


LETTER

Tax Shifting and Incentives for Biodiversity Conservation on Private Lands

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Abstract

Conservation in human-dominated landscapes is challenging partly due to the high costs of land acquisition. We explored a property tax mechanism to finance conservation easements or related contracts as a partial-property acquisition strategy to meet Convention on Biological Diversity (CBD) treaty targets to conserve critically imperiled coastal Douglas fir ecosystems in Canada. To maximize cost-efficiency, we used systematic planning tools to prioritize 198,058 parcels for biodiversity values, estimated the cost of eliminating property tax on high-priority parcels to engage land owners in conservation, and then calculated the tax increase on nonpriority parcels necessary to maintain tax revenue. Marginal tax rate increases of 0.13, 0.21, and 0.51% on nonpriority parcels were necessary to offset the elimination of tax revenue on ~21,000 ha of high-priority parcels, and potentially sufficient to increase area protection from 9% to 17% to meet CBD targets given uptake rates of 100, 50, or 25%, respectively. Sensitivity analyses suggest uptake rates of 30% to 40% could allow government to achieve a 17% target with 30% of the planning area prioritized for inclusion in a property tax mechanism. Our results suggest prioritizing parcels for biodiversity value and commensurate “tax shifting” may offer an efficient route to conservation on private land.

Introduction

Developing effective mechanisms to conserve biodiversity in human-dominated landscapes is challenging in part due to the high costs of land acquisition (Naidoo *et al.* 2006; Wunder 2007). Without the opportunity to transfer state-owned land into dedicated conservation zones, such as statutory protected areas, alternative approaches are needed to protect biodiversity and meet international treaty commitments to conserve 17% of terrestrial ecosystems by 2020 (Convention on Biological Diversity [CBD], 2010). To reach CBD targets, a conservation approach combining formally protected areas and “other effective area based conservation measures,” especially on private lands, will be necessary. Yet, implementing con-

servation on private lands is no simple task, in part, because landowners must be sufficiently incentivized. As such, a wide variety of tax-funded programs have been developed to engage landowners in conservation actions or the protect greenspace (Hibbard *et al.* 2003; Polyakov & Zhang 2008). Most programs are structured as voluntary agreements between a government agency and a private landowner that allow for tax reductions in return for restrictions or specifications on land use (Polyakov & Zhang 2008).

Tax-reduction programs an important funding mechanism for one of the most effective conservation approaches on private lands—conservation easements, or “covenants” (Fishburn *et al.* 2009; Gordon *et al.* 2011). Compared to acquiring land outright, easements have

much lower initial cost (Pence *et al.* 2003) and can appeal to landowners wishing to retain title (Knight *et al.* 2010; Selinske *et al.* 2015). Similar to many other tax-based programs, conservation easements also involve voluntary agreements between an easement holder, typically a land trust or government agency, and a private landowner (Rissman *et al.* 2007). Easement holders acquire and retain certain property rights to restrict land use including, in some cases, a requirement that specific conservation actions be applied permanently (Gustanski & Squires 2000; Owley 2004). In return, private landowners may receive payments and/or a reduction in property or income taxes (Byers & Ponte 2005).

In Canada, for example, existing tax-based conservation programs include, among others, the federal Ecological Gifts Program, which provides income tax benefits in return for charitable gifts of land. Similar provincial and municipal programs are proposed or already exist, including the Ontario Conservation Land Tax Incentive Program, which allows a 100% property tax reduction on portions of land maintained to protect “provincially important natural heritage features.” Similar mechanisms are under consideration in British Columbia (BC) after the Union of BC municipalities approved a 2015 resolution to allow local governments to implement tax-based conservation incentive programs. Overall, these existing and emerging programs reflect elements of conservation easements, funded by property tax reductions, with the potential to include a variety of conservation actions and contract types.

While easements and other tax-based programs seem to be a natural win-win, the reality is that these agreements can incur costs to participants and government. For example, land owners incur opportunity costs by foregoing land uses that are incompatible with their contracted obligations (Drechsler *et al.* 2007; Klimek *et al.* 2008), as well as transaction costs and costs of conservation management (Moon & Cocklin 2011; Stroman & Kreuter 2015). Easement holders, whether trusts or government agencies, incur monitoring and enforcement costs (Cheever & McLaughlin 2015; Kamal *et al.* 2015). From a government perspective, tax programs and easements can reduce revenue (Schuster & Arcese 2015). Although such costs are recognized, they are seldom made explicit in the literature. Furthermore, participation rates in both program types are often low and, potentially taken up more often by land owners with pro-conservation motivations, raising questions about additionality (Farmer *et al.* 2017). Despite these challenges, in landscapes comprising mainly private land, conservation easements and tax-programs may represent the most feasible option for realizing conservation goals (Kamal *et al.* 2015). However, in the absence of detailed, area-

based pilots aimed at exploring the potential costs and benefits of such programs, and given uncertainties about additionality and uptake, empirical simulation studies have the potential to reduce uncertainty and inform decision makers.

Here, we develop a case study by the coastal Douglas fir (CDF) Conservation Partnership (www.cdfcp.ca) to conserve critically imperiled CDF ecosystems of the Georgia Basin of south-western BC by identifying high-priority parcels for potential biodiversity conservation (“high conservation priority”). Two scenarios were developed: (1) increase the protection of this imperiled ecosystem from 9% to 17% to meet CBD targets and (2) increase protection from 9% to 30% to meet consensus scientific assessment (Cardinal *et al.* 2004; Noss *et al.* 2012). We next estimated: (1) the gross expected reduction in tax revenue to government if owners of parcels with high conservation priority paid no property tax in exchange for engaging in conservation activities and (2) the marginal increase in tax rates on lower priority parcels that would be necessary to offset the above reductions and yield no net change in tax revenue across the region. We next: (1) describe potential outcomes of a property tax-shifting mechanism involving private landholders and the government administering property taxes and (2) test via simulation how uptake rates by private land owners may affect the efficacy of tax shifting as a mechanism to finance contracts for specific conservation actions or easements sufficient for nations to achieve internal conservation goals as well as commitments to international treaties.

Materials and methods

Study region

We studied a 2,520 km² portion of the CDF ecological zone of the Georgia Basin of BC, Canada. The CDF includes several critically endangered old forest and savannah plants and animal communities endemic to the region, but now >80% is privately owned and 49% converted to human uses such as urban and rural development, transportation and utility corridors and agriculture (Austin *et al.* 2008). In this region, ≤0.3% of old forest (>250 years) and ≤10% of oak woodlands extant prior to European contact remain (Lea 2006). The majority of the CDF is severely degraded, but remaining areas still provide habitat for 117 species at risk of extirpation (Austin *et al.* 2008). Prior to European colonization the CDF occurred as uneven-aged forest (often >300 years old) dissected by shallow and deep soil meadows and woodlands (Meidinger & Pojar 1991) and was maintained in part by aboriginal land management practices designed to

enhance hunting opportunities and root and fruit harvests (Arcese *et al.* 2014). The region also constitutes one of the most desirable places to live in Canada, which is reflected by high real estate values, averaging \$5.2m (Canadian) per hectare, but still including lower-valued parcels in rural areas (8% of parcels are valued less than \$247,000 per hectare, assessment year: 2011).

Prioritizing high-biodiversity parcels for potential conservation

We used conservation prioritization scenarios developed by the CDF and Associated Ecosystems Conservation Partnership (CDFCP; Appendix S1) to achieve goals of conserving 17% and 30% of remaining, high conservation priority ecosystems in this critically endangered region. These high-priority ecosystems were represented by composite maps of Old Forest, Savannah, Wetland focal bird communities (Schuster & Arcese 2013; Schuster *et al.* 2014), richness of oak and maritime meadow plant species (Bennett 2014), and the occurrence of provincially red-listed Douglas fir/dull Oregon-grape plant communities (sourced from the BC Conservation Data Centre). High-priority properties were identified by calculating optimization solutions that conserved focal bird and plant species communities, while minimizing potential acquisition costs. Solutions were based on 2012 cadastral data representing 198,058 properties within the study area. Scenarios and their rationale are provided in the “2015 Conservation Strategy” of the CDFCP (Appendix S1), and were analysed using a Marxan framework, but using integer linear programming optimization in software Gurobi v.6.5.0 (<http://gurobi.com/>; Beyer *et al.* 2016) and the feature layers noted above (further details in Appendix S2).

Property tax analysis

The property tax rate for the study region was based on 22 municipalities (BC Ministry of Community, Sport and Cultural Development; http://www.cscd.gov.bc.ca/lgd/infra/library/Schedule702_2014.xls, accessed: March 2015) using residential, light industry, business, managed forest land, and recreation nonprofit rates to estimate a mean tax rate of \$15.54 per \$1,000 property value applied to all properties to estimate total property tax revenue for 2014. For each scenario, we estimated the reduction in tax revenue under the assumption that all parcels identified as priorities in optimization solutions (“high conservation priority”) would accept tax breaks to remain in their current state and then calculated the marginal increase in property taxes necessary on remaining parcels to offset lost government tax revenue. We used two different levels of tax shifting, wherein (1) owners of un-

selected parcels paid 100% of the tax exemption of the participating high-priority parcels and (2) owners of unselected parcels paid 200% of the tax exemption of the participating high-priority parcels to fund stewardship on participating land and monitoring.

We also conducted sensitivity analyses of participation rates in property tax programs given prior results indicate that participation rates are unlikely to reach 100% (Moon 2013). First, we repeated the prioritization by varying conservation targets from 10% to 50% in 1% increments, to give a pool of parcels “eligible” for property tax reduction given high estimated biodiversity value. We then recalculated each tax-shifting scenario assuming a range of property owner uptake rates from 0% to 100% (5% increments, participation assigned randomly), and then determining whether the 17% target was met. In total, this resulted in 861 conservation plans and tax scenarios. All analyses were conducted using R v.3.2.3 (R Development Core Team 2015).

Results

Annual property tax revenue for the 198,058 modeled parcels examined in the Georgia Basin was estimated at \$2.32bn. The optimization solutions identified 464 and 1,401 parcels (21,092 and 53,380 ha, respectively) to be added to the 1,188 already protected parcels (23,788 ha) to achieve 17% and 30% protection targets, respectively (Figure 1).

Reducing tax rates on high-biodiversity parcels in CDFCP scenarios implied reductions in annual property tax revenues of \$3.1 or \$6.3m, given a 100% or 200% shift in property tax burden to achieve a 17% conservation target (Table 1). However, offsetting these declines in property tax revenue only required increases of 2.1 to 4.2 cts per \$1,000 on unselected parcels, amounting to increases of 0.13% to 0.27% in the current property tax rate, assuming 100% uptake by landowners (Table 1). Reductions in annual property tax revenues necessary to reach a 30% protection target amounted to \$16.2 or \$32.4m given a 100% or 200% shifts in property tax burden away from selected parcels, respectively. These declines imply offsetting increases of 10.9 and 21.8 cts per \$1,000, which amount to increases in annual property tax rates on non-selected properties of 0.7% to 1.4% (Table 1).

However, a sensitivity analysis over 861 prioritization and tax scenarios further indicated that program uptake rate has the potential to dramatically affect conservation goals by affecting the efficiency of the prioritized, tax-shifting mechanism we explored (Table 1). For example, as uptake rates by owners of “eligible” parcels declined from 100% to 25%, the corresponding solutions included

Table 1 Example targets for increased protection of terrestrial coastal Douglas fir ecosystems and the estimated reduction in gross property tax revenue caused by 100% or 200% reductions in tax rate on high conservation priority parcels selected

Target	Scenario	Uptake rate [%]	Tax loss [\$ M]	New tax rate [\$]	Rate change [cts]	Rate change [%]
17%	100% red	100	3.13	15.56	2.10	0.13
		50	4.90	15.57	3.28	0.21
		25	11.70	15.62	7.87	0.51
	200% red	100	6.26	15.58	4.20	0.27
		50	9.79	15.61	6.56	0.42
		25	23.41	15.70	15.73	1.01
	30%	100	16.20	15.65	10.91	0.70
		50	48.90	15.88	33.41	2.15
		25	—	—	—	—
	200% red	100	32.40	15.76	21.82	1.40
		50	97.79	16.21	66.81	4.30
		25	—	—	—	—

For each scenario, we present three uptake rates: maximum (100%), optimistic (50%), and typical (25%). Revised rates reflect increase over current base rate estimated for the study area (\$15.54 per \$1,000 valuation; see Materials and Methods Section). Absolute increase estimated as cts per \$1,000 valuation and as a percentage of base rate. Typical uptake rates (25%) did not yield feasible results at 30% target using the CDFCP scenarios.

more suboptimal parcels and required that a larger number of candidate parcels and overall area had to be prioritized to meet the 17% and 30% targets (Figure 2). As a consequence of these reductions in efficiency, estimated reductions in tax revenue to government and the corresponding increases in property tax rates applied to nonselected parcels increased from \$3.1 to \$11.7m, and 0.13% to 0.51%, respectively. Nevertheless, our results also suggest that uptake rates as low as 25%, and property tax rate increases on nonselected parcels of 0.51%, may be sufficient to reach a 17% target (Table 1). The potential property tax savings for participating private land owners across all 861 scenarios ranged from \$51 to \$1.5m per property and year, with an average of \$10,017 (SD = \$3,307).

Discussion

Property tax programs to promote conservation, including those funding easements, often include mechanisms whereby governments offer incentives to the owners of biologically diverse lands in return for agreements to maintain or enhance conservation, amenity, or ecosystem service values on those lands to meet targets for biodiversity conservation. Our results indicate that raising property tax rates by as little as 0.13% on parcels of low biodiversity value may be sufficient to offset the elimination of property taxes on high-biodiversity parcels for the purpose of incentivizing conservation on private land given 100% uptake by owners (but see below). More proactive, science-based targets to conserve 30% of landscapes (Cardinall *et al.* 2004; Noss *et al.* 2012) required larger increases in tax rates but appeared feasible

given uptake rates of 40% (Table 1). These results imply that, given sufficient uptake by landowners of high-biodiversity parcels, tax shifting may offer an efficient mechanism for governments to meet conservation targets in partnership with private landowners, without reducing tax revenue or requiring land purchase. Importantly, the cost-effectiveness of such an approach will be partly linked to the ability to identify and prioritize parcels with high conservation value to avoid allocating limited funds to parcels that contribute little to reaching targets.

That said, we recognize that property tax programs designed to incentivize conservation on private land face challenges, including: (1) the willingness of owners to participate, (2) permanence of easements, (3) potential additionality, and (4) the monitoring and enforcement effort necessary to ensure compliance. Because 100% participation by landowners is unlikely (Moon 2013), we modeled the effect of participation rate on the ability to meet conservation targets and found that as participation rate declined, the fraction of the target ecosystems prioritized had to increase (Figure 1). However, because increasing those targets resulted in the more frequent inclusion of suboptimal parcels in modeled solutions, our results further suggest that marginal tax rate increases of 0.13, 0.21, and 0.51% on nonpriority parcels would be required to offset the elimination of taxes on selected parcels needed to increase protection from 9% to 17%, as uptake rate declines from 100% to 25% (Table 1). Nevertheless, even uptake rates of 25%, corresponding to an increase in the property tax rate of 0.51% on properties not prioritized for conservation, appear modest in comparison to a 3% property tax hike and 17% jump in assessments documented in BC's lower mainland in

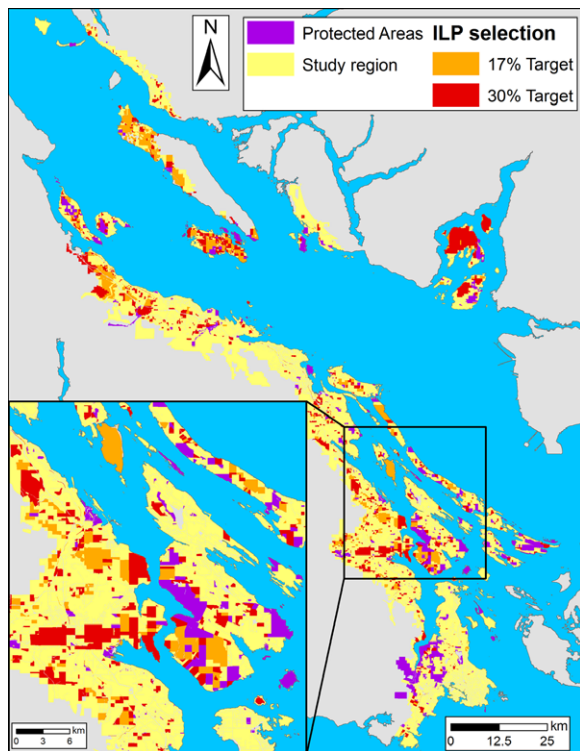


Figure 1 Integer linear programming optimization results. Protected areas represent already protected areas in the region, which were locked into optimization solutions. The spatial representation of the 17% is therefore a combination of protected areas in purple and 17% target in orange. The 30% target comprises all three; purple, orange, and red polygons. For target details, see Materials and Methods Section.

2017 (Figure 2). Empirical studies report mean uptake rates of 17% by participants in federal cost-share programs aimed at forest landowners in the northern United States (Jacobson *et al.* 2009) to 40% for participants in the Ontario Conservation Lands Tax Incentive Program (Drescher *et al.* 2017). Overall, these results emphasize a continuing need to identify: (1) factors affecting uptake by owners of high-biodiversity land as well as (2) potential trade-offs between uptake rate, the magnitude of incentives offered, and the ability to create efficiencies via the application of prioritization tools like those developed for the imperiled landscapes in BC that we studied.

Lack of additionality is also a concern even in the case of high uptake by owners of high-biodiversity parcels when no change in the existing management regime is required to maintain a desired conservation outcome. However, in the case of permanent easements, additionality is likely to be achieved given high observed and predicted rates of land conversion in human-dominated landscapes (Hamilton *et al.* 2016). Monitoring and enforcement of easements also present challenges

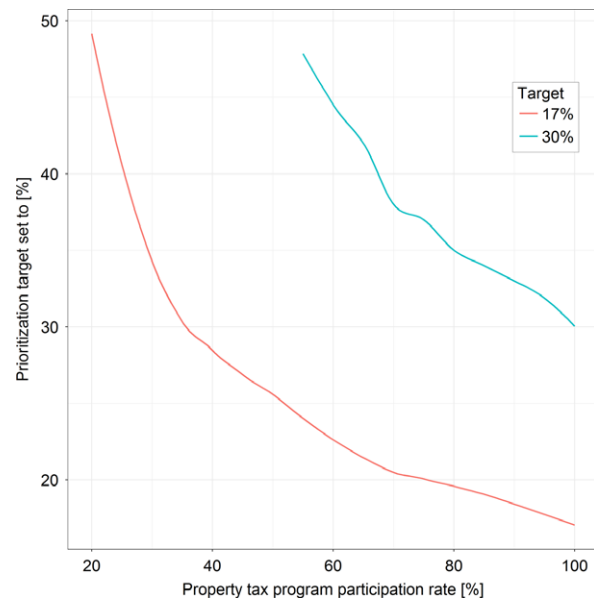


Figure 2 Sensitivity analysis trade-off curves contrasting property tax program participation rate with what prioritization target is needed to create a big enough pool of candidate properties for the tax-shifting program to reach a 17% or 30% target. As an example, if we want to reach a protection target of 30% and assume a tax program participation rate of 80%, we would need to set the conservation optimization goal to roughly 35%. This would ensure a large enough candidate pool of high-biodiversity properties to reach the 30% conservation target given less than 100% participation. Shown are the results of 42 out of the 861 conservation plans and tax scenarios investigated in our sensitivity analysis (see Materials and Methods Section).

(McLaughlin 2013), particularly as titles change and the entities holding them merge or dissolve. Allocating a portion of tax-shifted revenue to support monitoring, land stewardship, or short-term conservation actions in regions where permanent easements are prohibitively expensive (e.g., BirdReturns; <http://birdreturns.org/>; Table 1) or otherwise subject to failure may offer one potential remedy. Last, the potential to bundle tax-shifting programs with revenue derived from payments for ecosystem services, such as carbon offsetting, may further offset such costs (Schomers & Matzdorf 2013; Schuster *et al.* 2014). Overall, tax-shifting programs and easements appear to offer a viable alternative to land acquisition in regions where acquisition costs are prohibitive.

Our case study provides one such example, wherein easement and property tax-based mechanisms, reminiscent of existing federal and provincial programs, have the potential to use shifts in property taxes to enhance widely held conservation goals. Specifically, as one of the 196 signors of the CBD, the Canadian government has committed to conserve at least 17% of terrestrial ecosystems by 2020. Yet, as for many other nations, this target

will be difficult or impossible to achieve via land acquisition and protection due to land scarcity and high cost (MacKinnon *et al.* 2015). In order to qualify as a conservation action under CBD, agreements made as part of the proposed programs will need to put restrictions on property development and resource extraction to insure compatibility with conservation goals. In the scenarios we examined, purchasing private land sufficient to conserve 17% and 30% of target ecosystems implied government investments of \$360m to \$1.2bn, respectively, including 15% of the purchase value in trust to support management (Schuster & Arcese 2015). This level of investment far exceeds any precedent in conservation via private land undertaken to date in Canada.

Despite the promise of our case study, two caveats suggest that further study is required. First, the threat of biodiversity loss was not considered in our analysis as there currently exist no credible data to reliably estimate the potential of biodiversity loss due to development in our study region. Once these data come available, a more realistic benefit-cost-loss targeting could be implemented. Second, our use of average tax rates across the study region likely implies larger property tax costs in some parts of the region. To solve this problem, this program would need a region-wide revenue-sharing structure.

Our study illustrates that small shifts in property tax rates may be sufficient to finance conservation programs capable of helping nations achieve internal conservation goals and meeting commitments to international treaties. Given a diversity of potential incentives for private land conservation (Hanley *et al.* 2012), our results suggest that tax shifting may represent an attractive route for governments striving to meet international treaty commitments.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web site:

Appendix S1. This supplementary material provides the analysis scenario settings, followed by the CDFCP's "2015 Conservation Strategy" for background and rationale.

Appendix S2. This supplementary material includes the Marxan tutorial developed for the CDFCP's "2015 Conservation Strategy" project. The feature layers' details used here can be found in Section 2.2.2.

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