Field evidence that ecosystem service projects support biodiversity and diversify options

Rebecca L. Goldman*,†, Heather Tallis‡, Peter Kareiva§, and Gretchen C. Daily¶

*Interdisciplinary Program in Environment and Resources, Department of Biological Sciences, 371 Serra Mall, Stanford University, Stanford, CA 94305-5020; ‡Department of Biological Sciences, 371 Serra Mall, Stanford University, Stanford, CA 94305-5020; and §The Nature Conservancy, 4722 Latona Avenue NE, Seattle, WA 98105

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.

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

Author contributions: R.L.G. and H.T. designed research; R.L.G. performed research; R.L.G., H.T., and P.K. analyzed data; and R.L.G., H.T., P.K., and G.C.D. wrote the paper.

The authors declare no conflict of interest.

This article is a PNAS Direct Submission.

†To whom correspondence should be addressed. E-mail: rgoldman@tnc.org.

This article contains supporting information online at www.pnas.org/cgi/content/full/0800208105/DCSupplemental.

© 2008 by The National Academy of Sciences of the USA
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 \( (3.16 \pm 2.03 \text{ (mean \pm SD)}) \) than do BD projects \( (2.24 \pm 1.88 \text{ (mean \pm SD)}) \) (Wilcoxon–Mann–Whitney \( U \) test; \( \chi^2 = 6.32; \) \( P = 0.012 \)).

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. 1a; \( P = 0.010, \ n = 57) \). 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. 1b; \( P = 0.023, \ n = 33) \).

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. 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.

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). * \( P < 0.05; **, \ P < 0.01. \)
Agricultural and pasture lands represent the subject of a larger debate (for example, see ref. 23). Human population and human-dominated lands (2) and has been critically important given continuing rapid growth of both the economic constraints (22). Conservation outside reserves is also protected areas, ES projects differ in also pursuing conservation projects and 92% of BD projects engage in at least one protected areas are properly managed (Pearson $\chi^2 = 1.88, P = 0.17; \chi^2 = 2.17, P = 0.14; \chi^2 = 2.24, P = 0.13$, respectively).

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 United 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 $\chi^2 = 5.14, P = 0.023$). 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 $\chi^2 = 5.83, P = 0.043$) (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 $\chi^2 = 4.11; P = 0.043$). 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 $\chi^2 = 11.62; P = 0.0034$ (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.
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. We randomly select 40 projects at 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 conversation on 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 hr (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 checkboxes 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’s Red List threat assessment) 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 χ² 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).

ACKNOWLEDGMENTS. We thank all TNC staff and partners who helped make this research possible. We thank K. Braunam, B. Broi, J. Goldstein, H. Mooney, and L. Pejchar for their feedback on previous versions of this manuscript. We also thank two anonymous reviewers for very helpful comments. We thank Teresa Heinz Environmental Scholars fellowship for funding this research and the National Science Foundation Graduation Research Fellowship for supporting R.L.G. Additionally, we thank P. and H. Bing, V. and R. Sant, T., W., and K. Kirth for their generosity in supporting The Natural Capital Project.

Supporting Information

Methods

DATABASE INFORMATION

Interview Protocol

BASIC INFORMATION
Project name
Those interviewed
Organization of interviewees
Date of interview
Main project contact
Project location
Project ecoregion
Start date
Expected project length
Project category (ES versus BD)
Interview type (in person versus by phone)

RATIONALE
What are the major threats to the project area?
What are the project goals?
What Ecosystem services are targeted or have been incorporated?
What are the species and habitat targets/goals?
Socioeconomic goals?

PROJECT INFRASTRUCTURE
Who are the major project partners (federal, state, local, education, non-profit, corporate)?
What are the major goals for each partner?

FUNDING DETAILS
Who are the major funders and what funds has the project secured?

<table>
<thead>
<tr>
<th>Funder type</th>
<th>Number</th>
<th>Amount</th>
<th>Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corporate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Federal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>State</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non Profit</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Amount Categories

1) $1000-$10000
2) $10,000-$100,000
3) $100,000 – $ 1 million
4) $ 1million – 10 million
5) 10 million – 100 million
6) 100 million – 1 billion
7) 1 billion – 10 billion

What are the funders motivations?

LANDSCAPE DETAILS
What is the project implementation scale (local, regional, global)?
Impact scale?
Who are the main landowners in the area?
   Pre project?
   Target?
What is the land cover of the area?
   Original?
   Pre-project?
   Target?
What is the land use?
   Pre project?
   Target?

ENABLING TOOLS
What are the major finance tools in use?
If easements are used, what type of easement?
What are the major institutional/legal tools in use?
Does the project try to engage the community?
   If yes, using what mechanisms?
   How do they communicate project goals?

ON-THE-GROUND IMPLEMENTATION
In order to achieve project goals/targets what are the major conservation actions/on the ground activities occurring in the project area?
   Who is implementing these activities?
What activities are or are not allowed by humans in the project area?
In terms of ecosystem services, who are the major recipients of the services?
Who pays for the service?
Who receives payment for the service?

VALUATION/ANALYSIS
Was an economic valuation of services done for the project? If yes, when (pre, post, during)?
How was the valuation used?
What type of valuation was done?
What services were valued?
Was a policy analysis done for the project? In other words, did the project assess what was needed politically/legally in order to be able to institute project actions?
   If yes, when?
How was the policy analysis used?
Was an ecological analysis done? Was original vegetation surveyed? Was there some assessment of current ecological/biological conditions?

**COMPLIANCE MONITORING**
Is compliance monitoring done? For What?
   Biodiversity?
   Ecosystem services?
   Socioeconomic?
In each case, what is being monitored?
How is it being monitored?
In how many locations is the monitoring occurring?
With what frequency?
When did this start?
Who (what organization) is collecting data?
Who analyzes data?
   Samples?
   Data analysis?
What is the end date for monitoring?
Who is paying?
   For sample collection?
   For sample analysis?
   For data analysis?

**PERFORMANCE MONITORING**
Is performance monitoring done? For What?
   Biodiversity?
   Ecosystem services?
   Socioeconomic?
In each case, what is being monitored?
How is it being monitored?
In how many locations is the monitoring occurring?
With what frequency?
When did this start?
Who (what organization) is collecting data?
Who analyzes data?
   Samples?
   Data analysis?
What is the end date for monitoring?
Who is paying?
  For sample collection?
  For sample analysis?
  For data analysis?

CHALLENGES/LESSONS
What institutional challenges were faced in setting up the project?
Were there challenges communicating the project’s purpose and goals to the public/community?
What were the key challenges in creating the project? The project process?
What other data is/was needed for this project?
Are/were there any economic challenges? Funding? Valuation?
What are/were the political challenges?
Are/were there any scientific shortcomings in the project? Science that is needed to make the project better?
Lessons Learned?
Checkbox Definitions

**BROAD THREATS**

*Habitat conversion* – any threat that risks altering current/original land cover such as agricultural expansion, logging, fire, fragmentation, development, roads, dams, shipping lanes, watershed alteration

*Over-harvest* – the over extraction of wild populations such as fishing, hunting

*Pollution* – any form of pollution from exotic and/or excess materials not part of the natural system. This can include household waste, urban waste, industrial and military effluents, agricultural and forestry effluents, and garbage and solid waste

*Climate Change*

*Invasive Species*

*Other*

**MAIN THREATS (IUCN)**

– **Classified by grouping with Broad Threats (above)**

*Habitat conversion*

1) Housing and Urban ➔ any kind of residential or city development can include non-housing development but integrated with is such as schools, churches, etc
2) Commercial and industrial ➔ development that is not homes or home-integrated such as industry or stand alone shopping centers
3) Tourism and Recreation ➔ ski, golf, tourism sites that have a substantial impact on the surrounding habitat
4) Non-timber crops ➔ commodity, specialty, subsistence farming – food, fodder, fuel crops
5) Ranching – domestic, terrestrial animals
6) Wood and pulp plantations – forest plantations, forests managed for production; outside of natural forests
7) Marine and freshwater aquaculture
8) Energy production and mining ➔ includes oil and gas exploration, mining, and renewable energy exploration
9) Recreational activities (off-road vehicles, motorboats, motorcycles, etc) ➔ traveling in nature outside established transportation corridors
10) War, civil unrest, and military ➔ actions by military without a permanent footprint
11) Fire and Fire suppression ➔ either the suppression or enhancement of fire outside of its natural range of variation
12) Damn and water management ➔ changing water flow patterns deliberately through dams or dikes or other means
13) Fragmentation; degradation - Any stress that affects the community or ecosystem and causes conversion
14) Species stresses - Stresses that affect species such as causing mortality or disturbances (direct or indirect)
15) Roads and service corridors ➔ disturbance to ecosystems from building and use of roads that lead to mortality.
16) Shipping lanes → transportation in freshwater and ocean waterways that affect ecosystems (dredging, canals, shipping lanes, crashing into animals)
17) Ecosystem degradation/fragmentation → Any stress to that affects the community or ecosystem and causes conversion

*Over-harvest*
18) Hunting
19) NTFPs – non-timber forest product collection which are then often marketed or used for spiritual or cultural or economic purposes
20) Logging – primary forest clearing for timber, fuel, or fiber
21) Fishing – for any purpose – commercial, recreational, subsistence, cultural

*Invasive species*
22) Invasive species - threats from non-native plants or animal species outcompeting natives – harmful effects on biodiversity

*Pollution*
23) Point pollution
24) Non-point pollution

*Climate Change*
25) Climate change - habitat shifting and alteration, droughts, temperature extremes, storms and flooding

**Goal Partner/Funder**
1) Political Will – commanded from above – change in policy or other that requires the institution to participate in the project
2) Efficiency of operation – investing in the project because the resource that is provided will help the operation of the institution (e.g. need clean water in order for a hydropower industry to function)
3) Conservation – believe in species or habitat or community conservation
4) Market access – investing to be able to have access to a special/niche market
5) Communication – using the project to draw in stakeholders or to pass along information
6) Employment – investing in the project to create jobs for people
7) Education – usually a University or research institution that is part of the project doing research
8) Mitigation – participating to mitigate against legislation or regulation either current or potential.
9) Development – human welfare issues – primary concern is for human welfare and development related goals
10) Recreation – interested in enhancing recreation opportunities
11) Test methodology – new idea that want to make broader scale so testing a method or an approach in the field
12) Other
**SCALE**

*Implementation scale* – Level at which project actions occur

1) Local – one community
2) Regional – more than one community
3) Global – everyone

*Impact scale* – Level at which projects actions make an affect

1) Local – one community
2) Regional – more than one community
3) Global - everyone

**LANDOWNER**

1) Federal – any type of government land, i.e. land title is held by the national government
2) State – owned by state jurisdiction
3) Local – county, municipal, city government owned
4) Corporate – private landowner but company level
5) Private nonprofit – NGO owned or other non profit
6) Native American – highly US based – tribal land
7) Individual private – different from a corporation in that it is a single person or single family ownership
8) Indigenous – non-Native American but people who have cultural and historical attachments to land
9) Other – could include communal lands

**LAND COVER**

*Grassland* – Prairie, savanna, herbaceous

1) Native grassland – native species, original land cover
2) Non-native grassland – includes the same as above but not natives
3) Mixed grassland – mix of native and non-native species; same as above

*Forest* – Riparian, treed land

4) Native forest – native trees – hardwoods, firs, pines, any and all tree species
5) Non-native forest – forest area but all non-native species
6) Mixed forest – mix of natives and non-natives

*Wetlands*

7) Wetland – marsh, lagoon, wetlands

*Scrub/Shrub* – tundra, glade, bush

8) Native scrub/shrub – native bushes and shrubby ecosystem
9) Non-native scrub/shrub – same only not native
10) Mixed scrub/shrub – mix of native and non-native species

*Intertidal*

11) Intertidal – mangroves, sea grasses

*Subtidal*

12) Subtidal – reefs, kelp beds

*Converted*

13) Converted – agriculture, ranching, development, any change due to human use
14) Other
LAND USE
1) Primary forest clearing - industrial timber harvest or unsustainable timber harvest
2) Selective logging – smaller scale logging of selected logs but not sustainable
3) Sustainable timber harvest – selective, sustainable logging practices
4) Sustainable agroforestry – crops interspersed with patches of trees. Crops are harvested sustainably
5) Unsustainable agroforestry – similar matrix landscape but crops unsustainably harvested
6) Commodity crops – any crop that could possibly qualify for commodity support payments under the US USDA farm bill commodity programs. Large-scale commercial crops
7) Specialty crops – non-commodity crops – those that don’t qualify for farm bill subsidies but still are large-scale commercial harvesting
8) Subsistence farming – crop growing for the purposes of feeding family rather than harvesting for commercial value
9) Sustainable agriculture – any type of agriculture/cropping system that is done sustainably using sustainable technology or practices
10) Other crops – any other cropping system not included above including plantation forestry
11) Nature Reserve – limited use system that is managed for conservation
12) Aquaculture – fish farming
13) Unsustainable Grazing - ranching of the land, probably in grasses to support livestock but at unsustainable levels and with unsustainable practices (using herbicides, pesticides, over feeding, etc)
14) Sustainable grazing – ranching for livestock in a sustainable fashion (e.g. organic or natural beef)
15) Industrial development – development of industry and factories
16) Commercial development – development for shopping centers and shops and non-housing associated infrastructure
17) Residential development – home development
18) Recreational open space – areas for recreation – can have use such as fishing or hunting or can be limited access but it is zoned or managed for recreation rather than building infrastructure
19) Abandoned – Land formerly used or could be used for a variety of things but has been vacated and left unattended prior to project
20) Other use – any other use not included above

CONSERVATION FINANCE TOOLS (Note italics are broad categories of tools)
Rights transfer
1) Fee acquisition – purchasing of property
2) Easement – purchasing of certain rights
Markets
3) Niche market – selling of a value added product – fitting into a niche market such as organic, NTFPs, shade coffee, certified products
4) Banking markets – revolving fund markets where money is received through a conservation action such as sustainable timber harvest and reinvested in further conservation
5) Wetland mitigation markets – wetland mitigation banks
6) Habitat banking markets – same as wetlands but for other types of habitats
7) Carbon market – sale or credits of carbon offsets
8) Water quality market – sale of clean water
9) TDR – tradable development rights

Taxes – applies to public goods – a person may or may not benefit from the product of the tax
10) Redistribution of taxes
11) New taxes (e.g. carbon tax)

Fees – Private consumption – always enjoy the benefit
12) User fee/access fee – common in ecotourism where there is a fee to use

Subsidy
13) New subsidy – money actually coming from a new pool of money
14) Redistribution of subsidy – the money already existed for a particular outcome/goal
15) Donation – The landowner or user agrees to donate the land to conservation

Other

INSTITUTIONAL TOOLS – Note: with institutional tools an actual regulation or policy is being created to cause some kind of change

1) New tax → the project is working to create or has led to the creation of a new tax
2) Redistribute tax → a tax already exists but the collection process has been altered
3) New subsidy → project creates a new subsidy
4) Redistribute subsidy → subsidy already exists but the project aims to have it distributed differently – new stakeholders, etc. and changes policy accordingly
5) New fee – fee is created
6) Redistribute fee → a fee exists for use or access for example but the fee is now being put towards new and different conservation actions
7) Other policy change
8) Cap – maximum amount placed on something
9) Ownership rights – change in ownership of a particular good within the landscape – for example change in ownership of water rights or property or timber (often happens with easements) – could be individual, community, or wildlife
10) Development rights – change in the rights to develop; deals with change in zoning
11) Administration rights – who is in charge of administering or managing the land area changes
SOCIAL TOOLS

1) Education and outreach – programs designed to educate and reach out to the community often through those in grade school
2) Community forums – open forums for all members of a community to inform them or seek participation for projects
3) Volunteers – Community actually engages in the project process
4) Stakeholder engagement – refers to a single person that the project tries to engage in a long term manner
5) Training – part of the way they engage the community is to train them to manage and protect the area or enhance the project process
6) Workshops – more involved forums that have a product
7) Meetings – similar to forums but restricts members and invitees and is just information – no products
8) Committee formation – getting a group of stakeholders together in a larger, long term engagement
9) Publications – spreading of word through publications such as brochures, handouts, papers, etc

CONSERVATION ACTIVITIES (Italics are, again, the broader definition categories)

**Best Management Practices**

1) BMP forestry – certification, selective timber harvest, etc
2) BMP agriculture – contour farming, no-till, conservation till, buffers, integrated pest management, organic, etc
3) BMP ranching – rotational grazing
4) BMP fishery/aquaculture – sustainable harvest
5) Fencing (this can also be Restoration or Preservation) – it is a BMP if involved with keeping out cattle but restoration if it’s to allow and area to regrow and preservation if it’s keeping an area untouched

**Research**

6) Biodiversity assessment – this is a rapid assessment – this assesses species and habitat quality – could be looking at richness and abundance surveys
7) Ecosystem service assessment – same type of assessment only for the provision of services
8) Mapping – a more specific kind of assessment that yields a “map” of service flows or species in the area
9) Research – long term assessment - the primary activity on the landscape, or one of them, is conducting research into what is happening in the area, the conditions, etc
10) Pilot/demonstration - the project is using this site and a particular methodology as a mechanism for demonstrating the potential of scaling this project out….

**Restoration**
11) Outplantings – active restoration due to the loss of seed bank and this involves the planting of saplings or seedlings to restore the area – can be trees or other
12) Reseeding – active restoration due to loss of seed bank – replanting of seeds – can be trees or other
13) Regeneration – passive regrowth of native vegetation – trees or otherwise
14) Infrastructure – (can also be preservation) using some kind of built mechanism be it a fence or a dyke or a damn or whatever as an action - restoration if it’s to restore an area and preservation if it’s to keep it pristine or to secure it.
15) Removing invasive species – active monitoring and control of invasive species
16) Restoring channel flow – this is the removal or decommissioning or management (e.g. restoring in stream flows to particular levels) of water constricting infrastructure such as a dam, dykes, and levees. This is any action that is working to undo past constrictions of a waterway.
17) Flood plain restoration – this is a more board level restoration process of actually trying to restore a flood plain. This could be done naturally by simply no longer pumping water out or may involve decommissioning infrastructure. This is more than just restoring channel flow because it actually means restoring spillover flow.
18) Creating seed source (nursery) – using the land to have a source of native seeds for regeneration or for other restoration projects
19) Restoring riparian zone – this is more than just building riparian buffers which would be a BMP but actual restoration of the zone for biodiversity and other benefits.
20) Midstory removal – particularly important in forest restoration – way to diminish fire load and restore native stands.

Preservation
21) Park Guards
22) Fire management – (this can be restoration too) - this is Restoration when active fire management has to be done because the landscapes has been so altered that natural fire regimes are no longer helpful and maybe even be detrimental or may no longer occur frequently enough. It’s preservation if the natural fire regime is being maintained.
23) Legal protection – This is where the status quo is being maintained or enhanced, but there is protection of something occurring on the ground – this may happen through a number of different mechanisms

Other
24) Tourism infrastructure – tourist areas and booths and bathrooms
25) Trail building

ALLOWABLE USE
1) No take recreation – hiking, birding, horseback riding, etc.
2) Sustainable take recreation – hunting
3) Ranching
4) Managed forestry – some logging but selective
5) Subsurface extractions – oil and mineral and sub surface products can be extracted
6) Natural product extraction – non-timber forest products, natural medicines, above ground products
7) Agriculture
8) Other
9) None

PROJECT IMPLEMENTATION – who is implementing the project – who is actually running and organizing the activities
Managing organization – TNC or WWF
Partner organization – Other partner

TARGETED ECOSYSTEM SERVICE RECIPIENTS
1) Urban domestic – city domestic – living in towns, cities, and non-rural environments
2) Rural domestic – farmers, ranchers – non highly developed area as a whole
3) Hydropower
4) Agriculture – irrigation and agricultural production
5) Paper mill
6) Bottling plant
7) All water users – recreation, agriculture, ranching
8) Recreation users – only using area for recreation – hiking, swimming, canoeing
9) All
10) Other
11) Floodplain occupants – particularly those living in riparian area
12) None

WHO PAYS/WHO RECEIVES PAYMENT (Italics are, again, the broader definition categories)
Private Landowner – individual or family owning a portion of land; can also be someone who has occupied the land and used it for generations even if land title is not explicit (often true in South America)
1) Forester – landowner doing forestry on his land, any and all kinds of timber harvesting whether small scale or large scale
2) Agriculture – any agricultural landowners growing any kinds of crops
3) Rancher – anyone with pasture creating activities grazing any kind of ungulate
4) Private landowners/users – the catch all category for landowners/users that do not fit within the above but who are still living on the land individually or as a family unit
5) Urban domestic – only urban residents pay or get payment for the service
6) Rural domestic
7) Recreation users – only those using an area recreationally pay

Industrial/Corporate – also private but owned by a company
8) Hydropower – any industry creating hydroelectric power at any scale
9) Bottling plant
10) Paper Mill
11) Energy company – any gas, electric, oil company including car gas companies and others
12) Other corporate – catch all for those specific industries not listed previously.

Tax Payer/Government (really depends on if it’s giving or receiving the payment)
13) Federal tax payer – often times this will involve a federal tax or subsidy or regulation that is paying or receiving taxes based on conservation – it goes to everyone in the nation or is charged to everyone in the nation
14) State tax payers – this is the same as above only limited to a particular state within the US or abroad
15) Municipality – same idea as state and federal only here it’s dealing with local taxes and local fees and regulations
16) International tax payers

Community/Committee ➔ A particular committee or group of stakeholders either receives or gives money
18) Committee of stakeholders – special situations where it is actually a group of stakeholders that comes together to manage funds.

Non-profit
19) Implementing NGO – NGO that is managing the project. Is not always TNC or WWF but rather whoever is managing the on the ground conservation activities
20) Other NGO

**USE OF ECONOMIC VALUATION**

1) Set fees – Used to actually define how much the ecosystem service is worth
2) Motivate legislation – Using the valuation to motivate the legislation
3) Change industry practice – indicate to industry the advantage of providing services
4) Change land user practice – indicate to landowners the advantage of changing different land use practices
5) Redirect money to conservation – show how much money can be saved or how much more money can be gained through investing in conservation
6) Leverage partnerships – get landowner and other organization partnerships

**USE OF POLICY ANALYSIS**

1) Motivate legislation – trying to change or alter or design policy
2) Stakeholder buy-in – get others to engage in the project
3) ID policy to target – figure out what needs to happen at policy level
4) Reveal need for policy change – Demonstrate that a policy change has to happen
**Fill-in box Definitions**

*Main project contact* – person who would have information about the project – best to contact for details

*Start date* – main date for implementation – actually starting to design the project and look into funding sources

*Project goals* – goals and the reasons why TNC participates in the project – the importance of the project in the broad sense

*ES target comments* – specifics about the types of services – e.g. for water quality if it’s water for a particular purpose (irrigation, consumption, etc). Also, any other details about the types of services included.

*Socioeconomic targets* – anything to do with human welfare and equity and maintaining quality of life

*Landowner transition comments* – details of landowner transitions such as issues surrounding establishing land title or use of easements rather than fee transfer. Also multiple transitions of one type can occur and this box would include details about all the transactions.

*Land cover transition comments* – details about the type of land cover. Check box sets are very general categories so this box includes details more specific information on vegetation type (e.g. prairie versus savanna versus hardwoods, etc)

*Land use transition comments* – Types of crops or ranching that is done or what types of products from aquaculture or types of recreation. If the land use change is particular to a riparian region or any other specific details will be in this box.

*Conservation finance tools comment* – details about finance tool use such as who is buying the easement or fee acquisition or how TNC or other NGO might be brokering a deal or leveraging a partnership using a particular tool. If “Habitat market” is selected this is where to define that more clearly.

*Role of Institutional tools* – details about the institutional tool such as type of ownership rights being exchanged or how and why development rights are being sold. Give details of “other policy changes” – basically capture what is happening in words.

*Role of social tools* – Details about whatever is checked in the box such as level of education being influenced or who is being asked to be on a particular committee or what the workshop was trying to target. Or if there is something else going on with how the project partners are reaching out to the community that is not captured (such as via the radio) the details will be in this box. This basically includes all the details about how communities are being involved in the process: who and how.
*Conservation activities comments* – more detailed information about the activities taking place such as the exact number of outplantings or what best management practices are occurring or who is engaging in what activities, etc.

*Monitoring* – In these sections, the main boxes are fairly detailed so the comment box is to capture the general picture of assessment if specifics either are not occurring or are not readily available.
Supporting Results

**Figure 5.** Use of finance and institutional tools by project type within the US and outside the US. Within the US, 100% of both ES and BD projects use a finance tool, but BD projects use a more narrow range of such tools: 73% of BD projects use either an easement and/or a fee acquisition and 74% of those projects are in the US. In the US, ES projects not only use a broader range of finance tools, but significantly more projects ($\chi^2_1=5.14; p=.023$) use some kind of institutional tool: over 70% of US ES projects alter an institutional policy (such as a tax, subsidy, or administration right) while less that 30% of US BD projects evoke a policy change. Outside of the US, BD projects are more likely to initiate an institutional change but significantly less likely to use finance tools. * indicates $p<.05$ and ** $p<.01$

Not only do BD projects transfer land out of private ownership than ES projects, but also, about 50% of all BD projects involve land ownership transfers to a private non-profit while only about 35% of ES projects undergo this type of landowner transition. In sum, 62% of BD projects involved a landowner transition while only 38% of ES projects did ($\chi^2_1=3.20; p=.074$).
Supporting Information

Goldman et al. 10.1073/pnas.0800208105

Fig. S1. Use of finance and institutional tools by project type within the United States and outside the United States. Within the United States, 100% of both ES and BD projects use a finance tool, but BD projects use a more narrow range of such tools: 73% of BD projects use either an easement and/or a fee acquisition and 74% of those projects are in the United States. In the United States, ES projects not only use a broader range of finance tools, but significantly more projects (χ² = 5.14; P = 0.023) use some kind of institutional tool: 70% of United States ES projects alter an institutional policy (such as a tax, subsidy, or administration right) whereas <30% of U.S. BD projects evoke a policy change. Outside of the United States, BD projects are more likely to initiate an institutional change but significantly less likely to use finance tools. *, P < 0.05; **, P < 0.01. Not only do BD projects transfer land out of private ownership than ES projects, but also, ~50% of all BD projects involve land ownership transfers to a private nonprofit whereas only ~35% of ES projects undergo this type of landowner transition. In sum, 62% of BD projects involved a landowner transition whereas only 38% of ES projects did (χ² = 3.20; P = 0.074).

Other Supporting Information Files

SI Appendix