The Impacts of World Bank Development Projects on Sites of High Biodiversity Importance

Graeme M. Buchanan, Bradley C. Parks, Paul F. Donald, Brian F. O'Donnell, Daniel Runfola, John P. Swaddle, Łukasz Tracewski, and Stuart H.M. Butchart

Abstract:

The impacts of international development projects on biodiversity are poorly documented, yet many areas of biodiversity importance are potentially affected by such efforts. We assessed the impact of World Bank development projects on sites of biodiversity significance (Important Bird and Biodiversity Areas; IBAs) using remote sensing derived forest change data and in situ monitoring data on the conservation state (conditions), pressures (threats), and responses (conservation interventions) at these sites. IBAs <10 km from World Bank project locations had a marginally lower rate of forest loss than matched IBAs > 100 km from World Bank project locations and were subjected to lower pressures than matched sites, although there were no differences in conservation state or responses underway. Despite important caveats, these results suggest that World Bank development projects do not have a negative impact on biodiversity, and in some cases might be a benefit to biodiversity. Thus, while more work is needed, our results suggest that international development projects might be compatible with nature conservation objectives if delivered with appropriate safeguards.

Keywords: Aid, development finance, forest loss, IBA, Important Bird and Biodiversity Area, land cover change, matching, sustainable development, biodiversity.

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AidData is a research and innovation lab located at the College of William & Mary that seeks to make development finance more transparent, accountable, and effective. Users can track over $40 trillion in funding for development including remittances, foreign direct investment, aid, and most recently US private foundation flows all on a publicly accessible data portal on AidData.org. AidData's work is made possible through funding from and partnerships with USAID, the World Bank, the Asian Development Bank, the African Development Bank, the Islamic Development Bank, the Open Aid Partnership, DFATD, the Hewlett Foundation, the Gates Foundation, Humanity United, and 20+ finance and planning ministries in Asia, Africa, and Latin America.

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1. Introduction

The reconciliation of biodiversity conservation and human development activities is challenging and contentious [1, 2, 3]. Scenarios that benefit both biodiversity and people are difficult to achieve [4]; yet biodiversity conservation interventions do not necessarily hinder human development [5]. Facing the dual challenges of human development and biodiversity conservation, many aid agencies have made efforts over the last twenty-five years to incorporate environmental considerations into their development projects [6,7]. The World Bank, in particular, has introduced a set of project safeguards that include environmental impact assessments, environmental education programs, management plans to strengthen habitat protection, reforestation activities, and other efforts to preserve and protect natural habitats and biodiversity [8, 9, 10]. These safeguards apply to most World Bank-funded projects, regardless of whether or not their primary purpose is environmental protection, and require compliance with various national and international biodiversity regulations, site-selection criteria that take into consideration biodiversity conservation aims, offsetting of expected losses in natural habitats, and sustainable harvesting of forest products [11, 12, 13].

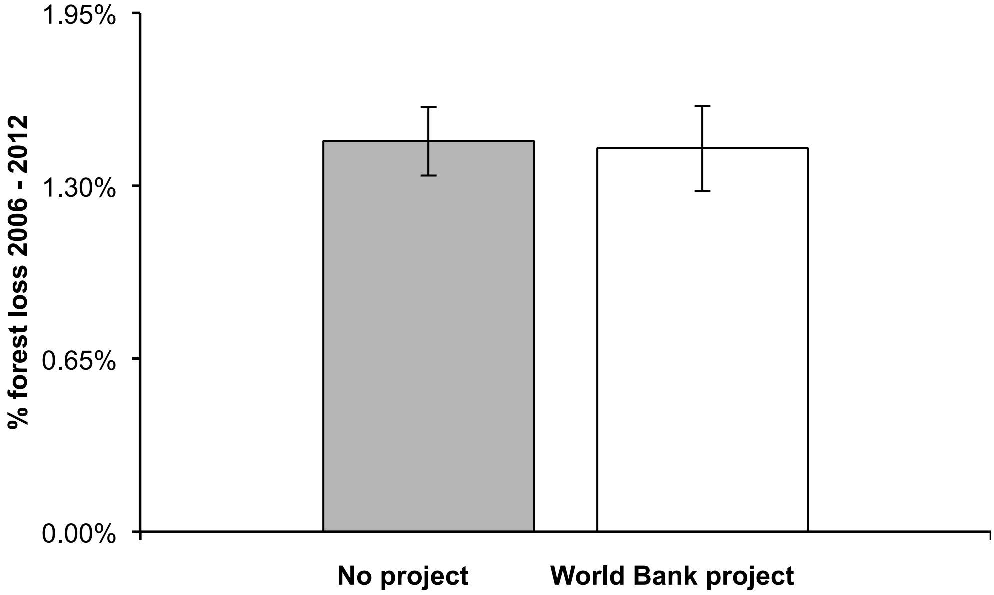
However, the effectiveness of these environmental safeguards is a source of controversy [14, 15, 13, 8, 3]. Some argue that the World Bank has made thorough efforts to mainstream environmental considerations into its project design and implementation processes (13, 8). Others claim that the World Bank safeguards are inconsistently applied, or that they constitute a "greenwashing" attempt to satisfy external stakeholders [1,15]. Yet, there is a lack of rigorous empirical evidence on the impact of World Bank projects since its purportedly stringent environmental safeguard regime was implemented in the late 1990s.

We assess whether development projects funded by the World Bank between 2000 and 2011 were associated with positive or negative conservation outcomes in IBAs. IBAs form a global network of sites of international significance for birds, identified using standardized criteria for populations and assemblages of threatened, restricted-range, biome-restricted and congregatory species [16]. We used information on conservation action and outcome data from *in situ* monitoring of IBAs and data on forest cover change on IBAs between 2006 and 2012 [17]. We compared conservation actions and outcomes in IBAs that were exposed to World Bank project interventions (<10 km from World Bank project locations) with a matched set of IBAs that were not known to have been exposed to World Bank project interventions (>100 km from World Bank project locations). This match is conducted based on variables associated with land cover change in an attempt to control for potentially confounding effects. We use this matching approach to test the hypothesis that World Bank projects with environmental safeguards have an impact upon biodiversity conservation.

2. Results

The rate of forest loss during 2006-2012 in the 489 IBAs that were <10 km from World Bank project locations was marginally lower than the rate of forest loss in 489 matched IBAs >100 km from World Bank project locations (1.4418% *vs* 1.4678%; Figure 1). This difference was statistically significant ($W = 110540$, $P = 0.0409$). While only marginally significant, the lower rate of forest loss on IBAs < 10 km from World Bank project locations does suggest that there may be a net benefit of World Bank projects on deforestation in nearby sites of biodiversity importance. At the very least we found no evidence of any negative impact. This result proved robust, with country-specific matching showing a similar pattern (Text S1, Figure S1).

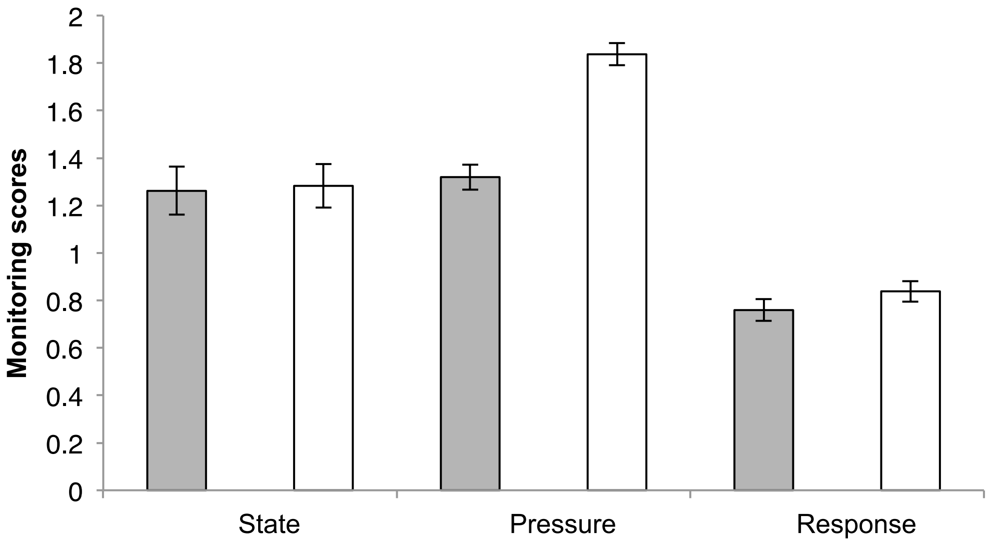
Figure 1. Mean (± SE) percentage gross forest loss between 2006 and 2012 (from Hansen et al. 2013) for IBAs <10 km from World Bank projects (open bars) and matched IBAs >100 km from World Bank projects.



For all three of the in situ monitoring scores for biodiversity – representing the state, pressure, and response in IBAs – our findings indicated either a null or positive impact of being proximate to World Bank projects. Monitoring scores for the state of biodiversity in IBAs indicated that there was no consistent difference between 134 IBAs <10 km from World Bank project locations and 134 matched IBAs > 100km from project locations ($W = 8647$, $P = 0.596$; Figure 2). This indicates that while World Bank projects conferred no detectable benefit to proximal sites of conservation importance, there is again no evidence of a negative impact. There was a statistically significant difference in the scores for the pressure on biodiversity in IBAs: scores were lower for the 384 IBAs <10 km from World Bank project locations than for the matched IBAs > 100km from project locations ($W = 53412$, $P < 0.001$; Figure 2). This result might indicate a strong, net benefit of proximity to World Bank projects. There was a statistically non-significant difference in response scores ($W = 68974$, $P = 0.0797$; Figure 2). This might indicate that more conservation activities are underway in IBAs that are proximal to World

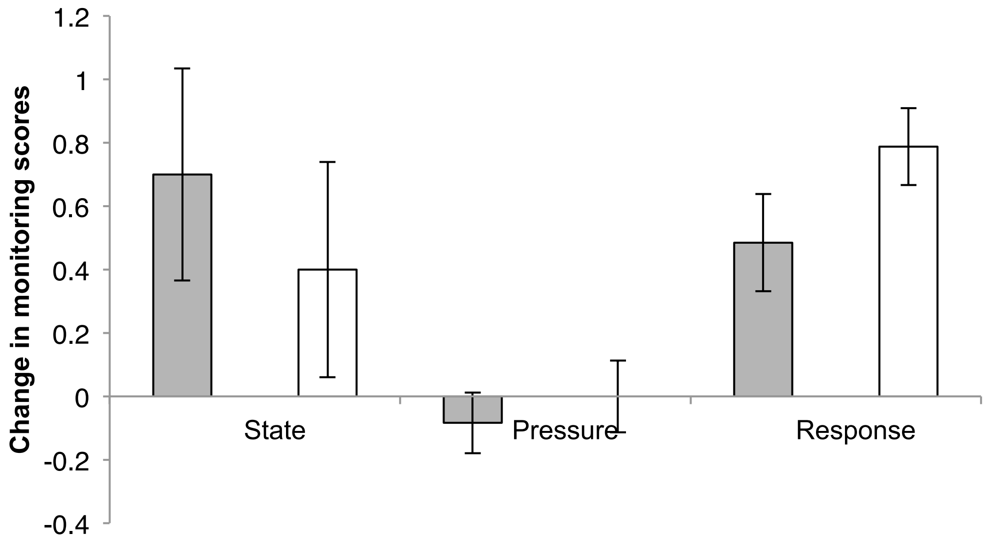
Bank projects. The results from the analysis based on exact matching on country were similar, although the difference in conservation response was larger and statistically significant (Text S1, Figure S2).

Figure 2. Mean (± SE) monitoring scores for state, pressure, and response for IBAs <10 km from World Bank projects (open bars) and matched IBAs >100 km from World Bank projects.



In addition to testing for impact on the state of forests and biodiversity, we also explored the change in these variables over time, up to 12 years. We found no differences in the change in conservation state scores between the 10 IBAs <10 km from World Bank project locations and the 10 matched IBAs that were > 100km from project locations (W = 42, P = 0.552; Figure 3). However, in addition to the small sample size, short time-scale (a maximum of 12 years)) and relative coarseness of the IBA monitoring system that reduced the power of our analysis, the matching process did not produce a balanced set of IBAs for comparison with this test (see Methods and Table S1). Consequently, these comparisons are limited in their value, and our results should be treated with caution. There was no significant difference in the change in pressure between the 60 IBAs <10 km from World Bank project locations and the 60 matched IBAs that were > 100km from project locations (W = 1947.5, P = 0.400; Figure 3), suggesting that the initiation of World Bank projects < 10 km from an IBA did not change the pressures (the pressure scores for the IBAs < 10 km World Bank projects were initially lower than those on IBAs > 100 km from World Bank projects; Figure 2). Finally, there was a marginally non-significant difference in the change in response scores (W = 2546, P = 0.0794), with increasing conservation responses underway at 66 IBAs <10 km from World Bank project locations than the 66 matched IBAs that were >100km from project locations (Figure 3). The results from the analysis based on exact matching on country were similar, although the difference in the change in conservation response did differ significantly (Text S1, Figure S3).

Figure 3. Mean (±SE) differences in scores between initial and repeat monitoring for pressure, response, and state at IBAs in <10 km from World Bank projects (treatment ; open bars) and matched IBAs >100 km from World Bank projects (controls; filled, grey bars). Positive values indicate improvements in state, reductions in pressure, and increases in response.



3. Discussion

Our results strongly suggest that there is no evidence that World Bank projects (albeit with a limited sample of International Development Aid (IDA) and International Bank for Reconstruction and Development (IBRD) funded activities from 2000 to 2011) have had a net negative impact on biodiversity. Indeed, the results indicate that in some cases the World Bank projects analysed were associated with conservation benefits. These benefits might derive from projects that make biodiversity conservation a central goal. Because we analysed data over a short timescale (about 12 years) we cannot assess whether these benefits tend to persist over time. However, our results provide encouraging evidence that such finance might improve conservation outcomes at sites of conservation importance. Our results are likely to be conservative, since it is possible that many of the IBAs assigned to our reference group (i.e. at least 100 km from World Bank projects) were in fact closer to World Bank projects for which we had no geographical data. Furthermore, the relative coarseness of the IBA monitoring scores (a four-point scale for each of state, pressure and response) mean that we could have detected only substantial differences in these parameters between matched sites and over time.

The absence of a net negative impact on biodiversity from World Bank projects (and a potential benefit in some cases) suggest that the intense pressure the World Bank has faced to “green” its lending portfolio [18,8] might have proved to be at least partly effective. The results might also provide partial support for the suggestion put forward by [9] that World Bank safeguards would improve biodiversity conservation through the consideration of local environmental and social issues. Our findings also broadly corroborate the findings of [19] who reported that World Bank sustainability policies reduced environmental impacts of projects, albeit with exceptions. While our results are consistent with no negative impact, and potentially a small conservation benefit of World Bank projects, we cannot exclude the possibility that World Bank interventions were deliberately or inadvertently sited in locations that were already in a better conservation state, or that faced lower pressures. Even if the there was a bias (whether intentional or unintentional) in World Bank project location, we suggest that the results indicate there is still a benefit for conservation. Benefits would occur if any bias were to create incentives for improved conservation conditions in sites (and countries) seeking international development aid. In addition, our analysis of the change in conservation response suggest a relative improvement at sites located closer to World Bank project locations compared with those much further away. Even if the World Bank projects were more likely to be initiated closer to sites with initially higher rankings of conservation responses, this would not necessarily account for the somewhat improved change over time that we document here.

We used matching to control for potentially confounding factors that might be associated with susceptibility to site condition or conservation activity. However, these just formed a subset of variables that could potentially affect site condition, meaning potentially important confounding variables may have been omitted from our matching analysis (e.g. economic activity, local attitudes to conservation), thereby biasing our estimates of impact. The inclusion of country in our matching procedure reduced the sample size available for testing, but the results remained similar. The absence of substantial differences indicates that even though conditions might not be standard across all countries within a continent, the results appear to be robust. Importantly though, we were able to include in the matching procedure measures of outcomes from before World Bank projects were assumed to be implemented. The inclusion of these variables is in line with the suggestions of [20], and, by matching on initial condition, should control for exposure to impacts between the two sets of sites.

We stress that our analysis did not account for the potential effects of development projects financed by donors other than the World Bank. It is therefore unclear how much of the apparent effect we have detected is attributable to the clustering of aid, a known pattern whereby donors are attracted to locations where other aid projects have been initiated [21]. It is also possible that some of the projects that we were unable to map may have generated countervailing, negative impacts on biodiversity conservation. Our estimates of effects are derived from the treatment group that was not fully representative of the World Bank's projects (Table S1, S2 & S3 and Figure S1). We were not able to include many World Bank project activities in our sample for various reasons (e.g. the project operated at a regional or national scale, or there was uncertainty about intervention locations). This produced a dataset that was biased towards infrastructure rather than societal or institutional development, with a greater representation of environmental themes and greater stringency on assessment of impact, something that may be important in interpreting the results [22]. Nevertheless, even if our patterns are interpreted solely in terms of these biases, our data still indicate that the World Bank's categorization of environmental safeguards has some positive impacts on metrics of conservation outcomes.

The impact of development aid on biodiversity is contentious, and while our study has limitations, as highlighted above, we are not aware of any studies that have undertaken a rigorous analysis of the topic across multiple sites worldwide. We have provided some evidence that World Bank development projects have no net negative impact on biodiversity, and in some cases might benefit biodiversity. The results might indicate that the World Bank environmental safeguards are more than 'greenwash'. However, we have not determined if the relationship is truly causal, and if it is, through what mechanism are the benefits delivered. We suggest that future research needs to focus on these questions, the role of the World Bank's environmental safeguard policy, and assessment of differences in conservation outcomes associated with improper enforcement of the environmental safeguards from World Bank projects. The World Bank is only one of many organisations funding overseas development activities. An assessment of the impact on biodiversity of other development projects with differing environmental safeguards would help to quantify their significance.

We suggest, based on a precautionary principle, that the types of environmental safeguards used by the World Bank around development projects should be implemented by all development projects until we have a better understanding of which, if any, of these are important. More and better data are needed to assess the robustness of our findings, overcome some of the limitations of our analyses, and test if the effects that we have detected persist over the longer term. Nevertheless, our analyses provide important preliminary evidence that development projects can be associated with better conservation outcomes even while attempting to deliver human welfare benefits.

4. Methods

4.1 Data

We used georeferenced data on World Bank project activities from AidData [23, 24]. Specifically, we employed the geocoded dataset of all International Development Association (IDA) and International Bank for Reconstruction and Development (IBRD) projects approved between 2000 and 2011[25]. These projects funded activities in a wide range of sectors, including infrastructure, pollution control, and institution building (Table S1). The full data set contained details of 3,534 projects, implemented across 41,307 locations, with a total cost of US $334 billion. We removed projects where the location at which the project was too broadly defined or had insufficient data to be precisely mapped, such as projects implemented across entire regions or countries. Thus, we excluded 12,749 incidences where projects were implemented but which the location was not accurate to within 25 km (AidData precision codes > 2). We cannot map these projects, but assume they are randomly distributed with regard to

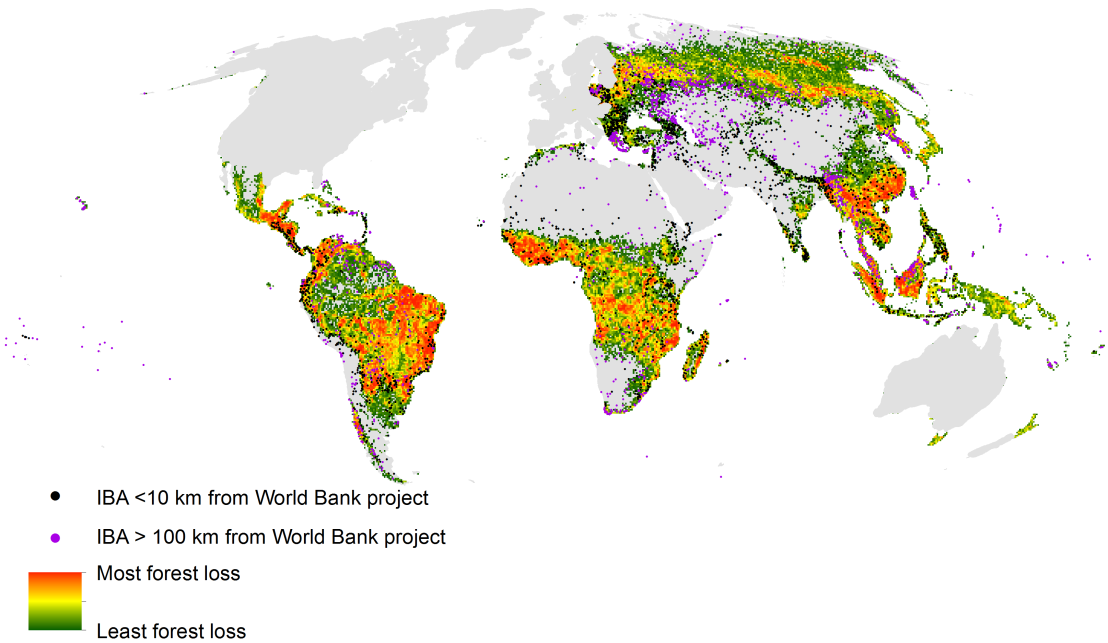
IBAs. This left 1,471 projects operating in 20,621 locations. These projects were approved between 2000 and 2011, although some might have closed in this time, and had a total cost of US $129 billion. These projects included activities from the full range of sectors, as described below.

Digital IBA boundaries were obtained for 11,822 IBAs [16], of which 7256 contained forest according to forest cover data retrieved from [17]. For each IBA, *in situ* monitoring at a-systematic temporal scales assessed conservation state (conditions), pressures (threats), and responses (conservation interventions) on a four-point scale (0 to 3, with 3 indicating the highest level of threat, a very good state, or greatest response) following [26]. Pressures (threats) are initially scored on a negative scale ranging from -3 (most threatened) to 0 (least threatened), but were converted here to 0 to +3 for ease of analysis (0 being least threatened). Of the 1,780 IBAs, 1,671 had at least one of the three types of *in situ* data available. The frequency of monitoring varied between these IBAs. Spearman rank correlations indicated that changes in conservation responses between first and last monitoring assessments for IBAs were independent of changes in conservation states and pressures (r_{s353} = 0.089, P = 0.234 and r_{s751} = 0.108, P = 0.097, respectively), but changes in states and pressures were negatively correlated (r_{s339} = -0.285, $P < 0.0001$), indicating that these two measures were not independent.

Forest loss data was extracted from [17], who estimated tree cover and tree-cover loss between 2000 and 2012 in 30-m cells across the globe using Landsat satellite image data, and also undertook an accuracy assessment of these data. A JavaScipt code was used to extract and process the Hansen data in Google Earth Engine (http://earthengine.google.org/), a cloud platform for earth-observation data analysis. The code is available from https://github.com/RSPB/IBA. For each IBA polygon, tree cover in the year 2000 was derived from "treecover2000" layer. The number of pixels from which forest was lost in each subsequent year, based on the "lossyear" layer was then calculated. This calculation assumed that all the original tree cover (based on the cover in the "treecover2000" layer) within the pixel was lost. For instance, if the pixel's value in the "treecover2000" layer was 70% and it was marked in the "lossyear" layer in 2005, we assumed 70% loss by 2005. Each pixel could be 'lost' only once in "lossyear" layer. Any pixel identified as 'forest gain' was ignored as very young forests are unlikely to support forest-dependent species.

Approximately 45% of all IBAs were within 100 km of a World Bank project location, of which over a third were within 10 km (including IBAs which contained World Bank projects within their boundaries). During our analysis, we considered all 1,780 IBAs that contained or were within 10 km (i.e. <10km) from a project location (covering 2,898 project locations). Of these 1,780 IBAs, the World Bank project locations fell within 441 IBAs, and for those projects that fell outside of IBAs the median distance between given project location and IBA boundary was 3.95 km. These IBAs had a very wide geographic spread (Table S4, Figure 4). The 2898 World Bank project locations correspond to 774 World Bank projects costing a total of US $73.4 billion.

Figure 4. Distribution of IBAs < 10 km of a World Bank project location (black dots) and IBAs > 100 km of a World Bank project location (purple dot) overlaid on map of proportion of forest lost between 2000 and 2012 (from Hansen et al 2013). IBAs in countries that are not World Bank borrowers have been removed.



All of these projects were approved and financed through IDA and IBRD arms of the World Bank Group between 2000 and 2011. The World Bank projects containing at least one location within 10km of an IBA covers roughly half of all projects (2,902) in the World Bank's project dataset. On average, each project in this group has been implemented at 65 (±3.16) total locations. If we assume that project funds were split equally across all locations (i.e., those that fall within 10km of, or are contained inside of, IBAs), treatment project locations account for only about 3% of all IDA and IBRD funding during the 2000-2011 period. Table S1 and Table S2 indicate that projects and project locations <10 km of an IBA were predominantly focused on transport, energy, agriculture, forestry, fishing, and various forms of infrastructure (e.g. water supply, social infrastructure), in terms of number and cost. In general, the sectoral composition of the treatment projects is similar to the composition of the broader sample of IDA and IBRD projects approved between 2000 and 2011.

The World Bank has ten mandatory environmental and social safeguard policies. One of these policies—the Operational Policy 4.01 on Environmental Assessment—requires that the World Bank screen projects prior to approval to identify their potentially adverse environmental impacts. Projects that are deemed likely to result in adverse environmental impacts are subjected to the World Bank's most stringent environmental safeguards [11,12,13,9]. Of the 774 World Bank projects that had at least one location implemented proximate to an IBA, there was a higher proportion of projects subjected to the World Bank's most stringent environmental safeguards compared to the broader sample of IDA and IBRD projects approved between 2000 and 2011 (Table S3).

The World Bank's Operational Policy 4.01 on Environmental Assessment [11] classifies proposed projects into one of four environmental categories: Category A projects are likely to have "significant adverse environmental impacts that are sensitive, diverse, or unprecedented." Category B projects have "potential adverse environmental impacts on human populations or environmentally important areas - including wetlands, forests, grasslands, and other natural habitats - which are less adverse than those of Category A projects. These impacts are site-specific; few if any of them are irreversible; and in most cases mitigation measures can be designed more readily than for Category A projects." Category C projects are "likely to have minimal or no adverse environmental impacts. Beyond screening, no further [environmental assessment] action is required." Category F projects "involve investment of Bank funds through a financial intermediary, in subprojects that may result in adverse environmental impacts." The results reported in Figure S1 indicate that projects within the treatment group are significantly more likely to be subjected to the World Bank's most stringent environmental safeguards (i.e. those projects classified as category "A" or "B" projects). This evidence supports the central proposition in this article that the introduction and enforcement of World Bank environmental safeguards has facilitated conservation improvements in ecologically sensitive areas (i.e. near IBAs).

4.2 Data Analysis

We undertook three sets of analysis. The first of these compared the rate of forest loss between 2006 and 2012 on IBAs <10 km from a World Bank project location with that on a matched group of IBAs that were >100 km from a World Bank project location. We only considered IBAs where projects were approved between 2005 and 2010 as projects approved after 2010 might not necessarily have been initiated by 2012. Secondly, we compared *in situ* monitoring scores for state, pressure and response on IBAs <10 km from a World Bank project location with that on a matched group of IBAs that were >100 km from a World Bank project location. Data from year closest to 2014 were used if IBAs had been monitored on multiple occasions. We discarded data that were collected before or within the two years after World Bank project approval. Thirdly, we compared changes in the *in situ* monitoring scores for state, pressure and response on IBAs <10 km from a World Bank project location with a matched group of IBAs that were >100 km from a World Bank project location. We only used IBAs for which the first monitoring data were collected before the approval of the nearest World Bank project (for those in the location of projects), and the second were collected at least two years after the approval of the project intervention (allowing two years to give the project time to be initiated).

To account for the potentially non-random distribution of project locations with respect to conditions that might affect the conservation condition of and forest loss within IBAs [27], we used a statistical matching algorithm to create matched sets of IBAs that were <10 km from project locations and IBAs that were >100km from project locations. Specifically, we matched IBAs using the MatchIt [28] package in R, using nearest neighbour propensity matching. The maximum difference between matched IBAs was set to 0.5 standard deviations for each matching covariate. We did so for each of the three sets of analysis, meaning the process was repeated for each of the seven analyses (forest change, conservation state, conservation pressure, conservation response, conservation state change, conservation pressure change, and conservation response change; Table S5). All covariates were entered together into the algorithm to generate a group of IBAs that were <10 km from project locations and a group of IBAs that were >100km from project locations that should be similarly susceptible to land cover change.

The covariates we include in the matching algorithm were ruggedness of terrain within an IBA (a measure of topographic and altitudinal variation based upon 30 arc seconds global data [29] and a 3×3 cell area), whether IBAs overlapped a protected area (based on comparison with the World Database on Protected Areas [30], human population density (mean human population density per km^2) using data for 2000 at 0.25 degree resolution [31], the proportion of agricultural land within the IBA [32], and the total length of primary and secondary roads within a 25 km radius (based on a buffer produced in Arc Map) of the IBA in 1997 [33]. We matched exactly on the continent within which each IBA was located. We also conducted a separate analysis in which we matched exactly on country to check for robustness, but this resulted in much reduced sample sizes for the subsequent tests and did not always improve the balance of the matching (Table S6).Based on the recommendations of [20], we also included initial condition in the matching algorithm for the four tests where we were interested in change in condition to account for common pre-treatment trends. Thus, initial condition scores from IBA monitoring, or forest loss between 2000 and 2005 were used to account for common pre-treatment trends across the IBAs <10 km from project locations and those >100km from project locations.

Details of the variables pre- and post-matching are given in Table S5. For forest loss between 2006 and 2012, the matching process improved the balance in the covariate distance between the IBAs <10 km from the location of World Bank projects and those >100 km from the location of World Bank projects by 76%. The difference between the means of IBAs <10 km from the location of World Bank projects and those >100 km from the location of World Bank projects was just 0.0056, well within the 0.0557 SD around the mean for IBAs >100 km from the location of World Bank projects. This included an improvement in the balance of initial forest loss by 87%. For state scores, the matching process improved the balance in the covariate distance between the IBAs <10 km from the location of World Bank projects and those >100 km from the location of World Bank projects by 47%. The difference between the means of IBAs <10 km from the location of World Bank projects and those >100 km from the location of World Bank projects was just 0.0995, which was still well within the 0.2767 SD around the mean for IBAs >100 km from the location of World Bank projects, although there a large differences remained for human population. For pressure scores, the matching process improved the balance in the covariate distance between the IBAs <10 km from the location of World Bank projects and those >100 km from the location of World Bank projects by 71%. The difference between the means of IBAs <10 km from the location of World Bank projects and those >100 km from the location of World Bank projects was 0.0189, again within the 0.3553 SD around the mean for IBAs >100 km from the location of World Bank projects. The pattern was very similar for the response scores, the matching improved the balance in the covariate distance between the IBAs <10 km from the location of World Bank projects and those >100 km from the location of World Bank projects again by 71%. The difference between the means of IBAs <10 km from the location of World Bank projects and those >100 km from the location of World Bank projects was 0.0112, again within the 0.092 SD around the mean for IBAs >100 km from the location of World Bank projects.

Sample sizes were much smaller for the analysis of change in the condition of IBAs, which limits the pool of IBAs available for matching. For the change in state, the matching process improved the balance in the covariate distance between the IBAs <10 km from the location of World Bank projects and those >100 km from the location of World Bank projects by 74%. The difference between the means of IBAs <10 km from the location of World Bank projects and those >100 km from the location of World Bank projects was 0.0936 was relatively high compared to the 0.1938 SD around the mean for IBAs >100 km from the location of World Bank projects. This might indicate the balance between IBAs <10 km from the location of World Bank projects and those >100 km from the location of World Bank projects was imperfect. Although the percentage improvement in balance for change in pressure was lower than for change in state, at 59%, the difference between the mean for the matched IBAs <10 km from the location of World Bank projects and IBAs >100 km from the location of World Bank projects was, at 0.0479, much less than the 0.1351SD around the mean for IBAs >100 km from the location of World Bank projects. For change in response, the matching process improved the balance in the covariate distance between the IBAs <10 km from the location of World Bank projects and those >100 km from the location of World Bank projects by 41%. The difference between the means of IBAs <10 km from the location of World Bank projects and those >100 km from the location of World Bank projects was 0.0285 was relatively high compared to the 0.0654 SD around the mean for IBAs >100 km from the location of World Bank projects. The matching process increased the differences in surrounding agriculture and protection between the IBAs <10 km from the location of World Bank projects and those >100 km from the location of World Bank projects. However, the matching process did produce a better balance in the initial response scores between the IBAs <10 km from the location of World Bank projects than IBAs >10 km from World Bank projects.

We used a Wilcoxon rank sum test to compare rate of forest loss between 2006-2012, state, pressure, and response scores and change in state, pressure, and response between the IBAs <10 km and those >100 km from World Bank project locations. Statistical tests were interpreted with twotailed distributions of probability. We report the results from the same analysis for the country level matching in Text S1 and Table S6.

Appendix

Table S1: Percentage of IDA and IBRD project locations by sector, 2000-2011. Treatment locations are those projects < 10 km from an IBA, compared to all World Bank projects.

Count of Project Locations

Sector Names	Treatment Locations	All Locations
Transport and storage	34.41%	25.79%
Water supply and sanitation	14.97%	13.14%
Government and civil society, general	5.64%	9.87%
Energy generation and supply	9.25%	8.10%
Health	6.92%	7.69%
Other social infrastructure and services	5.36%	7.57%
Agriculture	7.47%	7.52%
Agriculture, forestry, fishing	3.52%	4.86%
Basic education	1.73%	4.36%
Banking and financial services	2.28%	2.37%
General environmental protection	1.89%	1.34%
Secondary education	0.92%	1.33%
Industry	1.16%	1.30%
Forestry	1.03%	1.14%
Education, level unspecified	0.71%	0.80%
Post-secondary education	0.84%	0.76%
Communications	0.62%	0.72%
Mineral resources and mining	0.65%	0.49%
Other	0.45%	0.47%
Health, general	0.16%	0.35%
Trade policy and regulations	0.01%	0.03%
Total	100.00%	100.00%

Table S2: Percentage of IDA and IBRD project commitment amounts by sector, 2000-2011. Treatment projects are those projects < 10 km from an IBA, compared to all World Bank projects.

Sum of Project Commitments

Sector Names	Treatment Projects	All Projects
Transport and storage	45.66%	30.86%
Government and civil society, general	2.76%	15.26%
Energy generation and supply	21.23%	15.08%
Water supply and sanitation	11.16%	9.29%
Other social infrastructure and services	2.42%	5.37%
Banking and financial services	1.74%	5.25%
Health	3.00%	4.22%
Agriculture	3.89%	3.85%
Agriculture, forestry, fishing	1.59%	1.96%
Basic education	0.49%	1.77%
Post-secondary education	1.41%	1.35%
General environmental protection	1.11%	0.88%
Education, level unspecified	0.11%	0.87%
Secondary education	0.30%	0.83%
Other	0.81%	0.73%
Industry	0.52%	0.62%
Forestry	0.82%	0.60%
Mineral resources and mining	0.78%	0.57%
Health, general	0.07%	0.35%
Communications	0.14%	0.27%
Trade policy and regulations	0.00%	0.02%
Total	100%	100%

Table S3: Comparison of Funding Levels for Environment and Natural Resources Theme. Treatment Projects are those projects < 10 km from an IBA.

Quintile of Project Funding to Environment Theme	Outside Treatment Group	Treatment Projects	All Projects
No funding	80.05	65.02	72.57
1-20	7.05	10.92	8.98
21-40	5.71	11.68	8.69
41-60	3.25	6.13	4.69
61-80	1.64	3.17	2.4
81-100	2.29	3.07	2.68

Table S4. Summary of matching and improvement in balance for each seven matching runs. All variables were entered together, and overall distance between pre matching and matched data is given, in addition to a variable by variable breakdown.

		Pre matching data				Matched data				Comparison of pre and post matching
Statistical comparison	**Co Variate**	**IBAs < 10 km mean**	**IBAs > 100 km mean**	**IBAs > 100 km SD**	**Difference in means**	**IBAs < 10 km mean**	**IBAs > 100 km mean**	**IBAs > 100 km SD**	**Difference in means**	**% balance improvement**
Forest loss	**Overall distance**	**0.1648**	**0.1392**	**0.0501**	**0.0256**	**0.1594**	**0.1538**	**0.0557**	**0.0056**	**78.2214**
Forest loss	surrounding agriculure	0.3148	0.2583	0.3078	0.0566	0.3053	0.2586	0.3083	0.0467	17.3839
Forest loss	ruggedness	0.0053	0.0043	0.007	0.001	0.0053	0.0055	0.0078	-0.0003	74.0212
Forest loss	human population	240.1899	90.999	380.2665	149.1909	153.502	89.0334	281.1889	64.4686	56.7878
Forest loss	protected area coverage	0.5515	0.6807	0.4663	-0.1291	0.5685	0.5583	0.4971	0.0102	92.082
Forest loss	Initial forest loss	0.0079	0.0097	0.0238	-0.0017	0.0079	0.0081	0.0161	-0.0002	87.2815
Forest loss	RegionAfrica	0.25	0.0423	0.2013	0.2077	0.2454	0.2454	0.4308	0	100
Forest loss	RegionAsia	0.3302	0.1524	0.3594	0.1778	0.3497	0.3497	0.4774	0	100
Forest loss	RegionAustralasia	0	0.0697	0.2546	-0.0697	0	0	0	0	100
Forest loss	RegionCaribbean	0.0401	0.0363	0.187	0.0038	0.0429	0.0429	0.2029	0	100
Forest loss	RegionCentralAmerica	0.0515	0.0019	0.0437	0.0496	0.0123	0.0123	0.1102	0	100
Forest loss	RegionCentralAsia	0.0095	0.0515	0.2211	-0.042	0.0102	0.0102	0.1007	0	100
Forest loss	RegionEurope	0.2004	0.5102	0.5	-0.3098	0.2147	0.2147	0.4111	0	100
Forest loss	RegionMiddleEast	0.0076	0.0143	0.1188	-0.0067	0.0061	0.0061	0.0782	0	100
Forest loss	RegionNorthAmerica	0	0.0448	0.207	-0.0448	0	0	0	0	100
Forest loss	RegionOceania	0.0019	0.0038	0.0617	-0.0019	0.002	0.002	0.0452	0	100
Forest loss	RegionSouthAmerica	0.1088	0.0728	0.2599	0.0359	0.1166	0.1166	0.3212	0	100
State	**Overall distance**	**0.3965**	**0.3489**	**0.0967**	**0.0476**	**0.4028**	**0.3776**	**0.0924**	**0.0252**	**46.9802**
State	surrounding agriculure	0.2746	0.2266	0.29	0.048	0.2901	0.1906	0.2762	0.0995	-107.3468
State	ruggedness	0.0033	0.0027	0.0064	0.0005	0.0037	0.0041	0.0066	-0.0004	26.186
State	human population	371.6608	78.5809	379.1657	293.0799	324.378	105.5989	541.1321	218.7791	25.3517
State	protected area coverage	0.6682	0.5096	0.5006	0.1587	0.709	0.709	0.4559	0	100
State	RegionAfrica	0.3981	0.1644	0.3711	0.2337	0.4403	0.4403	0.4983	0	100
State	RegionAsia	0.3886	0.1123	0.3162	0.2763	0.291	0.291	0.4559	0	100
State	RegionCaribbean	0.0095	0.0082	0.0904	0.0013	0.0075	0.0075	0.0864	0	100
State	RegionCentralAmerica	0.0047	0	0	0.0047	0	0	0	0	100

State	RegionCentralAsia	0.0284	0.2384	0.4267	-0.2099	0.0448	0.0448	0.2076	0	100
State	RegionEurope	0.0948	0.2685	0.4438	-0.1737	0.1493	0.1493	0.3577	0	100
State	RegionMiddleEast	0.0427	0.0082	0.0904	0.0344	0.0149	0.0149	0.1217	0	100
State	RegionOceania	0.0047	0.1014	0.3022	-0.0966	0.0075	0.0075	0.0864	0	100
State	RegionSouthAmerica	0.0284	0.0904	0.2872	-0.062	0.0448	0.0448	0.2076	0	100
Pressure	**Overall distance**	**0.2104**	**0.1733**	**0.0658**	**0.037**	**0.2078**	**0.197**	**0.0918**	**0.0108**	**70.7595**
Pressure	surrounding agriculure	0.2745	0.1996	0.3034	0.0749	0.2758	0.2956	0.3553	-0.0198	73.6397
Pressure	ruggedness	0.004	0.005	0.0078	-0.001	0.004	0.0048	0.0075	-0.0008	22.3506
Pressure	human population	275.1351	65.9481	296.1951	209.187	275.0988	129.6227	538.7557	145.4761	30.4564
Pressure	protected area coverage	0.5599	0.654	0.4758	-0.0941	0.5495	0.5547	0.4976	-0.0052	94.4659
Pressure	RegionAfrica	0.2673	0.041	0.1983	0.2263	0.2083	0.2083	0.4066	0	100
Pressure	RegionAntarctica	0	0.0005	0.0225	-0.0005	0	0	0	0	100
Pressure	RegionAsia	0.3134	0.1361	0.3429	0.1773	0.3516	0.3516	0.4781	0	100
Pressure	RegionAustralasia	0	0.1654	0.3716	-0.1654	0	0	0	0	100
Pressure	RegionCaribbean	0.0092	0.0081	0.0896	0.0011	0.0104	0.0104	0.1017	0	100
Pressure	RegionCentralAmerica	0.0138	0	0	0.0138	0	0	0	0	100
Pressure	RegionCentralAsia	0.0346	0.0728	0.2599	-0.0383	0.0391	0.0391	0.194	0	100
Pressure	RegionEurope	0.1475	0.4294	0.4951	-0.282	0.1641	0.1641	0.3708	0	100
Pressure	RegionMiddleEast	0.1452	0.0349	0.1836	0.1103	0.1484	0.1484	0.356	0	100
Pressure	RegionNorthAmerica	0	0.0116	0.1073	-0.0116	0	0	0	0	100
Pressure	RegionOceania	0.0138	0.0668	0.2497	-0.0529	0.0156	0.0156	0.1242	0	100
Pressure	RegionSouthAmerica	0.0553	0.0309	0.173	0.0244	0.0625	0.0625	0.2424	0	100
Response	**Overall distance**	**0.2098**	**0.1712**	**0.066**	**0.0386**	**0.2061**	**0.1949**	**0.092**	**0.0112**	**70.9011**
Response	surrounding agriculure	0.2769	0.2038	0.3051	0.0731	0.2804	0.2805	0.3511	-0.0001	99.8335
Response	ruggedness	0.004	0.005	0.0077	-0.001	0.004	0.0044	0.0065	-0.0003	68.4094
Response	human population	274.919	65.3068	291.5603	209.6122	274.2959	118.5129	534.0057	155.783	25.6804
Response	protected area coverage	0.5576	0.6567	0.4749	-0.0992	0.5532	0.5221	0.5002	0.0312	68.5677
Response	RegionAfrica	0.2754	0.0401	0.1962	0.2353	0.2104	0.2104	0.4081	0	100
Response	RegionAntarctica	0	0.0005	0.0221	-0.0005	0	0	0	0	100
Response	RegionAsia	0.307	0.1315	0.3381	0.1755	0.3481	0.3481	0.477	0	100
Response	RegionAustralasia	0	0.1599	0.3666	-0.1599	0	0	0	0	100
Response	RegionCaribbean	0.009	0.0083	0.0908	0.0007	0.0104	0.0104	0.1015	0	100
Response	RegionCentralAmerica	0.0135	0	0	0.0135	0	0	0	0	100

Response	RegionCentralAsia	0.0339	0.0704	0.2559	-0.0366	0.039	0.039	0.1938	0	100
Response	RegionEurope	0.1467	0.445	0.4971	-0.2983	0.1636	0.1636	0.3704	0	100
Response	RegionMiddleEast	0.1445	0.0337	0.1806	0.1107	0.1481	0.1481	0.3556	0	100
Response	RegionNorthAmerica	0	0.0112	0.1055	-0.0112	0	0	0	0	100
Response	RegionOceania	0.0135	0.065	0.2467	-0.0515	0.0156	0.0156	0.124	0	100
Response	RegionSouthAmerica	0.0564	0.0318	0.1755	0.0246	0.0649	0.0649	0.2467	0	100
State change	**Overall distance**	**0.7431**	**0.3886**	**0.181**	**0.3546**	**0.5903**	**0.4967**	**0.1938**	**0.0936**	**73.5963**
State change	surrounding agriculure	0.2053	0.2582	0.3124	-0.0528	0.0482	0.0003	0.001	0.0479	9.4042
State change	ruggedness	0.0019	0.0007	0.0016	0.0012	0.0009	0.0005	0.0013	0.0004	65.3169
State change	human population	174.2884	18.6496	41.7657	155.6388	244.9545	28.1524	71.6466	216.8022	-39.2982
State change	protected area coverage	0.8644	0.6923	0.4676	0.1721	0.8	0.9	0.3162	-0.1	41.8939
State change	initial state	2.1017	2.1282	0.9228	-0.0265	2.4	2.4	0.6992	0	100
State change	RegionAfrica	0.9322	0.2564	0.4424	0.6758	1	1	0	0	100
State change	RegionAsia	0.0678	0.1026	0.3074	-0.0348	0	0	0	0	100
State change	RegionCaribbean	0	0.0256	0.1601	-0.0256	0	0	0	0	100
State change	RegionCentralAsia	0	0.4359	0.5024	-0.4359	0	0	0	0	100
State change	RegionEurope	0	0.1282	0.3387	-0.1282	0	0	0	0	100
State change	RegionMiddleEast	0	0.0513	0.2235	-0.0513	0	0	0	0	100
Pressure change	**Overall distance**	**0.4318**	**0.3209**	**0.1271**	**0.1109**	**0.3926**	**0.3447**	**0.1351**	**0.0479**	**56.8085**
Pressure change	surrounding agriculure	0.2571	0.2199	0.3187	0.0372	0.1909	0.1601	0.2715	0.0308	17.2266
Pressure change	ruggedness	0.0041	0.0046	0.0087	-0.0006	0.0043	0.0041	0.0064	0.0001	79.8888
Pressure change	human population	536.0292	58.6951	202.9375	477.3341	159.5696	81.8518	278.2895	77.7177	83.7184
Pressure change	protected area coverage	0.7705	0.6296	0.484	0.1409	0.7333	0.75	0.4367	-0.0167	88.1681
Pressure change	initial pressure	1.418	1.5787	0.9466	-0.1607	1.5667	1.6833	0.9112	-0.1167	27.3878
Pressure change	RegionAfrica	0.582	0.162	0.3693	0.4199	0.5833	0.5833	0.4972	0	100
Pressure change	RegionAsia	0.3361	0.0741	0.2625	0.262	0.2667	0.2667	0.4459	0	100
Pressure change	RegionAustralasia	0	0.1111	0.315	-0.1111	0	0	0	0	100
Pressure change	RegionCaribbean	0.0082	0.0278	0.1647	-0.0196	0.0167	0.0167	0.1291	0	100
Pressure change	RegionCentralAsia	0.0164	0.1111	0.315	-0.0947	0.0333	0.0333	0.181	0	100
Pressure change	RegionEurope	0.0246	0.25	0.434	-0.2254	0.05	0.05	0.2198	0	100
Pressure change	RegionMiddleEast	0.0328	0.0833	0.277	-0.0505	0.05	0.05	0.2198	0	100
Pressure change	RegionNorthAmerica	0	0.0093	0.096	-0.0093	0	0	0	0	100
Pressure change	RegionOceania	0	0.1574	0.365	-0.1574	0	0	0	0	100

Pressure change	RegionSouthAmerica	0	0.0139	0.1173	-0.0139	0	0	0	0	100
Response change	**Overall distance**	**0.3191**	**0.2708**	**0.0898**	**0.0483**	**0.3163**	**0.2878**	**0.0654**	**0.0285**	**41.0561**
Response change	surrounding agriculure	0.257	0.2711	0.3323	-0.0141	0.2052	0.1259	0.2337	0.0793	-461.7847
Response change	ruggedness	0.0042	0.0044	0.0077	-0.0002	0.0048	0.0047	0.0068	0	74.4587
Response change	human population	499.6217	77.4066	281.3239	422.2151	164.77	31.9921	60.1236	132.778	68.5521
Response change	protected area coverage	0.7239	0.7418	0.4383	-0.018	0.6667	0.7121	0.4562	-0.0455	-153.0994
Response change	initial response	0.7761	0.5816	0.8522	0.1945	0.8182	0.8485	1.0265	-0.0303	84.4214
Response change	RegionAfrica	0.5672	0.1039	0.3055	0.4633	0.5152	0.5152	0.5036	0	100
Response change	RegionAsia	0.306	0.0504	0.2192	0.2555	0.2424	0.2424	0.4318	0	100
Response change	RegionAustralasia	0	0.0712	0.2576	-0.0712	0	0	0	0	100
Response change	RegionCaribbean	0.0075	0.0178	0.1324	-0.0103	0.0152	0.0152	0.1231	0	100
Response change	RegionCentralAsia	0.0149	0.0801	0.2719	-0.0652	0.0303	0.0303	0.1727	0	100
Response change	RegionEurope	0.0224	0.4777	0.5002	-0.4554	0.0455	0.0455	0.2099	0	100
Response change	RegionMiddleEast	0.0821	0.0564	0.231	0.0257	0.1515	0.1515	0.3613	0	100
Response change	RegionNorthAmerica	0	0.0208	0.1428	-0.0208	0	0	0	0	100
Response change	RegionOceania	0	0.1128	0.3168	-0.1128	0	0	0	0	100
Response change	RegionSouthAmerica	0	0.0089	0.0941	-0.0089	0	0	0	0	100

Table S5. Summary of matching and improvement in balance for each seven matching runs, matching exactly on country. All variables were entered together, and overall distance between pre matching and matched data is given, in addition to a variable by variable breakdown. Comparisons of forest loss and in situ monitoring scores for the country matching and for comparison the regional matching (results in main text) are given with test statistic from Mann-Whitney (W) . Significance indicated by * P<0.05, # P<0.1, no symbol indicates non significant.

		Pre matching data				Matched data				Comparison of pre and post matching		Country matching analysis summary	Continent matching analysis summary
Statistical comparison	**Co Variate**	**IBAs < 10 km mean**	**IBAs > 100 km mean**	**IBAs > 100 km SD**	**Difference in means**	**IBAs < 10 km mean**	**IBAs > 100 km mean**	**IBAs > 100 km SD**	**Difference in means**	**% balance improvement**	**n**	**W**	**W**
Forest loss	Overall distance	0.1648	0.1392	0.0501	0.0256	0.15	0.1454	0.0444	0.0046	**82.01**	160	27130*	110540*
State	Overall distance	0.3965	0.3489	0.0967	0.0476	0.3649	0.3524	0.0783	0.0125	**73.67**	42	789.5	8647
Pressure	Overall distance	0.2104	0.1733	0.0658	0.037	0.2117	0.1988	0.0543	0.0129	**65.08**	123	6701	53412
Response	Overall distance	0.2098	0.1712	0.066	0.0386	0.2088	0.1951	0.0532	0.0137	**64.59**	125	6691*	68974#
State change	Overall distance	0.7431	0.3886	0.181	0.3546	0.3751	0.422	0.1306	-0.0469	**85.63**	4	N/A	42
Pressure change	Overall distance	0.4318	0.3209	0.1271	0.1109	0.3335	0.3179	0.0799	0.0156	**85.95**	16	125.5	1947.5
Response change	Overall distance	0.3191	0.2708	0.0898	0.0483	0.2879	0.2697	0.0396	0.0182	**62.36**	18	220.5*	2546#

Text S1. Results for analysis based on exact country matching

The rate of forest loss during 2006-2012 in IBAs in the IBAs <10 km from project locations was, on average, two thirds that of the rate of forest loss in matched IBAs >100 km from project locations, although the difference was again only marginally statistically significant (W=27130, n=160, P = 0.039; Figure S1).

Comparison of monitoring scores for IBAs indicated that there was no consistent difference in state scores between IBAs <10 km from World Bank project locations and those > 100km from project locations (W = 789.5, n= 42, P = 0.399) or pressure (W= 6701, n=123, P = 0.113; Figure S3). However, there was evidence of more conservation responses underway at IBAs <10 km from project locations compared to those >100km from project locations (W = 6691, n=125, P =0.028; Figure S2).

Across the matched IBAs for which monitoring data were available at multiple time-points, we found no differences in the change in conservation pressure scores between the IBAs <10 km from World Bank project locations and those > 100km from project locations (W=125.5, n = 16, P=0.930). There was evidence of a marginally significant difference in response scores (W=220.5, n = 18, P=0.049), with stronger conservation responses underway at IBAs <10 km from World Bank project locations than those >100km from project locations (Figure S3). The matching for changes in state matched just four IBAs <10 km from project locations with 4 IBAs >100 km from project locations. Consequently, we did not analyze these data.

Figure S1. Mean (± SE) percentage gross forest loss between 2006 and 2012 (from Hansen et al. 2013) for IBAs <10 km from World Bank projects (open bars) and matched IBAs >100 km from World Bank projects (grey bars), matched exactly by country.

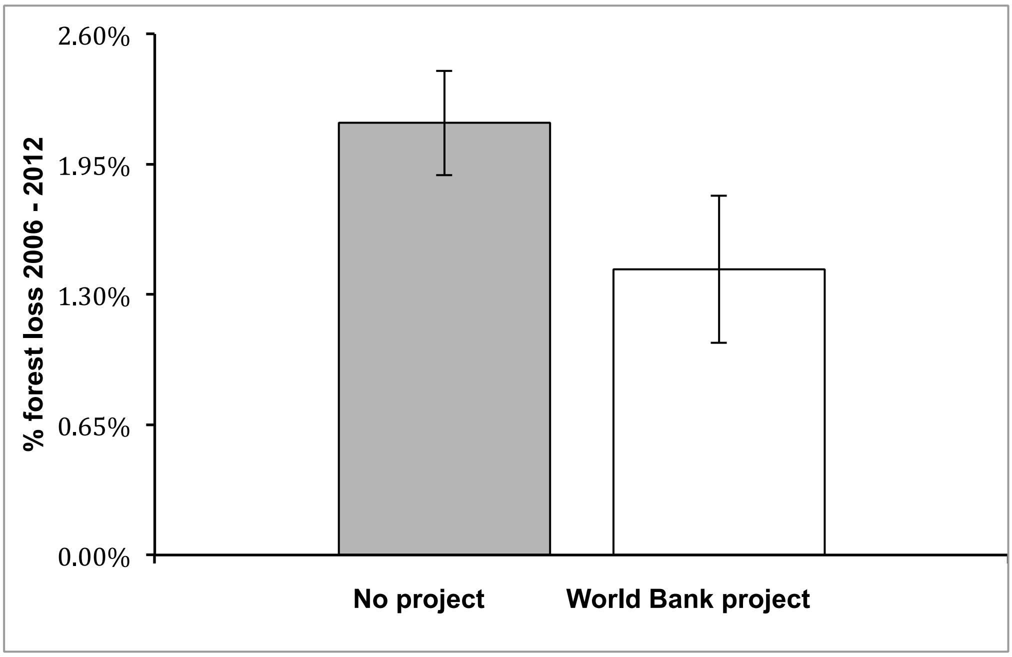


Figure S2. Mean (± SE) monitoring scores for state, pressure, and response for IBAs <10 km from World Bank projects (open bars) and matched IBAs >100 km from World Bank projects), matched exactly by country.

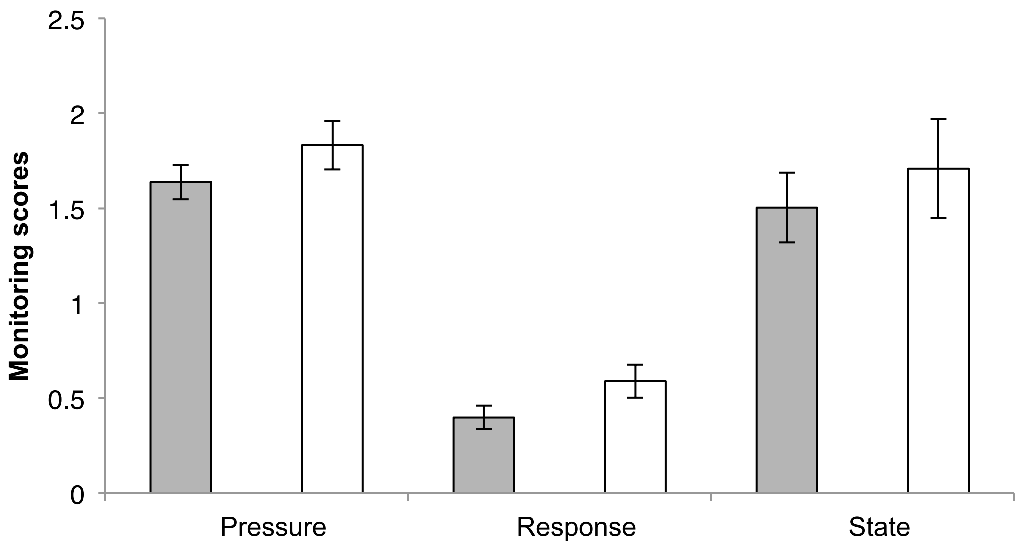


Figure S3. Mean (±SE) differences in scores between initial and repeat monitoring for pressure, response, and state at IBAs in <10 km from World Bank projects (treatment ; open bars) and matched IBAs >100 km from World Bank projects (controls; filled, grey bars), matched exactly by country. Positive values indicate improvements in state, reductions in pressure, and increases in response.

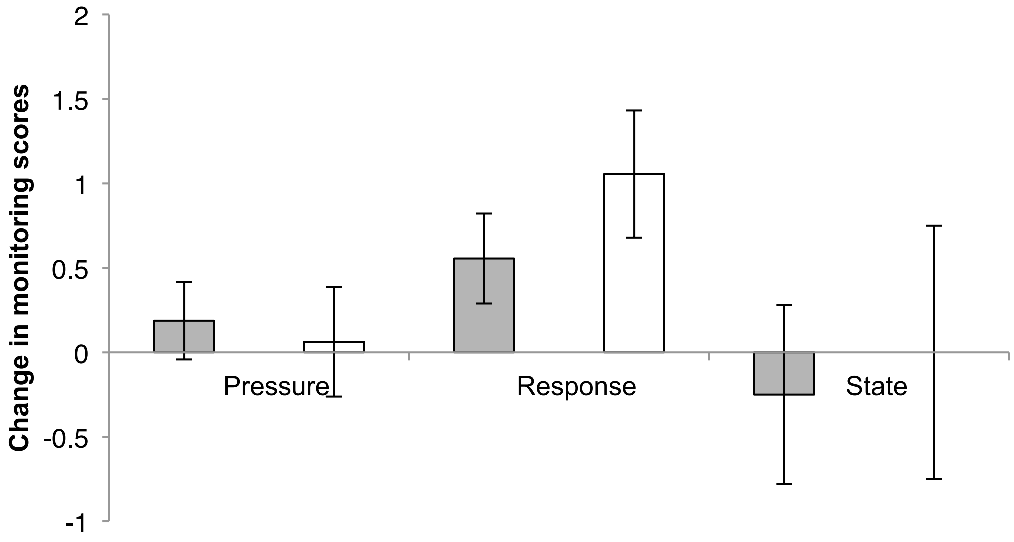
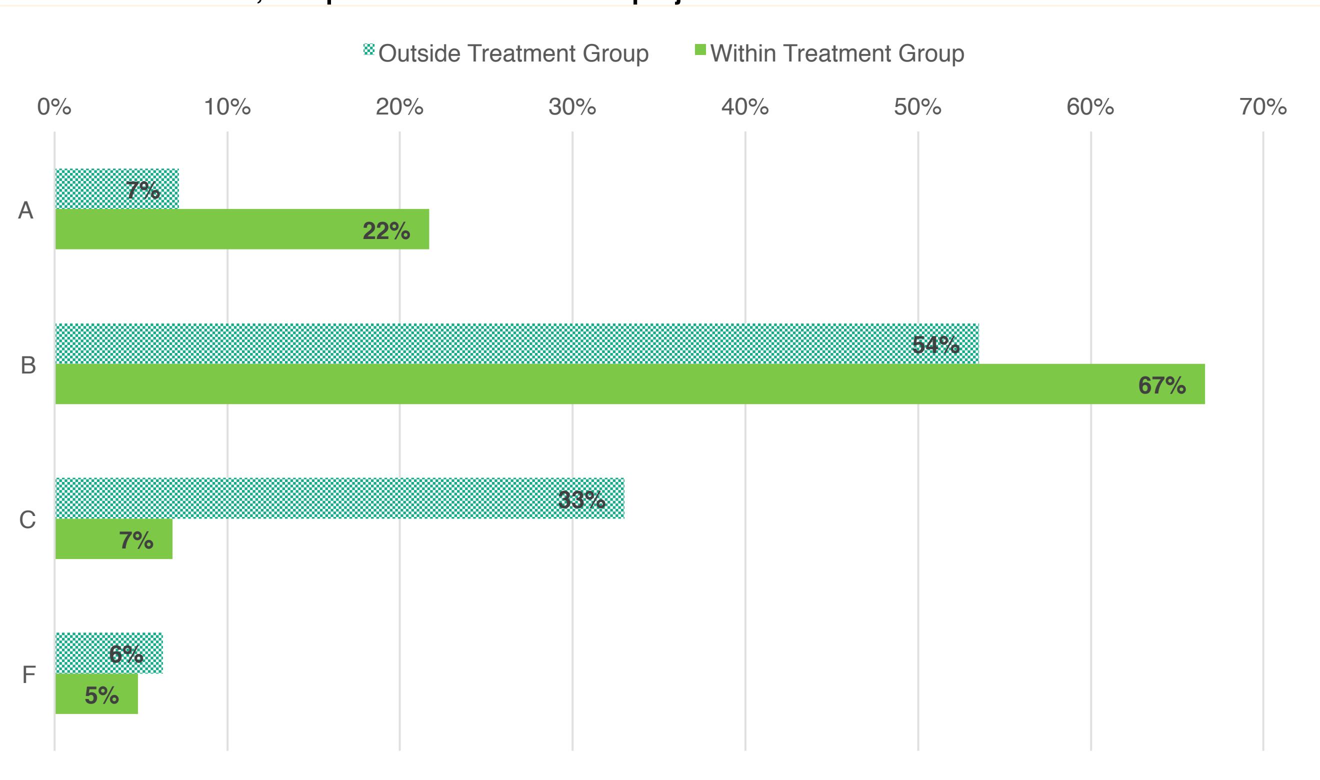


Figure S4: Project Country by Environmental Category. Treatment projects are those projects < 10 km from an IBA, compared to all World Bank projects.



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