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Analysis

The Vermont Common Assets Trust: An institution for sustainable, just and efficient resource allocation

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ABSTRACT

Both private and public sectors have failed to adequately provide critical ecosystem goods and services or an equitable distribution of wealth and income. To address this problem, the Vermont legislature is considering the creation of a Vermont Common Assets Trust (VCAT) that would make the state's atmosphere, aquifers and other resources created by nature or by society as a whole the common property of all Vermonters, present and future. Under the Trust, a board of trustees would have the legal obligation to manage these assets for the benefit of all Vermonters, including future generations. This paper first explains why certain resources are likely to be managed more sustainably, fairly and efficiently as common property than as private property. It then discusses mechanisms for integrating assets into the trust. Estimates of potential revenue from a VCAT suggest that it could eliminate the state budget deficit, contribute to a better distribution of wealth and resources, and help address critical ecological problems. Survey results suggest that a VCAT is politically feasible. The VCAT promises to be an important pilot project that could later be scaled up to a national or global level.

1. Introduction

Human society currently faces a number of unprecedented challenges that seriously threaten our welfare and perhaps even long term survival (IPCC, 2013; Millennium Ecosystem Assessment, 2005; Rockstrom et al., 2009; Steffen et al., 2011). Three general types of problems deserve mention.[1]

The first is unsustainable resource depletion and accumulation of harmful wastes, which in turn can be subdivided into three components:

- Continual consumption of renewable resources such as fisheries and forests faster than they can regenerate, which must inevitably result in stocks crashing;
- Continual emission of wastes faster than they can be absorbed by eco \systems, which must inevitably result in constantly increasing waste stocks; and
- Depletion of stocks of essential non-renewable resources, such as fossil fuels, faster than we can develop renewable substitutes (Daly, 1977).

Renewable and many abiotic resources alternatively serve as the structural building blocks of ecosystems, which in turn generate ecosystem services[2] essential for the survival of humans and other species. The depletion or re-configuration of resource stocks together with accumulating waste emissions threatens non-linear and potentially catastrophic change to global ecosystems (Farley, 2008; Limburg et al., 2002; Muradian, 2001). These problems can be lumped together as unsustainable throughput, where throughput is defined as the extraction of raw material and energy from the ecosystem, its conversion into economic products, and its return to the ecosystem as waste (Daly, 1990, 1996).

A second serious problem concerns the distribution of wealth and income. While individuals deserve a fair return from their own labor and fairly acquired capital, resources provided by nature or society as a whole should be a shared inheritance of all citizens. Unfortunately, a small minority too often captures or exploits these common assets

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[1] Most readers of this journal will be familiar with the problems of unsustainable resource use, unjust distribution, and inefficient allocation, as well as the problems with non-excludable and non-rival resources. This article strives to strike a balance between boring the ecological economists and informing the law-makers and political activists who we hope will read it. Many ecological economists may choose to skim or skip Section 2. For those who in contrast would like more detail on these topics, please visit http://www.uvm.edu/~gflo/VCAT.

[2] We define ecosystem services as benefits to human society generated by a particular configuration of ecosystem structure (i.e. the material building blocks of ecosystems, such as plants, animals, water and minerals) that do not require the physical transformation of the structure, are made available at a certain rate over time, and cannot be stockpiled for later use. This is distinct from ecosystem goods, which are physically transformed into economic products, can be harvested at a rate that humans choose, and can be stockpiled (Daly and Farley, 2010; Farley and Costanza, 2010).

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(Barnes, 2006; Bollier, 2002; Gaffney, 2009). The poor suffer from inadequate access to resources required to meet their basic needs and disproportionate exposure to life-threatening pollutants, while the consumption patterns of the wealthiest individuals contribute disproportionately to unsustainable throughput (Martinez Alier, 2003). Inequality contributes to a variety of health and social ills, ranging from obesity and homicide rates to loss of trust (Wilkinson and Pickett, 2009). Pronounced inequality may also increase throughput, as lower socioeconomic groups try to increase their status by attempting to keep pace with consumption standards of wealthier ones (Frank, 1999; Levine et al., 2010).

A third serious problem is the inefficient[3] allocation of scarce resources towards unmet human needs. The dominant institutions for resource allocation are currently competitive markets (the private sector) and government (the public sector). It is widely recognized that markets fail to function when resources are non-excludable (i.e. anyone who wants can use the resource without paying), and are inefficient when resources are non-rival (i.e. use by one person does not leave less for others) (Samuelson, 1954; Sandler, 1998). Many natural resources and ecosystem services are non-rival and/or non-excludable (Farnsworth et al., 1983; Sandler, 1993), while information is actually anti-rival in that it improves through use (Kubiszewski et al., 2010; Lessig, 2004; Weber, 2004). Furthermore, market prices fail to reflect the value of natural resources to future generations (Bromley, 1989; Georgescu-Roegen, 1975). While governments have no automatic mechanism for balancing marginal costs and marginal benefits, they account for many costs and benefits that markets ignore.

Current trends suggest that neither markets nor government are adequate for achieving the sustainable, just and efficient use of resources. A promising institution designed to address this problem is the common assets trust (CAT)—a third sector to complement the roles of the private and public sectors. A trust is a legal relationship between trustees, who manage a pool of wealth, and beneficiaries, for whom the wealth is managed. The commons, an ancient concept that can be traced back at least to the Greeks and Romans, refers either to those resources that *are* commonly owned, or those resources that for reasons of justice, sustainability or efficiency *should be* commonly owned (Bollier, 2002; Raffensperger et al., 2009; Wood, 2014). A CAT is a legal entity with explicit obligations to protect, manage and create common assets for the common good of present and future generations (Barnes, 2006; Barnes et al., 2008).

Vermont State House Bill 385, identical to the 2007 State Senate Bill 44 and following the guidelines laid out by Barnes (2006), proposes the creation of a Vermont Common Assets Trust (VCAT) that would make certain resources the common property of all Vermonters. This idea was first proposed in 2005 by co-author and Gund Institute researcher Gary Flomenhoft as the Vermont Permanent Fund. In 2007 the idea was developed into a bill by State Senator Hinda Miller working with co-author and Gund Director Robert Costanza. The authors of this article were consulted in the writing of the bill and continue to research and analyze the VCAT. The bill "proposes to make it clear that state policy is to protect certain common assets (such as air and water) for the benefit of present and future generations, and to establish a framework pursuant to which certain users of those common assets may be assessed fees that would be deposited into a common assets trust fund, which would be managed so as to protect those assets and serve the interests of present and future people of the state" (Vermont House Bill 385, 2011, p. 1). State representative Chris Pearson reintroduced the bill in 2011, and again in 2012 together with representatives Deen, Edwards, Klein, Masland, Partridge, Ram, Sharpe, Weston and Wizowaty. The bill has so far failed to progress beyond committee (the fate of most bills). However, the effort to promote VCAT likely facilitated the passage of a separate law in 2008 that for the first time extends the Public Trust Doctrine, which is the legal basis for a CAT, to groundwater.

As no states have yet developed such a comprehensive common assets trust (CAT), Vermont's legislators have little information to guide their votes on this bill

This article presents the initial results from research intended to provide the background information necessary for Vermont's citizens and legislators, and the citizens and legislators of other states or countries that may want to consider such legislation, to make informed decisions about a CAT. Sections 2 and 3 explain why the existing private and public sectors are unlikely to achieve sustainable, just and efficient solutions to society's pressing problems described above; Section 4 describes how VCAT could do so, how resources should be incorporated into VCAT, how VCAT should manage them, and how much revenue they might generate; Section 5 explains how a CAT increases the effectiveness and enforceability of the economic incentives it uses, and how it conforms to the design principles for managing common pool resources laid out by Elinor Ostrom (2002). Finally, Section 6 offers a brief summary and conclusions.

2. Private Sector Failures

Markets based on private property rights are the dominant form of resource allocation in the much of the world, often trusted to solve society's most pressing problems. In order to develop more effective institutions, we must understand how markets generate sustainable, just and efficient outcomes in theory, and why they often fail to do so in practice.

2.1. The Private Sector and Sustainability

Market prices theoretically reflect resource scarcity. Rising prices reduce demand, and provide incentives to use resources more efficiently, develop substitutes, or discover new sources, ensuring we will never run out. Most economists saw the downward trend in major commodity prices throughout the 20th century as evidence that technology could substitute for growing resource scarcity (Barnett and Morse, 1963; Simpson et al., 2005).

However, it is also possible to meet current demand by more rapidly extracting natural resource stocks, even though this reduces the capacity of ecosystems to regenerate raw materials and provide essential ecosystem services in the future (Wackernagel et al., 2002). New technologies and increased energy use can reduce extraction costs even as resources become scarcer, temporarily masking stock depletion while simultaneously speeding it up. Many substitutes for scarce resources, such as industrial nitrogen for natural nitrogen fixation and mined phosphorous, also rely on rapidly depleting supplies of fossil fuels (Ayres et al., 2013; Cleveland, 1991). Eventually, growing scarcity of resource stocks must dominate these other factors. For example, in spite of new technologies such as hydraulic fracturing, the supply of oil has increased by only 7% over the last ten years as market prices have increased by 130% (British Petroleum, 2012), and these figures ignore the greater energy inputs required to extract increasingly lower quality and less accessible oil deposits (Cleveland et al., 1984; Hall et al., 2014). Since 2000, resource prices have risen rapidly (Grantham, 2011).

Furthermore, the price signal fails for non-marketed ecosystem goods and services. Unregulated markets therefore systematically favor the conversion of ecosystem structure into market products over its conservation to provide un-priced ecosystem services, regardless of the relative contributions of the two to human welfare. Most economists are optimistic that simple policies can force markets to account for these non-market resources and ensure their continued provision (Simpson et al., 2005). Since these policies require government intervention, we explain them below in our discussion of the public sector.

[3] An allocation is efficient when it maximizes the ratio of benefits to costs. Defining benefits and costs is therefore essential. The benefit of economic activity is the shared well-being of this and future generations, while costs must include ecological degradation.

2.2. The Private Sector and Just Distribution in Theory and Practice

The cost share theorem in conventional economics states that markets reward factors of production such as labor, capital and natural resources according to their marginal contribution to market value.[4] This would ensure a just distribution of income only if the initial distribution of capital and natural resources were just. Market forces on a finite planet however will systematically exacerbate injustice resulting from unequal initial distributions or from stochastic events through the private capture of economic rent, or unearned income.

The classic example of rent creation is from land, a gift of nature with zero cost of production and fixed supply. The price of land is determined by the income stream it generates, and increases with its productive capacity or with the value of what it produces (Gaffney, 2009). New technologies that increase agricultural output per hectare[5] or increased demand for output from population growth or biofuels will increase prices for agricultural land, while new technologies for capturing wind or solar energy will drive up the price of windy or sunny land. In fact, since land is a required substrate for virtually all production, economic growth and technological improvements in general will drive up land prices (Gaffney, 2009).

In general, when the supply of a resource is inelastic, a small increase in demand leads to a large increase in price. When demand for a resource is inelastic—which is the case for essential and largely non-substitutable resources such as land, food, energy, or important minerals—a small percentage decrease in supply will lead to a large increase in price. Exxon for example earned a record $46 billion in corporate profits when oil prices soared in 2008 (Romero and Andrews, 2006). Therefore, when resource productivity or demand increases or when resource supply decreases, those who own the resources—typically the wealthiest fraction of society—will become dramatically wealthier. In the face of increasing demand, decreasing supply or output enhancing technologies, markets systematically exacerbate existing income inequalities.

2.3. The Private Sector and Efficient Allocation

Markets prices theoretically allocate resources towards the products that add the most monetary value then ration those products to the consumers who value them the most (as measured by willingness to pay), ensuring efficient allocation. This holds true however only for excludable resources that can be bought and sold in markets and that generate no externalities. As previously mentioned, many ecosystem goods and services are non-excludable, so markets ignore the costs of their degradation. Markets are also inefficient for non-rival resources (i.e. use by one person does not leave less for others), particularly for green technologies that may be essential for overcoming serious environmental problems. For example, if a clean, carbon free energy technology is patented, it can be sold at a very high price. Those who cannot afford royalties may continue to burn coal instead. The economic surplus from existing information is paradoxically maximized at a price of zero, at which price markets will not supply it (Kubiszewski et al., 2010).

Perhaps most important, market efficiency is narrowly defined by the satisfaction of subjective individual preferences. The market mechanism weights preferences by purchasing power, awarding resources to those willing to pay the most even if additional use contributes little to physiological needs (i.e. the conditions for sustaining life) or happiness. It is difficult to objectively assess happiness, but not physiological needs. When food prices skyrocketed in 2007–2008, the countries consuming the fewest calories per capita saw the greatest decline in consumption, while those consuming the most saw no significant change (Farley et al., in press). We expect that most readers of this article did not decrease their consumption of bread at all in response to the price of wheat tripling, even as the same price signal contributed to malnutrition, rioting and political disruption in poorer countries (Arezki and Brueckner, 2014; Berazneva and Lee, 2013). In short, markets frequently allocate essential resources towards those whose physiological benefit from additional consumption is the lowest. Integrating ecological costs into the market prices of essential resources such as food without first addressing income inequality would cause similar hardship for the poor (Farley et al., in press). The more equal the initial distribution of resources, the more likely that market price rationing will maximize human welfare in addition to monetary values.

3. Public Sector Solutions and Failures

The public sector (or a commons sector, once created) has several options for addressing the market shortcomings described. One is explicit regulations that require compliance with inflexible rules. For example, the government can limit the amount of pollution that individual firms are allowed to emit, impose limits on resource harvests (e.g. a daily catch limit or a seasonal limit on fisheries), or demand that firms use a specific technology.

However, most economists argue that the lack of flexibility is inefficient and creates little incentive to innovate. They prefer instead market-like mechanisms that allow firms to respond to price signals (Pearce and Turner, 1990). We briefly describe two approaches here that can address the problem of non-excludable resources: taxation and marketable property rights. Both approaches require the public sector to make decisions concerning sustainability and distribution before the price mechanism can function.

Imposing a tax on an undesired activity such as waste emissions or resource extraction cost effectively reduces the activity (ideally to sustainable levels) and compensates society for harm done. One potential drawback is that the level of pollution is determined by price, rather than the ecosystem's capacity to absorb waste, even though prices can adjust to ecological constraints more rapidly than ecosystems can respond to price signals (Daly and Cobb, 1994).

Taxes can also be used to address income inequality and to improve efficiency. As discussed above, rent is defined as unearned income (i.e. revenue above and beyond what is required to bring a resource to market). Rent therefore includes the return on land and other natural resources. Rent does not include fair returns to improvements to land or to the labor and capital necessary to extract resources. The social capture of rent at worst does not affect market efficiency, and at best improves it. For example, a high tax on land designed to capture rent forces landowners to put land into its most productive use in order to pay the tax. This leads to denser development of urban land, reducing urban sprawl and its associated costs: infrastructure, pollution and destruction of green space. High land taxes do not affect the supply of land, but dramatically reduce land speculation and the economic instability it causes. Virtually all assets created by nature and society as a whole generate rent, and most of this is currently captured by the private sector. Revenue from taxing rent could replace taxes on productive activities (Cobb, in press; Gaffney, 2009).

Another option is to create marketable property rights—public or private—to natural resource stocks and waste absorption capacity (Coase, 1960; Demsetz, 1967; Smith, 1981).[6] With cap and trade schemes, governments or some other collective institution establishes quotas on

[4] Ayres et al. (2013) actually show that the cost share theorem does not hold when some resources are essential and non-substitutable, such as energy.

[5] Paradoxically, because there is a very inelastic demand for food, a new technology that increased global food production could drive down the total value of food, hence the income stream from land and the price of land. However, given that food can be converted to biofuels, this outcome is highly unlikely in today's world.

[6] Ironically, while Coase is generally given credit for the idea of creating private property rights as a means to solve the problem of externalities and open access resources, he believed that this approach was only appropriate when transaction costs were minimal, which they rarely are. In his own words: "[t]he world of zero transaction costs has often been described as a Coasian world. Nothing could be further from the truth. It is the world of modern economic theory, one which I was hoping to persuade the economists to leave." (Coase, 1988, p. 174).

total resource use, ideally at or below the renewal rate of the resource, decides on the distribution of permits entitling owners to a share of the quota, then allows trading of permits in markets. This has been done successfully for sulfur dioxide and nitrogen emissions[7] in the US (Napolitano et al., 2007) and for fisheries in many countries (Costello et al., 2008; Macinko and Bromley, 2004), and is the basic mechanism behind the Kyoto protocol. When permits are distributed to current users (i.e. polluters and harvesters), those users capture the resulting rent. For example, the European Union Emission Trading Scheme (EU-ETS) initially awarded emission allowances to polluting firms, generating an estimated €19 billion in annual rent for the electricity sector alone (Keppler and Cruciani, 2008).

An alternative is to auction emission allowances or harvest permits at frequent intervals (Woerdman et al., 2008) while enforcing anti-trust rules and eliminating re-sale to reduce the potential for speculation and private capture of rent. Vermont for example is a member of the regional greenhouse gas initiative (RGGI), a 10 state cap and trade scheme for carbon emissions from the electricity sector, and auctions off 99% of its quota (RGGI Inc., 2011). With cap and auction, the public sector captures rent.

Though ecosystem services such as climate regulation and protection from UV radiation cannot be made excludable, all ecosystem services are generated by a particular configuration of ecosystem structure. It is generally possible to make the ecosystem structure and waste absorption capacity excludable, though this will frequently require international agreements and enforcement. Private property rights to ecosystem structure however can lead to perverse outcomes. For example, individuals would be unwilling to convert a wetland to farmland or aquaculture in the absence of private property rights because the resulting output would be open access. With property rights, individuals convert wetlands even when the value to society of the wetland's public good services exceeds the private benefits of conversion. In this case, private property may be even worse than no property rights (Adger and Luttrell, 2000; Farley et al., 2010).

Private property rights may also prove worse than no property rights in the case of information, and especially for information that can help provide or protect public goods, such as green technologies as previously mentioned. The public or commons sector should invest in the research, development and dissemination of technologies that promote the public good and make them freely available to all (i.e. open access) for at least three reasons. First, the private sector has little incentive to invest in providing public goods. Second, patents currently increase the cost of developing new technologies; for example, each new medical technology infringes on average upon dozens of existing patents (Heller and Eisenberg, 1998). Third, using patents to ration access to new technologies reduces use and hence benefits, without reducing costs. Many economists argue that patents are required to incentivize the creation of knowledge, but collectively funded scientists would presumably work at least as hard as their corporately funded counterparts. Rather than the monopolistic pricing associated with patents, firms could compete based on their ability to minimize production costs and maximize quality (Farley and Perkins, 2013; Kubiszewski et al., 2010).

Unfortunately, the public sector has largely failed to implement these policies, has implemented them poorly, or has weakened them where they have been implemented in the past. One reason is that governments are heavily influenced by the private sector, which lobbies vigorously against policies that could affect their profits. For example, the mining industry in the US has successfully lobbied to retain an 1872 mining bill that allows them to purchase federal land for dollars an acre and exempts them from royalties (Snyder, 2007). In the EU, businesses pressured policy makers for the EU-ETS to issue emission allowances in excess of actual emissions (Alberola et al., 2008; Porto, 2010).[8]

In the US, taxes on rent, resource extraction and pollution are negligible and declining. Vermont for example has no severance taxes. The inflation adjusted federal gas tax has declined steadily since 1994. Taxes on unearned income have also declined, and are currently much lower than taxes on earned income (Hudson, 2012). The federal government has virtually stopped collecting royalties on offshore oil (Andrews, 2007) and instead subsidizes the fossil fuel industry for billions of dollars a year (Kocieniewski, 2010). Since 1980, Public law 516–517 (commonly known as the Bayh–Dole act) the private sector has been allowed to patent the results of government-financed research.

Wealth and income inequality is rapidly increasing around the world (Picketty, 2014) including in the state of Vermont (Bernstein et al., 2008) and has reached record levels in US as a whole (Saez, 2013). Recent rulings in the US supreme court have struck down many limits on campaign spending. The likely result is increased subservience of the public sector to big private sector money.

In short, in spite of their many positive features, both markets and government are failing to solve the problems of central concern to society.

4. The Promise of the Commons

The commons refers to resources collectively owned by all and managed by mutual agreement. The movement to distinguish common property from public property arises from the role of the state in turning public property over to the private sector with little or no compensation. For example, in the US 98% of broadcast spectrum has been given away for free to media companies, and only 2% auctioned. There are many different ways to manage common property resources. This article focuses largely on the institution of a Common Assets Trust (CAT) and specifically on the Vermont Common Assets Trust (VCAT). A CAT is uniquely suited to address the most serious societal challenges we face. It can impose limits on throughput, internalize externalities, and ensure that benefits created by nature and society as a whole are fairly distributed. It can also invest in the technologies that must contribute to solving pressing societal problems.

A commons sector in general and a CAT in particular complement the private and public sectors rather than replacing them. In many ways it fulfills the role that the public sector should fulfill if it were not so subject to private sector influence, but goes even further by creating legally binding inalienable rights to common assets for this and future generations. The public sector must create a CAT, but this requires only a brief window of opportunity in which politicians are willing to place the common good ahead of private interests (Barnes, 2006). Once a CAT exists, it will be difficult to destroy in a democratic society, as voters would correctly perceive its loss as taking away their property rights. This section will explain what assets should be included in a CAT, how they should be included, and how their inclusion can address the major societal problems outlined above.

It is first necessary however to dispel some misconceptions about the commons. Hardin used the phrase ‘tragedy of the commons’ to describe the over-exploitation of non-excludable but rival resources (Hardin, 1968), and proposed as a solution “mutual coercion, mutually agreed upon” (p. 1247). At the same time, many economists have called for expansion of private property rights to address the tragedy (Anderson, 2004; Coase, 1960). However, the phrase ‘tragedy of the commons’ is a misnomer. The tragedy results from the lack of ownership, and not from common ownership, which allows a community to effectively exclude outsiders (Bromley, 1991; Ciracy-Wantrup and Bishop, 1975). Resources that are owned in common can be effectively managed through

[7] The renewal rate in the case of pollutants is waste absorption capacity, i.e. pollutants should be emitted no faster than ecosystems can absorb them. Limits on nitrogen emissions far exceed absorption capacity.

[8] To be fair, the initial stage of the EU-ETS was meant to build the necessary infrastructure, and not necessarily to reduce emissions (Ellerman and Joskow, 2008), but emissions allowances also frequently exceeded emissions during the second stage.

decentralized collective institutions that assure cooperative compliance with established rules (Feeny et al., 1990; Berkes, ed. 1989; Ostrom, 1990), to be discussed in Section 5.

Common ownership through a CAT can avoid the tragedy of open access resources and also overcome the numerous other market failures described above.

4.1. What Resources Should Be Included in VCAT?

The VCAT bill is the first comprehensive CAT legislation that we are aware of and no agreed upon methods exist for determining which assets should be included in the trust or how they should be included. The bill explicitly calls for including "natural assets such as undisturbed habitats, entire ecosystems, biological diversity, waste absorption capacity, nutrient cycling, flood control, pollination, raw materials, fresh water replenishment systems, soil formation systems, and the global atmosphere; and also… social assets such as the internet, our legal and political systems, universities, libraries, accounting procedures, science and technology, transportation infrastructure, the radio spectrum, and city parks" (Vermont House Bill 385, 2011, p. 4). The bill also suggests some specific guidelines. First, the bill seeks to protect common assets for the benefit of present and future generations, and states that "inalienable rights of all humans logically should include rights of access to common assets essential for life" (p. 3), suggesting sustainability should be one criterion for inclusion. Second, the bill identifies assets that were "inherited or created together" (p. 3), implying that justice is a second criterion. Though not directly mentioned in the bill, efficiency is a logical third criterion. When a CAT can be expected to generate 1) more monetary value or 2) greater social welfare from a resource than private or state property rights (Farley, 2010), the resource or the rent it generates should be included.

The concepts of rivalry and excludability are helpful for determining what resources should be included, and how to include them.

4.1.1. Rival but Currently Non-excludable Resources

Creating common property rights to open access resources is fairly straightforward, as it does not take away existing property rights. The most relevant open access resources in Vermont are waste absorption capacity (e.g. for CO_2, nitrogen, phosphate, and other pollutants) and water. The VCAT would be legally required to eventually cap waste emissions at or below waste absorption capacity. In the short run, this might not be possible for the absorption capacity for CO_2, phosphorous, or other emissions generated by activities that provide essential and non-substitutable benefits. Global CO_2 emissions for example need to be reduced by at least 80% to prevent atmospheric concentrations from increasing to dangerous levels (IPCC, 2007), but such dramatic reductions in the short run could threaten economic collapse. An ecological threshold conflicts with an economic threshold. Achieving 80% reductions without economic collapse will require dramatic structural changes in the economy, efficiency improvements and alternative energy sources, but such changes take time. A CAT would therefore need to gradually reduce emissions to sustainable levels, ideally while contributing to the development of new technologies (Kirk, 2010). While reducing Vermont's CO_2 emissions alone would have negligible impact on global warming, responsibility for governing common resources must be built up in nested tiers from the lowest level to the entire interconnected system (Ostrom, 2002).

There is an ongoing debate whether a cap and trade scheme or taxation is the best way for a government or commons sector to manage currently non-excludable, rival resources (Hansen et al., 2008; Kahn and Franceschi, 2006). As Herman Daly has pointed out, with a cap, throughput limits are price determining, and with taxes, prices determine throughput (Daly and Cobb, 1994). Following the definitions provided by Calabresi and Melamed (1972) as well as Bromley (1978) the VCAT would give future generations an inalienable entitlement to essential resources and a healthy environment. Taxes in contrast impose a liability rule; the polluter is allowed to cause harm in exchange for payment (Bromley, 1978), but there is no guarantee that the level of harm will honor the inalienable entitlements of the future. Cap and trade, based on property rules, can limit resource use to regeneration capacity and waste emissions to absorption capacity while respecting the entitlements of future generations. Since the CAT awards property rights to all citizens, a cap and auction scheme is required. Frequent auctions with no subsequent trading both captures rent and avoids speculation (Barnes, 2006; Boyce and Riddle, 2007; Daly and Farley, 2010).

4.1.2. Non-rival Resources

All non-rival resources are also candidates for inclusion in VCAT, since price rationing reduces their value and market forces are unlikely to provide them without price rationing. Non-rival resources should be open access and hence require collective investment and protection (Daly and Farley, 2010; Kubiszewski et al., 2010). Two categories of non-rival resources merit attention: ecosystem services, which are primarily public goods, and information, which can be privately owned.

Many ecosystem services such as habitat for biological diversity, flood control, and pollination are both non-rival and non-excludable and hence require collective provision and protection (Farley and Costanza, 2010). However, they are generated by a particular configuration of ecosystem structure, much of which is privately owned. While arguably these private assets are a common inheritance of all Vermonters, most private owners purchased them under rules that allow management for private benefits. In this case, justice may demand that landowners be compensated for managing their resources for the public good, for example through a payment for ecosystem services (PES) scheme (Muradian et al., 2010). Vermont's Use Value Appraisal law already gives tax breaks to landowners who manage their land for forestry, agriculture, or ecosystem services, which generate more public good benefits than development, but in some cases, additional compensation may be appropriate (Kemkes, 2008; Massanari, 2007).

New technologies will almost certainly be necessary (though far from sufficient) to reduce throughput to sustainable levels without provoking economic collapse. The VCAT should invest in technologies that help reduce throughput, such as low carbon energy alternatives and efficiency improvements and make them open source to maximize their value.[9]

4.1.3. Rival and Excludable Resources

The remaining category, rival and excludable natural and social resources, includes what are conventionally considered market goods: land, timber, water (where laws regulate access), minerals, airwaves, and so on.[10] Most of these resources are gifts of nature, "created or inherited together" and/or "common assets essential to life", and hence remain potential candidates for inclusion in a CAT.

When the state is the legal owner of these resources, but returns from the resource are being inequitably distributed among Vermont's citizens, then property rights should be directly transferred to the commons. For example, though water is a public trust in Vermont, the government currently allows water bottlers to extract it free of charge even though there is inadequate information to determine if excessive extraction causes ecological harm or economic shortages (Kelly, 2013). A VCAT would ensure that water was allocated towards basic needs and healthy ecosystems before auctioning off or taxing any surplus used for commercial purposes. Airwaves and state lands, including their mineral wealth, should also be managed as common assets. If the state has

[9] One possibility would be to make information created by the VCAT open access only for residents of Vermont, including all businesses, which in turn would be required to make any improvements on this knowledge open access as well. This could attract green businesses and entrepreneurs to Vermont, potentially creating a 'green valley' to rival California's silicon valley, but would reduce total environmental benefits compared to open access information.

[10] Fossil fuels, extremely important rival assets, are not found in Vermont in any significant quantities, but are highly relevant to CATs in other states or at the national level.

given assets to the private sector for free or sold them for less than full value, they should be restored to the commons, if legally possible. Airwaves frequently fall into this category,

When the resource is privately owned but generates rent, the commons sector can be assigned the right to tax away that rent for the common good while leaving the asset itself in private ownership. Land is the classic example of a rent-generating resource, as its inherent value is created by nature and society as a whole. Unfortunately, much of the rent from land was captured by previous owners—for example, speculators who profited from real estate bubbles—and is therefore difficult to regain. To be fair to current owners, it would be best to shift taxes from value added (i.e. buildings) to the land itself then gradually increase the tax on land over time, or impose 100% taxes on increases in land prices independent from owner improvements. Such taxes would eliminate the speculative demand for land and prevent future real estate bubbles, stabilizing the economy. Severance taxes on natural resource extraction are another way to capture rent. Gaffney (2009) provides an excellent list of additional assets that generate rent. Economists almost universally recognize that capturing rent does not create the economic distortions that other taxes can cause because it does not affect supply.

4.2. How Much Revenue Could Be Captured?

How much revenue can be captured by a VCAT depends on how many different assets it manages, and how they are managed. Gaffney (2009) shows how simply capturing the rent from land through land value taxes could easily fund government. In the short term however, probably the two assets with the greatest immediate potential to become part of the VCAT are groundwater and waste absorption capacity for CO_2, phosphorous and nitrogen. There is widespread support in Vermont for making these resources common assets. A 2010 poll found that 95.2% of Vermonters believe that "Vermont's atmosphere is a resource that belongs to all Vermonters equally", and 82.5% believe that "individuals or companies should be charged money if they pollute the atmosphere" (Kirk, 2010). A 2011 survey found that 82% of Vermonters favor charges for water extraction, and 93% favor charges for water pollution (Kelly, 2013).

In 2009, bottling companies extracted about 33 million gallons of groundwater from Vermont. The proposed $0.28 per gallon tax could potentially generate just over $9 million in annual revenue, assuming that it did not lead to a decrease in production. In theory collecting rent has no impact on supply, but if bottler and retailers currently collect most of the rent and could source water from other states that do not tax rent, the Vermont industry could shut down. In any event, other commercial water uses overwhelm bottled water. The state currently charges municipal water systems $.0000359/gal for groundwater extraction. Simply applying this fee to commercial, industrial and agriculture users as well would generate $668,278 annually from the 51 million gallons per day extracted. Increasing this charge by a factor of 10 would increase household water costs by only about $.80 per month (Kelly, 2013).

The capture of revenue from carbon emissions is far more difficult to estimate though potentially far larger. The demand for fossil fuels and hence the demand for emissions from fossil fuel combustion is highly inelastic, meaning that a small reduction in quantity leads to a large change in price, though it is very difficult to say by how much. Estimates of short run price elasticity of demand (E_d) average about 0.23 (Stern, 2006), with considerable variation depending on use. This means that a 1% increase in price would decrease demand by 0.23%, or that a 1% decrease in supply would increase price by 4.3%. E_d increases in the long run, as consumers have time to adapt, with estimates ranging from .4 for gasoline to .7 for electricity (Carbon Tax Center, 2011). However, as caps grow tighter, people would have to forego increasingly important uses of fossil fuel, which would lead to increasingly inelastic demand and higher prices (Kirk, 2010). For example, a 9% decrease in supply in US between 1978 and 1980 induced a 108% price increase, suggesting an E_d of ~.08 (British Petroleum, 2012). Predictably higher prices on the other hand may lead to more rapid technological advances and societal adaptations that increase long run elasticity. Large price increases in the past have caused serious economic problems, but these transferred income from oil consumers to oil producers. In the case of the VCAT, all income would remain in the state, and could be targeted towards solving any problems that arise. The major impact would be a shift towards less energy intensive consumption and production.

In 2002 Vermont's Governor Howard Dean issued an Executive Order establishing goals for GHG emission reductions of 25% below 1990 levels by 2012, 50% by 2028 and 75% by 2050. Vermont has missed the 2012 target, and to achieve the 2028 target would require emission reductions of approximately 4.3% per year from 2013 levels.[11] Assuming an elasticity of demand for CO_2 emissions of about 0.23 (Stern, 2006), a roughly $19 per barrel tax would reduce oil consumption by 4.3%. Since a barrel of oil contains approximately .42 tons of CO_2 (Ferguson et al., 2009), this corresponds to a carbon permit auction price of roughly $44/tCO_2, which would generate revenues in the first year of approximately $332 million.[12] Price inelastic demand means that revenues would increase in future years as the number of permits declined. Since a large share of Vermont's emissions come from gasoline and a negligible share from electricity, we conservatively assume a long run elasticity of 0.4 (Carbon Tax Center, 2011), which means that in 2028, oil prices would have to increase by 108%, carbon permit prices would sell for $108 ton, and revenue would be on the order of $430 million per year. [13]

However, according to the IPCC, reductions of 75% in the developed nations by 2050 still pose a high risk of catastrophic climate change (defined as greater than 2 °C) (IPCC, 2013). To keep atmospheric carbon concentrations and hence the severity of climate change from increasing indefinitely, global society must reduce emissions by at least 80%, and global equity considerations would demand that Vermont reduce emissions by much more. How quickly we can achieve this will determine the final atmospheric concentration and the risk of catastrophic change. Hansen et al. (2008) argue that we should aim for 350 parts per million (ppm) atmospheric CO_2, less than current levels, which would require even more rapid reductions. Legal obligations to future generations would force the VCAT to undertake sharper reductions than those proposed by Governor Dean, hence generating greater revenue, unless costs to current society proved catastrophic. Such costs depend extensively on the development and adoption of new technologies and new infrastructure, and hence on the expenditure of VCAT revenue, as will be discussed below.

Three initial estimates of potential revenue capture from the incorporation of other assets into the VCAT bear mentioning. The auction value of broadcast airwaves in Vermont is estimated at $375 million per year while the annual increase in land values is estimated at $330 million. A 0.25% tax on financial transactions could generate $269 million (Flomenhoft and Baehr, 2008). To put these numbers in context, Vermont collected about $1.16 billion in taxes in 2013 (O'Sullivan et al., 2014).

[11] Vermont emissions were about 8 million metric tons (MMT) in 1990, 8.11 MMT in 2011 and an estimated 8 MMT for 2012 (ANR). Our calculations assume that emissions fell an additional 0.1 MMT in 2013, reaching 7.89 MMT.

[12] The equation for price elasticity of demand is $E_d = (\Delta Q / Q)/(\Delta P / P)$, hence $\Delta P = P(\Delta Q / Q) / E_d$. If $\Delta Q / Q = -4.3\%$, $E_d = .23$, and the price of oil is about ~$100 barrel, then $\Delta P =$ ~$19/barrel. ($19/barrel) / (.42 tCO_2/barrel) = $44/tCO_2. A 4.3% reduction in emissions from 7.89 MMT = $44 / tCO_2 * 7.87 MMT = ~$332 million.

[13] Estimates of long run $E_d = .4$ for gasoline are point estimates based on current consumption and small reductions. Furthermore, the steady decrease in supply would mean that the short run elasticity estimates would apply to recent reductions, and the long run estimates only to earlier reductions. On the other hand, alternative energy costs are falling rapidly. Any estimate of E_d for large reductions over long time periods is little better than a guess. Nordhaus (2007) estimates that we would require a global tax of ~$500/tC, or about $136/tCO_2 to achieve a similar level of reduction.

4.3. How Should Revenue Be Spent? Dividends or Investments

An ongoing debate among proponents of CATs and carbon cap and auction systems is whether the revenue should be invested by the VCAT trustees for the common good, or distributed equally as a dividend to all citizens (Barnes and McKibben, 2009; Boyce and Riddle, 2007; Costanza and Farley, 2009; Kirk, 2010). If the central purpose of the VCAT is to promote ecological sustainability and just distribution then these options should be evaluated according to those criteria. Political feasibility is also important. The VCAT bill currently mandates that 25% of revenue be returned as a dividend.

If VCAT takes inalienable property rights seriously, and reducing pollution to sustainable levels in the short run has unacceptable costs, then investment may be necessary. Investing VCAT revenue in developing and adopting green technologies could dramatically speed up the emissions reduction process. Currently, efficiency measures in the power sector in Vermont currently cost about $0.04/kW h, compared with a retail electricity price over $0.13/kW h (Efficiency Vermont, 2015). One influential report estimates that by 2030 it would be possible to reduce global emissions 58% over the business as usual scenario, corresponding to a 38% reduction over current emissions, at a net savings (Naucler and Enkvist, 2009). However, the private sector has perversely failed to take advantage of such savings. Reinvesting the revenue from carbon auctions into energy efficiency measures in the power sector may have five to seven times greater impact on reducing carbon emissions than the price signal alone (Cowart, 2008). The private sector has not eliminated negative-cost carbon emissions presumably because it would require significant up-front investments (Naucler and Enkvist, 2009). VCAT revenue could help finance these activities. Also, as discussed above, both the public and private sector currently fail to invest adequate resources in green technologies, and when the private sector does so, it creates artificial scarcity through price rationing. Recycling VCAT revenue back into RD&D for open source green technologies could increase the long run price elasticity of emissions and thus reduce costs for any given level of reductions. This would allow a rapid increase in reductions (i.e. a tightening of caps or an increase in taxes) without causing unacceptable economic hardships. Vermont currently auctions off 99% of its RGGI permits and invests 98% of the proceeds in energy efficiency (RGGI Inc., 2011).

In distinct contrast, a dividend would likely be spent on increased consumption. An estimated 65% of Vermonters' consumption expenditures are spent on goods and services from out of state (Hoffer and Kahler, 2000), where there may be no restrictions on throughput. A cap and dividend therefore is likely to reduce emissions by much less than a cap and invest approach.

However, if the goal of the VCAT is primarily just distribution, then a cap and dividend may be more appropriate. While the rich clearly spend absolutely more on most types of throughput than the poor, the poor spend a far higher percentage of their incomes on throughput. Financing investments in the common good using VCAT revenue would be similar to financing them with a regressive income tax. In contrast, a cap and dividend scheme would systematically redistribute wealth from the upper income brackets to the lower ones. At the national level, one study found that a cap and dividend policy for carbon would redistribute wealth from the wealthiest 40% to the poorest 60% (Boyce and Riddle, 2007).

The distributional impacts have led many people to favor a cap and dividend approach to carbon auctions both because it is more fair and also because it is widely considered more politically feasible, as everyone would receive a dividend payment. However, Table 1 shows the results from a 2010 statewide survey (N = 530) asking Vermonters "If individuals and companies in Vermont were charged money for polluting the atmosphere, how do you think that money should be spent?" Coupled with the fact that 98% of Vermont's RGGI revenue is currently spent on energy efficiency, a cap and investment strategy appears politically feasible.

Table 1
Results from a 2010 Vermonter Poll Survey on the allocation of VCAT revenue (Kirk, 2010).

"If individuals and companies in Vermont were charged money for polluting the atmosphere, how do you think that money should be spent?"	
Divided up and returned to each Vermonter as a payment check	5.8%
Invested into preserving natural resources like clean air and clean water for the public's benefit	64.2%
Invested into providing social wellbeing like education and healthcare for the public's benefit	14.2%
A combination of a check and investment in public benefits	15.8%

However, it is not necessary to choose between ecological sustainability and just distribution. In fact, the availability of so many negative-cost approaches to protecting the environment means that an effective cap and invest policy could potentially make the poor even better off than a cap and dividend. Preliminary results from RGGI suggest that every dollar invested in energy efficiency and renewable energy yields $3–$4 in savings; in other words, such investments are equivalent to tripling or quadrupling RGGI revenue. Households see significant savings of 15–30% on their energy bills, and thus capture much of that revenue directly (RGGI Inc., 2011). People fail to pursue these initiatives in part due to a lack of information, and acquiring information is costly. A VCAT however could make efficiency investments with positive returns the default alternative. It could pay for an audit for home owners (saving them the costs of acquiring information), offer financing at or below the estimated rate of return on efficiency investments, and move ahead with retrofits unless the homeowner actively opts out. Research in behavioral economics have shown such 'opt out' approaches to be highly effective without reducing freedom of choice (Ariely, 2008; Thaler and Sunstein, 2008). To address income distribution, interest rates and repayment schedules could be more lenient for low-income homeowners, ensuring them a dividend.

5. VCAT, Conventional Economic Incentives, and Design Principles for Common Pool Resources

Several policies suggested here for managing the VCAT, such as cap and auction schemes or taxes on rent are relatively conventional economic incentives that have been widely utilized without first establishing a CAT. Why bother then to establish a CAT? It is also worth asking the extent to which the VCAT conforms to the eight design principles for successfully managing common pool resources (i.e. rival but non-excludable resources) suggested by Elinor Ostrom and her colleagues. The answers to these questions are related.

To begin with, conventional economic incentives generally prioritize efficient allocation over sustainable scale and just distribution, while the VCAT prioritizes the latter two, as called for by many ecological economists (e.g. Daly, 1992). In addition, the VCAT creates an umbrella institution that simultaneously manages numerous resources, which otherwise require separate policies. Implementing the policies one by one is an enormous challenge that raises transaction costs. Since ecosystem functions are generated by a particular configuration of ecosystem structure, regulations or economic incentives affecting only a subset of resources is generally insufficient to maintain all desired ecosystem functions. Furthermore, explicitly turning rights to these resources over to citizens helps generate citizen support for the policy. Other advantages of VCAT over conventional incentives arise from its application of Ostrom's design principles, listed below in bold.

By declaring certain assets the shared property of all Vermonters, the community of beneficiaries has *clearly defined boundaries*, and all Vermonters will have an incentive to *monitor* their fellow citizens and ensure that no individuals takes what belongs to all. Those who do take more than their share are likely to be first rebuked by their compatriots, and if rebuke fails, reported to the law—an example of *graduated sanctions*. As Wilson et al. (2013) write, when citizens have "a sense of ownership, monitoring and graduated sanctions take place spontaneously." (p. 529). Cap and auction schemes ensure that everyone who uses common assets must pay the same price, with resulting revenue spent on the common good, while taxes on rent ensure that no one captures unearned profits from common assets; both policies ensure *proportional equivalence between benefits and costs*. Existing legal structures provide *conflict resolution mechanisms* that are widely perceived as fair. Implementation of the VCAT should pay close attention to two other principles: *collective choice arrangements* and *minimal recognition of rights to organize*, both of which relate to the unwillingness of people to accept rules imposed from above. With town meetings, accessible state government, a viable third party and very active civil society, government in Vermont exemplifies these principles, and communication between the board of trustees, town meetings and civil organizations should be built into the VCAT. However, we must also recognize that the VCAT is designed to protect the rights of future generations, which clearly cannot help formulate rules and goals. The need to respect ecological limits must therefore be non-negotiable. Finally, the VCAT explicitly proposes limits on waste emissions that cross state borders, ranging from greenhouse gasses to nitrogen runoff. *Appropriate coordination* between Vermont and the RGGI states currently exists for greenhouse gasses, but this is only one of many border-crossing pollutants. Our hope is that the VCAT can serve as a model for CATs at a larger scale, such as the global atmospheric CAT proposed by Ostrom and her colleagues (Barnes et al., 2008).

6. Summary and Conclusions

Society currently faces serious ecological and economic challenges that are not being addressed by either the public or private sector. With a legal mandate to ensure both sustainable throughput and just distribution, the VCAT could address these challenges. The VCAT would regulate access to rival resources, protect and provide non-rival resources without price rationing, naturally internalize externalities by shifting the decision unit from the individual to society, and capture rent for society as a whole (Barnes, 2006).

These results of course hinge on the VCAT's immunity from influence by the private sector and by future politicians influenced by the private sector. Short of a constitutional amendment, this may be difficult. However Social Security and Medicare are examples of institutions that may have achieved an adequate level of immunity. Alternatively, if society could implement laws that forced the public sector to fulfill VCAT's role, a common asset trust would be unnecessary (Raffensperger et al., 2009). The public trust doctrine (Wood, 2014) states that governments already have the legal and fiduciary responsibility to protect and restore common assets. A CAT can thus be seen as one possible way of implementing this responsibility in a way that minimizes transaction costs and is relatively immune from inappropriate manipulation.

There are no perfect solutions to society's most serious challenges, but the proposed CAT has enormous potential to improve the situation. Perhaps the greatest value of the VCAT is as a pilot study, that, if successful, can be replicated and expanded at different scales.

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