Field evidence that ecosystem service projects support biodiversity and diversify options

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Ecosystem service approaches to conservation are being championed as a new strategy for conservation, under the hypothesis that they will broaden and deepen support for biodiversity protection. Where traditional approaches focus on setting aside land by purchasing property rights, ecosystem service approaches aim to engage a much wider range of places, people, policies, and financial resources in conservation. This is particularly important given projected intensification of human impacts, with rapid growth in population size and individual aspirations. Here we use field research on 34 ecosystem service (ES) projects and 26 traditional biodiversity (BD) projects from the Western Hemisphere to test whether ecosystem service approaches show signs of realizing their putative potential. We find that the ES projects attract on average more than four times as much funding through greater corporate sponsorship and use of a wider variety of finance tools than BD projects. ES projects are also more likely to encompass working landscapes and the people in them. We also show that, despite previous concern, ES projects not only expand opportunities for conservation, but they are no less likely than BD projects to include or create protected areas. Moreover, they do not draw down limited financial resources for conservation but rather engage a more diverse set of funders. We also found, however, that monitoring of conservation outcomes in both cases is so infrequent that it is impossible to assess the effectiveness of either ES or BD approaches.

conservation | conservation organizations | protected area | working landscapes

Ecosystem service approaches to conservation offer a promising way to align conservation and production, simultaneously enhancing human well being and protecting Earth's biodiversity and life-support systems (1–10). Developing market-based mechanisms for ecosystem services by ascribing them value, both economic and social, may help diminish poverty and improve human welfare (11–15). These approaches offer hope for making conservation mainstream, by enlisting the support of a greater number and variety of funders and partners, by spanning the continuum of "wild" to human-dominated places, and by broadening the financial and institutional approaches used for conservation. At the same time, there is a risk that by straying from a pure focus on nature reserves and biodiversity, conservation projects that address ecosystem services may detract from biodiversity protection (16).

Previous research and reviews have demonstrated the use of specific tools for including ecosystem services in conservation (e.g., 11, 17, 18). Here, we provide the first quantitative comparison of conservation projects focused in part on ecosystem services (ES) and those oriented more traditionally around biodiversity (BD) alone. Our aim is to test whether ecosystem service projects attract new and more diverse financial support and to explore other differences between these two project types. In particular, we ask whether ecosystem service projects expand conservation options (finance tools, actions, and landscapes) without neglecting traditional approaches (maintaining and creating protected areas). There is great need for such understanding, given the rapid development and deployment of ecosystem service approaches globally.

We conducted a case study of The Nature Conservancy (TNC), the world's largest conservation organization investing more than $700 million annually in conservation in more than 30 countries on five continents. Using only TNC projects provides a relatively large and homogeneous sample of conservation efforts, all following the same methodology and all reporting their project design with the same terminology and framework ("conservation by design"; see ref. 19). Additionally, TNC maintains a project database that can be searched by geographic region so sampling is unbiased without regard to success or other attributes.

We developed a database (supporting information (SI) *Appendix*) of biodiversity-oriented (BD) and ecosystem service-oriented (ES) projects focusing on the Western Hemisphere because of the longevity of TNC investments in this area—the United States since 1954 and Latin America for almost 30 yr. (Only within the last decade has TNC started working beyond the Western Hemisphere.) TNC projects are sustained efforts at protecting species, habitats, or community types following explicit conservation objectives. All projects entail a written description of the strategies used to accomplish conservation, ranging from the establishment of a nature reserve or the purchase of conservation easements to advocacy for local zoning laws that restrict certain land uses. All have biodiversity goals or focal species or habitats (etc.) they aim to protect.

For our study, we defined projects with only biodiversity goals as "BD projects." "ES projects" are those that have biodiversity goals, but in addition have an explicit goal or strategy of at least one ecosystem service such as water purification, carbon sequestration, and opportunity for ecotourism. To be an ES project, reference to an ecosystem service must be explicit. This is not an outcome-based definition but rather a process-based one.

TNC works via partnership: the project participants in our database include 8 private corporations; 32 federal, 29 state, and 24 local government agencies; 67 nongovernmental organizations (NGOs); 12 universities; and 2 private landowners. The NGOs range from national (e.g., Trópico in Bolivia) to multilateral organizations (e.g., the World Bank). Thus, a focus on TNC actually draws from the ES and BD conservation efforts of a global array of institutions.

We collected information about project strategy and structure through a series of semistructured, open-ended interviews [rather than surveys because interviews are more appropriate for

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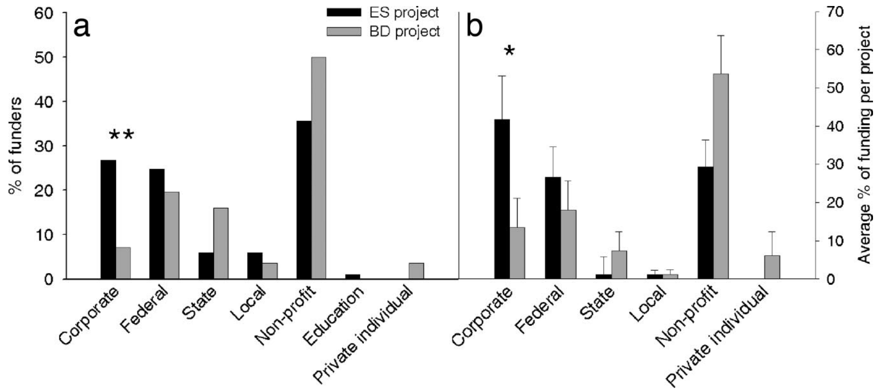

Fig. 1. Project funding information. Corporate funders are private, for-profit organizations. Federal, state, and local funders refer to levels of government. Nonprofit donors are nongovernment organizations. Education donors have a connection to a university, and private individuals refer to private landowner donations. (*a*) Proportion of funder types by project type. On average, 27% of funders are corporate for ES projects whereas only 8% are for BD projects ($P = 0.010$, $n = 57$ using 9,999 permutations in a randomization experiment). (*b*) The subset (17 ES, 16 BD) of projects with exact funding information and the average percentage of overall funding coming from the different funding sources. ES projects have significantly more revenue sources overall, particularly from corporate sources, and on average, an ES project receives 42% of its funding from corporate sources compared with an average of 14% for BD projects ($P = 0.023$, $n = 33$). *, $P < 0.05$; **, $P < 0.01$. The error bars represent SD.

capturing details and nuances in case studies (20)] of TNC personnel and partners to determine characteristics of on-the-ground implementation of ES and BD projects. Attributes included goals (both broad and specific goals such as species, habitats, and services targeted), partners, funding, landscapes encompassed, activities promoted, and monitoring involved (*SI Appendix*). All recorded information was checked by the interviewee in the database. We sampled 60 projects: 34 ES and 26 BD with a relatively similar geographic breakdown to account for differences in project implementation based on geography. For ES projects, 35% were in South America, 24% in Meso-America and Caribbean region, and 41% in the United States; BD projects were 28%, 16%, and 56%, respectively. We had a 74% response rate of contacts responding to our interview request. Our initial sampling aimed for 30 projects of each type, but four of the BD projects sampled turned out to be ES projects during interviewing.

For the subset of ES ($n = 17$) and BD ($n = 16$) projects for which we received exact funding information, ES projects, on average, obtain more than four times the revenue of BD projects (one-way ANOVA, $F_{1,33} = 5.57$; df = 1; $P = 0.02$). Looking at our full sample of projects, ES projects also have significantly more funders [3.16 ± 2.03 (mean ± SD)] than do BD projects (2.24 ± 1.88) (Wilcoxon–Mann–Whitney U test; $\chi^2_1 = 6.32$; $P = 0.012$).

Although we cannot determine why ES projects received more money from more sources, it is evident that ES projects are more successful at securing corporate funding. On a per-project basis, ES projects have at least one corporate funder nearly three times more often than BD projects ($P = 0.009$, $n = 57$). ES projects also engaged significantly more corporate funders overall (27% of funders) as compared with BD projects (7% of funders) (Fig. 1*a*; $P = 0.010$, $n = 57$). In addition, again focusing on projects with exact financial breakdowns, on average ES projects received much more (42%) of their funding on a per project basis from corporate sources compared with BD projects (14%) (Fig. 1*b*; $P = 0.023$, $n = 33$).

In addition to funding sources, the actual finance tools (e.g., purchasing land rights, selling carbon credits, designing new subsidies, etc.) used as incentives to advance conservation are important. When no finance tools are used, conservation is imposed without any compensation to affected parties. A total absence of finance tools is almost eight times more common in BD than in ES projects (Fig. 2; 23% versus 3%, Pearson $\chi^2_1 = 5.80$, $P = 0.02$); the difference is even more dramatic outside the United States where 50% of BD projects used no finance tool compared with 5% of ES projects (Pearson $\chi^2_1 = 8.89$, $P = 0.003$) (Fig. S1). ES projects also draw on a broader portfolio of finance tools. Traditionally, conservation organizations have relied on land purchase and purchase of property rights (easements) (21), both of which are expensive and can be restrictive outside the United States where many such organizations cannot own property. BD projects employ land purchasing 1.5 times and easements almost 2.5 times more often (Fig. 2; Pearson $\chi^2_1 = 7.27$, $P = 0.007$) than ES projects. Additionally, ES projects use markets (e.g., creating carbon credits, mitigation banking, organic products) and user access fees (e.g., water use or ecotourism) significantly more frequently than BD projects (Fig. 2; Pearson $\chi^2_1 = 3.79$, $P = 0.052$ and $\chi^2_1 = 7.06$, $P = 0.008$, respectively).

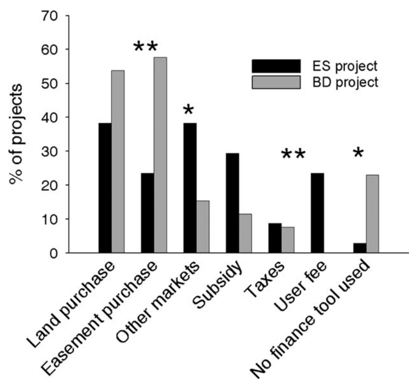

Fig. 2. Greater diversity and number of finance tools are used in ES projects. Easement purchase involves purchase of particular property rights. The other markets category includes carbon credits, mitigation banking, habitat banking, and specialized-product markets (e.g., organic products). Taxes and subsidies involve creating new as well as redistributing existing ones. User fees are for water or ecotourism. Projects that use no finance tools are also indicated. More than 50% of BD projects use land and easement purchasing whereas <40% of ES project purchase land and <25% purchase easements. Targeting ecosystem services opens up the ability to use finance tools such as markets (almost 40% of ES projects use a market) and user access fees (almost 25% use this finance tool). In general, ES projects use more finance tools (>97% use at least one tool) than BD projects (only ≈75% use one, mostly in the United States). *, $P < 0.05$; **, $P < 0.01$.

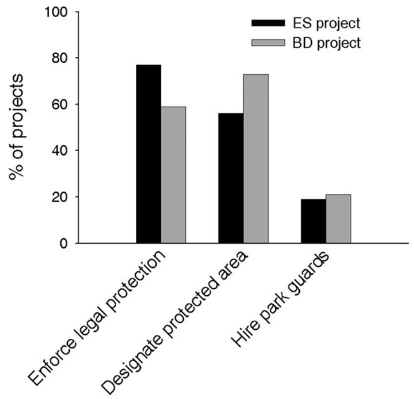

Fig. 3. Types of preservation activities used in ES and BD projects. There is no significant difference between investments in enforcing legal protection of previously designated protected areas, designating new protected areas for conservation, and hiring park guards (77%, 56%, 19%, respectively, of ES projects; 59%, 73%, 21%, respectively, of BD projects) to ensure protected areas are properly managed (Pearson $\chi^2_1 = 1.88$, $P = 0.17$; $\chi^2_1 = 2.17$, $P = 0.14$; $\chi^2_1 = 2.24$, $P = 0.13$, respectively).

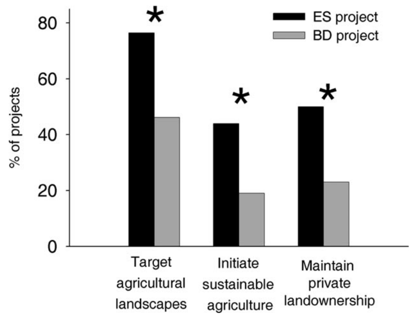

Fig. 4. Types of landscapes and landowners included in ES and BD projects. Projects that initiate sustainable agriculture introduce sustainable techniques (such as contour farming, no till, organic crops). Projects that maintain private landownership involve no private land purchasing within the project area. Land starts as private and remains private. Significantly more ES projects target agricultural landscapes (75% compared with 46% of BD projects) initially. More ES projects also work to maintain human use by initiating sustainable agriculture (44%) and maintaining private landownership (50%) as opposed to BD projects (<20% initiate sustainable agriculture and only 23% maintain private ownership). *, significant $P < 0.05$.

Both ES and BD projects employ a wide range of institutional tools (defined as changing or creating policy or altering a law). These institutional tools include creating or redistributing a tax, subsidy, and/or a fee. They also encompass legal alteration of ownership rights, development rights, or administration rights. Within the Unites States, BD projects rely heavily on land purchase and do not emphasize institutional change (only 30% of BD projects in the United States work to affect policy). In contrast, significantly more ES projects, 70% in total, alter an institutional policy (Fig. S1; Pearson $\chi^2_1 = 5.14$, $P = 0.023$). In the United States, some of these institutional policy changes in ES projects include changing ownership rights of a dam to allow decommissioning, selling rights to carbon credits, and being granted access rights to particular forests. In Latin America, one recent example is changing administration rights but not ownership rights of a park from public control to nonprofit control. Affecting policy will likely lead to project longevity because it institutionalizes conservation efforts.

Given the changes ES projects bring to conservation practice, it is important to ask whether these projects fail to address the conservation of protected areas. The answer is no. We considered enforcing legal protection, designating new protected areas, or hiring park guards as means of protected area conservation and found no significant difference between the proportions of projects engaging in these strategies (Fig. 3). Overall, 76% of ES projects and 92% of BD projects engage in at least one protected area strategy.

Although ES and BD projects have similar commitments to protected areas, ES projects differ in also pursuing conservation outside reserves, a strategy limited by both political and socioeconomic constraints (22). Conservation outside reserves is also critically important given continuing rapid growth of both the human population and human-dominated lands (2) and has been the subject of a larger debate (for example, see ref. 23). Agricultural and pasture lands represent ≈40% of global land surface (24), and these lands can provide important contributions to biodiversity protection (25). It is striking the extent to which ES projects target agricultural lands compared with BD projects (75% and 46%, respectively; Pearson $\chi^2_1 = 5.83$, $P = 0.012$) (Fig. 4). Approximately 44% of ES projects initiate sustainable agriculture (e.g., introduce contour plowing, conservation tillage, organic farming, etc.) as a strategy for achieving sustainable human activity within the project area. By contrast, <20% of BD projects maintain any agriculture in the project area, aiming to prevent direct human use (Pearson $\chi^2_1 = 4.11$; $P = 0.043$). Both ES projects and BD projects work with private landowners, but significantly more ES projects keep land in private ownership rather than negotiating a land purchase (Pearson $\chi^2_1 = 4.52$; $P = 0.034$) (Fig. 4 and *SI Appendix*). Both BD and ES projects invest in protection, but ES projects are significantly more likely to invest in working landscapes, investments critical for conservation success.

ES projects are being implemented exactly as one might expect given the link between ecosystem services and human well being. Compared with BD projects, ES projects are obtaining greater revenue overall and more funding from corporate sources, using a wider variety of financial incentives, and giving much more attention to private lands, especially those used for agriculture. This final point emphasizes the essential role ES projects will likely play in the future because agricultural lands are projected to expand by at least 120 million hectares by 2030 (26). Pursuing conservation in pristine and working landscapes will be essential, and ecosystem services give us a tool to use in both.

The ultimate question is whether either of these strategies is enhancing biodiversity—the mission of TNC and many other conservation organizations. Our sample of 60 BD and ES projects revealed that <20% of all projects are doing comprehensive monitoring (systematic monitoring geared to at least two desired outcomes/goals). Most of the biodiversity monitoring involved sampling the change in abundance of a particular species of rare plant or animal over time. In addition, only 26% of ES projects are monitoring any ecosystem service outcomes, and the vast majority of this monitoring involves ensuring that carbon projects meet their targets, and nothing beyond that. Thus, we do not have the data to assess whether either ES or BD projects are delivering their conservation promises.

The absence of measures for monitoring conservation projects is widely appreciated (27), but ours is one of the first quantitative reports of what proportion of projects do monitor. Although the data we report show that ES projects are broadening the scope and support for conservation, the question of outcomes is critical. In many cases public funds and taxes are being used to finance ecosystem service projects with the promise of better services being delivered to people. If we fail to monitor and evaluate the delivery of ecosystem services, we risk alienating the new support base that ecosystem service approaches are bringing to conservation.

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Materials and Methods

Data Sampling. From November 2006 to July 2007, we interviewed relevant personnel (such as project managers and field coordinators) at The Nature Conservancy (TNC) both in person and over the phone to sample a variety of ecosystem service and biodiversity projects. When TNC's role in a project was relatively peripheral, we talked with key partners. We conducted >70 interviews and sampled 60 projects: 34 ES projects and 26 BD projects. We limited our sampling to three TNC regions: South America, Meso-America, and the Caribbean (which includes Mexico), and the United States.

For ES projects, we tried to sample comprehensively because, compared with BD projects, there are relatively few. TNC traditionally and presently focuses on biodiversity projects with hundreds of such projects ongoing. ES projects, on the other hand, are far fewer, and we attempted to sample as many of such projects as exist in the Western Hemisphere. Most ES projects at TNC started within the last decade and many in the last 5 yr. To comprehensively sample ES projects we used email correspondence with each regional director (as defined by TNC) asking for project managers to contact us if they had a project in the region they considered an ES project. We also then used a snowballing technique, where project managers would tell us about other projects they knew of, to acquire other ES projects that did not appear in the first sampling. The request was sent out with an outline of our definition of an ES project. We sent around this request twice to each region.

To sample the vast array of BD projects, we used TNC's basic repository of projects to randomly select 40 projects all of which had a project start date of 1990 or more recently as this was as old as the oldest ecosystem service project. We used a random number generator to select projects. We used a stratified random sampling technique to ensure relevant and accurate coverage of projects in the three main regions of study and to ensure a similar geographic breakdown of projects to the ES projects. We originally tried to sample the same number of ES and BD projects. Because we found 30 ES projects, we randomly selected 30 BD projects. Upon conducting interviews, however, we found that four projects that appeared to be BD projects were actually ES projects by our definition.

For each project, we conducted a semistructured interview based on a database we designed to assess, analyze, and compare the projects across a variety of different characteristics (see *Interview Protocol* in *SI Appendix*). We chose an interview approach rather than a survey approach to enable an in-depth and rigorous comparison of the two conservation approaches (18). Semistructured interviews help minimize the amount of information left up to interpretation. We were able to explain terminology and ensure that interviewees were answering the intended question.

We sampled for information about project goals; targets (species, habitat, ecosystem services); threats; partners and partner motivations; funding information (who and why); types of landowners, land uses, and land covers involved; financial, institutional, and social tools used; on-the-ground conservation activities in use; details on who pays and who receives payment for ecosystem services, when relevant; types of monitoring and policy analysis used; and lessons learned. Interviews were conducted in person (27 projects) or over the phone (33 projects) and lasted anywhere between 45 min and 6 h (if a tour of the project site was involved). Interview transcripts based on notes taken during the interview were used to upload the information into the database. R.L.G. was responsible for all interviews, note taking, and data entry thereby eliminating inconsistencies in the data collection process.

The database was designed for both quantitative and qualitative data. Quantitatively, the database consists of a series of checkbox sets defining a range of possible outcomes for a given project characteristic (see *Checkbox Definitions* in *SI Appendix*). For example, we created a list of possible threats a project could combat (based on the International Union for Conservation of Nature threat list that TNC uses for their project definitions) and incorporated this list as a checkbox set within the database where for each project we ''checked'' all applicable threats. These sets were coded to record presence/absence of project characteristics as well as summations of various attributes (e.g., total number of corporate donors).

Qualitatively, the database has a number of ''fill-in'' boxes in which text can be entered to capture the more nuanced, unique features of each project (see *Fill-In Box Definitions* in *SI Appendix*). All checkboxes and fill-in boxes were completed by using interview transcripts.

After completion of interviews in July 2007, each project entry was sent to the interviewee(s) for him/her to approve and correct, as appropriate. Based on these responses, the database was updated and changed to better reflect the actual project.

Data Analysis. Categorical presence/absence data were analyzed by using the Pearson χ^2 test appropriate for this sample size (28) in JMP version 5.0.1.2 (29). Summary data of total project funding by project type used a one-way ANOVA after a log transformation to normalize the data (29). We assessed the independence of our project types based on likelihood of corporate funding and amount of total funding from corporate sources using a one-tailed probability distribution permutation test with 9,999 permutations coded in MATLAB following Sokal and Rohlf (30).

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