A Sustainable Redesign of the Secure Rural Schools Act

Allocating County Payments According to Maintenance and Improvement of Ecosystem Services on Federal Lands

Oregon Wild

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Written by

Shannon Bell
Oregon Wild

With assistance from

Lauren Anderson
Steve Pedery
Oregon Wild

Executive Summary

Less than one percent of relatively undisturbed old growth forests remain in the lower 48 U.S. states (Bryant et al. 1997). Most of these forests lie in isolated patches on federally protected lands, so fragmented that the network of species they support is diminishing. Though federal forestland has received increasing protection over the past several decades, logging persists, and mature forests continue to shrink. The Secure Rural Schools and Community Self-Determination Act (SRS), which Congress passed in 2000, was meant to cushion the economic blow of declining timber harvests in regions like the Pacific Northwest, where the timber industry has been both a key part of the economy and the culture. If public land management efforts are to meet increasing conservation challenges presented by habitat loss and climate change, county payments must be less focused on compensating counties for the loss of logging and more focused on incentivizing ecosystem conservation and restoration that protects and supports mature forest habitats.

Congress enacted SRS in 2000, replacing the previous revenue-sharing program that had provided counties containing federal forestland with a portion of the revenue generated from logging those lands. Over the last several decades of the 20th century, federal forestlands received increasing protection, leading to lower timber harvests and increasingly inconsistent revenue-sharing payments. The SRS payments were meant to be a temporary solution, providing more stable funding to struggling counties as the federal forest agencies shifted to more sustainable logging practices. However, Congress has continued to reauthorize the program, and many rural counties have continued to advocate for extractive approaches to federal forestland management.

Federal forestlands continue to face habitat fragmentation and degradation as a result of extractive management approaches, such as fire suppression and logging. Though forests serve as hotbeds of biodiversity and huge nature-based climate solutions, programs like SRS oriented around forest-based economies continue to focus on traditional economic valuation that prioritizes the extractive value of forests. Mature forests, however, hold ecological, social, cultural, and spiritual value that is not adequately accounted for by public land management agencies.

A revised county payment formula must embrace a more holistic perspective on the value of federal forestlands. To better capture the ecological, social, cultural, and spiritual value of these lands, the new formula should be redesigned to better incorporate several indices related to forest ecosystem condition, including a:

- habitat suitability index
- structural diversity index
- tree species diversity index
- wildlife diversity index
- riparian habitat quality index
- carbon sequestration index
- recreation resources availability index

For each forested area under consideration, the indices should be scaled and weighted such that the indices most correlated with ecosystem health most influence the combined index. The weighted average of these index values will produce the combined index, called the Ecosystem Services Value Index (ESVI).

County payments should still be calculated as the product of the full funding amount for the SRS program and the share for each eligible county. However, to provide incentive for counties to push for additional protection of federal lands, the program should instead cover all federally protected areas, including Wilderness Areas and Wild and Scenic River areas, rather than just National Forests, Oregon and California Railroad Revested (O&C) lands, and Coos Bay Wagon Road (CBWR) lands. The share that each eligible county is entitled to under the program should also be increasingly influenced by the ESVI associated with the federally protected land located within the boundaries of that county. A weighted average of the share of federally protected land in the county, the share of the highest revenue-sharing payments received by the county, and the county's share of total ESVI across federally protected lands should determine the county's share of SRS funding. This average should be recalculated every four years, and the weight of the historical revenue-sharing payments should decrease by 20 percent with each recalculation, gradually shifting from a framework that emphasized timber to one based on protection and restoration of public values. The ultimate removal of historical timber payments from the SRS formula would help eliminate the current incentives that lead counties to aggressively advocate for increased logging and introduce greater incentive for counties to push for investments in conservation.

A revised county payment framework would not only serve as a powerful tool in increasing public lands conservation, but it would also provide an opportunity to expand collaboration and promote inclusivity in federal forestland management. Shifting the focus of SRS away from timber harvests and towards more sustainable ecosystem services creates an opportunity to engage stakeholders in the management planning process. The SRS program can therefore provide both an incentive to cultivate diverse and resilient forest ecosystems and a pathway to a more just and inclusive approach to public lands management.

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History of County Payments

The Origin of County Payments

The Forest Service first began allocating a portion of its timber revenue to the counties containing federal forestland in the early 20th century. In 1906, Congress first directed the agency to share its revenues with the counties in which the timber harvests took place. Congress required the Forest Service to pay 25% of its gross annual revenues from timber sales to the states to pay for road and school improvements. However, over the course of the 20th century, timber payments became increasingly inconsistent. From the mid-1980s to 2000, the payments fluctuated an average of nearly 30% each year. With the aim of providing more reliable and consistent payments, Congress enacted the Secure Rural Schools and Community Self-Determination Act (SRS) in 2000. The Act was only meant to provide temporary relief to timber-dependent counties and was set to expire in 2006, but it was extended and has been reauthorized almost every year since its enactment (Hoover, 2020). As management of public forestlands increasingly incorporated more conservation objectives, SRS was meant to serve as a bridge to a future in which these historically timber-dependent counties were less reliant on natural resource extraction.

Secure Rural Schools Payment Framework

When SRS was first enacted, each county payment was calculated as the average of the three highest payments received by each county between FY1986 and FY1999. In 2008, the formula was modified, and the total SRS payment available to eligible counties was set to decline by 5% annually. The SRS county payment contains allocations for Title I, Title II, and Title III projects. Counties receiving the largest payments are required to allocate more funds to Title II and Title III projects, and counties receiving the lowest payments may allocate most or all of their funds to Title I projects. Title I payments are restricted to improvements for roads and schools. Title II payments are used for conservation or restoration projects that benefit the federal lands contained within the county. Title III payments are allocated to other, more specific county purposes. Fifteen-member collaborative groups containing broad representation of industry and expertise, called Resource Advisory Committees (RACs), provide recommendations on what Title II conservation and restoration projects should be implemented on federal land (Hoover, 2020).

Inconsistency in County Payments

The SRS program has provided substantial support to rural counties with an abundance of federal forestland. However, in recent years, reauthorization efforts have faced more resistance, and the program has become a far less reliable source of funding. Revenue-sharing counties are even more dependent on inequitable and unreliable payments, and they have failed to diversify economically (Haggerty, 2018). The lingering hope for continued appropriations and revival of the timber industry has kept many Northwest counties from exploring other industries and transitioning their local economies (Mortenson, 2012). Each reauthorization of the SRS program is hard fought, and the authorization lapsed in FY2016, leading to sharp declines in county payments. Instability in county payment structures has stifled momentum towards alternative economies, perpetuating extractive approaches to federal forestland management and hindering progress towards more conservation-focused management strategies.

Ecosystem Services and Management on Federal Land

The Biden administration announced in July of 2021 that it would end large scale logging of old growth forests in the Tongass National Forest in Alaska (Davenport, 2021). However, regions like the Pacific Northwest with a long history of vigorous old-growth timber harvesting remain vulnerable. In areas of the Pacific Northwest that the Northern Spotted Owl has historically inhabited, old growth forest cover has declined by 70 percent over the past three decades, due to continued logging and forest conversion (Mandel, 2021). Though SRS was meant to serve as a bridge to a future in which rural counties were less dependent on timber harvests from federal forestlands, the culture of extraction on these lands persists, degrading forest ecosystems.

After over a century of fire suppression, many forests on public lands are experiencing far less frequent fires than they are adapted to. Anthropogenic climate change, on top of already high fuel loads, is spurring more frequent high-severity wildfires (Halofsky et al. 2020). Meanwhile, forests remain underutilized as a climate change mitigation solution. Pacific Northwest forests, for example, have vastly untapped carbon sequestration potential. However, federal forestlands continue to undersupply ecosystem services that could protect forest communities and mitigate the ongoing climate crisis. As long as public land management agencies lack an effective decision support framework to guide ecosystem service management approaches, progress toward optimal sustainable management will lag.

Decreased Fire Resistance and Resilience

After over a century of fire suppression, many fire-adapted forest ecosystems on public lands are experiencing far less frequent fires. These forests are far denser, with a larger proportion of species on the landscape that are sensitive to fire and drought, especially at higher elevations (Merschel et al. 2021). Ponderosa pine, which historically dominated the fire-adapted forests of the east Cascades in Oregon, is now facing competition from shade-tolerant grand fir, white-fir, and Douglas-fir (Merschel et al. 2021). Furthermore, the age structure in Oregon's forests is far more homogenous than it was historically, since old trees were selectively logged (Merschel et al. 2021). This leaves far fewer fire-resistant trees on the landscape to serve as seed sources and promote regeneration following wildfire.

Along with providing increased fire resistance to forest ecosystems, large diameter trees contribute to critical ecosystem processes like water and nutrient cycling (Lindenmayer & Laurance, 2017). Large old trees also increase drought tolerance, reduce flooding risk, redistribute soil water, and connect mycorrhizal networks (Mildrexler et al. 2020). Logging, in selectively removing these trees, alters the microclimate, structure, and species composition of forest ecosystems (Lindenmayer et al. 2009). This can result in increased buildup of wildfire fuels, more prevalent ignition points, and more homogenous, young stands (Lindenmayer et al. 2009). As logging activity continues on private lands, efforts to conserve old growth trees, as well as large-diameter trees and structure, where appropriate, are critical on federal forest lands.

Untapped Carbon Sequestration Potential

Climate change mitigation represents one of the most critical services provided by forest ecosystems, with large-diameter trees sequestering a disproportionate amount of carbon on the landscape. On average, half of the live tree biomass in all forest types around the world is stored in the largest 1% of trees (Mildrexler et al. 2020). These large trees also have deep roots, allowing for more sequestration and transfer of carbon belowground (Kauppi et al. 2015). When these trees die, they take much longer to decay, resulting in long-lasting carbon stores in snags or coarse woody material (Kauppi et al. 2015).

Changes in forest management, including deferred timber harvest, riparian restoration, and reforestation, can have substantial positive impacts on carbon sequestration (Graves et al. 2020; Law et al. 2018). Depro et al. (2008), in demonstrating the carbon sequestration potential of public forestlands, showed evidence that ceasing timber harvest altogether would result in a 43% increase in carbon sequestration levels on public forestlands. Therefore, by substantially reducing or deferring timber harvests, there is potential to significantly increase carbon storage on federal forestlands.

Ecosystem Service Management Guidance

The Forest Service introduced a Planning Rule in 2012 that set guidelines for national forest management that emphasizes ecosystem services (Nie, 2019). Judge Dwyer's ruling in *Seattle Audubon Society v. Lyons* (1994) also set precedent for land managed by the BLM, stating that management for multiple uses meant ensuring that logging does not inhibit the preservation of wildlife. However, agencies have wide discretion to enhance or degrade ecosystem services and still lack a clear mandate to invest their resources and capacity in ecosystem service approaches (Schaefer et al. 2015). Public land management agencies also lack sufficient technical guidance on ecosystem service assessment and would benefit from having a decision support framework that can be adapted to various national forest ecosystems (Schaefer et al. 2015). As of now, there exist at least eleven different ecosystem service frameworks, making it difficult for decision-makers to discern what ecosystem services should be included in analysis (Crook et al. 2021). Therefore, to harmonize competing management objectives on public lands and promote ecosystem services consistently and equitably across all federal lands, agencies must be provided with specific decision-making standards and formulae and required to consult with relevant stakeholder groups, including Indigenous communities.

A New Ecosystem Service-Focused Payment Framework

Indices

Ecosystem services are integrated into this reformed county payment formula in the form of indices. The formula incorporates some of the most developed indices, including habitat suitability, structural diversity, tree species diversity, wildlife diversity, riparian habitat quality, carbon sequestration, and recreation resource availability indices. These indicators of forest condition and management cover a broad swath of ecosystem services and emphasize ecological, economic, social, and cultural values.

Habitat Suitability

Protection and restoration of mature forest habitat is critical for the conservation of at-risk species and preservation of important ecological functions. Northern Spotted Owl populations, for example, have declined precipitously throughout the Pacific Northwest, due to both old growth forest habitat loss and competition from the invasive barred owl. However, recent research shows that maintaining and expanding spotted owl habitat facilitates increased territory occupancy and dispersion across different forested areas (Franklin et al. 2021). The Northern Spotted Owl is an important indicator species for forests of the Northwest, meaning that their threatened status reflects larger ecological crises in the region. Therefore, it is essential that any effort to support and restore ecosystem function heavily consider the effects of management on such at-risk species.

The Forest Service already employs one version of a habitat suitability index, largely applicable to large game like elk and deer, called ArcHSI. This index includes the habitat values for both forage and cover. For elk and deer, the index also incorporates the distribution of feeding and cover, along with road effects.

In most cases, large game like deer and elk are not the primary species of concern in forest ecosystems. Therefore, in order for the habitat suitability index to reflect the overall condition of available forest habitat, the focal species included in the index should be important indicator species, identified by forest ecologists. The index should also incorporate other endangered or threatened species listed at the federal level, or species of concern listed at the state level. Oregon's Conservation Strategy, for example, identifies 294 Strategy Species "of greatest conservation need" that include species not listed at the federal level. The habitat suitability index's parameters should be tailored to each focal species' individual needs, focusing on the measurable habitat qualities that promote their survival and successful reproduction.

Big game habitat as indexed by Arc HSI is just one example of a habitat-centered approach. In practice, the habitat needs of at-risk species and indicator species should be given priority. Decisions on what species should be included in the habitat quality index for a particular protected area should be made by forest ecologists, in collaboration with surrounding Tribal Nations. Required consultation with surrounding tribes promotes further consideration of species' specific importance, including their cultural value, to regional Indigenous communities.

Structural Diversity

Greater diversity in forest structure ensures a wider range of habitats and supports a higher level of biodiversity (Lexerød & Eid, 2006). Structurally diverse forests with variable canopy cover and multiple layers of vegetation have many different micro-environments that can support diverse sets of species (Grotta & Withrow-Robinson, 2017). Ensuring diversity in stem diameter therefore helps support biodiversity and create refuges for at-risk native species.

Tree size diversity indices can be used to compare the structural diversity of different areas of forest (Lexerød & Eid, 2006). The Shannon diversity index is commonly used in forest management to quantify structural diversity. The index is based on the proportion of basal area, the cross-sectional area of trees at breast height, for various diameter size classes (Lexerød & Eid, 2006). If all of the basal area is occupied by a single diameter size class, meaning the forest is totally homogenous in structure, the value of the index is zero. The maximum possible value for the index is equal to the natural logarithm of the total number of diameter classes (S) in the forest, represented as ln(S). This maximum value indicates that basal area is evenly distributed across all diameter classes (Lexerød & Eid, 2006).

The index is calculated using the following equation (Shannon, 1948):

$$H' = -\sum_{i=1}^{S} p_i ln(p_i)$$

Where H' is the index value, S is the number of diameter classes, and p_i is the proportion of basal area for a given diameter class, i.

Tree Species Diversity

Forests with a high level of tree diversity contain both a wide array of species and a vast range of sizes and ages. Dead standing and fallen trees, along with charred wood, also support increased levels of biodiversity in a forest (Lähde et al. 1999). Forests with more diversity in tree species also provide higher levels of multiple ecosystem services like soil carbon storage and berry production (Gamfeldt et al. 2013). Thus, management that promotes higher levels of tree species diversity and leaves dead standing and fallen trees on the landscape results in positive impacts on many diverse ecosystem services that support both human and wildlife communities.

Lähde et al. 1999 developed the LLNS diversity index, based on indicators of biodiversity in tree species. These indicators include stem distribution by tree species (stems ha^{-1}), basal area of growing stock (m^2 ha^{-1}; density in sapling stands, stems ha^{-1}), standing dead trees by tree species (m^3 ha^{-1}), fallen dead trees by tree species (m^3 ha^{-1}), coverage or relative density of undergrowth (%), occurrence of special trees (significance and/or number), and charred wood (m^3 ha^{-1}) (Lähde et al. 1999). The stems of trees are divided into three diameter groups representing small, medium, and large trees. Special trees include exceptionally old or large trees, as well as rare subspecies, varieties, and forms (Lähde et al. 1999). These trees are not only important to maintain in order to support ecological diversity, but they are important contributors to the genetic diversity of a forest (Lähde et al. 1999). Charred wood is not differentiated by species.

The equation for the LLNS index is as follows:

$$IND_{FS} = IND_{LT} + IND_{DST} + IND_{DFT} + IND_{CW} + IND_{SP}$$

Where IND_{FS} is the LLNS index for the entire stand, IND_{LT} is the diversity index for living trees, IND_{DST} is the diversity index for dead standing trees, IND_{DFT} is the diversity index for dead fallen trees, IND_{CW} is the diversity index for charred wood (values= 0, 0.5, or 1), and IND_{SP} is the diversity index for special trees (values= 0, 0.5, or 1) (Lähde et al. 1999).

Wildlife Diversity

Native forests have some of the greatest species richness and diversity on earth (Lindenmayer, 2009). However, forest conversion and logging can alter or remove essential habitat and introduce invasive species that can outcompete or prey on native species (Lindenmayer, 2009). In comparing the mature forests of headwater regions in Oregon with logged forests downstream, Corn and Bruce Bury (1988) found that unlogged forest streams had significantly higher amphibian species richness than logged forest streams. Furthermore, the density of all amphibian species examined was significantly higher in the unlogged forest streams, indicating that preservation of old-growth habitat has a positive effect on both diversity and abundance of such species.

Loss of biodiversity, which can occur through habitat loss or introduction of highly competitive invasive species, degrades ecosystems and the services they provide. Over one-third of national animal symbols that hold cultural and historical significance in their associated countries are threatened, making biodiversity a key cultural service (Hammerschlag & Gallagher, 2017). Meanwhile, biodiversity is also the foundation of a thriving global economy, providing food, water, shelter, and raw materials for every product on the market. Therefore, by quantifying the effect of forest management on wildlife diversity, forest managers can support the existence of at-risk wildlife species and simultaneously increase provision of the cultural, economic, ecological, and spiritual services that depend on those species.

The Shannon diversity index can provide a measure of species diversity in different taxonomic groups (e.g. birds, fungi, arthropods, ungulates). These scores can then be scaled to fall between 0 and 100 and averaged to obtain an overall species diversity value for the ecosystem in question.

Riparian Habitat Quality

Riparian habitats support high levels of biodiversity, buffer forest ecosystems from large disturbances, stabilize aquatic ecosystems, and provide habitat and food for wildlife species (Munné et al. 2003). Diverse populations of riparian vegetation capture nutrients that are cycled throughout the surrounding ecosystems. Riparian organic matter can also support a diversity of food webs in both aquatic and terrestrial ecosystems. Finally, structurally and biologically diverse riparian habitats reduce downstream flooding by absorbing excess water (Riis et al. 2020).

Munné et al. 2003 developed a QBR index to assist in quantifying the quality of riparian habitat across different geomorphological and ecological conditions. The index is based on four components: total riparian vegetation cover, cover structure, cover quality, and channel alterations (Munné et al. 2003). The index score ranges from 0 to 100 points. It must be calculated in lengths of 50m in upstream areas of the waterway or 100m in middle and lower stretches of the waterway (Munné et al. 2003). The QBR index is the sum of four scores, each containing values of either 0, 5, 10, or 25 (Munné et al. 2003). The scores are calculated for total riparian vegetation cover, cover structure, cover quality, and channel alterations (Munné et al. 2003).

Total vegetation cover is assessed for both the main channel and the surrounding banks. It includes any type of tree, bush, shrub, or helophyte (perennial marsh plant) (Munné et al. 2003). The connectivity between riparian habitat and adjacent terrestrial habitat is used to refine the index score, given that it represents a key factor in the preservation of biodiversity (Munné et al. 2003).

Vegetation cover structure is scored according to the total percentage of cover occupied by trees (Munné et al. 2003). The score may increase with the presence of shrubs and other vegetation underlying the trees (Munné et al. 2003). Helophytes and other vegetation in the main channel of the waterway also contribute to a higher score for vegetation cover structure (Munné et al. 2003). Linear arrangements of trees, like those found in tree plantations, or fragmented clusters of trees will decrease the score (Munné et al. 2003).

The cover quality score depends on the number of native trees present along the stretch of waterway in question (Munné et al. 2003). Since the number of tree species present in and along a waterway will vary according to river geomorphology, the index categorizes streams into three types. These types are defined according to the total geomorphological score, which is based on the form and slope of the riparian environment (Munné et al. 2003). The cover quality score can be raised if the native riparian forest is continuous along the waterway or if the species are distributed in corridors (Munné et al. 2003). The score decreases if there are non-native trees present or if the habitat has been modified by man (Munné et al. 2003).

The score for channel alteration will be zero if there are permanent continuous structures physically separating the riparian habitat from the aquatic habitat (Munné et al. 2003). When these channel barriers are not continuous or exist in less than one-quarter of the waterway in question, the alteration score is 5 points. Modification of channels that constricts waterways results in a score of 10 points.

The sum of all the above scores provides the final QBR index.

Carbon Sequestration

Forests in the western United States, especially those that are highly productive and have low vulnerability to fire and drought, are a key climate mitigation strategy. Research shows that these forests could account for up to one-fifth of the global carbon sequestration potential for all temperate and boreal forests by the end of the century, offsetting up to six years of current fossil fuel emissions (Buotte et al. 2020). Forests with high sequestration potential also have high above and belowground carbon density, high tree species richness, and a high proportion of critical habitat for endangered species, meaning that promoting carbon sequestration can also support the provision of multiple other ecosystem services (Buotte et al. 2020).

An index developed by Pascual et al. (2021) interpolates the productivity of vegetative biomass in a given area, assigning values for carbon sequestration potential to areas with lower amounts of aboveground biomass. The carbon sequestration potential index (CSPI) is calculated by multiplying the ratio of gross primary productivity (GPP; measured in kg m^{-2} $year^{-1}$) and aboveground carbon density (ACD; measured in kg C m^{-2}) by the proportion of a given area lacking sufficient forest cover (1 – FC):

$$CSPI = \left(\frac{GPP}{ACD}\right) \times (1 - FC)$$

With the carbon sequestration potential index, the value decreases as forest cover increases, leading to values approaching zero for areas reaching full sequestration potential. In order for the index's values to instead increase as the areas under consideration sequester more carbon, the CSPI values must be translated into a new carbon sequestration index (CSI):

$$CSI = \frac{\left(\frac{GPP}{ACD} - CSPI\right)}{\left(\frac{GPP}{ACD}\right)}$$

With this formula, as long as the values for GPP and ACD are above zero, CSI will increase as the carbon sequestration on the landscape reaches its full potential. Thus, at an FC of 1, the CSI would equal 1. At an FC of 0, the CSI would equal zero.

Recreation Resources Availability

The National Park Service recorded over 237 million recreation visits to national parks in the United States in 2020 (NPS, 2021). The Forest Service estimates that there are over 150 million national forest visits per year (Warren, 2018). In 2018, the Forest Service collected almost $80 million in revenue from recreation, double the amount provided from timber sales, grazing and mining (USDA, 2018). Public lands have provided the space for many people who would not otherwise have access to recreational opportunities to appreciate diverse natural landscapes. It is important to note, however, that public lands, like all lands in the United States, have excluded and discouraged visitation from certain groups. An effort to protect these lands and promote equity in their accessibility is essential in helping Americans of all means and backgrounds connect with their environment.

The recreation resources availability index is formulated by combining models based on both supply and demand factors that influence potential visitation. The model based on supply focuses on the forest structure characteristics, the amenities at the location in question, and the distribution of the surrounding population (Tardieu & Tuffery, 2019). Variables incorporated into the supply model include the population within a 2km buffer of the site, the share of various forest types at the site, the amount of hiking paths, the number of natural and cultural points of interest, the amount of waterways and water bodies, and the elevation (Tardieu & Tuffery, 2019).

The model based on demand is derived using travel cost methods. The trip cost and generic predictors of individual demand can be used to derive a recreation demand function (Tardieu & Tuffery, 2019). The trip cost is the total cost of traveling to and staying at the location in question combined with the opportunity cost of the time spent on that trip. With very localized analyses, opportunity cost becomes negligible. Variables in the demand model include the annual number of visits per visitor, the trip cost, the median individual net income, and the availability of substitutes (Tardieu & Tuffery, 2019).

The supply and demand models are used to produce a recreation resources supply index (RRSI) and recreation resources demand index (RRDI). The geometric mean of these indices represents the combined availability index (CAI) for the location in question. A high value for the CAI represents both high supply of recreation resources and high demand for access to those resources (Tardieu & Tuffery, 2019).

Developing the Ecosystem Services Value Index

All indices must first be scaled such that they contain values between 0 and 100. Then, in order to ensure that the ESVI reflects the value of the most relevant ecosystem services in various environmental contexts, the value of each index must be weighted. These weights must represent the social and ecological priorities of the landscape, which will differ based on the local climate, species composition, and surrounding communities. Decisions made by the Forest Service have consistently emphasized the economic value of forest resources, though these ecosystems hold much more extensive value in terms of their ecological functions and cultural significance. Prioritizing certain ecosystem services, like provision of timber, across the landscape may result in adverse ecological effects and continuing degradation of cultural and recreational resources. Therefore, it is necessary to create a flexible combined index that can accommodate differing ecological, social, cultural, and economic priorities and help generate progress towards the most sustainable outcomes for public lands and their surrounding communities.

The potential to sequester carbon and rate of accumulation of live biomass, for example, has been shown to differ between ecoregions (Hudiburg et al. 2009). In Oregon, the Coast Range and Klamath Mountains have the highest amount of live biomass and thus sequester and store a disproportionate amount of carbon (Hudiburg et al. 2009). The East Cascades and Blue Mountains, by contrast, do not hold the same potential to sequester carbon, and actually may benefit from sequestering less carbon than technically feasible on the landscape (Hudiburg et al. 2009). Mitchell et al. (2009) found that East Cascades ponderosa pine forests with uncharacteristic levels of understory fuel accumulation benefited from fuel reduction treatments, though those treatments immediately reduced aboveground live biomass. National forests are mandated to be managed for multiple uses, meaning that sustainable management in different parts of the country may require different prioritization of certain objectives (Gray & Whittier, 2014). In the case of dry forest types like those found in the East Cascades, reducing wildfire severity and restoring habitat conditions similar to those found prior to a century of fire suppression may be more sustainable than striving to maximize carbon storage (Gray & Whittier, 2014). Furthermore, investments in wildfire resistance and resilience can pay off in terms of carbon sequestration over time, as wildfires may burn less severely and leave more live aboveground biomass that can continue sequestering carbon.

Decision-making on how to weight the various indices should fall on forest planning committees, with required representation of surrounding Tribal Nations. These decisions must be based on set environmental metrics, including population densities of focal species, wildfire risk, habitat connectivity, net primary productivity (NPP), maximum live biomass, and aquatic indicator species population densities, to provide a more structured decision-making framework. The weighted average of these indices represents the ESVI, which will fall between 0 and 100. This index will then be incorporated into the county payment allocation formula.

Formula

Current Formula

The general formula for the current SRS allocation process involves a total funding amount, available for all eligible counties, multiplied by the adjusted proportion of that amount designated for a particular eligible county. The sum of these payments for all eligible counties in a state equals the total state payment.

$$State\ Payment = \sum (Full\ Funding\ Amount \times Adjusted\ Share\ for\ Each\ Eligible\ County)$$

<u>Adjusted Share</u>

The adjusted share for each eligible county is simply the initial base share of that county, with an included income adjustment, divided by the sum of base shares for all eligible counties. This ensures that the proportions designated for all eligible counties sum to one.

$$Adjusted\ Share = \frac{\left(\frac{Base\ Share}{Income\ Adjustment}\right)}{\left(\sum \frac{25\%\ Base\ Share}{Income\ Adjustment} + \sum \frac{50\%\ Base\ Share}{Income\ Adjustment}\right)}$$

<u>Base Share</u>

The base share represents each eligible county's initial entitlement to federal funds. It is the average of that county's share of federal forestland and that county's share of revenue-sharing payments.

$$Base\ Share = \frac{\left(\frac{Acres\ of\ Federal\ Land\ in\ County}{\sum All\ National\ Forest\ and\ BLM\ Land} + \frac{Average'High\ 3'\ 25\%\ Payments}{\sum All\ 25\%\ and\ 50\%\ Payments}\right)}{2}$$

<u>Income Adjustment</u>

An income adjustment is included as a part of the adjusted share formula to ensure that the socioeconomic status of counties is accounted for, and that counties with lower per capita personal income are slightly favored in county payment allocations.

$$Income\ Adjustment = \left(\frac{County\ Per\ Capital\ Personal\ Income}{Median\ Per\ Capita\ Personal\ Income\ in\ All\ Eligible\ Counties}\right)^2$$

Ecosystem Services-Focused (ESF) Formula

In the revised county payment framework that emphasizes ecosystem service provision, the general formula for county payment allocation remains the same.

$$State\ Payment = \sum (Full\ Funding\ Amount \times Adjusted\ Share\ for\ Each\ Eligible\ County)$$

ESF Adjusted Share

The process of adjusting counties' base shares also remains the same as in the current framework.

$$Adjusted\ Share = \frac{\left(\frac{Base\ Share}{Income\ Adjustment}\right)}{\left(\sum \frac{25\%\ Base\ Share}{Income\ Adjustment} + \sum \frac{50\%\ Base\ Share}{Income\ Adjustment}\right)}$$

ESF Base Share

The calculation for the base share in the revised county payment framework involves taking the weighted average of each county's share of federally protected land, revenue-sharing payments, and total ecosystem service index values on federally protected land. Federally protected land includes land in the National Park System, National Forest System, National Conservation Lands, and National Recreation Areas. The base share will be recalculated every 4 years, to allow for comprehensive measurements and incentivize both short-term and long-term investments in forest ecosystem condition.

The formula in the first year:

$$\frac{\left(1 \times \left(\frac{Acres\ of\ Federally\ Protected\ Land}{\sum All\ Federally\ Protected\ Land}\right) + 1 \times \left(\frac{Average\ 'High\ 3'\ 25\%\ Payments}{\sum All\ 25\%\ and\ 50\%\ Payments}\right) + 1 \times \left(\frac{County\ ESVI}{\sum ESVI\ on\ All\ Eligible\ Counties}\right)\right)}{3}$$

With each recalculation of the payment every 4 years, the weight associated with timber receipts decreases by 20%. For example, the first recalculation would look like:

$$\frac{\left(1.10 \times \left(\frac{Acres\ of\ Federally}{\sum All\ Federally\ Protected\ Land}\right) + 0.80 \times \left(\frac{Average' High\ 3'\ 25\%\ Payments}{\sum All\ 25\%\ and\ 50\%\ Payments}\right) + 1.10 \times \left(\frac{County\ ESVI}{\sum ESVI\ on\ All\ Elivgible\ Counties}\right)\right)}{3}$$

After 20 years, the weight of historical timber receipts in calculating eligible county's base shares would reach zero, and the proportion of federally protected land and ecosystem service values would solely determine a county's base share.

Determining County ESVI

Within each federally protected area, public land management agencies will identify several areas in which they will take measurements to determine the ESVI. These ESVI values will then be averaged to obtain the ESVI value associated with that federally protected area.

To determine the ESVI value for each eligible county, the ESVI value associated with each federally protected area contained within the county will be multiplied by the proportion of that federally protected area that lies within the boundaries of the county. The sum of these shares of ESVI values for all federally protected areas within the county is the County ESVI.

Implementation

Distribution of Funds

To assist in implementing the above proposed revisions to the SRS program, a collaborative committee structured similarly to RACs and regional collaborative groups should have authority over the allocation of a portion of the funds. These committees should have required representation from the Forest Service, regional Tribal governments, and the state fish and wildlife agency/agencies. These agency and Tribal representatives should include experts in wildfire ecology, biodiversity conservation, forest carbon science, and habitat connectivity. The collaborative committees should also have a restricted number of representatives from nongovernmental, science or academic organizations with expertise in environmental science. There may also be a limited number of voluntary representatives of private landowners with land near or adjacent to the federal lands in question. The number of representatives from the ranching, timber, mining, or other land-intensive or extractive industries should not exceed one. This ensures that there is no disproportionate influence of extractive industries on decisions meant to prioritize conservation of forest ecosystems. Furthermore, to help shield these collaboratives from political pressure, each representative should be limited to a term of four years.

Each regional collaborative body should be required to direct the funding over which they have authority to select projects proposed by the federal public land management agencies overseeing the federal lands in question. Their recommendations on which projects to endorse must be supported with clear and documented reasoning on their ecological, economic, and cultural benefits for the regional environment and communities. These recommendations must be released for public comment, allowing 60 days for members of environmental organizations, regional Tribes, local businesses, and private landowners to share their thoughts on the proposed projects. After this period of comment, the collaborative committee must finalize their decisions in writing and submit their projects to the relevant land management agency for implementation.

A portion of a county's funds will also be earmarked for projects maintaining or enhancing ecosystem services on the federal lands that extend into that county, to be selected, designed, and implemented by the public land management agencies in control of that land. Counties receiving payments over $100,000 will be required to allocate more funds to conservation projects, including those selected by collaborative committees and by public land management agencies. Finally, the remaining funds will be allocated to the county government for discretionary county spending.

Prioritizing Diversity, Equity, and Inclusion

As Stephen Pyne wrote in 1982, "…virgin forest was not encountered in the sixteenth and seventeenth centuries; it was invented in the late eighteenth and early nineteenth centuries." Many national forests, national parks, Bureau of Land Management (BLM) areas, and other federally protected areas are composed of land that was seized from Native Americans through treaties in the 19th century and The General Allotment Act of 1887 (McAvoy, 2002). Public land management agencies should recognize this and proceed with greater adherence to their responsibility to engage and collaborate with the Native American communities that represent the original stewards of federal lands.

Tribal Nations in the United States remain physically, culturally, and spiritually connected to forest ecosystems. As a result, many are also on the frontlines of the environmental crises setting in as a result of anthropogenic climate change and forest management practices. Biodiversity losses, habitat shifts, and changes in the density and distribution of wildlife are substantially altering forest ecosystems within tribes' ancestral territories and impacting Traditional Ecological Knowledge (TEK). This knowledge is carried down through generations and describes relationships among species, ecosystems, and ecological processes (Voggesser et al. 2013). If this knowledge is lost or becomes irrelevant as ecosystems change or species populations shift, Native Americans may lose important connections to their traditional landscapes (Voggesser et al. 2013).

Though Native American tribes and the Forest Service share almost 3,000 miles of contiguous boundaries, and 60 tribes have treaty rights that allow them to access culturally significant resources in federal forests (USDA, 2012), the current practices and policies of public land management agencies do not adequately address the needs and concerns of tribal nations (Seppälä et al. 2009; Cordalis and Suagee 2008; Krakoff 2008). Land management decision-making continues to proceed in a top-down manner, which imposes external values, policies, and actions on Indigenous communities and landscapes without equitably incorporating the value of Indigenous cultural practices (Flores & Russell, 2020). Furthermore, the culture within public land management agencies like the Forest Service is often centered on managing by the best-available science and valuing the knowledge derived from peer-reviewed literature and academically trained specialists over traditional knowledge, collective tribal experiences, and tribal observation (Dockry et al. 2018).

Incorporating more TEK and Indigenous perspectives would bring a more holistic understanding of various ecosystems and cultivate a more realistic representation of the values that those ecosystems hold (Flores & Russell, 2020). Improving the inclusivity of the forest planning process can result in consideration of the social, sacred, and cultural values that have historically been overlooked by federal agencies focused on economic and recreational value.

The process of choosing which ecosystem service objectives to prioritize, which areas to apply treatments to, and how those treatments are applied should be carried out in collaboration with a representative set of community members, including from Indigenous and other minority groups. Within these collaborative decision-making frameworks, the existing hierarchy between community members and representatives of federal agencies should diminish, leading to a more equitable distribution of power and responsibility. Equity in conservation approaches requires decision-makers to consider the procedural, distributional, contextual, and recognitional aspects of justice. In other words, they need to ensure equitable involvement of all stakeholder groups; equitable distribution of costs, benefits, and responsibilities; equitable consideration of historical and present social, political, economic, and cultural conditions that affect a stakeholder's ability to participate in decision-making; and equitable respect for alternative knowledge systems, values, norms, and stakeholder rights (Sanborn & Jung, 2021).

Conclusion

The SRS program was enacted over two decades ago, and many historically timber-dependent counties still remain tightly tied to extractive industries. This reliance on natural resource extraction both precludes more profitable economic diversification in these areas and hinders efforts to develop and implement management strategies that prioritize conservation of federal forestland ecosystems. Reimagining county payments for the decades to come requires incorporating the services that our nation's forests provide beyond extractive value. The county payment framework described above, in emphasizing the social, ecological, and cultural value of forests, can serve as a bridge to more sustainable rural economies and more fruitful, equitable collaboration in federal forestland management. The increasing environmental stress on our forestlands and lingering injustice in forestland management demand an incentive system that, instead of compensating for the past, rewards actions that support a sustainable future.

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Senior Attorney, Western Environmental Law Center

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