Restoration Ecology
THE JOURNAL OF THE SOCIETY FOR ECOLOGICAL RESTORATION

RESEARCH ARTICLE

Cultural Ecosystem Services and Popular Perceptions of the Benefits of an Ecological Restoration Project in the Brazilian Atlantic Forest

Pedro H. S. Brancalion,[1,2] Ines Villarroel Cardozo,[3] Allan Camatta,[4] James Aronson,[5,6] and Ricardo R. Rodrigues[4]

Abstract

It is essential to understand how ecological restoration (ER) improves human well-being in order to justify more investments and upscaling in this emergent field of action. As part of a 22-year-old, 80 ha ER project being carried out around a water reservoir that supplies drinking water to the city of Iracemápolis (population 19,700), in the megadiversity Atlantic Forest biome of Brazil, we assessed local community perceptions of the tangible and intangible benefits expected to arise from this project. A detailed questionnaire was completed for 292 members of the local community to gauge perceptions of benefits arising from various cultural and provisioning ecosystem services (ESs; especially safe and clean drinking water) provided by the 80 ha forest restoration project. A striking 94% of those interviewed wanted more ER projects in their community. Participants reported an appreciation for cultural ESs such as esthetic landscape improvement, tourism, recreation, as well as various religious, spiritual, and educational services. In addition, 87% of interviewees believed that the restoration project improved the quality of their drinking water, and 63% said they would agree to an increase in water tariffs if the proceeds were to be invested in more forest restoration. Judging from this study, investigation and subsequent communication of popular perceptions of the various benefits of ER projects could promote consensus-building and support for projects among stakeholders, and inform governmental and societal investments in restoration.

Key words: monitoring, payments for ecosystem services, restoration assessment, restoration planting, tropical forest restoration.

Introduction

The assessment of ecosystem services (ESs) has an important role in efforts to show local stakeholders the importance of protecting and restoring natural ecosystems, by establishing clear links between nature conservation and human well-being (MEA 2005; Daily & Matson 2008; Redford & Adams 2009). Consequently, the reestablishment of these services by ecological restoration (ER) projects has also been explored in schemes of payments for ES (Palmer & Filoso 2009). In a meta-analysis carried out on 89 ER assessments, Rey Benayas et al. (2009) found that both biodiversity and ES were enhanced by approximately 44 and 25%, respectively. However, these authors only examined supporting, provisioning, and regulating services. Cultural services were not measured explicitly in any of the studies included in the meta-analysis. Indeed, case studies about cultural services, or the perceptions thereof, in the context of restoration projects are few and far between.

Cultural ES are defined as "nonmaterial benefits that people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and esthetic experience" (MEA 2005). Along with the loss of provisioning, regulating and supporting ES, ecosystem degradation may also compromise fundamental aspects of culture which indirectly or directly link humans and nature (de Groot et al. 2005). However, just as ER can assist the recovery of impaired ecosystems, it may also contribute to reestablish and/or reinforce direct and indirect cultural benefits provided by functional ecosystems. However, contrary to other ES, the assessment of cultural services does not depend on measurements of ecological processes nor of biotic composition, but rather relies on objective or subjective perceptions of people who interact with the ecosystems of concern. Cultural ethnic group, age, gender, educational level, profession, and much more will influence responses. Assessing perception of cultural services is,

[1]Department of Forestry, "Luiz de Queiroz" College of Agriculture, University of São Paulo, Avenue Pádua Dias 11, 13.418-900, Piracicaba, Brazil
[2]Address correspondence to P. Brancalion, email pedrob@usp.br
[3]Master in Ecosystem Restoration, University of Alcalá, Avenue Madrid-Barcelona, Km 33.600 28,871, Alcalá de Henares Madrid, Spain
[4]Department of Biology, "Luiz de Queiroz" College of Agriculture, University of São Paulo, Avenue Pádua Dias 11, 13.418-900, Piracicaba, Brazil
[5]Centre d'Ecologie Fonctionnelle et Evolutive (CNRS-UMR 5175), 1919, Route de Mende, 34293, Montpellier, France
[6]Missouri Botanical Garden, St. Louis, MO, U.S.A.

doi: 10.1111/rec.12025

therefore, a complex and transdisciplinary issue, representing an important challenge for the future.

Some recent studies investigated cultural-related services in various contexts other than ER and provided a firm conceptual basis. Data from these investigations can shed light on the challenges of this type of assessment. For instance, Martín-López et al. (2009) showed that cultural services valuation in a protected area, where these services vary according to location and season, is affected by spatial and temporal heterogeneity. This indicates the difficulty of extrapolating from isolated case studies to more complex landscapes. Due to the lack of background on how to assess and valuate cultural ES, practitioners and researchers are frequently discouraged from including this issue in their studies. Fortunately, important advances have recently been made to guide research and practice in cultural ES (see a framework in Chan et al. 2012a).

Although ES have recently received greater attention from researchers and policy makers, cultural ES are still not adequately integrated within assessment models. Daniel et al. (2012) reviewed several categories of cultural ES based on the social and behavioral sciences, and merged these data with the ES approach. Another advance is the framework proposed by Chan et al. (2012b) for guiding cultural services valuation and decision-making for overcoming problems which limit the application of conventional approaches of economic valuation derived from the intangibility and incommensurability inherent in such services.

These examples demonstrate the importance of integrating consideration of historical, political, economic, and cultural factors when planning and executing ER projects. All of these factors will come into play when attempting to negotiate trade-offs related to the interaction between economic development and nature conservation (Bhattacharya et al. 2005). Similarly, the inclusion of social, economic, political, and juridical aspects in ER is still one of the major gaps of the emerging field of restoration ecology (RE; Aronson et al. 2011). In a meta-analysis carried out by Aronson et al. (2010) on 1,589 peer-reviewed papers on RE and ER, only 3% of the studies investigated the perception of stakeholders in ER projects. Cultural or socio-economic issues were also not included in the measures of restoration success in Ruiz-Jaen and Aide (2005). However, the theme of the 4th World Congress of the Society for Ecological Restoration, held in 2011, was "Reestablishing the link between nature and culture"—a clear attempt to remind restoration ecologists and practitioners of the panoply of cultural issues involved, and to open up cross-disciplinary debates and collaboration.

In the hopes of shedding some light on these poorly studied issues of ER, we assessed cultural ES and popular perceptions of the benefits of an ER project in the Brazilian Atlantic Forest.

Methods

Study Site

The project is an 80-ha tropical forest restoration site (between 22°350°S and 47°310°W; 605 m above sea level), within Iracemápolis municipality, São Paulo state in southeastern Brazil. This region is part of the Brazilian Atlantic Forest biome—a top priority global biodiversity hotspot. The dominant vegetation in this area is semi-deciduous seasonal Forest. In the early 1980s, it was found that the reservoir that supplied drinking water to this city, which was created by placing a dam across a river, was silted up as a result of erosion caused by sugarcane plantings along its borders. In order to solve this problem and avoid recurrence, the city council, universities, and outreach agencies created a plan for dredging and elevating the height of the dam. This formed a new shoreline for the recovery and expansion of reservoir's water storage capacity. A visionary ER project was then implemented between 1988 and 1990 in riparian corridors of 50 m in width by planting approximately 120 native and 20 exotic tree species (Fig. 1). The municipality of Iracemápolis has only 5.6% of remaining natural vegetation cover; and the principal land use is sugarcane plantations (9,075 ha; 85.4% of the total area). The site of the ER project was previously under sugarcane. Given that this municipality has only 652 ha of extant native forests, this 80-ha ER project represents approximately 12% of remaining native forests in this municipality.

Questionnaire Construction and Application

We developed a questionnaire based on six steps: (1) create a pilot questionnaire; (2) seek experts' opinions to improve the reliability of the sampling design, as well as the cohesion and level of relevance of questions addressed; (3) redesign the questionnaire based on the corrections suggested by experts; (4) conduct pilot interviews; (5) redesign the questionnaire based on the results of the pilot interviews; (6) finalize the questionnaire for further application. We adopted a survey-based evaluation of touristic values of cultural services and the improvement of drinking water through restoration efforts (see Schultz et al. 2012 for a similar approach). Due to the complexity of the questions raised, the questionnaire was only submitted to people >15 years old.

The questionnaire was divided into four sections: (1) popular perceptions of the practice of ER; (2) popular notions of the socio-economic aspects of ER; (3) cultural ES assessment; and (4) popular perceptions of benefits derived from the ER project under study (Appendix S1, Supporting Information). Before applying the questionnaire, we collected demographic data on the interviewed person (IP). In the questionnaire, we used the term "forest recovery," rather than "forest restoration," in order to facilitate communication and understanding. Due to the importance of the drinking water supply, we investigated perceptions among IPs of the possible links between forest restoration and water production and purification. The number of interviewees was calculated based on the sample size of finite population formula (Cochran 1977), which indicated a minimum sample size of 263 individuals and 292 questionnaires were completed.

Note that when presenting our results, below, we omit the percentage of respondents who did not answer a given question, in order to avoid repetition of unnecessary information.

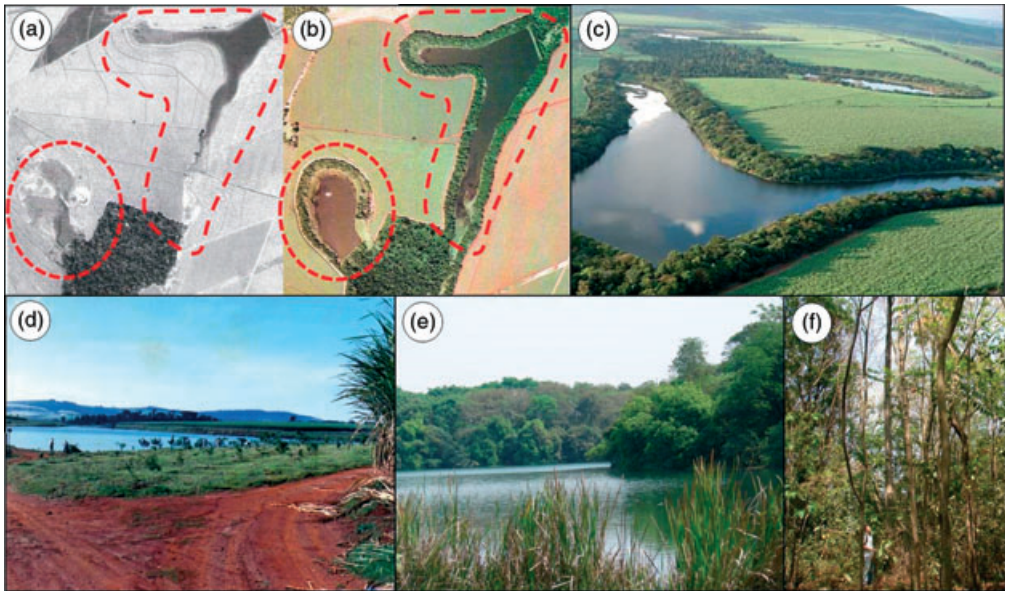

Figure 1. Contours of an 80 ha tropical forest restoration project implemented in the buffer zone of a water reservoir that supplies drinking water to the city of Iracemápolis, southeastern Brazil: water reservoir borders before ((a) 1984) and after ((b) 2002 and (c) 2007) the implementation of the restoration planting in 1988 ((d) 1989), and external ((e) 2011) and internal ((f) 2012) aspects of the forest today.

Hence, the sum of percentages for each question does not always equal 100%. We also used documents and records supplied by the Municipal Environment Secretariat in order to complement information gathered with the questionnaires.

Results

Profile of the IPs

Approximately 70% of IP respondents were middle-aged adults living in the urban zone of Iracemápolis with almost half of them in close proximity to the restoration project. The majority of them had a mid-level education and some were employed in various professional occupations (Table 1).

Population Perceptions on the Practice of Tropical Forest Restoration

Although 90% of the population was familiar with the ER project, 27% had no idea that a forest plantation had been carried out. Indeed, 55% of the IP respondents declared that they did not see any difference between the restored forest and a natural forest. Among those 45% that considered the restored forest different, 32% identified biodiversity as the main source of divergence, whereas 29% cited the anthropogenic nature of the forest, without identifying an objective criterion related to the forest itself. Interviewees expressed no clear preference for native species; only 36% of the IP respondents declared that a restoration planting should be carried out exclusively with native species of the region; 6% indicated species from other Brazilian regions would be acceptable; 16% preferred fruit-bearing trees, 24% preferred any tree species, 16% preferred native species of the region plus fruiting trees, and 2% said native species of the region plus those from another regions would be acceptable. Although native species were not the priority for most IP respondents, there was a clear emphasis on number of species used, regardless of identity, as 50% of IP declared that a restoration planting should have more than 100 species, 22% between 51 and 100 species, and 28% between 1 and 50 species. These values are similar to those expressed with regards to native forest species richness. To wit, 57% of the IP stated that native forests of the municipality have more than 100 species of trees, whereas 27% quoted between 51 and 100 species, and 16% between 1 and 50 species. Thus, in general, most IP respondents were familiar with the restoration project and found strong similarities between it and native forests, including the number of species that restoration projects should have, regardless of differences in botanical composition.

Popular Vision of the Socio-economic Aspects of Tropical Forest Restoration

Notably, 94% of IP wanted more forest restoration projects in their community. Similarly, 90% of the IP declared that they were against converting restored forests into crop fields. No less than 44% of IP thought that restoration funding should be a collective investment of farmers, community, government, and private companies, although some believed that this should be taken in charge either by government (28%), by farmers, (10%), by private companies (12%), or the local community (6%). In addition, 90% of the IP declared that if they were farmers, they would agree to free up a small portion of their lands for forest restoration projects. More specifically, 24, 16,

Table 1. Profile of the persons interviewed for assessing cultural ecosystem services and popular perceptions of the benefits of an ecological restoration project in the Brazilian Atlantic Forest.

Age (%)	15–30 years old (35)	30–60 years old (55)	>60 years old (10)		
Residence					
City (%)	Iracemápolis (89)	Other cities (7)			
Living place (%)	Urban (94)	Rural (4)			
Proximity to the restoration project (%)	Nearby (41)	Far (55)			
Educational degree (%)	No degree (6)	Elementary school (31)	High-school (38)	University bachelor (17)	University graduate (8)
Professional occupations (%)	Civil servants (18)	Industrial employees (16)	Students (15)	Teachers (12)	Retired (7)
	Traders (6)	Housewives (4)	Communicators (2)	Farmers (1)	Others (18)

26, and 20% of the IP said they would volunteer, respectively, 1, 2, 5, and 10% of their lands for this purpose. Only 9% of the IP said they would agree to restore as much land as the National Forest Code by the time that the research was carried out (approximately 10% of permanent preservation areas along streams, plus 20% of legal reserve areas).

Cultural Ecosystem Services

Esthetic Values. Regarding the preference of the image that most appealed to them for its scenic beauty, 96% of the IP chose the restored forest, whereas only 2% chose sugarcane fields and 2% said they liked both restored forest and sugarcane fields.

Recreation and Tourism Values. The restoration site was used for several purposes by the IP population, that is, recreation (35%), education (12%), fishing (11%), work (2%), research (2%), and other cultural activities (2%). Only 36% of the IP declared they did not use the area for any reason; of these, approximately two-thirds stated they lived too far from the restoration site to use it, and 75% of the IP that visited the area stated they lived nearby. The main reason for not visiting the restoration site was lack of time (44%), followed by lack of interest (23%), distance (12%), problems with security (9%), and health problems (4%).

Estimates of the Environmental Secretariat of the city indicated that the visitors are mainly bikers, fishermen and hikers (2,880 persons per year), and elderly people that are part of an official visiting program (100 persons per year). The potential for recreation and tourism of this restoration project was reinforced by the fact that 88% of the IP would like a guided tour to learn about the forest and its history, and 62% would agree to pay for a visit. The values suggested for this service were US$ 0.53 (45%), US$ 1.06 (27%), US$ 2.66 (17%), and US$ 5.32 (11%) (conversion Brazilian R$ 1.00 = US$ 0.53; 19 April 2012). The minimum wage in Brazil is US$ 270.00 per month.

Religious and Psychological Values. Approximately 1.5% of the IP declared that they practice some sort of religious rites in the forest. Indeed, several religious offerings were found in the forest during field work. When questioned as to what impressions respondents associated with the photo of the restored forest, responses ranged from tranquility (46%), a sense of order (28%), and development (25%). In contrast, the photo of the sugarcane field resulted in an opposite effect, as only 3% of the IP felt tranquility and 3% reported feeling a sense of order after looking at the photo, whereas 27% felt a sense of disorder, 20% delay, and 27% nuisance. Sugarcane production was interpreted as development by 21% of the IP.

Educational Values and Knowledge Generation. The restoration planting of Iracemápolis has been extensively used for outings and formal field classes in various courses taught in botany, ecology, and forestry (Table 2). In the last 20 years, approximately 7,500 students, from elementary education to graduate students, visited this project for educational purposes. In addition, 12% of the IP declared to use this restoration project for educational purposes, as described before. In addition, this restoration planting has been used as an outdoor lab for 1 post-doctoral research, 8 PhD dissertations, and 13 Master's theses (Appendix S2).

Population Perceptions of Benefits Derived from the Restoration Project

The IP stated that the most important benefits provided by the ER project was the production of water (18%), recreation (13%), wildlife refuge (12%), biodiversity protection (12%), soil protection against erosion (10%), scenic beauty (10%), carbon sequestration (7%), decrease in outbreaks of crop pests (4%), generation of forest products (3%), and use for religious rites (1.5%). Only 0.5% of the IP stated that the restoration project had no benefit for the local population.

Eighty-seven percent of the IP said that the restoration project improved water quality and quantity, whereas 11% said that the ER project had no affect on water. In fact, 76% of the IP remembered a period of severe water scarcity in the city; among persons over 60 years old, no less than 88% expressed this viewpoint. For the group that associated water production improvement with riparian buffer restoration, the benefits for the drinking water supply resulted from

Table 2. Use of a tropical forest restoration project implemented around a water reservoir in the municipality of Iracemápolis, southeastern Brazil, for field trips of various kinds of formal school courses.

Type of Student	*Institution*	*Course*	*Years of Visitation*	*Students per Year*	*Students in the Last 20 Years*
High-school	Municipal institutions	Science	6	350	2,100
Undergraduation	University of São Paulo, Esalq	Agronomy	20	200	4,000
		Biology	8	35	280
		Forestry	10	40	400
		Environmental management	3	30	90
Stricto sensu graduation	University of São Paulo, Esalq	Environmental management	5	40	200
		Soil management	6	40	240
Lato sensu graduation	University of São Paulo, Esalq	Environmental planning	8	20	160
		Ecological restoration	2	20	30
Total				775	7,500

(1) the general improvement of the ecosystem (28%); (2) the protection of the water reservoir against siltation due to the reduction of erosion in its borders (7%); (3) the barrier that the native vegetation creates to halt or limit the arrival and seepage of pesticides from the sugarcane field to the water (4%), the combinations of (1) and (2) (8%), (1) and (3) (3%), and (2) and (3) (3%); but predominantly, due to the combined contribution of all of these factors together (44%).

Recognizing the importance of riparian forest restoration for improving drinking water, 63% of the IP would agree with an increase in water tariff if the tax money were invested in forest restoration in the municipality. However, 56% of this group would not accept to pay this extra value if the money was invested in restoration efforts at the regional or national scale. Among those willing to pay an extra value in the water bill to expand local ER projects, 28, 26, and 30% of them would agree to pay, respectively, 1, 2, and 5% more on their regular water bills.

According to the billing data provided by the water supply service of Iracemápolis for May 2010, there were 5,875 residential, 364 commercial, and 238 industrial consumers, who received a mean monthly bill of US$ 18, US$ 32, and US$ 83, respectively. On the basis of these values, and on the mean percentage of IP willing to pay a supplement to their water bill (4.12%), a total of US$ 6,198 per month (US$ 74,372 per year) would be obtained for direct investments in restoration projects in Iracemápolis.

Discussion

The assessment of cultural ES, socio-economic aspects, and population perceptions of benefits associated to ER projects, as carried out in this work, provided interesting insights for transforming ER into a more attractive activity to stakeholders (see Aronson et al. 2010), as well as a way to identify sources of funding for ER projects (Holl & Howarth 2001). The case study provided by the Iracemápolis restoration project may be applied with appropriate modifications to other tropical developing countries, because the characteristics of this project reflects the reality of most of these countries: human-modified landscapes occupied by agriculture, very low forest cover, the population concentrated in cities, and generally low educational levels.

A majority of the IP declared that forests undergoing restoration and natural forests do not differ. This result indicates that more investment is needed to communicate to society the irreplaceable value of native forests, mainly the primary ones (Gibson et al. 2011), and the limitations of ER (Maron et al. 2012). The lack of preference for native species for restoration plantings points to a trade-off that may be required by restorationists when selecting species to emphasize: the local population may prefer species with economic uses, including exotics (Román-Dañobeytia et al. 2011). This dilemma highlights that restoration designs which include the exploitation of forest products (Lamb et al. 2005), or even crops in agro-successional models (Vieira et al. 2009), may be more attractive to the population in general and could create more suitable conditions for upscaling restoration in human-modified landscapes (Brancalion et al. 2012). Concurrently, the fact that respondents gave high priority to obtaining a high number of species, independent of their identity, indicates that biodiversity is still misinterpreted as just a matter of numbers or species richness by the public.

Independently of how ER is carried out, there was a huge support by IP to expand restoration projects in their community, mainly based on a collective investment of the society. This tendency to contribute was also reinforced by the willingness of IP to offer lands for restoration if they were farmers. However, they would only offer a small portion of their lands for this purpose, a great deal less than legally established. The difference between the amount of land that society at large requires from farmers for restoration through law enforcement and the amount that farmers are able to provide is a key aspect of ER: when a private individual is benefited by the actions of others, this individual will offer no resistance to expand ER, but if this same individual is in charge of freeing her/his own land for restoration, then ER may be hampered (Clewell & Aronson 2006). This may be the key factor determining the different acceptance of ER between farmers and the urban population, as frequently observed in

debates for designing public policies. Therefore, win-win ER schemes are essential for convincing tropical farmers and landowners to agree to restore portions of their lands (Knoke et al. 2009).

Although conflicts of interest may hamper the extension of ER projects on private lands, the favorable responses to cultural ES near the Iracemápolis restoration project site show the important role of restoring degraded lands for human well-being and, consequently, for societal investments in this field (Neßhöver et al. 2011). Restoration projects near or within cities can be remarkable places for recreation, as indicated by our results, whereas in the countryside these projects could be explored for tourism (Blangy & Mehta 2006). Quality of life for local people could also be enhanced, as shown by our results, as well as by other studies (Bullock et al. 2011). ER projects may also be used for open-door classes, as well as live laboratories for investigating ER. The 19 graduate thesis projects of RE students carried out in this site to date is an indicator of its importance for the advancement of ER in Brazil, and in tropical forest biomes. Some of the results and insights obtained by using this restoration project as a case study have also served to create legal instruments—laws and regulations—to guide restoration efforts in the state of São Paulo (Aronson et al. 2011).

An important issue to be addressed when assessing cultural ES is that perceived benefits cannot be compared with, or supported by, biophysical evidence of real benefits provided by the ecosystem under study. For instance, the perceived benefits of riparian buffer restoration for improving the quality of drinking water can be compared with water chemical analyses to determine if the perception of respondents corresponds to a real change in water quality. Personal values, culture, and the socio-economic environment may predispose a person to a given view of the cultural benefits provided by a given ecosystem. However, it is important to highlight that, although more dependent on social constructs than other ES, an adequate assessment of cultural ES should ideally be supported by a direct or indirect association with the relevant ecological structure or functionality of the ecosystem. Otherwise these services should be considered as benefits, rather than as services (see a proposal of scientific foundations for assessing cultural ES in Daniel et al. 2012).

In addition to cultural ES, the population also pointed out several other benefits derived from this project. As expected, the improvement of water production and quality was the main benefit reported. This empirical association between ecosystem integrity and improvement of hydrological services is well supported by the literature (see review in Brauman et al. 2007). It is important to highlight that the IP chose, as the most important benefits of the restoration project, those benefits that could have an immediate impact on their community. Most respondents were only willing to pay extra taxes as part of their water bill if this money were to be invested in local restoration projects, and not at the regional and national scale. Hence, depending on the ES to be explored by payments for ES schemes, different markets have to be accessed and developed (Wunder 2006; Daily & Matson 2008).

Most respondents were willing to pay more for drinking water for the purpose of expanding ER in their community (see also Whitehead 1990). Considering the potential value of this strategy (US$ 74,372 per year) and the overall value (US$ 5,000 per ha) for implementing a typical forest restoration project in Brazil, it would be possible to restore approximately 15 ha of degraded lands per year, that is, approximately one project, like the one described here, every 3 years.

This provides evidence for the importance of stated preferences to estimate ES valuation, as reviewed by Schultz et al. (2012), in order to find new sources for restoration funding and support of local communities. Nonetheless, revealed preference and replacement cost methods can also be applied (Brauman et al. 2007). However, we are aware of the limitations of willingness to pay surveys as contingent valuation to assess sources of funding for restoration, as already discussed by Holl and Howarth (2001). Other strategies, such assessing the reduction of water treatment costs, economic attractiveness of land use change through PES to landowners, avoiding damages from flooding, improving dam functionality, etc., could be useful to better communicate to society the benefits of ecosystem conservation and restoration, thereby mainstreaming more investments regarding the enhancement of hydrologic services (Brauman et al. 2007). It is well known that drinking water is one of the main sources of disease transmission and thus is of paramount importance for public health and well-being.

In summary, this study found that the forest restoration project provides several cultural ES, as well other ES, to society. The investigation and communication of these benefits may help convince stakeholders of the importance of ER, advance consensus-building, and improve societal investments in this emerging field of activity. Increased understanding of the perceptions of the local population about the pros and cons of ER may also be a valuable tool for the design and implementation of projects, and for identifying gaps in the communication and dissemination of scientific knowledge.

Implications for Practice

- Investigation of willingness-to-pay for water resources protection by ecological restoration projects, as well as for guided tours to visit them, may indicate promising strategies for funding restoration.
- More investment is needed to communicate to society the potential and the limitations of ecological restoration to improve the quality of life and to help maintain remaining natural forests. Restoration designs that include exploitation of forest products (or even crops in agro-sucessional models) may be especially attractive to populations in developing countries, which in turn could boost efforts to upscale restoration programs in human-modified landscapes.

Acknowledgments

We thank Dr. H. T. Zarate Couto for support in the design of questionnaire application. R.R.R. thanks the National

Council for Scientific and Technological Development (CNPq) for financial support. We also warmly thank K. Holl, W. Throop, M. N. Roble, and an anonymous reviewer for helpful comments on a previous version of the manuscript.

LITERATURE CITED

Aronson, J., J. N. Blignaut, S. J. Milton, D. Le Maitre, K. J. Esler, A. Limouzin, et al. 2010. Are socioeconomic benefits of restoration adequately quantified? A meta-analysis of recent papers (2000–2008) in Restoration Ecology and 12 other scientific journals. Restoration Ecology **18:**143–154.

Aronson, J., P. H. S. Brancalion, G. Durigan, R. R. Rodrigues, V. L. Engel, M. Tabarelli, et al. 2011. What role should government regulation play in ecological restoration? On-going debate in São Paulo State, Brazil. Restoration Ecology **19:**690–695.

Bhattacharya, D. K., E. S. Brondizio, M. Spierenburg, A. Ghosh, M. Traverse, F. deCastro, C. Morsello, and A. D. Siquiera. 2005. Cultural services. Pages 401–422 in Millennium ecosystem assessment. Ecosystems and human well-being: current state and trends. Island Press, Washington, D.C.

Blangy, S., and H. Mehta. 2006. Ecotourism and ecological restoration. Journal for Nature Conservation **14:**233–236.

Brancalion, P. H. S., R. A. G. Viani, B. B. N. Strassburg, and R. R. Rodrigues. 2012. Tropical forest restoration as a profitable land use. Unasylva **239:**25–34.

Brauman, K. A., G. C. Daily, T. K. Duarte, and H. A. Mooney. 2007. The nature and value of ecosystem services: an overview highlighting hydrologic services. Annual Review of Environment and Resources **32:** 67–98.

Bullock, J., J. Aronson, J. M. Rey Benayas, R. Pywell, and A. Newton. 2011. Restoration of ecosystem services and biodiversity. Trends in Ecology & Evolution **26:**541–549.

Chan, K. M. A., A. Guerry, P. Balvanera, S. Klain, T. Satterfield, X. Basurto, et al. 2012a. Where are 'cultural' and 'social' in ecosystem services: a framework for constructive engagement. Bioscience **62:**744–756.

Chan, K. M. A., T. Satterfield, and J. Goldstein. 2012b. Rethinking ecosystem services to better address and navigate cultural values. Ecological Economics **74:**8–18.

Clewell, A. F., and J. Aronson. 2006. Motivations for the restoration of ecosystems. Conservation Biology **20:**420–428.

Cochran, W. G. 1977. Sampling techniques. 3rd edition. John Wiley & Sons, New York.

Daily, G. C., and P. A. Matson. 2008. Ecosystem services: from theory to implementation. Proceedings of the National Academy of Sciences of the United States of America **105:**9455–9456.

Daniel, T. C., A. Muhar, A. Arnberger, O. Aznar, J. W. Boyd, K. M. A. Chan, et al. 2012. Contributions of cultural services to the ecosystem services agenda. Proceedings of the National Academy of Sciences of the United States of America **109:**8812–8819.

Gibson, L., T. M. Lee, L. P. Koh, B. W. Brook, T. A. Gardner, J. Barlow, et al. 2011. Primary forests are irreplaceable for sustaining tropical biodiversity. Nature **478:**378–381.

de Groot, R., P. S. Ramakrishnan, A. van deBerg, T. Kulenthran, S. Muller, D. Pitt, et al. 2005. Cultural and amenity services. Pages 455–476 in Millennium ecosystem assessment. Ecosystems and human well-being: current state and trends. Island Press, Washington, D.C.

Holl, K. D., and R. B. Howarth. 2001. Paying for restoration. Restoration Ecology **8:**260–267.

Knoke, T., B. Calvas, N. Aguirre, R. M. Román-Cuesta, S. Günter, B. Stimm, M. Weber, and R. Mosandl. 2009. Can tropical farmers reconcile subsistence needs with forest conservation? Frontiers in Ecology and the Environment **7:**548–554.

Lamb, D., P. D. Erskine, and J. A. Parrotta. 2005. Restoration of degraded tropical forest landscapes. Science **310:**1628–1632.

Maron, M., R. J. Hobbs, A. Moilanen, J. W. Matthews, K. Christie, T. A. Gardner, D. A. Keith, D. B. Lindenmayer, and C. A. McAlpine. 2012. Faustian bargains? Restoration realities in the context of biodiversity offset policies. Biological Conservation **155:**141–148.

Martín-López, B., E. Gómez-Baggethun, P. L. Lomas, and C. Montes. 2009. Effects of spatial and temporal scales on cultural services valuation. Journal of Environmental Management **90:**1050–1059.

MEA (Millennium Ecosystem Assessment). 2005. Ecosystems and human wellbeing: multiscale assessments. Synthesis report series. Vol **4**. Island Press, Washington, D.C.

Neßhöver, C., J. Aronson, J. N. Blignaut, D. Lehr, A. Vakrou, and H. Wittmer. 2011. Investing in ecological infrastructure. Pages 401–448 in P. ten Brink, editor. The economics of ecosystems and biodiversity in national and international policy making. Earthscan, London and Washington, D.C.

Palmer, M. A., and S. Filoso. 2009. Restoration of ecosystem services for environmental markets. Science **325:**575–576.

Redford, K. H., and W. M. Adams. 2009. Payment for ecosystem services and the challenge of saving nature. Conservation Biology **23:**785–787.

Rey Benayas, J. M., A. C. Newton, A. Diaz, and J. M. Bullock. 2009. Enhancement of biodiversity and ecosystem services by ecological restoration: a meta-analysis. Science **325:**1121–1124.

Román-Dañobeytia, F., S. Levy-Tacher, J. Aronson, R. R. Rodrigues, and D. Douterlunghe. 2011. Classification of tropical tree species into ecological groups: implications for forest management and restoration in the Lacandon region, Chiapas, México. Restoration Ecology **20:**378–386.

Ruiz-Jaen, M. C., and T. M. Aide. 2005. Restoration success: how is it been measured? Restoration Ecology **13:**569–577.

Schultz, E. T., R. J. Johnston, K. Segerson, and E. Y. Besedin. 2012. Integrating ecology and economics for restoration: using ecological indicators in valuation of ecosystem services. Restoration Ecology **20:**304–310.

Vieira, D. L. M., K. D. Holl, and F. Peneireiro. 2009. Agro-successional restoration as a strategy to facilitate tropical forest recovery. Restoration Ecology **17:**451–459.

Whitehead, J. C. 1990. Measuring willingness-to-pay for wetlands preservation with the contingent valuation method. Wetlands **10:**187–201.

Wunder, S. 2006. The efficiency of payments for environmental services in tropical conservation. Conservation Biology **21:**48–58.

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix S1. Questions included in the questionnaire submitted to a sample population of Iracemápolis, São Paulo state, southeastern Brazil, in order to assess cultural ecosystem services and population perceptions of benefits associated with an ecological restoration project carried out in this municipality.

Appendix S2. Graduate research projects carried out in a tropical forest restoration site implemented around a water reservoir in the municipality of Iracemápolis, southeastern Brazil.