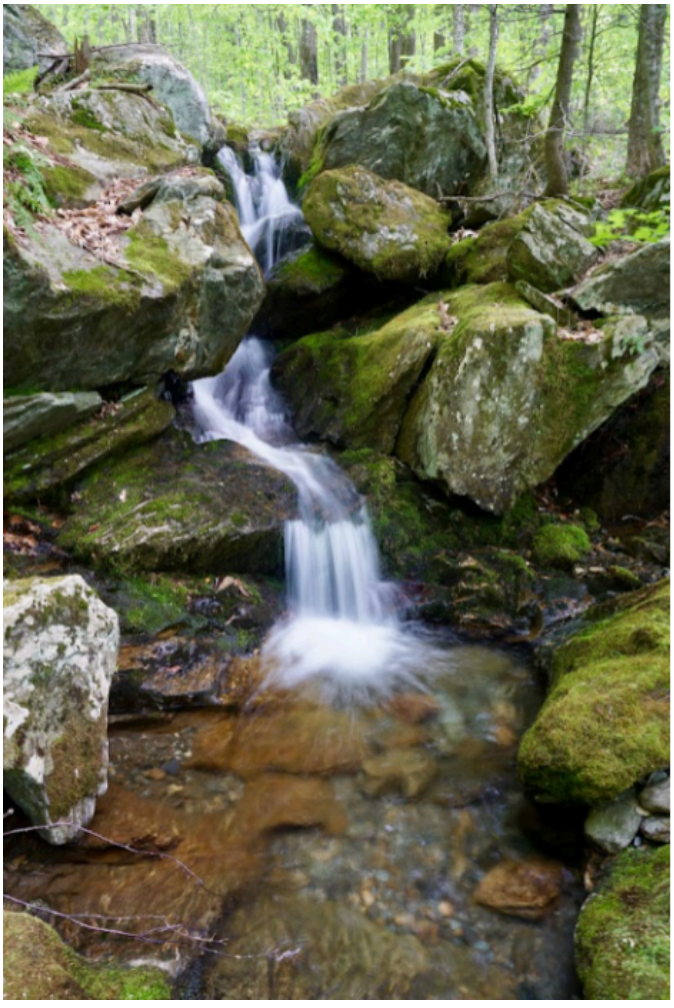
The Economic Value of Vermont's Public Conservation Lands



August 2025

Prepared for Standing Trees

Spencer Phillips, Ph.D.

KEY-LOG ECONOMICS

Research and strategy for the land community.

keylogeconomics.com

Abstract

The economic value of Vermont's public conservation lands and to whom that value accrues is important to the consideration of how those lands should be managed. While private financial gains from extractive uses like timber are often prioritized, protected conservation lands provide significant, tangible ecosystem service values (ESVs), such as flood control, water purification, climate regulation, biodiversity habitat, and recreation. The challenge is that most ESVs are not traded in formal markets.

To estimate these and other public values, we employ the Benefit Transfer Method (BTM), drawing per-hectare ESV estimates from the Ecosystem Services Valuation Database (ESVD) and applying them to Vermont's public lands, categorized by management type, land cover, and GAP status. Vermont's public conservation lands, comprising 13.3% of the state (331,268 hectares), are heavily forested and strategically distributed, connecting to 86% of the state's subwatersheds and 93% of its population.

We estimate that Vermont's Public Conservation Lands supply $2.25 billion in ecosystem services each year. The most valuable services are, in order, Recreational Opportunities, Air Quality Regulation, Climate Regulation, Existence & Bequest Value, and Moderation of Extreme Events, together accounting for over 88% of the total estimated ESV. In contrast, the value of timber from these public lands represents only about 0.13% of the other ESV. Managing these lands for their ecological integrity ensures the continued flow of substantial public values with minimal opportunity cost in terms of statewide timber production.

Table of Contents

Cover photos, clockwise from top: paddlers on Chittendon Reservoir, Green Mountain National Forest; Worcester Range skyline from Mt. Worcester, Putnam State Forest; tributary to Ridley Brook, Camel's Hump State Park. Photo credit: Zack Porter.

Public Lands and Their Public and Private Economic Value

In New England, as elsewhere, decisions regarding the management of public lands should (and where required by statute, must) consider all of the economic value, both private and public, that these lands provide. Unfortunately, the private financial benefits from extractive uses (timber harvest, mining, or conversion from natural to developed uses) are often prioritized over the restoration and maintenance of natural forest cover. Some may believe that these private benefits support local and regional economic activity in ways, or to a degree, that are more tangible — and financially valuable — than the public benefits, and that extractive uses, despite their impacts on many public benefits, are a worthwhile tradeoff.

However, public conservation lands that are protected from extractive uses provide tangible benefits to people, and – according to the estimates we present in this report – the economic value of such public benefits far exceeds that of extraction. Well-functioning natural lands can protect people and property from extreme weather events (e.g. flood control) (Underwood and Brynn 2015), purify water for drinking, irrigation, and industrial uses (FB Environmental Associates et al. 2021), increase resilience to climate change and other stressors (Thom et al. 2019), provide habitat for Vermont's full range of biodiversity (Kellett et al. 2023), contribute to local/regional, and global climate regulation (Moomaw et al. 2019), including via carbon sequestration and storage (Birdsey et al. 2023), and, in the words of the federal Wilderness Act represent "opportunities for solitude or a primitive and unconfined type of recreation" important to Vermonters and visitors alike (Wilderness Act 1964). Because people enjoy those values and indicate by their choices that they are willing to give up other things to have that value, we can say that they have *economic* values. While these "ecosystem service values" (ESVs) are quite real, they are often unaccounted for or undervalued in analyses by state and federal land managers. Thus, they are at risk of underappreciation by policymakers and the public.

Peacham Bog Natural Area & Groton State Forest. Photo credit: Zack Porter.

The challenge is that few ESVs are traded in formal markets, and they therefore do not have readily observable prices. (The advent of carbon markets provides one exception.) Neither does ESV typically show up directly in traditional economic measures, such as gross state product or county employment and income figures. It is simply more difficult to quantify the value of what the forest is doing for people by controlling floods, purifying air and water, and providing pleasant scenery for visitors or nearby residents than it is to know the market price of a sawlog. That difficulty, however, is not a reason to ignore public values or ESV. Indeed (and at least as of this writing), federal agencies are expected to take ESV into account when considering the benefits and costs of federal actions (Office

of Management and Budget 2024). Federal agencies are also developing "natural capital" accounts to measure the value of land and resources from which ESV flows so that decision-makers have more to go on than just Gross Domestic Product and other market-based measures of our national wealth (Office of Science and Technology Policy et al. 2023).

There are other ways of getting some of the same value that natural capital provides. But restoring and maintaining natural capital, including in the form of wild forest lands, is arguably the most efficient way to ensure the future provision of ESV (Foster et al. 2023; Faison, Laflower, et al. 2023; Faison, Masino, et al. 2023). Such lands require little maintenance or new infrastructure, and they are mostly self-regulating and self-renewing. Apart from the opportunity cost of protecting them — that is, the value of what we might otherwise use those lands for — they provide ESV to the public at a very low cost.

That opportunity cost, however, is the rub and the reason for perennial (and lately renewed) debates about whether America is kept (or made) beautiful by using public lands for public values or for private commodity production (Ahn 2025). Along with ethical, aesthetic, social, public health, and other arguments important to those debates, economics can provide a way of considering the alternatives and identifying efficient solutions.

Natural Land Values in New England

While questions about commodity and community values from forests are neither new nor unique to New England, New England stands out with its collective aspiration, as yet far from realized, to find *balance* among the competing visions for and uses of its forests. In the late 1990s and early 2000s the Northern Forest Alliance urged more and better wildland protection, a move toward sustainable (as opposed to industrial) forestry, and diversification of the rural economy rooted in amenity-based development (which depends on enhanced land protection), value-added forest products manufacturing (requiring improved forestry), and heritage and nature-based tourism (which relies on both) (Northern Forest Alliance 2002). Researchers from the Harvard Forest later published "Wildlands and Woodlands: A Vision for the New England Landscape", urging the retention of 70% of the New England landscape in forest cover, with 10% protected as "wildlands" and the remainder in managed "woodlands" (Aber et al. 2010).

Lake Groton from Little Deer Mountain, Groton State Forest. Photo credit: Zack Porter.

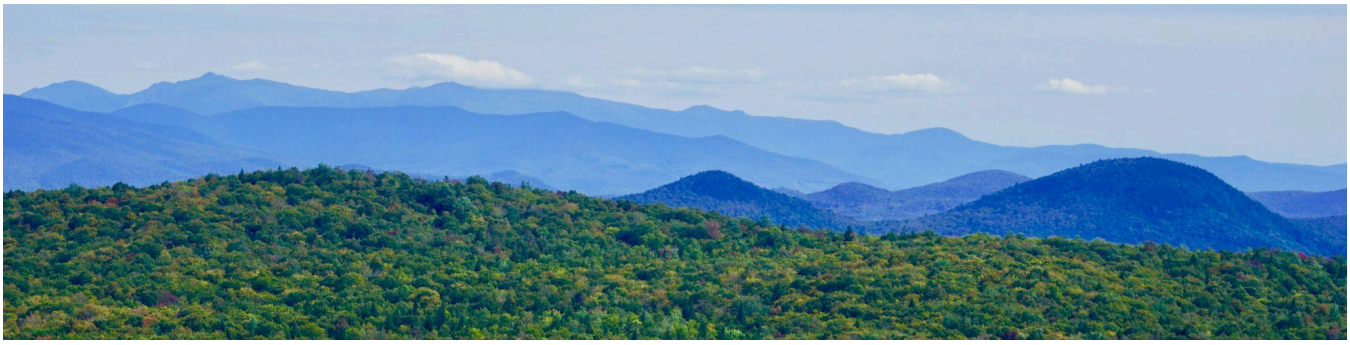
At the time of those publications, the perceived threats to New England's forested landscape had been the decline of large industrial and non-industrial timberland ownership and the loss of forestland to poorly planned development. Bill McKibben put it this way: "We're at [a] moment of enormous change, exemplified by the huge land sales that rip through the region, leaving everyone unsure of what they will be doing, and for whom, a year or a decade hence (Northern Forest Alliance 2002)." Climate change (both impacts on the region's forests and the region's potential contribution to mitigation through carbon sequestration) and biodiversity loss figured into these visions, but they are now front and center. Extreme weather events, such as Hurricane Irene in 2011 and the multiple flooding events of 2023 and 2024, highlight the

importance of keeping forests intact to slow floodwaters and retain soil, as well as providing a host of other ecosystem services.

As the 2024 Conference of the Parties to the Convention on Biological Diversity (CBD) highlighted, CBD signatory nations have made little progress on the goal of protecting 30 percent of land and water by 2030 (the "30 by 30" pledge) (Casey and Larson 2024). Nevertheless, Vermont's Act 59, the Community Resilience and Biodiversity Protection Act, which became law in 2023, sets ambitious goals for conserving 30% of Vermont's land area by 2030 and 50% by 2050. Embedded within these percentages is a target for restoring old forests across approximately 10% of Vermont, at a minimum.

In a follow-up to the Wildlands and Woodlands report, Littlefield et al. keep the same goals (70% of the region in forests protected from development and 10% managed as wildlands) but add goals of 1) producing all of New England's wood products, locally, and 2) of reducing wood consumption by 25%, echoing earlier calls for greater wood-use efficiency in general (Phillips 1994; Littlefield et al. 2024). Notably, the authors argue that managing "even 20% [of the New England landscape as] Wildlands would be compatible with a regional reorientation of meeting our wood product needs." The authors would like to see New England become more self-sufficient in timber and push fewer of the environmental externalities of wood production onto places where ecological forestry might be harder to achieve or ensure (Littlefield et al. 2024).

Prior research has investigated the value of conserving additional lands, irrespective of land ownership, and without regard to whether those lands are used for commercial extraction, including timber harvest (Roman 2018). Until now, relatively little information has been synthesized on the comparative value of public vs private lands, and for extractive vs non-extractive uses. This report helps to fill a critical information gap for lawmakers, land managers, and the public.



Silvio O. Conte National Fish & Wildlife Refuge. Photo credit: Zack Porter.

There is broad consensus that more of Vermont's conservation lands (defined here as state-owned portions of State Forests, Parks, Wildlife Management Areas, and other lands, plus the federally-owned Green Mountain National Forest (GMNF)) should be managed as "wildlands," to use the Wildlands and Woodlands term (Foster et al. 2023).[1] Such designation and management would increase Vermont's contribution to regional and national goals for wildland protection and biodiversity conservation, while ensuring that more of Vermont's rural

[1] "Wildlands" according to Foster et al. (2023) are lands for which: (a) the intention of management is to preserve the wild character of the land and the "controlling entity must have the the authority and presumed capacity to enforce this intent"; (b) the management itself is designed to keep land in an "untrammeled" condition, meaning the land can "develop freely under prevailint environmental conditions and natural processes" rather than being managed to achieve "any explicit outcome and does not seek to either guide ecosystem development or shape ecosystem structure function or composition"; and (c) the intention and management are expected to continue "either in perpetuity or open-ended and expected to persist" (pp. 30-31).

landscape is providing a full range of ecosystem services, from aesthetics and recreation enjoyed on site to regulating water flows and regional and global climate, which benefit people downstream and across the globe.

By assessing the economic value associated with alternative uses of Vermont's public lands, with a focus on lands in public ownership, we can shed light on the potential tradeoffs if future management moves toward or away from greater wildland conservation. We examine values including timber and ecosystem services already mentioned and, where data permit, provide monetary estimates of these values. We begin by placing Vermont's public lands in the context of overall land use and conservation designations in the State.

Vermont's Public Conservation Land

According to our analysis of data on public lands, land cover, and land protection status, Vermont's state[2] and federal fee-owned conservation land (i.e., "Vermont's public conservation land") comprises 13.3% of the state (331,268 hectares, or 818,577 acres[3]). Each management unit on these lands is assigned to a "GAP Status" of 1, 2, 3, or 4, depending on the degree to which the area is managed for biodiversity protection and what types of management activities are permitted to occur in the area[4]. Roughly one-fifth (20.5%) of Vermont's public conservation land (69,991 ha.) or 2.7% of the state) are "GAP Status 1" lands.[5] As such, they are managed primarily for biodiversity conservation and for natural processes to predominate. This means that four-fifths of Vermont's public conservation land (263,277 ha) is subject to "uses or management practices that degrade the quality of existing natural communities (PAD-US Team, n.d.)" including extractive uses such as logging, mining, or off-highway vehicle use.

Of these conservation lands, 46% are state-owned and managed by the Vermont Agency of Natural Resources (ANR) as State Forests, State Parks, Wildlife Management Areas, and others. The remaining 54% are federally owned and managed by the USDA Forest Service, US Fish and Wildlife Service, or National Park Service. GAP 1 lands make up 18.0% of the state-owned conservation lands and 22.6% of federal conservation lands.

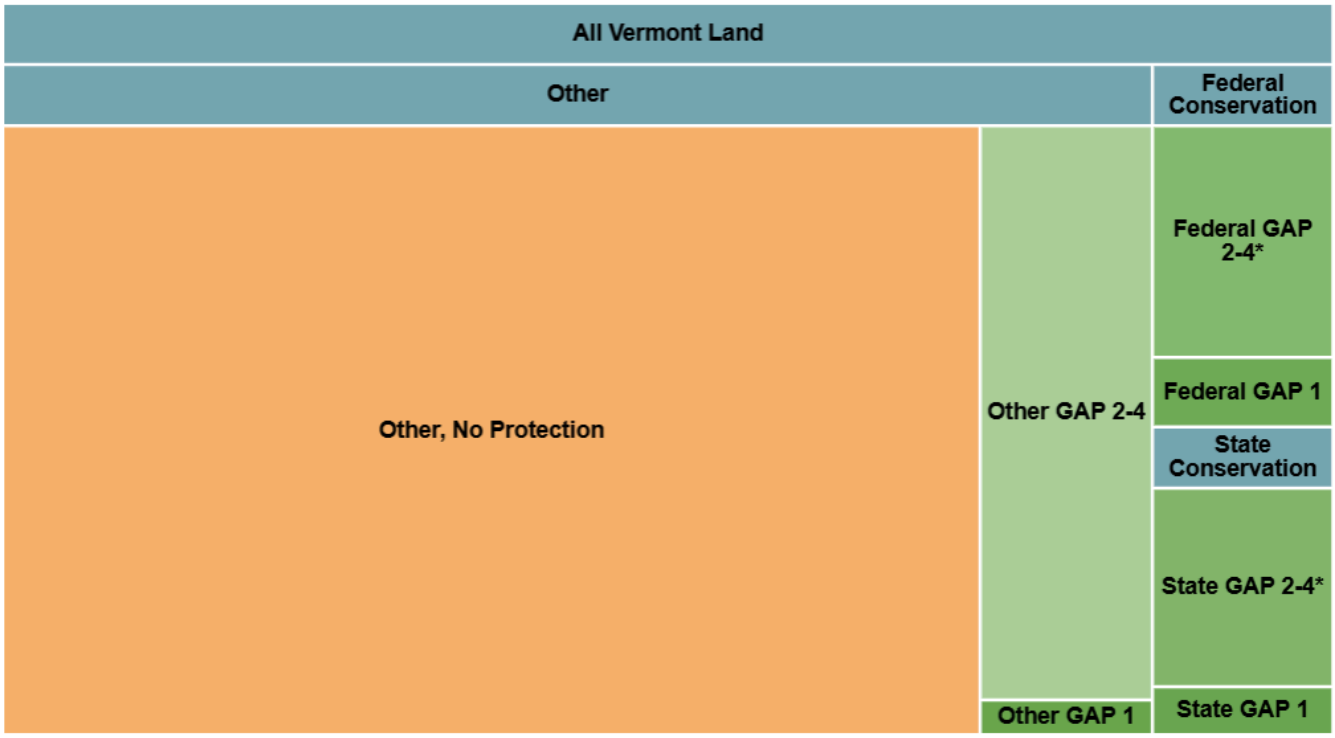
[2] These lands are a subset of those included in the state's GIS layer showing all land managed by the Vermont Agency of Natural Resources. We extracted records for all **units** for which the ownership interest is listed as "Fee", thus excluding records for other classes of interest (easements, rights of way, etc.) from analysis (Vermont Agency of Natural Resources 2022). Included units are state forests, state parks, wildlife management areas, and others with the exception of fish culture stations, the value of which would be transferred off-site through stocking.

[3] For compatibility with the international database of ESVs we employ in this study, and with this one exception, we are reporting all areas in hectares rather than acres. For reference, one hectare is 2.4710 hectares: readers can therefore obtain a close estimate of acreage by multiplying the number of hectares by 2.5. So, 1000 ha ≅ 2,500 ac.

[4] GAP Status 1 is assigned to areas "having permanent protection from conversion of natural cover and a mandated management plan [that maintains] a natural state within which disturbance events…are allowed to proceed without interference or are mimicked through management." GAP Status 2 is similar to GAP Status 2, except that the area is managed to "maintain a *primarily* natural state, but which may receive uses or management practices that degrade the quality of existing natural communities…. [emphasis] added. GAP Status 3 lands "[have permanent protection from conversion of natural land cover for the majority of the area, but subject to extractive uses", such as logging, mining, or off-highway vehicle use. GAP Status 4 lands have "no known public or private institutional mandates…to prevent conversion of natural habitat types to anthropogenic habitat types" and for which "management intent is unknown." (PAD-US Team, n.d.) Non-extractive uses, including research, recreation, and traditional use by indigenous people, may occur on both GAP Status 1 and 2 lands.

[5] Alternative inventories of Vermont's "wildlands" show larger areas, at least partially due to the inclusion in those inventories of lands that lack a durable legal framework for wildland management, such as Vermont Natural Areas on state lands, which a Governor can un-designate, and which are not considered GAP 1 and those encumbered by a conservation easement but for which the fee ownership is retained by a private entity (Foster et al. 2023; Vermont Housing & Conservation Board and Nature 4 Justice 2025, 59; Vermont Laws, n.d.).

Figure 1. Allocation of Vermont Land and Water, by Ownership and Conservation Status.

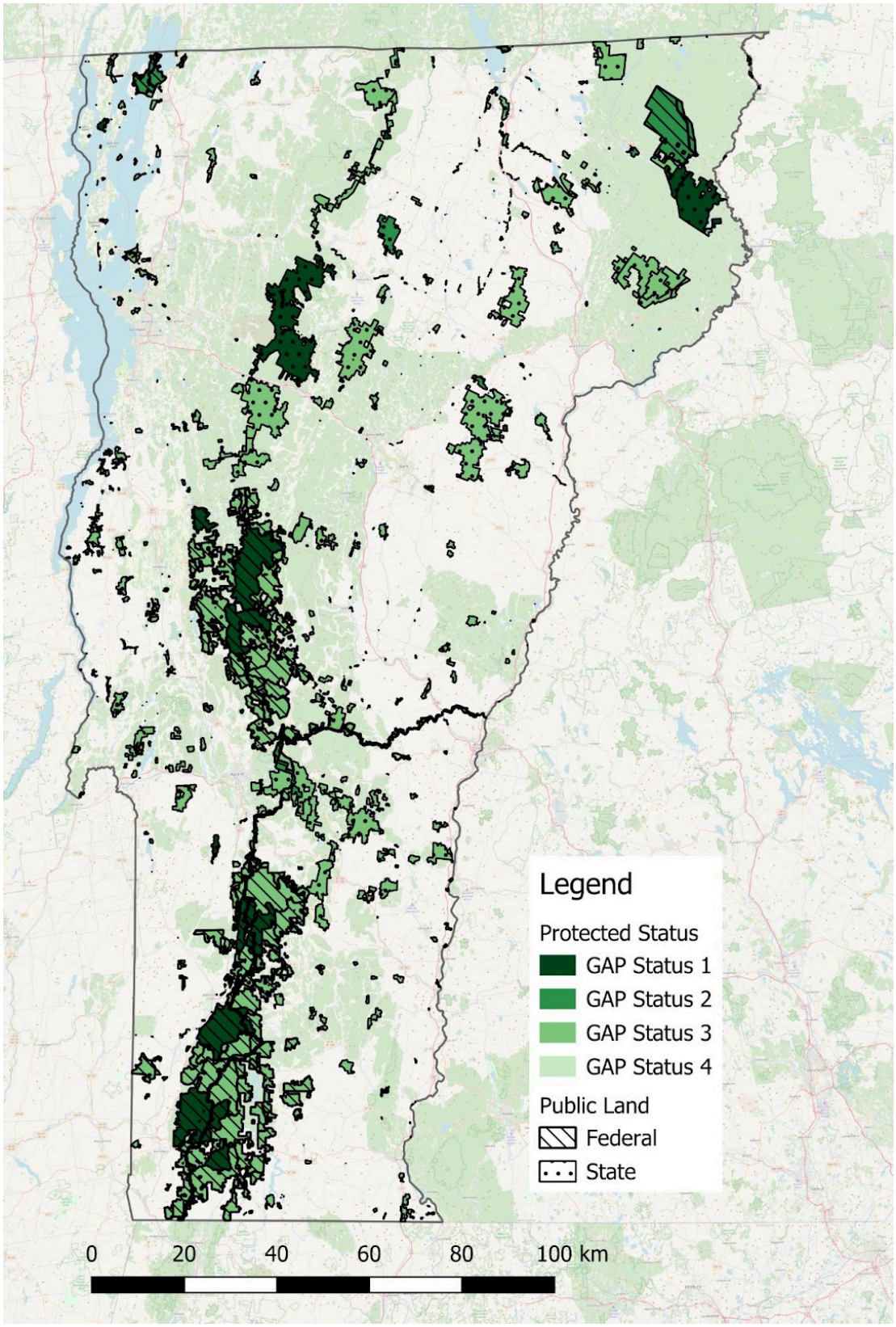


* For the state and federal ownership, small areas for which GAP status cannot be determined are added to the GAP 1-4 category. GAP 4 lands are protected from development (which we assume those in state or federal ownership are), but the degree to which they are protected is unknown. This adjustment applies to less than 0.2% of the federal ownership and 3.6% of the state ownership.
(United States Geological Survey [USGS] Gap Analysis Project [GAP] 2024; Multi-Resolution Land Characteristics Consortium [MRLC] and United States Geological Survey [USGS] 2023; Vermont Agency of Natural Resources 2022; Vermont Center for Geographic Information [VCGI] 2024)

While they are not a focus of the ecosystem service valuation below, we do note that Vermont has additional conserved areas. Town forests, town parks, and private lands owned by or subject to easements controlled by land trusts and other private conservation organizations may also, depending on their management, contribute to Vermont's conservation goals. Put together, these areas total 319,930 ha, or 12.8% of the state, and an area nearly as large as the federal and state conservation lands. These lands do differ from those focus areas in that only 5% are in GAP Status 1, leaving 95% subject to management that could reduce their ecological integrity.

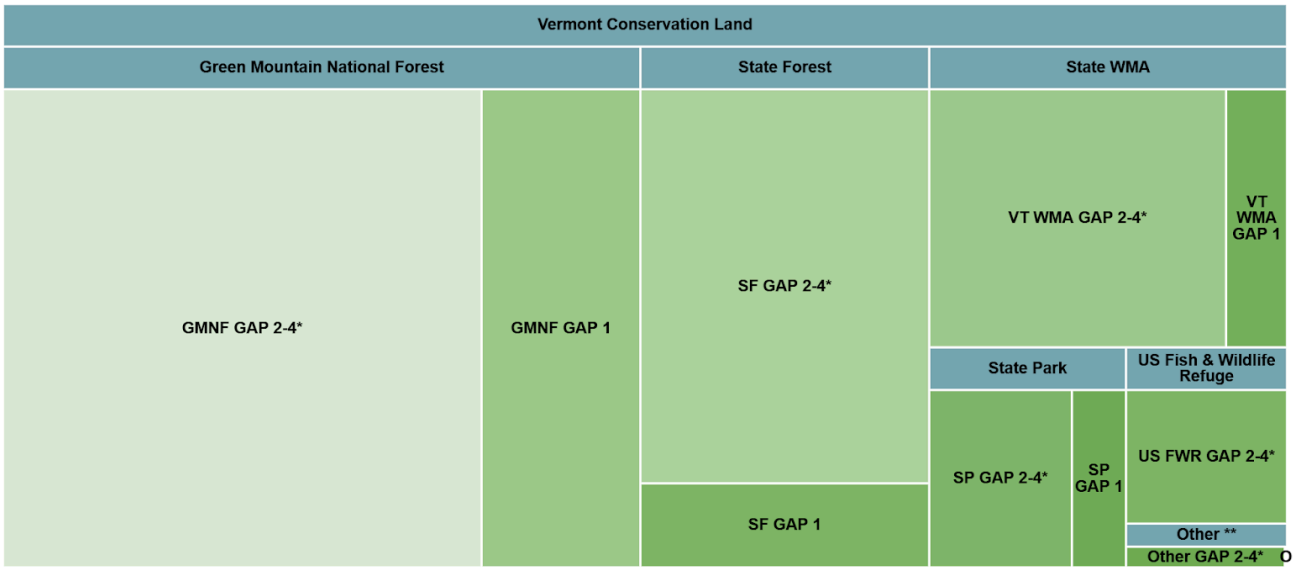
The balance of Vermont's land area, 1.84 million ha, or 73.8% of the state, includes private forests, farms, and residential, commercial, and other developed areas. (See Figures 1 & 2, and Map 1. (United States Geological Survey [USGS] Gap Analysis Project [GAP] 2024; Multi-Resolution Land Characteristics Consortium [MRLC] and United States Geological Survey [USGS] 2023; Vermont Agency of Natural Resources 2022; Vermont Center for Geographic Information [VCGI] 2024)

Map 1. Protected Status of Vermont's Conservation Lands



(Sources: United States Geological Survey [USGS] Gap Analysis Project [GAP] 2024; Vermont Agency of Natural Resources 2022; "Green Mountain National Forest Management Areas" 2024; OpenStreetMap Contributors 2025)

Figure 2. Allocation of Vermont's Public Conservation Land, by Management Type and GAP Status



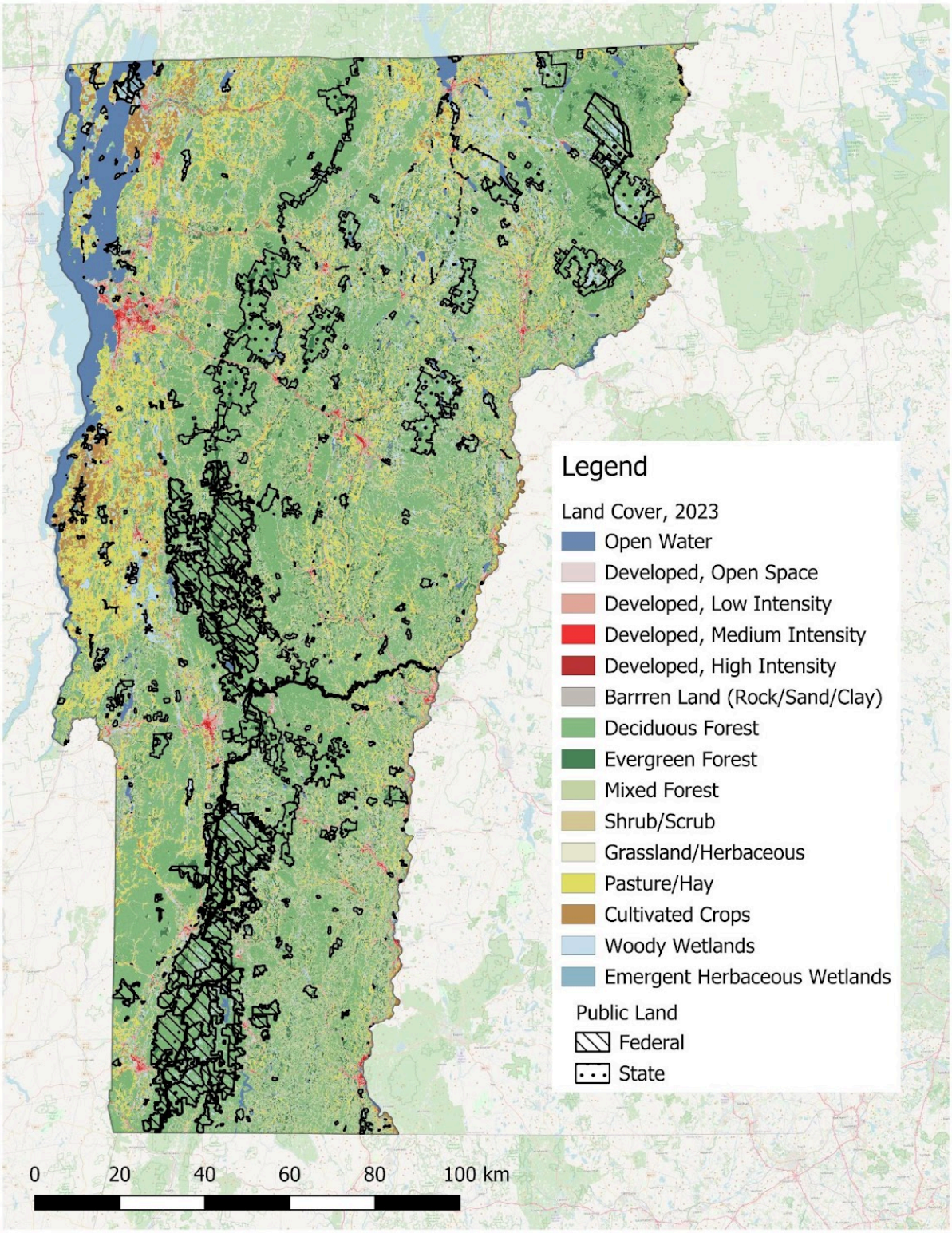
* For the state and federal ownership, small areas for which GAP status cannot be determined are added to the GAP 1-4 category.

** "Other" includes National Park System lands (Marsh-Billings Rockefeller National Park and portions of the Appalachian Trail not included with the GMNF), plus access areas, dams, ponds, streambanks, and miscellaneous areas managed by Vermont ANR. (Sources: United States Geological Survey [USGS] Gap Analysis Project [GAP] 2024; Multi-Resolution Land Characteristics Consortium [MRLC] and United States Geological Survey [USGS] 2023; Vermont Agency of Natural Resources 2022; Vermont Center for Geographic Information [VCGI] 2024)

While Vermont's public conservation lands are a small percentage of Vermont's land area, their position and distribution mean that they are connected to many of the state's communities and people. These connections have implications for benefits such as flood protection, clean water, wildlife habitat, recreational opportunities, and aesthetics, among others. For example, of the 268 subwatersheds (defined by 12-digit hydrological unit codes (HUC 12)) partially or completely within Vermont's borders, 231 (86%) contain some Vermont public conservation land. These subwatersheds share land with every one of Vermont's 256 towns. Using data from the 2020 U.S. Census, we find that these subwatersheds are home to 93% of the people (n=595,396) and housing units (n=251,648) in the state ("United States - Census Bureau Search," n.d.).

In terms of land cover, Vermont's conservation lands are heavily forested, with nearly two-thirds (64.9%) covered in deciduous forests and almost a quarter in evergreen (9.1%) or mixed forest (16.0%) (United States Geological Survey [USGS] Gap Analysis Project [GAP] 2024; Multi-Resolution Land Characteristics Consortium [MRLC] and United States Geological Survey [USGS] 2023; Vermont Agency of Natural Resources 2022; Vermont Center for Geographic Information [VCGI] 2024)). (See Map 2 and Figures 3 and 4.) Wetlands (mostly woody wetlands, but also some herbaceous wetlands) comprise another 8.1% of Vermont's conserved landscape. Other land covers, including open water, and developed areas (which on the public lands could include visitor facilities, parking areas, roads, etc.) contribute less than one percent each to the mix.

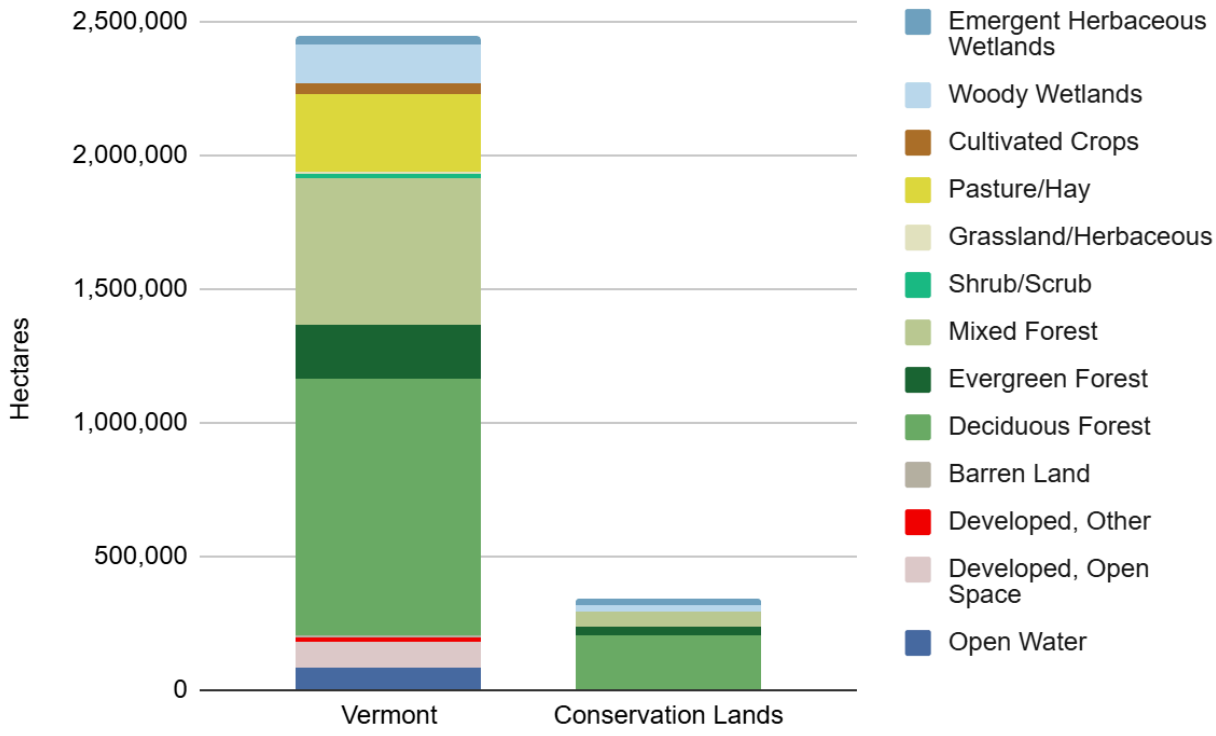
Map 2. Land Cover/Land Use and Vermont's Public Conservation Lands



(Sources: Multi-Resolution Land Characteristics Consortium [MRLC] and United States Geological Survey [USGS] 2023; United States Geological Survey [USGS] Gap Analysis Project [GAP] 2024; Vermont Agency of Natural Resources 2022; "Green Mountain National Forest Management Areas" 2024; OpenStreetMap Contributors 2025)

As we describe under Estimation Methods, land cover is critical to the task of estimating ESVs. Each piece of the landscape is like a factory for improving air quality and mitigating flood risks, for enhancing wildlife habitat and aesthetic appeal, and for providing other ecosystem services enjoyed by people. And just like any production process, these factories are tuned to produce a particular mix of services. Forests produce a different set of services than wetlands, and wetlands deliver a different set of values than open water or developed areas. Combined with GAP status as a proxy for the productivity of each particular forest, wetland, and other area, we can estimate how much ESV each unit of conservation land is likely to produce in a given year.

Figure 3. Land Cover in Vermont & on Vermont's Public Conservation Lands



(Sources: Multi-Resolution Land Characteristics Consortium [MRLC] and United States Geological Survey [USGS] 2023; United States Geological Survey [USGS] Gap Analysis Project [GAP] 2024; Vermont Agency of Natural Resources 2022; "Green Mountain National Forest Management Areas" 2024; OpenStreetMap Contributors 2025)

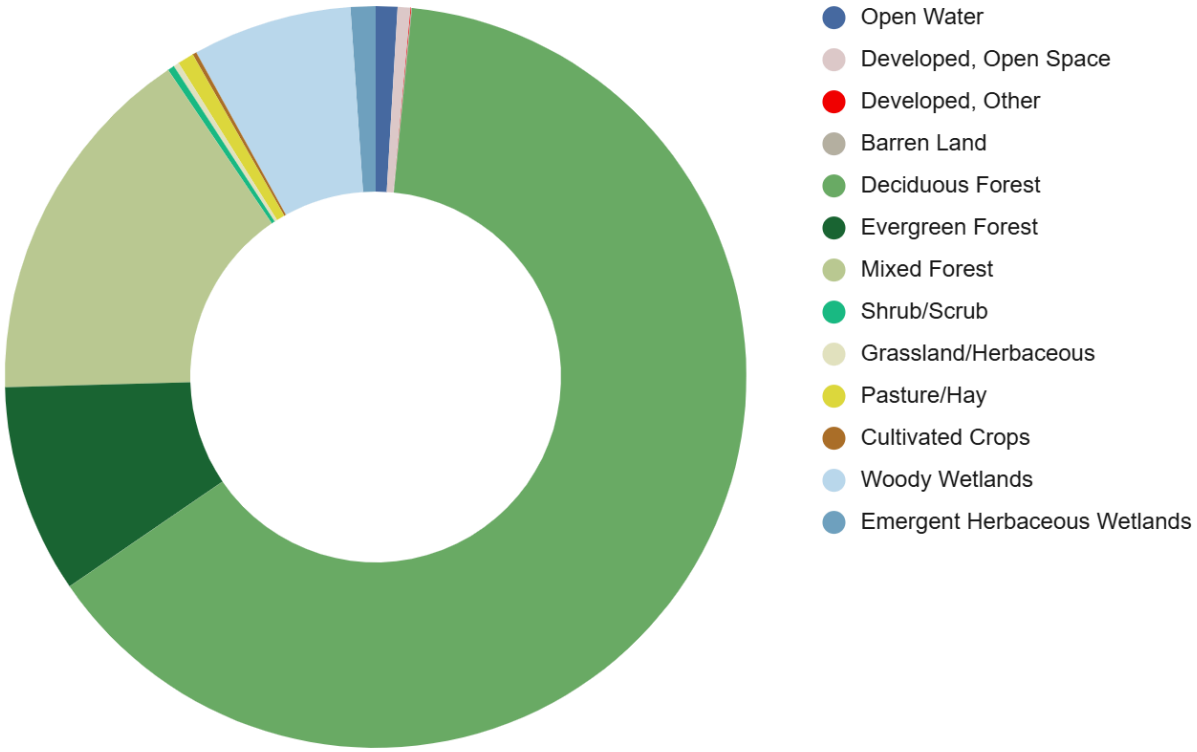
Ecosystem Services are Economic Values

The ecosystem services noted above are defined as "benefits people obtain from ecosystems ((USDA Forest Service 2012; Johnson 2010), p 21271)," or more specifically, they are "the effects on human well-being of the flow of benefits from an ecosystem endpoint to a human endpoint at a given extent of space and time (Johnson 2010)." These services include filtering air and water, moderating water flows (that is, reducing flood risk while providing steady flows of water for drinking, irrigation, and industrial processes), regulating local, regional, and global climate, providing spaces for recreation and beauty to enjoy, and a host of other services. Such "ecosystem endpoints" become "human endpoints" when and where we make use of them (as in the case of drinking water, enjoying a recreational experience, or using a home that has been protected from flooding) or

simply appreciate them (as in the case of aesthetic and cultural value, or the value of knowing the ecosystem is functioning and will provide benefits to others).

Ecosystem services are *benefits* because people have at least a hypothetical — and often an actual — "willingness to pay" for them. That is, we would be willing to give up something else we value to have them or have more of them. Some of this value is reflected in dollar-valued transactions, such as when we pay for water or other physical ecosystem outputs, when we pay more for a home near a well-protected natural area than we would pay if it were surrounded by less appealing land uses (Phillips 2004). We express our value for recreational experiences by laying out funds for park entrance fees, gear, food, lodging, and fuel, and by giving up wages or precious PTO so that we have the time to recreate.

Figure 4. Land Cover on Vermont's Public Conservation Lands



(Sources: Multi-Resolution Land Characteristics Consortium [MRLC] and United States Geological Survey [USGS] 2023; United States Geological Survey [USGS] Gap Analysis Project [GAP] 2024; Vermont Agency of Natural Resources 2022; "Green Mountain National Forest Management Areas" 2024; OpenStreetMap Contributors 2025)

But much of the value is unpriced, and its value is implicit. For example, the value of intact forest areas for holding back floodwaters shows up in the damage to homes and businesses that *doesn't* happen, and the value of those landscapes for purifying our drinking water is what we would otherwise have to pay to purify the water through mechanical and chemical means, or perhaps what we would pay to treat illnesses caused by drinking impure water. While the *price* of these benefits is zero — nature is providing the benefits for free — their *value* is not. Indeed, the value of ecosystem services worldwide has been estimated to be several times the value of global GDP (Costanza et al. 1997; 2014; 2017), and if most of the biggest regional industries around the world

were to pay for their use of natural capital, they would cease to be profitable (Trucost Plc and TEEB for Business Coalition 2013).

Clearly, it is essential to account for these important economic values when considering actions that can preserve and enhance, or could diminish or degrade, the ecological productivity of Vermont's public lands. We are most interested in the value of these lands for providing the following services.

- **Recreation:**
  - Public conservation lands attract visitors and provide spaces for visitors and residents alike to enjoy activities like hiking, camping, fishing, skiing, hunting, and wildlife observation.
- **Water Quality Regulation:**
  - Natural landscapes regulate water flow and filter out pollutants by trapping sediment and giving microbes and other organisms time to break down, and often trap material from reaching human users.
- **Water Flow Regulation / Flood Protection:**
  - By slowing water down, natural land cover on public conservation lands gives water a chance to infiltrate into soil and recharge groundwater and/or to be taken up by plants. The reduction in the volume and rate of runoff also means less flood risk to private homes and businesses, as well as to roads and other infrastructure.

Bogs, like this one in the Joseph Battell Wilderness on the Green Mountain National Forest, filter water and regulate its flow, which can reduce flood risks. Photo credit: Zack Porter.

- **Air Quality Regulation:**
  - Similar to water quality regulation, natural vegetation can trap particulate matter and/or absorb chemicals that could harm human health.
- **Carbon Sequestration and Climate Change Mitigation:**
  - Forests sequester and store carbon dioxide, thus helping to curb global warming, and they provide shade and retain humidity, which improves public health and provides a more hospitable environment at the local and regional level.
- **Biodiversity Conservation:**
  - Public conservation lands include habitat for diverse species that make up the food webs and other relationships that support the wildlife that people use and enjoy directly through hunting, fishing, and observation.

- **Aesthetics:**
    - Natural areas, whether experienced up close, seen from afar, or even as those experiences are remembered or anticipated, support psychological and emotional benefits and help people be healthier and more productive in their daily lives.
- **Other Important Values:**
    - Erosion Prevention: Keeping soil in place supports future biomass production and improves aquatic habitat, hydroelectric power plant efficiency, and other human uses of clear, sediment-free water.
    - Existence & Bequest Value: What people would be willing to pay to keep natural areas protected and healthy for their own happiness (regardless of any future use) and for future use by others.
    - Inspiration for culture, art, and design: The value of images, stories, music, and other art inspired by natural lands.
    - Science/Research: Aldo Leopold wrote in "Wilderness" that natural areas provide the "base datum of normality" by which we can judge the quality of more active or intensive land management (Leopold 1990). Scientific research on well-functioning ecosystems helps us understand that "base datum" and improves our stewardship of managed woodlands, farms, and other areas.

These services and benefits are not exclusive to Vermont's public conservation lands, of course. But because those lands are statutorily mandated to provide public goods and values (Vermont Laws, n.d.), we argue here that they should be managed to maximize ecosystem services compared to private lands for which use and management are typically more focused on the creation of private value through timber harvest, agricultural production, and development. The importance of managing a greater percentage of public conservation lands as wildlands is also amplified by the relative scarcity of GAP 1 lands (5%) — those with the highest degree of protection — among privately conserved lands.

Estimation Methods

Economists have developed widely used methods to estimate the monetary value of individual ecosystem services and/or a suite of services produced from small areas, such as a watershed, a county, or a specific subset of the public estate. For example, the "travel cost" method divines willingness to pay for recreational experiences, and is inferred from surveys and other data on what visitors spend to use a resource, such as travel expenses (airfare, gasoline, hotels, meals), recreational gear purchases, and in the form of time away from work. With "hedonic pricing," the value of aesthetic quality, flood protection, or recreational access can be teased out of the market price or assessed value of residential properties. Integrated hydrological/economic modeling methods can help estimate the marginal effect of each variation in public land management on downstream flood risk and, therefore, the degree to which those variations might affect the cost of repairing flood damage and/or insurance. But such studies are time-consuming and often expensive.

For that reason, we use the Benefit Transfer Method (BTM). According to the Organization for Economic Cooperation and Development, BTM is "the bedrock of practical policy analysis," particularly when, as in the current case, collecting new primary data is not feasible (Pearce et al. 2006). In BTM, one takes a rate of ecosystem benefit delivery estimated for one or more "study areas" — the places and settings for which a primary travel cost, hedonic pricing, or other study has been completed — and applies that rate to the "policy area." Briefly, BTM entails the following three steps, details for which are included in the next three subsections.

1. Select suitable per-hectare ESV estimates from available study areas. Estimates are generally available for combinations of biome or land cover, and individual (or groups of) ecosystem service(s). The values are expressed in dollars per hectare per year. This step includes coding and summarizing the study area values to align with other data for the policy area.
2. Classify and estimate the number of hectares within the policy area according to their land cover and other relevant characteristics. In the present case, those characteristics are the type of management unit (National Forest, State Park, State Wildlife Management area, etc.) and the conservation status (i.e., GAP 1-4) of the unit.
3. The variety of ecosystem service measures and the number of studies for each land cover is a result of both the existence of primary studies in each type of land and service and the suitability of those values for application to the policy site.

The result is a three-dimensional dataset with dollar-value estimates of ecosystem services in each hectare of the study region based on land-cover type. This provides a preliminary baseline assessment of the region's ESV, which is the foundation for creating land-use change scenarios and measuring the impact of potential management actions or policies.

Per-Hectare Ecosystem Service Values

In the present case, we draw those rates from the Ecosystem Services Valuation Database (ESVD), which comprises nearly 11,000 estimates of individual ESVs drawn from 1,354 primary or original studies (Brander et al. 2023). The ESVD classifies each value according to the service(s) studied, the location of the study area, the biome(s)/ecosystem(s) present in the study area, and more than one hundred other attributes. In addition to vetting each study and value for inclusion in the database, ESVD's research team provides a standardized value for most of the estimates: ESVs are listed as international dollars per hectare per year for 2020 price levels. Thus, differences in purchasing power across nations and the effect of inflation over time are not a concern.

Not all 11,000 estimates are relevant for a study of public conservation lands in Vermont, of course, so we have applied a set of filters to winnow the ESVD study area estimates to a set of values suitable for our policy site. Specifically, we included estimates for which all of the following are true:

- The study area is in North America or Europe. In addition to considerations of income levels and purchasing power parity, this helps to control for what might be wider variation in cultural influences on ecosystem service benefits.
- The biome in the study area of a biome or biomes found in Vermont. That is, we excluded studies of mangroves, coastal, and marine ecosystems.
- The study area is **not** managed intensively for timber, crop, or other commodity production, nor is the ecosystem service in question a commodity. We consider timber values separately, below.
- The estimate is for one ecosystem service at a time only (no aggregated ecosystem services).
- The ecosystem service is not a precursor to or a product of another ecosystem service. This avoids double-counting of, for example, "water quality regulation" and "water flow regulation" plus the resulting "water supply".[6]
- The estimate is available in the standardized $/ha/year form.
- The estimate is **not** an extreme outlier (we set an upper limit of $100,000/year)

[6] In the case of the forest land covers, we did use estimates for water supply in place of water quality regulation. This is because there were no otherwise suitable water quality regulation estimates in the ESVD for the forest land covers.

Applying these filters yields 781 individual per-hectare ESVs. After classifying these values to match our land cover data (see below), we calculated the minimum, average, and maximum values for each of 62 combinations of land cover and ecosystem service. We do not have "wall-to-wall" coverage because the ESVD does not include estimates of all possible ecosystem services for all possible land covers. (Readers may view the list of these 781 ESVs here.)

In one important example, there were no study area estimates for the "mixed forest" land cover category, which comprises 16% of Vermont's Conservation Lands (see Figure 4). To fill that gap, we use estimates from the set of values of deciduous and evergreen forests. Other data gaps, such as the value of woody wetlands for air quality regulation or the value of forests for inspiration for culture, art, and design — clearly a gap in picture-postcard Vermont — remain unfilled.

The ESVD also lacks suitable estimates for some of the land cover types present on Vermont's public conservation lands. Areas classified as barren, developed, pasture/hay, or cultivated crops are treated as if there is no ecosystem service value produced on them. These four land covers represent less than 1.5% of the Public Conservation Land.

We understand that the resulting estimates of ESV will be lower than if we had additional study areas from which to draw information. Average ecosystem service values per-hectare-per-year for which we have suitable estimates for at least one land cover are shown in Table 1.

Not every hectare of public conservation land will be equally productive of ESV. The average ESV productivity estimates in Table 1 are applied to GAP Status 2 lands, which are those managed primarily for biodiversity conservation but where there may be "uses or management practices that degrade the quality of existing natural communities." We assume GAP Status 1 areas, which are managed for biodiversity conservation but not subject to potentially degrading uses or management practices, are more highly productive of ESV. We implement this in our calculations by applying the maximum ESV productivity estimate from the ESVD, by land cover type, to GAP Status 1 areas.

Table 1. Average Annual Per-Hectare Ecosystem Service Value Flows, by Ecosystem Service and Land Cover, in 2024 dollars

	Land Cover[b]							
Ecosystem Service[a]	**Open Water**	**Deciduous Forest**	**Evergreen Forest**	**Mixed Forest[c]**	**Shrub / Scrub**	**Grassland / Herbaceous**	**Woody Wetlands**	**Emergent Herbaceous Wetlands**
Aesthetic Information	$15,379.07	$92.21	$92.21	$92.21	$47.83			$1,434.38
Air Quality Regulation		$1,398.47	$135.52	$767.00	$9.15	$6.61		$4,140.20
Biodiversity Protection	$771.23						$353.23	$1,904.81
Climate Regulation	$48.41	$548.87	$123.94	$336.41	$299.56	$8,367.94		$1,270.22
Erosion Prevention		$761.93	$44.51	$403.22				
Existence & Bequest Value	$349.78	$1,174.14	$940.34	$1,174.14	$3,877.52	$23,608.74	$827.08	$3,838.15
Inspiration for culture, art, and design	$388.87				$268.20	$356.62		$1,003.93
Moderation of Extreme Events	$13.74	$324.36	$895.00	$609.68	$61.06			$5,356.99
Recreational Opportunities	$680.99	$1,911.85	$885.90	$1,911.85	$156.07	$300.22	$637.51	$3,584.08
Science/Research	$38.71	$184.71		$184.71	$269.03	$184.54		$80.24
Water Flow Regulation	$54.66	$76.15	$17.36	$46.76	$143.92	$66.57		$194.23
Water Quality Regulation	$1,367.76	$7.04[d]	$227.85[d]	$117.45[d]		$17.76[d]		$479.51

Notes: a. These service categories are based on the TEEB classification as implemented in the ESVD. (United Nations Environment Programme 2010; Brander et al. 2023). Blanks are present for those combinations of ecosystem service and land cover for which there are no suitable estimates in the ESVD database. Blanks DO NOT indicate that such values are zero.

b. Biomes in the ESVD are reclassified into the categories included in the National Land Cover Database (Multi-Resolution Land Characteristics Consortium [MRLC] and United States Geological Survey [USGS] 2023).

c. For mixed forests, we use the average of ESVs for deciduous and evergreen forests available in the ESVD.

d. The ESVD does not include estimates for Water Quality Regulation for these land cover classes. We have used the value of these land covers for the Water Supply service, which is not otherwise included, to fill the gap.

Areas open to extractive uses — that is, GAP Status 3 areas — would be less productive, at least when it comes to ecosystem services other than raw materials, which we cover separately. We therefore assign the minimum ESV productivity estimate, again, by land cover type, to GAP Status 3 areas. We do the same for GAP Status 4 areas. GAP Status 4 lands are those with no known legal requirements to prevent conversion to "anthropogenic habitat types", and where conversion to unnatural land cover is allowed, or management intent is unknown (PAD-US Team, n.d.). To be conservative in our overall ESV estimation, we assume they are the former, and we apply the minimum ESV productivity estimates to these areas as well.

Land Area times ESV Productivity Equals Total ESV

Putting the two data sets (one with land areas and one with ESV productivity) together yields estimates of the total ESV produced by Vermont's Public Conservation Lands each year. We multiply the number of hectares in each of 265 unique combinations of Management Unit Type, GAP Status, and Land Cover by each of the ESV productivity estimates that correspond to the area's land cover and GAP status. There are 2,277 resulting estimates of, for example, the annual value of Climate Regulation provided by Evergreen Forests on Vermont State Forests that are in GAP Status 2, or the annual value of Woody Wetlands on GAP Status 1 lands that are part of the Green Mountain National Forest for Biodiversity Protection. (See Table 2.)

Table 2. Sample ESV Calculations

Land Area in Hectares (by Management Unit, Gap Status, and Land Cover)	x	ESV Productivity in $/HA/Year (by Gap Status and Land Cover)	=	ESV per year (in 2024 dollars)
309.24 ha Vermont State Forest GAP Status 2 Evergreen Forest	x	$102.26 / ha / year Climate Regulation on GAP Status 2 Evergreen Forests	=	$38,327 / year
1,591 ha Green Mountain National Forest GAP Status 1 Woody Wetlands	x	$345.28 / ha / year Biodiversity Protection on GAP Status 1 Woody Wetlands	=	$665,809 / year

Ecosystem Service Value of Vermont's Conservation Lands

All totaled, Vermont's Public Conservation Lands supply an estimated $2.25 billion each year. (See Tables 3, 4, & 5, and Figure 5.) This sum is distributed among land owners (Federal and State), management types (parks, forests, WMAs, etc.), and GAP status in predictable ways. Land categories with more hectares, more highly-productive land covers, and greater degrees of ecosystem integrity (as indicated by GAP status) will have higher ESV output values.

Table 3. Annual Ecosystem Service Value, by Land Management Class (thousands of 2024 dollars).

Management Unit Type	GAP 1	GAP 2	GAP 3	GAP 4	Grand Total
Federal					
Green Mountain National Forest	$1,228,998	$24	$44,873	$0	**$1,273,895**
National Fish & Wildlife Refuge		$90,009			**$90,009**
National Park		$2,469	$217	$117	**$2,804**
Federal Total	$1,228,998	$92,501	$45,091	$117	**$1,366,708**
State					
Access Area		$71	$4	$103	**$178**
Dam		$321	$312	$6	**$639**
Miscellaneous			$40	$3	**$43**
Pond		$1	$296	$14	**$310**
State Forest	$533,255	$4,823	$21,428	$13	**$559,519**
State Park	$12,418	$25,176	$7,075	$9	**$44,678**
Streambank			$313	$4	**$316**
Wildlife Management Area	$249,128	$3,360	$21,390	$53	**$273,931**
State Total	$794,801	$33,752	$50,859	$204	**$879,615**
Grand Total	**$2,023,799**	**$126,253**	**$95,950**	**$321**	**$2,246,323**

Note: A value of zero in this table may be due to a lack of a suitable source study for the listed ecosystem service. It does not mean that the service is not present or does not provide any value.

Table 4. Annual Ecosystem Service Value, by Ecosystem Service (thousands of 2024 dollars)

Ecosystem Service	GAP 1	GAP 2	GAP 3	GAP 4	Grand Total
Aesthetic Information	$31,618	$12,994	$932	$14	**$45,559**
Air Quality Regulation	$484,796	$18,302	$43	$0	**$503,141**
Biodiversity Protection	$2,154	$4,489	$7,025	$62	**$13,729**
Climate Regulation	$399,925	$7,635	$2,855	$7	**$410,423**
Erosion Prevention	$121,816	$6,667	$8,691	$17	**$137,191**
Existence & Bequest Value	$355,933	$24,980	$11,677	$56	**$392,646**
Inspiration for culture, art, and design	$1,752	$1,707	$319	$5	**$3,783**
Moderation of Extreme Events	$95,519	$14,159	$34,074	$103	**$143,856**
Recreational Opportunities	$496,303	$29,628	$3,799	$9	**$529,739**
Science/Research	$14,421	$2,041	$23,579	$36	**$40,078**
Water Flow Regulation	$8,235	$1,043	$1,011	$5	**$10,295**
Water Quality Regulation	$11,327	$2,608	$1,943	$6	**$15,884**
Grand Total:	**$2,023,799**	**$2,608**	**$1,943**	**$6**	**$2,246,323**

Note: A value of zero in this table may be due to a lack of a suitable source study for the listed ecosystem service. It does not mean that the service is not present or does not provide any value.

Table 5. Annual Ecosystem Service Value, by Ownership and Ecosystem Service (thousands of 2024 dollars)

	Ecosystem Service	GAP 1	GAP 2	GAP 3	GAP 4	Grand Total
Federal	Aesthetic Information	$10,326	$5,861	$329	$2	**$16,518**
	Air Quality Regulation	$301,801	$13,963	$24	$0	**$315,788**
	Biodiversity Protection	$782	$3,779	$2,186	$4	**$6,751**
	Climate Regulation	$247,928	$5,744	$1,480	$3	**$255,156**
	Erosion Prevention	$76,170	$4,586	$4,511	$10	**$85,276**
	Existence & Bequest Value	$214,868	$19,390	$5,059	$3	**$239,319**
	Inspiration for culture, art, and design	$444	$1,421	$102	$1	**$1,967**
	Moderation of Extreme Events	$57,187	$11,704	$15,073	$69	**$84,033**
	Recreational Opportunities	$300,643	$22,146	$1,946	$3	**$324,737**
	Science/Research	$8,836	$1,446	$12,986	$19	**$23,287**
	Water Flow Regulation	$5,089	$774	$404	$2	**$6,269**
	Water Quality Regulation	$4,924	$1,688	$990	$2	**$7,604**
Federal Total		$1,228,998	$92,501	$45,091	$117	**$1,366,708**

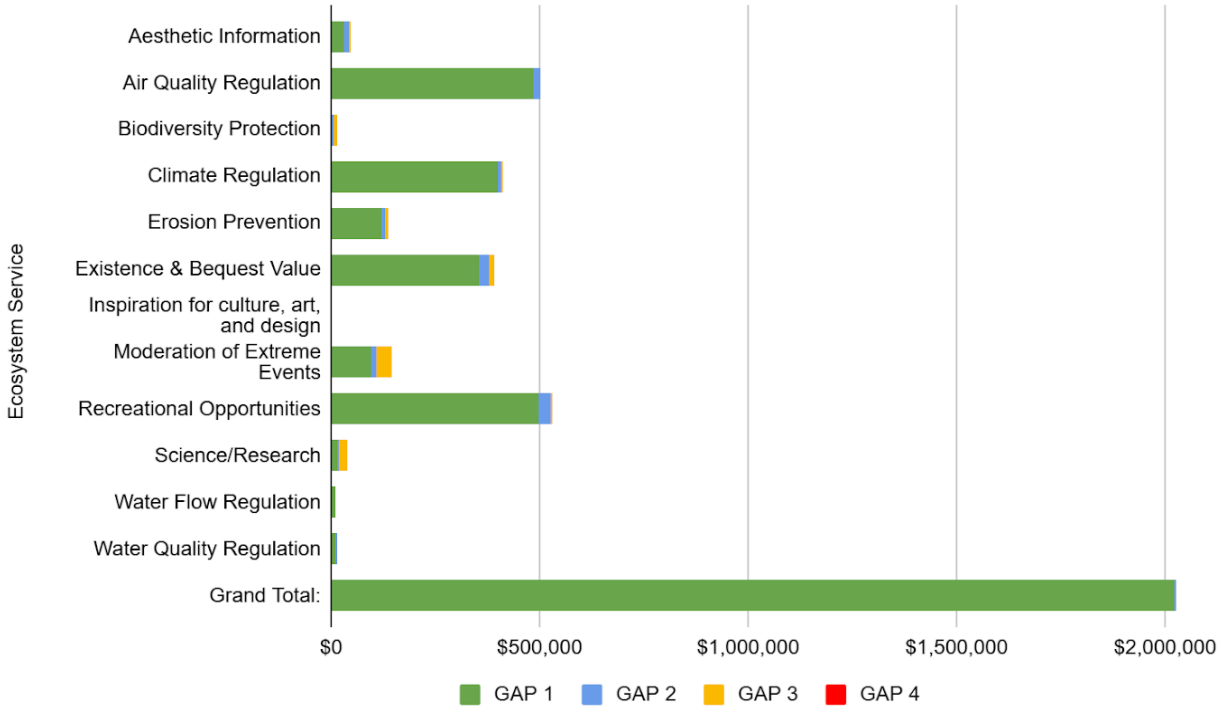
	Ecosystem Service	GAP 1	GAP 2	GAP 3	GAP 4	Grand Total
State	Aesthetic Information	$21,292	$7,134	$603	$12	**$29,040**
	Air Quality Regulation	$182,994	$4,338	$19	$0	**$187,352**
	Biodiversity Protection	$1,371	$709	$4,839	$58	**$6,978**
	Climate Regulation	$151,997	$1,891	$1,375	$4	**$155,267**
	Erosion Prevention	$45,646	$2,082	$4,181	$7	**$51,915**
	Existence & Bequest Value	$141,065	$5,590	$6,617	$53	**$153,326**
	Inspiration for culture, art, and design	$1,308	$286	$216	$5	**$1,816**
	Moderation of Extreme Events	$38,333	$2,455	$19,001	$34	**$59,823**
	Recreational Opportunities	$195,660	$7,482	$1,853	$7	**$205,002**
	Science/Research	$5,585	$595	$10,593	$17	**$16,791**
	Water Flow Regulation	$3,146	$269	$607	$3	**$4,026**
	Water Quality Regulation	$6,403	$920	$953	$4	**$8,279**
State Total		$794,801	$33,752	$50,859	$204	**$879,615**
Grand Total		**$2,023,799**	**$126,253**	**$95,950**	**$321**	**$2,246,323**

Note: A value of zero in this table may be due to a lack of a suitable source study for the listed ecosystem service. It does not mean that the service is not present or does not provide any value.

The Green Mountain National Forest and the State Forests make up 81.6% of total ESV, while National Fish and Wildlife Refuges and State WMAs add another 16.2%. (National Parks and state-managed parks, access areas, ponds, and streambanks contribute the remaining 2.2%.) Recreational Opportunities, followed by Air Quality Regulation, Climate Regulation, Existence and Bequest Value, and Moderation of Extreme Events, such as flooding and wind storms, are the five most valuable ecosystem services. Together, they represent $1.98 billion in economic value, or just over 88% of the total estimated ESV.

(Readers may view an interactive version of the ESV estimation results here.)

Figure 5. Ecosystem Service Value, by Service and GAP Status (thousands of 2024 dollars)



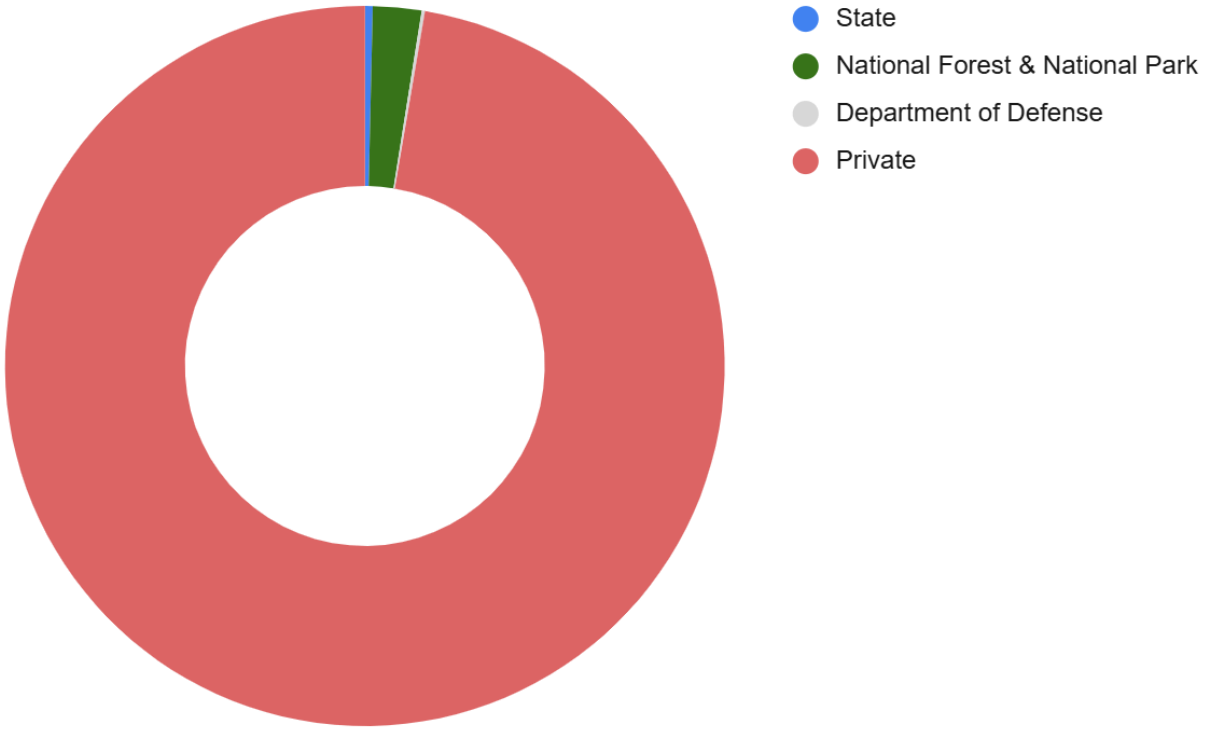
Timber as an Ecosystem Service

As noted, one ecosystem service not included in the estimates above is the provision of raw materials, specifically timber. The reason is that, unlike the other ecosystem service values included above, timber is a market commodity for which direct estimation of the value is possible. Namely, we can combine data on harvest volume from public conservation lands with estimates of the value of the output of the logging component of Vermont's forest products industry to estimate the economic value of timber from Vermont's public conservation lands.

Vermont's public lands supply an average of 2.53% of the state's annual timber harvest volume, based on available data for 2018 through 2024 (USDA Forest Service 2025). Of this, 1.99% is from the Green Mountain National Forest, 0.19% is from Marsh-Billings-Rockefeller National Park, and 0.35% is from state lands. Private timberlands account for the vast majority, or 97.33% of all Vermont timber harvest. (U.S. Department of Defense lands provide the remaining 0.13%.) Not only is public timber harvest a small portion of Vermont's timber supply, but Vermont's timber supply is much greater than estimated lumber, paper, and wood products consumption in

the state (Littlefield et al. 2024). Littlefield et al. estimate that Vermont's "timber harvest balance" (p. 38) is 147%, with harvest and recovery outstripping consumption by 23,000 mcf in 2020.

Figure 6. Vermont Timber Harvest, by Ownership Class
(Annual Average Harvest, 2018-2024 = 67,457 mcf)



Source (USDA Forest Service 2025)

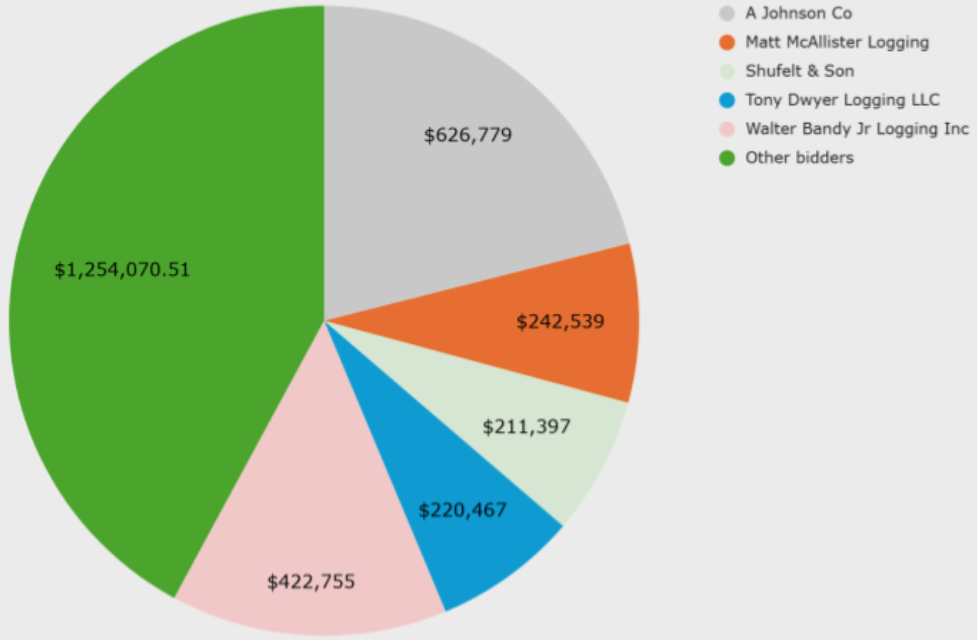
The direct economic contribution of the Vermont logging industry in 2017 was an estimated $116.5 million (adjusted for inflation to 2024 dollars) (*Forest & Wood Products Industries' Economic Contributions: Vermont* 2020). This sum is the value of the industry's output (i.e., sales) and reflects stumpage value plus the value added by the harvest and delivery of logs, chips, or other raw fiber to downstream processors. That downstream processing, including lumber, furniture, paper, and other value-added forest products manufacturing, does represent a further contribution of the raw material to the Vermont economy. The same can be said of other ecosystem services, however. For example, water purification contributes to brewing, dairy production, and other industrial processes. Since we count only the value of water as an input to those industries and do not count the value added by those industries, we do the same with timber so that we can compare raw material value to other ecosystem service values.

By multiplying the public share of Vermont's timber harvest by the output of Vermont's entire logging industry, we estimate that the raw material value supplied by Vermont's Public Conservation Lands to be $2.95 million in 2024 dollars ($116.5 million x 2.53% = $2.95 million), or approximately 0.13% of the economic contribution of the other ecosystem services.

Distribution of Raw Material Value from State Lands

The overall value of timber from Vermont's Public Conservation Lands may be small, but it does benefit some Vermont companies. The distribution of that benefit, however, is concentrated among a small number of firms, with five companies accounting for nearly three-fifths of the value of all recent timber sale contracts. A similar pattern had been true of the Green Mountain National Forest's timber sale program for several decades, with the top seven firms accounting for 90% of the contract value .

Figure 7: Distribution of Vermont State Timber Sale Value, by Winning Bidder (2019-2024, in 2024$)



Source: Vermont Department of Forests, Parks, and Recreation, 2025.

Conclusion: Public Lands for Public Values

In public debates over how to manage public lands, one often hears arguments along the lines of "We can have our cake and eat it too!", meaning we can keep managing public forests for commodity production, and chipping away a piece at a time for development or infrastructure, and still hope to have the flood control, climate regulation, recreational opportunities and other ecosystem services that provide so much value to the public. The trouble with that argument is that once eaten, cake is no longer cake. Natural areas that had been doing just fine (and producing billions in value to the public) as they are, would become less productive for almost all ecosystem service values if they were to be converted to developed uses or ecologically simplified through periodic harvest, however ecologically sensitive that harvest might be. A better metaphorical image, in our view, is that we should be careful not to kill (or otherwise decrease the productivity) of the goose that is laying the golden eggs.

Even though public lands may not be a large proportion of Vermont's total timber harvest volume, the impacts of public land logging on publicly owned forests and their ecosystem services are significant. Over the past decade, since 2016, the GMNF has approved approximately 50,000 stand acres for timber harvest in five major Integrated

Resource Projects,[7] amounting to one quarter of the 194,859 acres suitable for timber harvest in the Green Mountain National Forest (USDA Forest Service, Eastern Region 2006 Appendix A, Table A-6). Given rotational harvest patterns, we can infer that logging impacts will span a significant portion of the GMNF suitable timber base over the next half-century. Thus, even though the percentage of public land logging may be small compared to private land harvests in Vermont, the extent of impacted acreage is substantial within Vermont's relatively small – but critically important – tracts of public conservation land.

As our analysis above shows, the vast majority (>99.8%) of the economic value of Vermont's Public Conservation Lands is delivered as broad public values: recreation, flood control, water quality regulation, and protection against climate change. An extremely minor fraction is delivered in the form of timber, with most of that value benefiting a small number of private firms. Vermont's private lands, meanwhile, supply the vast majority of Vermont's timber supply, and that supply is more than sufficient to meet demand for forest products within the state, with room to spare for exports of logs and value-added forest products.

Vermont's Public Conservation Lands are best, and in some cases uniquely, suited for providing public ecosystem service values. Designating and managing more of these lands as wildlands to maintain and improve their ecological integrity, and therefore their ecosystem service productivity, would help keep that $2.25 billion in value flowing to Vermonters and visitors for the indefinite future, and at little cost in terms of timber value.

Works Cited

Aber, John D, Charles V Cogbill, and Brian M Donahue. 2010. *Wildlands and Woodlands: A Vision for the New England Landscape*. Harvard University.

Ahn, Ashley. 2025. "Trump Executive Order Creates Commission to Open Protected Public Land." U.S. *The New York Times*, July 4. https://www.nytimes.com/2025/07/03/us/politics/trump-executive-order-maba-public-land.html.

Birdsey, Richard, Andrea Castanho, Richard Houghton, and Kathleen Savage. 2023. "Middle-Aged Forests in the Eastern U.S. Have Significant Climate Mitigation Potential." *Forest Ecology and Management* 548 (November): 121373. https://doi.org/10.1016/j.foreco.2023.121373.

Brander, L.M., R.S. De Groot, V. Guisado Goni, et al. 2023. "Ecosystem Services Valuation Database (ESVD)." Foundation for Sustainable Development and Brander Environmental Economics. ..Csv. https://www.esvd.net/.

Casey, Michael, and Christina Larson. 2024. "As UN Conference Nears, Countries Have Made Little Progress toward Biodiversity Goals." News. PBS News, October 21. https://www.pbs.org/newshour/world/as-un-conference-nears-countries-have-made-little-progress-toward-biodiversity-goals.

Costanza, Robert, Ralph d'Arge, Rudolf de Groot, et al. 1997. "The Value of the World's Ecosystem Services and Natural Capital." *Environment: Key Issues for the Twenty-First Century. Valuing the Environment* 387 (May): 22.

Costanza, Robert, Rudolf de Groot, Leon Braat, et al. 2017. "Twenty Years of Ecosystem Services: How Far Have We Come and How Far Do We Still Need to Go?" *Ecosystem Services* 28 (December): 1–16. https://doi.org/10.1016/j.ecoser.2017.09.008.

Costanza, Robert, Rudolf de Groot, Paul Sutton, et al. 2014. "Changes in the Global Value of Ecosystem Services." *Global Environmental Change* 26 (May): 152–58. https://doi.org/10.1016/j.gloenvcha.2014.04.002.

Faison, Edward K., Danelle Laflower, Luca L. Morreale, et al. 2023. "Adaptation and Mitigation Capacity of Wildland Forests in the Northeastern United States." *Forest Ecology and Management* 544 (September): 121145. https://doi.org/10.1016/j.foreco.2023.121145.

[7] The five GMNF Integrated Resource Projects approved in the past decade are: South of Route 9, Robinson, Early Successional Habitat Creation, Somerset, and Telephone Gap.

Faison, Edward K., Susan A. Masino, and William R. Moomaw. 2023. "The Importance of Natural Forest Stewardship in Adaptation Planning in the United States." *Conservation Science and Practice* 5 (6): 12935. https://doi.org/10.1111/csp2.12935.

FB Environmental Associates, Horsley Witten Group, and The University of Maine. 2021. *A Regulatory, Environmental, and Economic Analysis of Water Supply Protection in Auburn, Maine*. City of Auburn, Maine. https://lakeauburnwater.org/wp-content/uploads/2022/06/LakeAuburn_FinalReport_100621.pdf.

Forest & Wood Products Industries' Economic Contributions: Vermont. 2020. Public Sector Consultants.

Foster, David, Emily E Johnson, Brian R Hall, et al. 2023. *Wildlands in New England: Past, Present, and Future*. Harvard Forest, Northeast Wilderness Trust, Highstead Foundation.

"Green Mountain National Forest Management Areas." 2024. Web Feature Servcie ArcGIS user "dan_vermonthuts." Https://services7.arcgis.com/Tnov4kXcO2klXM4Y/arcgis/rest/services/USFSManagement_Areas/FeatureServer/0, September 12. ArcGIS REST. https://www.arcgis.com/home/item.html?id=b797adb6b57e4c7cbeb015728cba8a88.

Johnson, Gary W. 2010. "ARIES: ARtificial Intelligence for Ecosystem Services." Gund Institute AIRES Workshop, University of Vermont, Burlington, Vermont, March.

Kellett, Michael J., Joan E. Maloof, Susan A. Masino, et al. 2023. "Forest-Clearing to Create Early-Successional Habitats: Questionable Benefits, Significant Costs." *Frontiers in Forests and Global Change* 5 (January): 1073677. https://doi.org/10.3389/ffgc.2022.1073677.

Leopold, Aldo. 1990. *A Sand County Almanac: With Essays on Conservation from Round River*. 29. pr. Ballentine Books.

Littlefield, Caitlin, Brian Donajue, Paul Cantanzaro, et al. 2024. *Beyond the "Illusion of Preservation": Taking Regional Responsibility by Protecting Forests, Reducing Consumption, and Expanding Ecological Forestry in New England*. Harvard Forest, University of Vermont, et al.

Moomaw, William R., Susan A. Masino, and Edward K. Faison. 2019. "Intact Forests in the United States: Proforestation Mitigates Climate Change and Serves the Greatest Good." *Frontiers in Forests and Global Change* 2 (June): 27. https://doi.org/10.3389/ffgc.2019.00027.

Multi-Resolution Land Characteristics Consortium [MRLC], and United States Geological Survey [USGS]. 2023. "National Land Cover Database [NLCD]." Version 2023. https://www.mrlc.gov/nlcd2011.php.

Northern Forest Alliance. 2002. *Shaping the Northern Forest Economy: Strategies for a Sustainable Future, Foreword by Bill McKibben*. Northern Forest Alliance.

Office of Management and Budget. 2024. *Guidance For Assessing Changes In Environmental And Ecosystem Services In Benefit-Cost Analysis*. Executive Office of the President. https://www.whitehouse.gov/wp-content/uploads/2024/02/ESGuidance.pdf.

Office of Science and Technology Policy, Office of Management and Budget, and U.S. Department of Commerce. 2023. *National Strategy to Develop Statistics for Environmental-Economic Decisions: A U.S. System of Natural Capital Accounting and Associated Environmental-Economic Statistics*. OSTP, OMB, & USDOC. https://www.whitehouse.gov/wp-content/uploads/2023/01/Natural-Capital-Accounting-Strategy-final.pdf.

OpenStreetMap Contributors. 2025. "OpenStreetMap." Https://www.openstreetmap.org/, June 11. https://osmfoundation.org/.

PAD-US Team. n.d. "GAP Status Code Frequently Asked Questions (FAQ) | U.S. Geological Survey." USGS GAP Analysis Project. Accessed May 20, 2025. https://www.usgs.gov/programs/gap-analysis-project/gap-status-code-frequently-asked-questions-faq.

Pearce, David W., Giles Atkinson, and Susana Mourato. 2006. *Cost-Benefit Analysis and the Environment: Recent Developments*. With Organisation for Economic Co-operation and Development. Organisation for Economic Co-operation and Development.

Phillips, Spencer. 1994. *Toward a Sustaining Forest: Development Opportunities for the Maine Woods.* The Wilderness Society.

Phillips, Spencer. 2004. “Windfalls for Wilderness: Land Protection and Land Value in the Green Mountains.” Virginia Polytechnic Institute and State University, Agricultural and Applied Economics.

Roman, Joe. 2018. *Vermont’s Return on Investment in Land Conservation*. Trust for Public Land. https://www.tpl.org/wp-content/uploads/2018/09/Vt.ROI_.8_16_18final.digital.pdf.

Thom, Dominik, Marina Golivets, Laura Edling, et al. 2019. “The Climate Sensitivity of Carbon, Timber, and Species Richness Covaries with Forest Age in Boreal–Temperate North America.” *Global Change Biology* 25 (7): 2446–58. https://doi.org/10.1111/gcb.14656.

Trucost Plc and TEEB for Business Coalition. 2013. *Natural Capital at Risk: The Top 100 Externalities of Business*. https://naturalcapitalcoalition.org/wp-content/uploads/2016/07/Trucost-Nat-Cap-at-Risk-Final-Report-web.pdf.

Underwood, Kristen, and David Brynn. 2015. *Enhancing Flood Resiliency of Vermont State Lands*. South Mountain Research & Consulting, and Vermont Family Forests. https://legislature.vermont.gov/Documents/2022/WorkGroups/House%20Natural/Use%20Value%20in%20Vermont/W~David%20Brynn~Enhancing%20Flood%20Resiliency%20of%20Vermont%20State%20Lands%20-%202105%20Report~1-19-2022.pdf.

United Nations Environment Programme, ed. 2010. *Mainstreaming the Economics of Nature: A Synthesis of the Approach, Conclusions, and Recommendations of TEEB*. The Economics of Ecosystems & Biodiversity. UNEP.

“United States - Census Bureau Search.” n.d. Accessed May 23, 2025. https://data.census.gov/all?q=United+States&g=040XX00US50.

United States Geological Survey [USGS] Gap Analysis Project [GAP]. 2024. “Protected Areas Database of the United States [PAD-US] 4.” PAD-US 4. Version 4. U.S. Geological Survey. https://doi.org/10.5066/P96WBCHS.

USDA Forest Service. 2012. “National Forest System Land Management Planning.” *Federal Register* 77 (68): 21162.

USDA Forest Service, Eastern Region. 2006. *Green Mountain National Forest Land and Resource Management Plan*. Land and Resource Management Plan Nos. R9-GM-FP. USDA Forest Service.

USDA Forest Service, Forest Inventory and Analysis Program. 2025. “Forest Inventory EVALIDator.” Web-application. Version 2.1.5. St. Paul, MN, May 27. https://apps.fs.usda.gov/fiadb-api/evalidator.

Vermont Agency of Natural Resources. 2022. “ANR Land Dataset (Unit).” Spatial Data (Vector). Vermont Center for Geographic Information Open Geodata Portal, June 16. ESRI Shapefile. https://geodata.vermont.gov/maps/391e5d445fc94dfba7585569126438ad/about.

Vermont Center for Geographic Information [VCGI]. 2024. “Vermont Data - Town Boundaries.” GIS Polygon. Vermont Open Data Portal, July 30. Geopackage (.gpkg). https://geodata.vermont.gov/maps/3f464b0e1980450e9026430a635bff0a_0.

Vermont Department of Forest Parks & Recreation. 2025. “Vermont Timber Sale Contract Data, 2000-2024, with Details from 2019-2024.”

Vermont Housing & Conservation Board, and Nature 4 Justice. 2025. *Act 59 of 2023 (10 V.S.A. Section 2803(b)) Inventory Report: Introduction, Overview, and Themes*. Vermont State Legislature. https://legislature.vermont.gov/Documents/2026/Workgroups/House%20Environment/Reports%20and%20Resources/W~Vermont%20Housing%20and%20Conservation%20Board~Act%2059%20of%202023%20Inventory%20Report~1-30-2025.pdf.

Vermont Laws, 10 V.S.A. § 2607. Accessed August 8, 2025. https://legislature.vermont.gov/statutes/section/10/083/02607.

Wilderness Act, Pub. L. Nos. 88–577, 16 U.S.C. (1964).