1	7.3
2004	64	2,077	2,141	57	125	182	89.1	6.0	8.5
2005	83	2,308	2,391	69	159	228	83.1	6.9	9.5
2006	72	2,617	2,689	68	137	205	94.4	5.2	7.6
2007	100	2,406	2,506	93	143	236	93.0	5.9	9.4
2008	56	2,611	2,667	50	166	216	89.3	6.4	8.1
Total	596	18,951	19,547	527	1,055	1,582	88.4	5.6	8.1

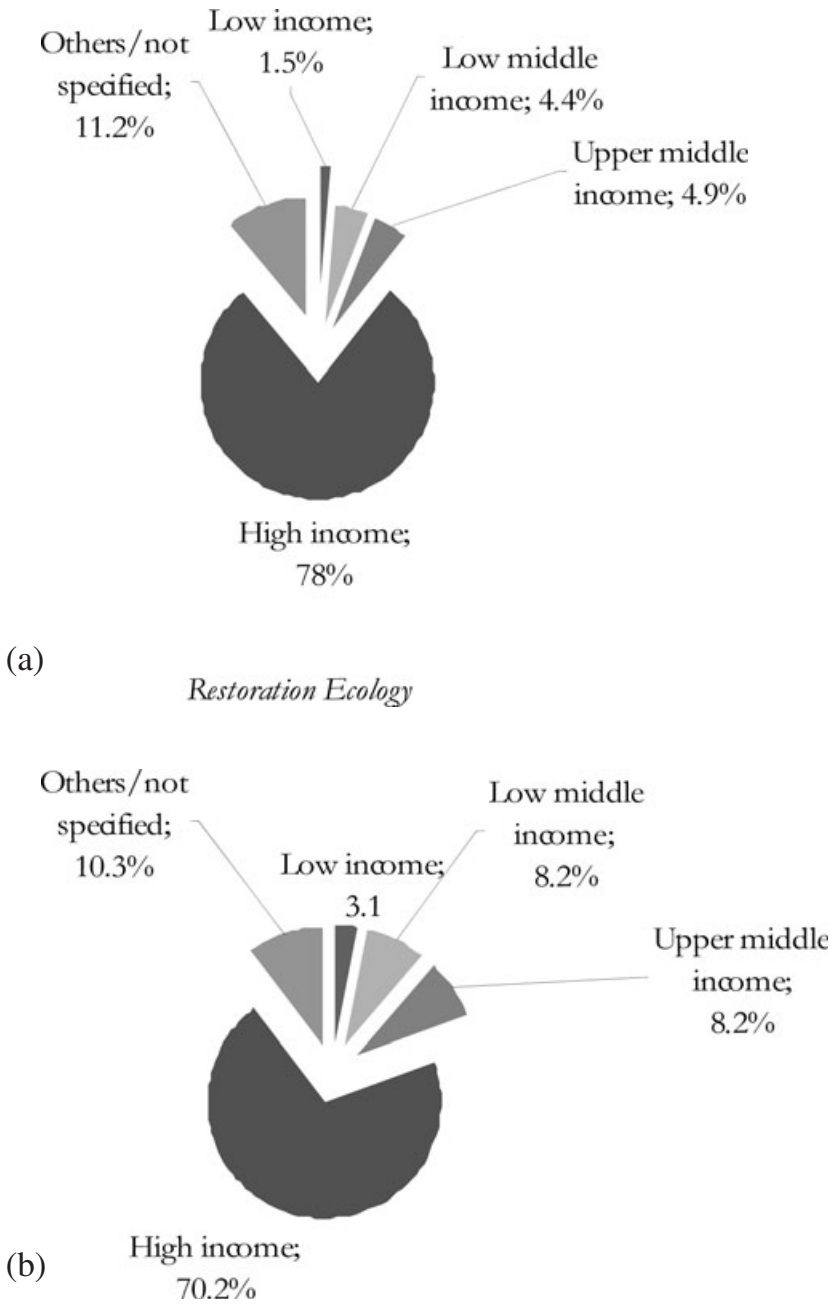

Figure 1. Geographic and economic distribution of papers.

reported in circa 80% of the "hits" in *RE*, as compared to circa 60% for those in the *OJ*. Only 8.7% of papers in *RE* and 8.2% in the *OJ* reported using passive methods (removal or cessation of cause of damage). This might seem paradoxical from a financial perspective, as active methods are generally far more costly than passive methods. They may however be expected, in most cases, to yield quicker and more dramatic results than passive methods.

Choice of Monitoring Techniques. In 77% of the "hits" in *RE* and 79% of those from the *OJ*, some form of instrument was used to monitor the results in both active and passive restoration studies. The difference between the use and nonuse of instrumentation is statistically significant in both instances (Pearson-adjusted χ^2-test: *RE*: $\chi^2 = 71.8$, df $= 2$, $p < 0.001$; *OJ*: $\chi^2 = 469.5$, df $= 2$, $p < 0.001$). However, interviews were used to evaluate perceptions of interested and affected parties about the achievements or success of a restoration project in only 3% of all cases.

Spatial Scale of Restoration Project. There is also a strong bias toward landscape and ecosystem scale restoration, that

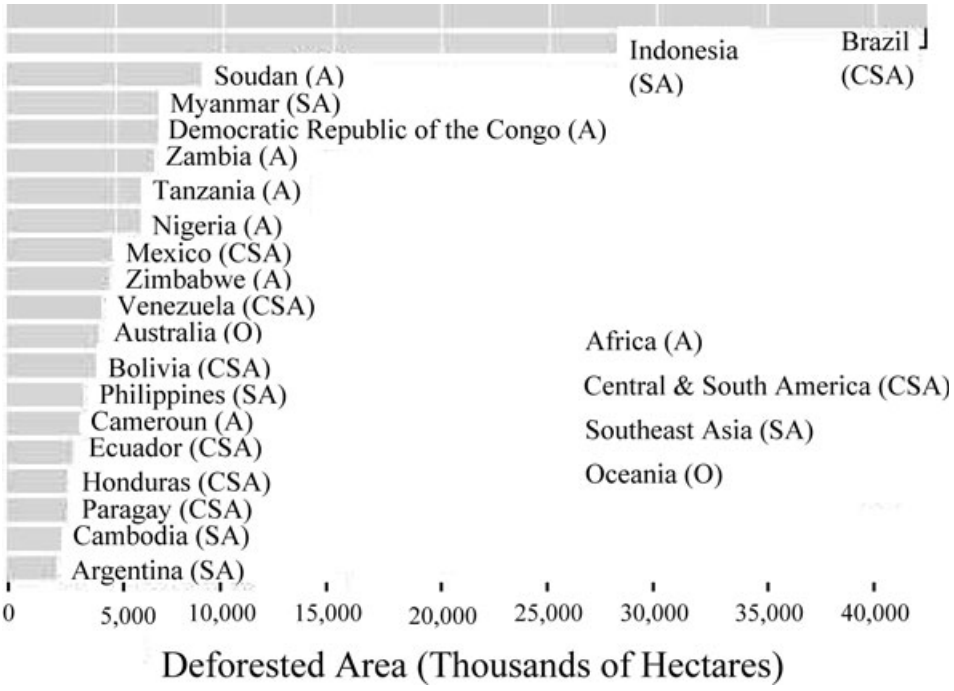

Figure 2. List of the "top 20" countries that cleared the largest percentage of their forests between 1990 and 2005. (Graphic by Robert Simmon, based on data provided by individual countries to the U.N. Foreign Agricultural Organization for the Global Forest Resources Assessment Report 2005. Downloaded from: http://earthobservatory.nasa.gov/Features/Deforestation/deforestation_update3.php, site accessed 11 January 2009.)

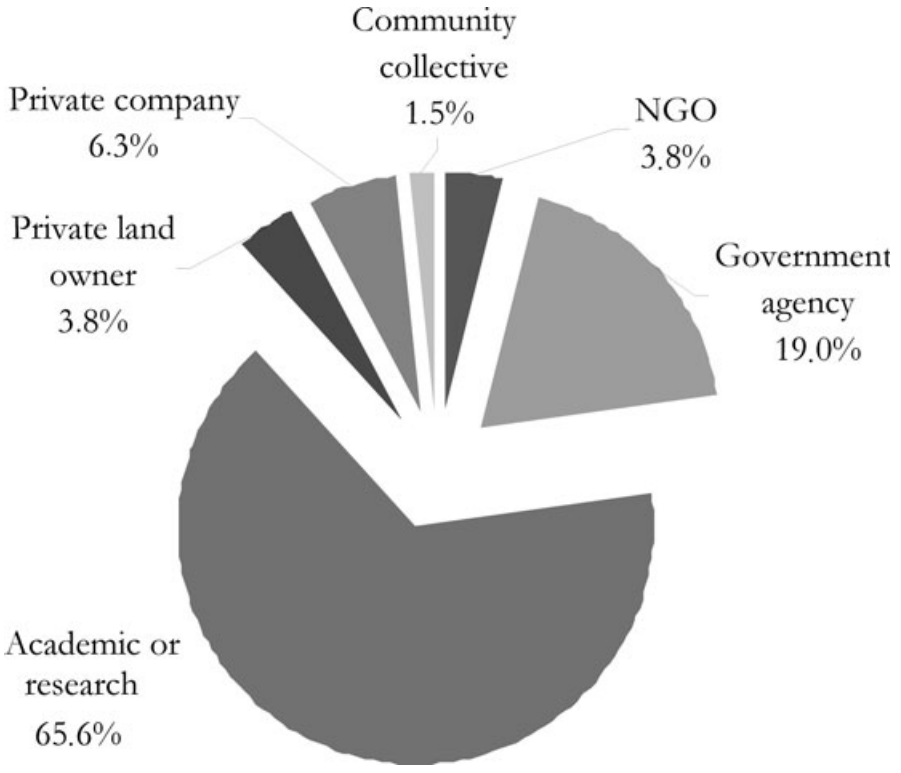

Figure 3. Institutional demarcation of those conducting restoration projects and related articles among the "hits" found in *Restoration Ecology*.

Table 3. Distribution of "hits" by ecosystem type: percentage of the total of papers published over the entire period in *Restoration Ecology* (*RE*), as compared to the 12 other journals (*OJ*).

	RE						*OJ*					
	Grasslands (%)	*Woodlands, Shrublands, Savanna (%)*	*Forests (%)*	*Arid Areas*[a] *(%)*	*Aquatic (%)*	*Other*[b] *(%)*	*Grasslands (%)*	*Woodlands, Shrublands, Savanna (%)*	*Forests (%)*	*Arid Areas*[a] *(%)*	*Aquatic (%)*	*Other*[b] *(%)*
2000	1	2	2	2	2	2	0	0	1	0	5	1
2001	1	0	1	0	2	2	0	1	2	0	3	2
2002	2	2	2	0	7	2	1	1	2	0	3	1
2003	2	1	1	0	2	2	1	1	2	0	4	2
2004	2	1	2	1	3	2	1	1	3	0	2	3
2005	2	2	2	0	4	2	2	1	3	0	7	2
2006	2	2	3	0	2	4	1	1	3	1	4	2
2007	2	1	2	1	4	7	2	1	3	1	5	3
2008	1	1	2	0	4	2	1	2	4	1	4	3
Total	14	12	17	5	29	24	10	10	23	3	36	19

[a] Including semiarid (according to UNESCO classification system).
[b] Human-transformed and modified land, urban environments, and unclassified.

is, larger restoration efforts outweigh smaller and more specific ones (Table 4). This is surprising given the dominance of active restoration and may reflect the dominance of developed countries with the resources required to fund large-scale restoration projects.

Are Authors Paying Attention to Links Between Restoration and Socioeconomic Issues?

There are various ways in which links between restoration and socioeconomic issues could be explored. In this section, we discuss three of them: payments for ecosystem services, agriculture, and policy.

Restoration and Payments for Ecosystem Services. A significantly lower proportion of papers from *RE* (2.7%) than from the *OJ* (10.5%) addresses or refers to payments for ecosystem services (Table 5). Further, the proportion of *RE* papers explicitly dealing with payments for ecosystem services was least (1.4%) in the most recent period, 2006–2008.

More than 90% of all explicit payments for ecosystem services–linked studies in the set of articles we considered as "hits" were undertaken at a landscape or ecosystem scale, rather than "lower" spatial and organizational scales (i.e. community and population) (Table 6). This is to be expected because the high start-up and transaction costs of payments for ecosystem services make it unlikely that single species or population, or even single community-focused restoration, would provide sufficient value to society to justify development of a payment system. Also, from a payment for ecosystem services perspective, the emphasis of rewarding restoration efforts must logically be more on restoring functioning whole ecosystems and landscapes (e.g. restoring catchment water storage through soil retention measures) that unambiguously provide direct benefits to people across the full spectrum of society.

Restoration and Agriculture. There was no significant difference between *RE* and *OJ* in the proportion of papers linking restoration with agriculture, in the narrow sense of the word, that is excluding forestry and wetland management (Table 5). Nevertheless, whereas the percentage of "hits" linked to agriculture, sensu stricto, increased over time from 34% to almost 39% for the *OJ*, it declined sharply in those published in *RE*, from a high of 57% in 2000–2002 to about 34% in 2006–2008. Most of the papers dealing with agriculture, or indicating a link with the agricultural sector, focus on the effects of restoring degraded, abandoned agricultural lands, also known as old fields, in formerly woody vegetation types. They therefore address attempts to reintroduce an original or different nature-based land use option after failed or abandoned agricultural production. However, once again, we acknowledge the bias in our selection criteria and methodology and call for follow-up studies that also address linkages to forestry and wetland management.

Table 4. "Hits" by restoration approach and scale of restoration in *Restoration Ecology* (*RE*), as compared to the 12 other journals (*OJ*).

		Landscape (%)	*Ecosystem (%)*	*Community (%)*	*Population (%)*	*Number of Observations*
RE	Active	32	41	21	6	487
	Passive	54	32	13	2	56
OJ	Active	35	38	19	9	842
	Passive	37	29	24	11	104

Table 5. Proportion of "hits" dealing with payment for environmental services (PES) in *Restoration Ecology* (*RE*), as compared to the 12 other journals (*OJ*).

	PES		*Agriculture*		*Reference to Policy Implications*	
	RE	*OJ*	*RE*	*OJ*	*RE*	*OJ*
Number of yes	14	111	214	389	151	65
Number of no	513	944	313	666	376	990
Total	527	1,055	527	1,055	527	1,055
Positive response (%)	2.7	10.5	40.6	36.9	9.7	6.2
χ^2 (with Yates continuity correction)	28.80		1.92		148.9	
Df	1	1	1			
p Value	<0.0001	<0.2	<0.001			

Table 6. Comparison between *Restoration Ecology* (*RE*) and the 12 other journals (*OJ*) concerning explicit mention of payment for environmental services (PES) and spatial/organizational scale (note that more than one scale can be mentioned in an article).

	Percentage of PES Observations				
	Landscape (%)	*Ecosystem (%)*	*Community (%)*	*Population (%)*	*Number of Observations*
RE	64	29	21	7	14
OJ	43	40	12	6	111

Restoration and Policy. Less than 10% of the 1,582 papers included in this study referred to policy implications of the restoration research programs under discussion but, notably, those in *RE* had a significantly stronger policy focus than the *OJ*, in statistical terms (Table 5). However, most of the papers that did refer to policy in both *RE* and *OJ* only made recommendations for improved or best practice and did not specifically discuss any policies.

Discussion

Almost three-quarters of the 1,582 "hits" were produced in high-income host countries rather than in those where the need for restoration—from national and global perspectives—is most acute. One additional and important gap to note among the papers studied in this review is that while 88% of the 1,582 papers used only instrumental measurements for monitoring, only 3% devoted resources to interviewing people.

The existence of a gap between research on ecological restoration and the rest of society is substantiated by our finding that only a very small percentage of the papers linked restoration to the development of payments for ecosystem services. More broadly, the concept of explicitly linking ecosystem services to beneficiaries of ecosystem restoration, and demonstrating their values to society, has only recently begun to enter the mainstream academic literature on the science and practice of ecological restoration (Galatowitsch 2009; Goldstein et al. 2008; Rey Beneyas et al. 2008, 2009). For example, in the highly regarded journal *Conservation Biology*—which is one of the *OJ*—there were only four "hits"—that is 2.5% of 48—that dealt explicitly with ecosystem services from January 2000 to October 2008. In *Journal of Arid Environments*, there were only two of 60 "hits"—that is 3.8% of the combined 1,568 articles—that made this link.

There are at least two plausible reasons for this: (1) The research community involved in ecosystem services is isolated from those in the restoration field, and vice versa (cf Cabin 2007); (2) Those involved in developing economic development pathways generally have overlooked the value of conserving ecosystems, and restoring natural capital through ecological restoration, as catalysts for economic development (Aronson et al. 2006b; Clewell & Aronson 2006). However, The Economics of Ecosystems and Biodiversity (TEEB) initiative (European Communities 2008) will help to rectify this situation. The World Bank, the Secretariat of the Convention on Biological Diversity, and other international organizations are also coming to the realization that ecological restoration should receive high priority from society in socioeconomic as well as ecological perspectives.

When restoration was studied or undertaken in low-income countries, much more attention was paid to links between restoration and agricultural systems, and hence to this aspect of human well-being. Overall, the links to agriculture in the

restoration literature are relatively weak and biased because of the underreporting of restoration projects in grasslands, shrublands, and transformed systems—the biomes and settings most clearly associated with agricultural activities.

Agriculture—that is people practicing agriculture—is, arguably, the primary beneficiary of an improvement in ecosystem goods and services through increases in land productivity, water flow, and the reduction of erosion. It is important, however, to recognize that there are differences between agricultural and environmental objectives or priorities in various restoration projects (Rey Benayas et al. 2008). Researchers and practitioners of ecological restoration need to examine these differences and, hopefully, use those insights to discuss how various land management goals and methods can be integrated, and their various benefits realized and rewarded.

Finally, 80% of the papers (data not shown) did not discuss or analyze direct policy impacts or implications of the restoration work. Restoration work undertaken to fulfill company obligations to restore or mitigate environmental damage may be considered an exception to this rule, but comprises only a very small proportion of the papers being published. Often, the only—and usually very weak—link between restoration research and practice, on the one hand, and policy implications, on the other, were researchers' recommendations—rather than any specific or concrete indication of actual policy impact. We have also seen that, from a global perspective, restoration work generally is not taking place in the countries where it is most needed.

In the decade since Holl and Howarth (2000) asked "Who will pay for restoration?," Clewell (2000), Milton et al. (2003), Clewell and Aronson (2007), and Goldstein et al. (2008), among others, have illustrated ways to integrate broad sets of ecological and socioeconomic objectives and criteria when planning and evaluating restoration projects (cf Cairns 1993; Janzen 2002; Jones & Schmitz 2009). Globally, ecological restoration can now be seen as a top priority for society, and increasingly as a good investment in our current state of ecological overshoot (Rey Benayas et al. 2009). Arguably, ecological restoration should also be recognized as an important element of sustainable socioeconomic development, particularly in developing countries. Conversely, it is clear from our findings that at least in our sample of the academic literature, the most tangible and concrete socioeconomic contributions of restoration to society are underemphasized, or often ignored altogether.

The gaps between researchers and policy, researchers and society at large, and restoration and payment systems should all be addressed as a matter of urgency, given the potential beneficial impacts and costs that restoration can have on people, society, and the environment. This historical disconnect could and should disappear as restoration can so clearly enhance the delivery of ecosystem services of all kinds (Aronson et al. 2007; European Communities 2008; Goldstein et al. 2008; Harris et al. 2006; Rey Benayas et al. 2008, 2009) and the maintenance of biodiversity (Blignaut & Aronson 2008).

The findings of this study are in line with results found in conservation science (Lawler et al. 2006), as evidenced by the growing call for a more rigorous, well-documented scientific process, not only in the way conservation and ecosystem management decisions are taken, but also in the measurement of their outcomes (Sutherland et al. 2004). Both in conservation and in restoration, our focus must be broadened, or refined, to clearly include "outcomes" from a socioeconomic perspective (Ferraro & Pattanayak 2006). Markets for ecosystem services and even for biodiversity maintenance are now emerging, but most restoration and conservation scientists and practitioners have not yet recognized the benefits of creating a new market for conservation and especially restoration-related ecosystem services (Cowling & Wilhelm-Rechmann 2007; Saunders et al. 2006). Ultimately, the "human choice" factor—which is critical to the successful implementation of conservation goals and restoration outcomes (Knight et al. 2006)—must become a bigger part of the focus of those who conduct ecological restoration research. Otherwise, the funding and public support we need will not be forthcoming.

Implications for Practice

- From a social sciences perspective, there is a clear need for definition and valuation of the socioeconomic outcomes of ecological restoration projects. The numerous links between restoration, economic development, and societal well-being should be highlighted and made explicit wherever possible.
- Bundling payments or incentives for ecosystem services and biodiversity maintenance provided through ecosystem restoration and related activities can help overcome the prevailing disconnection between society, on the one hand, and the science and practice of ecological restoration, on the other.
- Links to agriculture and other production systems merit particular attention in this context.
- Especially for large-scale projects, attention should be paid to obvious or potential impact on public policy and law, as well as lessons learned and recommendations that can be made for improved restoration practice in a specific setting.
- Whenever possible, authors of papers and reports should be encouraged to mention or discuss specific policies, financing, and/or funding opportunities that exist to finance restoration.

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Appendix. List of journals scrutinized and their main characteristics.

Journal	*Publisher*	*Scope of Journal*	*Specific Focus Relevant to This Analysis*
Agriculture, Ecosystem and Environment	Elsevier	Interface between agro-ecosystems (crops, pastures, livestock) and environment (energy, air, water, land)	Agricultural landscape ecology and processes; papers that advance understanding on how to make agro-ecosystems more diverse and sustainable
Biological Conservation	Elsevier (Society for Conservation Biology)	Biological, sociological, and economic dimensions of conservation and natural resource management	Theoretical and empirical investigations into the consequences of human actions for the diversity, structure, and function of terrestrial, aquatic, or marine ecosystems, including restoration ecology, resource economics
Conservation Biology	Wiley-Blackwell (Society for Conservation Biology)	Contributions to the study and preservation of species and habitats	Conservation biology, conservation ecology, and conservation science in general.
Ecological Economics	Elsevier (International society for Ecological Economics, ISEE)	Transdisciplinary, linking ecology and economics	Sustainable agriculture and development; renewable resource management and conservation; integrating natural resources and environmental services into income and wealth accounts
Ecological Engineering	Elsevier	Bridge between ecologists and engineers (eco-technology) involved in designing, creating, and restoring ecosystems for the mutual benefit of humans and nature	Eco-technology; synthetic ecology; bioengineering; sustainable agro-ecology; habitat reconstruction; restoration ecology; ecosystem rehabilitation; stream and river restoration; wetland restoration and construction; reclamation ecology
Environmental Development Economics	Cambridge University Press	Intersection of environmental, resource, and development economics	Theoretical and applied (policy) aspects of sustainable development
Environmental Management	Springer	Conservation of natural resources, protection of habitats, and control of hazards, spanning field of applied ecology without regard to traditional disciplinary boundaries	Ecology, ecological economics, environmental engineering
Frontiers in Ecology and Environment	Ecological Society of America (ESA)	All aspects of ecology, the environment, and related disciplines	Global issues, broadly impacting research, cross-disciplinary or multicountry endeavors, new technologies, new approaches to old problems, and practical application of ecological science

Appendix. Continued.

Journal	*Publisher*	*Scope of Journal*	*Specific Focus Relevant to This Analysis*
Journal of Applied Ecology	Wiley-Blackwell	Application of ecological concepts, theories, models, and methods to management of biological resources in broadest sense	Application and development of improved strategies for the conservation of wildlife; wildlife and habitat management; sustainable management of natural resources (including aquatic); management of pests and weeds
Journal of Arid Environments	Elsevier	Multidisciplinary/interdisciplinary, research on all aspects of arid environments, and their past, present, and future uses	Physical, biological, and anthropological aspects of arid, semiarid, and desert environments, including land use, conservation, land degradation and rehabilitation, techniques for monitoring and management
Journal of Forest Ecology and Management	Elsevier	Links forest ecology with forest management	Application of biological, ecological, and social knowledge to the management and conservation of human-made and natural forests
Restoration Ecology	Blackwell	Focusing on ecological restoration defined as "the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed" (SER 2004)	Experimental, observational, and theoretical studies on terrestrial, marine, and freshwater systems
Water SA	Water Resources Commission (WRC) (South Africa)	All branches of water science, technology, and engineering	Water resources development; surface hydrology; geohydrology; environmental pollution control; water quality and treatment; agricultural water science

Note: The excellent journals *Ecological Restoration* and *Ecological Management and Restoration* were not scrutinized for this study, for the simple reason that they are not as yet listed in the ISI Citation Index (http://www.isiwebofknowledge.com/).