Measuring the Value of Outdoor Recreation for National Environmental-Economic Statistics

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Abstract

The 2025 System of National Accounts establishes that comprehensive expenditure measurement across accounting boundaries can support welfare assessment. For ecosystem services like outdoor recreation, this requires comprehensive partitioning of expenditure between the System of National Accounts (SNA) boundary for market transactions and the household production boundary for travel time. Current U.S. satellite accounts fail to do this. The Outdoor Recreation Satellite Account captures only market expenditures for distant trips, while the Household Production Satellite Account excludes recreation entirely. We use detailed U.S. coastal recreation data to partition travel costs across these boundaries and quantify the resulting measurement gaps. Our central finding is that outdoor recreation is primarily a household-produced service. Travel time, not market purchases, represents the major expenditure. Household production values are approximately twice market expenditures, meaning assessments based only on market spending underestimate recreation's contribution to well-being by roughly threefold. Including recreation travel time would increase the Household Production Satellite Account by 4–5 percent nationally ($12.4 billion in the Gulf Region, or 0.7 percent of regional GDP). These measurement gaps have policy consequences: benefit-cost analyses that rely solely on market expenditures systematically understate recreation benefits, potentially leading to underinvestment in environmental protection and recreational infrastructure.

Keywords: Recreation, Household Production, Accounting Boundaries, Satellite Accounts
JEL Classification Numbers: Q51, Q56, E01

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1 Introduction

The 2025 System of National Accounts (SNA) marks a deliberate shift from production-focused measurement toward using the full sequence of accounts to inform changes in material well-being and the sustainability of economic income over time (United Nations, 2025). Achieving this goal requires that all expenditures on goods and services, whether market or non-market, are carefully partitioned across accounting boundaries to avoid double counting and ensure comprehensive coverage. For expenditure-based accounts to meaningfully approximate changes in material well-being, they must incorporate spending associated with ecosystem services to capture the benefits people derive from nature that are often omitted from traditional economic statistics. Outdoor recreation provides a useful illustration. Its value is realized through both market expenditures (such as fuel and equipment) and non-market household production (primarily travel time), and can be used to exemplify how expenditures should be allocated across multiple accounting boundaries. Moreover, recreation is among the most widely enjoyed ecosystem services, with implications for both individual well-being and national policy.

Despite growing recognition that national income measurement requires accounting for natural capital and ecosystem services, conventional economic statistics continue to omit many non-market benefits that contribute to well-being and wealth over time (Nordhaus and Tobin, 1973; Arrow et al., 2004; Nordhaus, 2006; Dasgupta and HM Treasury, 2021). These omissions have important policy implications. When outdoor recreation benefits are excluded or only partially captured, the value of environmental protection and infrastructure investment for recreation can be underestimated. The Bureau of Economic Analysis (BEA) has developed satellite accounts dedicated to outdoor recreation and household production to try to measure missing value (Landefeld et al., 2009; Highfill et al., 2018). However, these extensions remain incomplete. The Household Production Satellite Account excludes outdoor recreation entirely and the Outdoor Recreation Satellite Account (ORSA) captures only market expenditures and omits marginal spending associated with trips within 50 miles of home.

This paper addresses how outdoor recreation should be valued across national accounting boundaries and estimates the magnitude of current measurement gaps in U.S. satellite accounts. We focus on two key boundaries: the System of National Accounts (SNA) boundary capturing market transactions, and the household production boundary measuring non-market services produced for own consumption. Ecosystem services like outdoor recreation generate value across both accounting boundaries, requiring careful partitioning for comprehensive measurement (National Research Council, 2005; Office of Science and Technology Policy et al., 2023; Fenichel et al., 2024). Our central finding is that outdoor recreation is primarily a household-produced service: travel time, not market purchases, represents the dominant expenditure. Market-only measures underestimate outdoor recreation's welfare-relevant contribution by approximately a factor of three. Fixing the ORSA to include local trips changes the account's total value slightly (about 1%), but including travel time as household production increases the value of the Household Production Satellite Account by 4-5 percent.

Three streams of prior research inform our approach. First, ecosystem service valuation literature has established frameworks for measuring natural resource benefits (Boyd and Banzhaf, 2007; Barbier, 2013; Fenichel and Abbott, 2014), but these frameworks do not partition estimated values across accounting boundaries, as is needed for populating satellite accounts. Second, travel cost models provide well-established methods for estimating recreation values using market expenditures and travel time (Freeman et al., 2014; Parsons, 2017; Lupi et al., 2020). However, this literature estimates welfare changes (consumer surplus) rather than expenditure measures appropriate for national accounts, and it has not systematically addressed how to partition travel costs across SNA versus household production boundaries. Third, recent work has

clarified conceptual linkages between non-market valuation and national accounting frameworks (Fenichel et al., 2024; Office of Science and Technology Policy et al., 2023), but demonstrating how to partition the value of outdoor recreation for existing satellite accounts is still needed. These gaps are consequential. Without clear partitioning methods, existing satellite accounts either omit recreation's household production value entirely or risk double-counting when recreation values span multiple boundaries.

This paper makes two contributions. First, we document how existing U.S. satellite accounts currently measure outdoor recreation and identify gaps in their coverage. The ORSA excludes marginal expenditures on local trips (within 50 miles), while the Household Production Satellite Account omits recreation entirely despite travel time being a well-established component of recreation value. Second, we estimate the magnitude of these gaps using travel cost data from Gulf Coast recreation, demonstrating how to value household production of recreation services using time expenditures consistent with BEA methodology. Using detailed data from 7,621 recreation trips to shoreline sites, we find that 77% of trips occur within 50 miles of home and are excluded from ORSA. Yet these local trips have minimal market costs (median $3) but substantial travel time (median 36 minutes). The implication is that including local market expenditures increases ORSA by only about 1%, but including travel time as household production adds $12–38 billion annually in the Gulf region alone (4–5% of household production account values, or 0.7% of regional GDP). Benefit-cost analyses that rely solely on market expenditures systematically understate recreation benefits, potentially biasing decisions on environmental protection and recreational infrastructure toward underinvestment.

Our empirical approach measures realized expenditures under each accounting boundary using observed travel behavior, rather than estimating welfare changes through traditional travel cost demand models. While satellite accounts track expenditure rather than welfare directly, the more comprehensively they measure expenditure, including both market transactions and non-market household production, the better they can approximate welfare changes under duality (Nordhaus and Tobin, 1973; Arrow et al., 2004). The expenditure-based approach has practical advantages because it can be consistently tracked year over year without requiring repeated demand model estimation, providing the measurement infrastructure needed to assess how recreation's contribution to well-being changes over time.

The remainder of the paper proceeds as follows. Section 2 provides background on U.S. satellite accounts and how they currently measure outdoor recreation. Section 3 describes our data and the characteristics of Gulf Coast recreation patterns. Section 4 details our empirical methods for estimating values under each boundary. Section 5 presents results, highlighting how travel time dominates market expenditures for recreation trips. Section 6 discusses implications for each satellite account and for policy evaluation. Section 7 concludes.

2 Background on U.S. Satellite Accounts

Understanding current measurement gaps requires context about how U.S. satellite accounts operate and what they currently capture for outdoor recreation. The term "satellite account" can refer to two types of accounts. First, it can describe a reorganization of existing national income and product accounts compiled within the SNA accounting boundary, which the 2025 SNA calls a thematic account. Second, it can refer to an addendum account that includes goods and services beyond the SNA boundary, termed an extended account (United Nations, 2025). The ORSA is a thematic account that reorganizes market transactions already captured in traditional economic statistics like GDP. The Household Production Satellite Account is an extended account that measures economic activity outside traditional SNA boundaries.

2.1 Outdoor Recreation Satellite Account

The ORSA is a thematic account, meaning it reorganizes economic activity already recorded in the National Income and Product Accounts (NIPA) to highlight outdoor recreation's contribution. Every dollar in the ORSA is also counted in NIPA and GDP. The ORSA simply attributes these existing transactions to outdoor recreation rather than leaving them distributed across industries like retail, trade, or accommodation services. The ORSA was created in 2018 to measure this economic activity that otherwise would be attributed to other industries (Highfill et al., 2018). Available from 2017 onward, the ORSA reports that approximately 2 percent of GDP annually can be attributed to outdoor recreation, ranging from 1.4 percent in Connecticut to 5.6 percent in Hawaii (Bureau of Economic Analysis, 2023). The ORSA's methodology follows the BEA's Travel and Tourism Satellite Account, which is aligned with international standards (Highfill et al., 2018; United Nations Department of Economic and Social Affairs and Statistics Division, 2010). It measures fixed expenditures (apparel and gear) and marginal expenditures (gasoline and accommodations required for individual trips). However, following travel and tourism standards, the ORSA only tracks marginal expenditures on trips occurring at least 50 miles from a participant's home, excluding local recreation's marginal expenditures. Using data from English et al. (2018), we ultimately find that these local trips comprise 77 percent of all recreation trips.

2.2 Household Production Satellite Account

The Household Production Satellite Account is an extended account. It measures economic activity outside the SNA boundary that is not captured in NIPA or GDP. Unlike the ORSA, which reorganizes existing market transactions, the Household Production Satellite Account adds new value by tracking non-market services that households produce for their own consumption (Landefeld et al., 2009). Specifically, it measures "near-market" goods and services. These are activities that individuals could have performed for pay in the market but instead choose to do for themselves. A person who cooks dinner at home forgoes the wages they could have earned as a cook; a person who cleans their house forgoes the wages of a domestic worker. The account uses the American Time Use Survey to track time spent cooking, cleaning, childcare, and household maintenance, including travel time related to these activities. Time is valued using wages of general-purpose domestic workers rather than individual wage-based valuations typically used in travel cost models, because this wage-replacement approach captures the market price for household production time (Landefeld et al., 2009). The value of non-market services was 14.7 percent of GDP in 2020 (Bridgman et al., 2022).

However, this substantial account excludes outdoor recreation entirely, despite travel time being a well-established component of recreation value estimation (Lupi et al., 2020). An outdoor recreation trip has two time components: travel time and dwell time (time spent at the recreation site). Driving travel time is a near-market service (Creel and Fenichel, 2026). A person driving to a park forgoes the wages they could have earned as a driver for hire. Dwell time, by contrast, is not near-market because leisure cannot be purchased on someone else's behalf; no one can pay another person to enjoy a beach for them. The Household Production Satellite Account should therefore include recreation travel time but not dwell time, yet currently it includes neither.

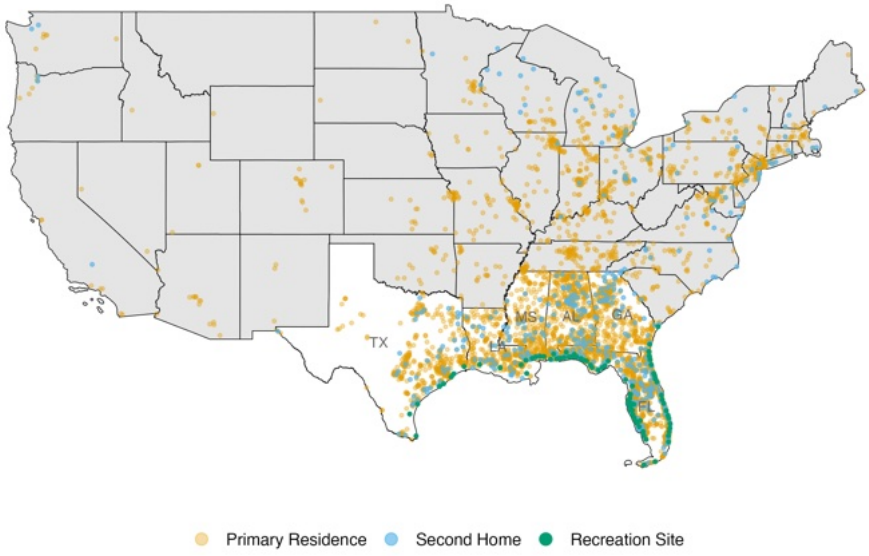

Figure 1: **Recreation Origins and Destinations in the Gulf Coast Region.** Map shows primary residences, second homes, and the 83 shoreline recreation sites from the Deep Water Horizon survey data. Gulf Coast states (TX, LA, MS, AL, FL, GA) are highlighted with state abbreviations.

3 Data

To implement our expenditure-based approach for adjusting existing satellite accounts, we use publicly available survey data that were collected by the National Ocean and Atmospheric Agency (NOAA) and partners on trips to coastal recreation sites in Texas, Louisiana, Mississippi, Alabama, Florida, and Georgia (hereafter referred to as the Gulf region) from 2012-2013. These data were used to estimate recreational losses due to the 2010 Deepwater Horizon oil spill in the Gulf of Mexico (English et al., 2018). The original data collection effort surveyed 41,708 people. Respondents provided their demographic characteristics and the number of trips taken to each of 83 shoreline recreation sites in the Gulf Coast region. Weights were applied to the choice occasion to account for the sampling strata to reflect annual shoreline trip-taking behavior for the adult population of the lower 48 states (Figure 3).

We use the final dataset used by the Deepwater Horizon (DWH) team for their shoreline model, which includes local and national trips for 6,383 unique individuals who took 7,747 trips. We observe total travel costs, one-way distance, market expenditure, and round-trip travel time for 7,621 of these trips (Figure 2). For the NOAA project, travel costs combined driving and flying expenses, weighted by the observed share of respondents who chose each travel mode. Both driving and flying cost calculations included market expenditures and the value of travel time (English et al., 2018). We partition the expenditure on market goods and the travel time using additional data from the DWH team. Due to data availability, we cannot use the weighted average of driving and flying expenditure. Instead, we use the costs associated with driving, which include out-of-pocket driving costs (gasoline, maintenance, and depreciation of average vehicle) and

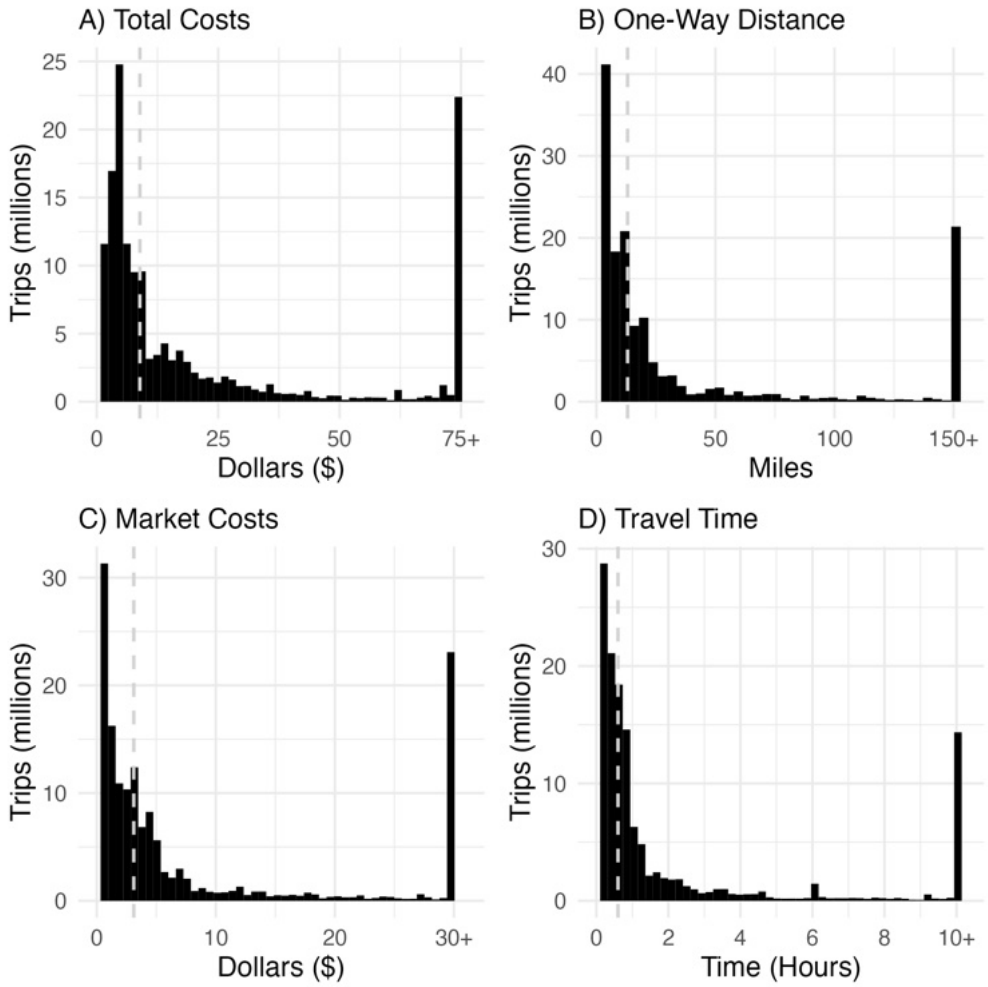

Figure 2: **Distribution of Trip Characteristics for Gulf Coast Shoreline Recreation.** Panel A shows total costs (market costs plus value of travel time) with a median of $8.88 (average $119). Panel B displays one-way distance traveled with a median of 13.1 miles (average 133 miles), highlighting that 77% of trips are local (within 50 miles of home). Panel C presents market expenditures (excluding travel time value) with a median of $3.11 (average $39). Panel D shows round-trip travel time with a median of 36 minutes (average 4 hours 17 minutes). The difference between medians and averages shows that while most recreation trips are low-cost, high-impact trips influence the averages. Dashed vertical lines indicate weighted medians. Sample includes 7,621 trips from the Deep Water Horizon shoreline recreation survey. Histograms are weighted by trip frequency and truncated at the 95th percentile for clarity.

hotel stays. We partition the total cost of a trip into market expenditures and travel time expenditure by subtracting the travel time expenditure associated with driving from the total cost of a trip and thus constructing the market expenditure for a trip. This calculation assumes the value of travel time is one-third the wage rate, as was assumed by English et al. (2018). This leads to underestimating the market expenditure and overestimating travel time for the few far trips when flying may be faster than driving.

We also consider different values of travel time than one-third of the wage rate. The household production accounts recommend against using the opportunity cost of time (Landefeld et al., 2009). We use the median

hourly wage of general-purpose domestic workers ($15.44 in 2022 dollars) to calculate outdoor recreation's contribution to the household production satellite account if included.

We use the ORSA reports by state provided by the Bureau of Economic Analysis (BEA) from 2022 to scale our results. The ORSA is broken down by industry and activity at the national level and, to a lesser degree, at the state level. We also use the BEA's reported GDP by state from 2022.

For estimating household production values, we use the aggregate national values from the Household Production Satellite Account, which report that household-produced services equaled 14.7 percent of GDP in 2020 (Bridgman et al., 2022). Unlike the ORSA, which is tracked by state and region, the Household Production Satellite Account is only available at the national level. To generate regional household production estimates, we estimate the ratio of household production value (travel time) to market expenditure value using our DWH data. We then apply this ratio to the regional ORSA market expenditure values to estimate regional household production values for outdoor recreation. This approach allows us to scale household production estimates to the state and regional level using the observed relationship between market and time expenditures in our recreation data.

4 Estimation Methods

The DWH data described above allow us to observe market expenditures and travel time for individual recreation trips, including whether each trip is local (within 50 miles) or distant. We use these trip-level observations to estimate adjustment parameters that quantify the measurement gaps in existing satellite accounts.

Total recreation expenditure can be expressed as $E_{total} = E_{market} + E_{time}$, where market expenditures E_{market} include gasoline and accommodation purchases under the SNA boundary, and time expenditures E_{time} represent household production of recreation services via travel time. Current satellite accounts face a fundamental partitioning problem: the ORSA captures E_{market} for trips exceeding 50 miles from home but excludes local recreation trips, which we find comprise 77 percent of all trips. The Household Production Satellite Account excludes E_{time} for recreation entirely.

We estimate two parameters to address these gaps. First, α is the ratio of total market expenditures to expenditures on distant trips (>50 miles), which allows us to scale ORSA values upward to include local recreation. Second, γ is the ratio of travel time expenditures to market expenditures, which enables estimation of household production values. Using these parameters, we scale existing ORSA expenditure data to calculate adjusted satellite account values that include local recreation (using α) and to estimate corresponding household production account values for travel time devoted to outdoor recreation trips (using γ). Scaling these parameters to national satellite accounts requires assuming that Gulf Coast recreation behavior (specifically, the ratio of local to distant trips and the ratio of travel time to market expenditures) is representative of the entire country. We report regional results as our primary estimates and present national extrapolations as illustrative benchmarks.

4.1 Estimating Expenditures Under SNA Boundary

To estimate the α parameter, we first calculate total market expenditure on driving costs and accommodations for outdoor recreation at shoreline sites in the Gulf region using the Deepwater Horizon dataset,

$$E_{DWH} = \sum_i \sum_s w_i p_{is} x_{is} \tag{1}$$

where we sum over individuals i and sites s. Here, p_{is} represents per-trip market expenditure for individual i visiting site s, x_{is} is the number of trips, and w_i are sampling weights that scale the data to represent the contiguous U.S. adult population. We reweight observations from the original DWH dataset due to losing 126 observations because of missing data, scaling weights so that the total number of trips in our dataset matches the original 156 million trips taken to the 83 sites. We estimate standard errors for E_{DWH} using the nonparametric bootstrap method with 10,000 replications.

Our goal is to determine how much the ORSA's gasoline and accommodation expenditures would need to be scaled up to include local recreation trips within 50 miles of home, which is the value currently excluded because the ORSA follows travel and tourism standards that focus on distant trips. We focus on scaled gasoline and accommodation expenditure recorded in the ORSA because the expenditures in the DWH dataset consist of driving expenses and hotel stays. We use shoreline recreation data as a representative sample of Gulf region recreation patterns, acknowledging that broader satellite account adjustments would require more comprehensive data across outdoor recreation types and regions.

To estimate α which can adjust the ORSA to include the market expenditure for local trips under 50 miles, we separate Equation (1) into expenditure on local and other recreation trips

$$E_{DWH} = \sum_i \sum_s \mathbf{1}(l_{is} < 50) \cdot w_i p_{is} x_{si} + \sum_i \sum_s \mathbf{1}(l_{is} \geq 50) \cdot w_i p_{is} x_{si} \tag{2}$$

where $\mathbf{1}(\cdot)$ are indicator functions for whether the one-way travel distance of a trip l is within 50 miles of home or not.

Equation 2 can be relabelled as the expenditure on local trips plus the expenditure on far trips, $E = L+F$. We assume that far trips F can be scaled to find total expenditure E, introducing the adjustment parameter α where $E = \alpha F$. This defines our adjustment parameter as $\alpha = E/F$.

We estimate the adjustment parameter using the DWH dataset,

$$\hat{\alpha} = \frac{E_{DWH}}{\sum_i \sum_s \mathbf{1}(l_{is} \geq 50) \cdot w_i p_{is} x_{si}} \tag{3}$$

We find the standard errors for $\hat{\alpha}$ using the non-parametric bootstrap method, resampling our dataset with replacement 10,000 times.

Having estimated $\hat{\alpha}$ from the DWH data, we adjust ORSA expenditure values state by state to include local recreation trips. The ORSA provides total state recreation expenditure, but our α parameter applies specifically to gasoline and accommodation expenditures, which are the components we observe in the DWH dataset. To isolate the relevant ORSA expenditure baseline, we use national-level data showing that "petroleum and coal products" and "accommodation" represent 13 percent of total ORSA expenditure in most years (12 percent in 2017, 11 percent in 2020). We assume this share applies across states and define $F^r_{ORSA} = 0.13 \times \text{Total ORSA}^r$ as our baseline distant-trip expenditure for gasoline and accommodations in region or state r.

This F^r_{ORSA} corresponds to the denominator in Equation 3, allowing us to use the estimated scaling parameter $\hat{\alpha}$ to calculate total gasoline and accommodation expenditure that includes local and distant trips. This estimates what ORSA gasoline and accommodation expenditure would be if it included the currently excluded local recreation within 50 miles of home. We calculate the regional expenditure on market driving costs and accommodation for recreation, now including local recreation, as

$$\hat{E^r} = \hat{\alpha} \cdot F^r_{ORSA}. \tag{4}$$

We calculate the share of GDP contributed by this expenditure, including local recreation, as

$$\hat{S^r} = E^r / GDP^r \tag{5}$$

We calculate the standard error for E^r and S^r using the delta method.

4.2 Estimating Value under Household-Production Boundary

While the ORSA partially measures market expenditures (excluding only local trips), household production satellite accounts currently exclude outdoor recreation entirely. The γ parameter enables us to estimate what household production account values would be if recreation travel time were included, by providing the ratio needed to convert observable market expenditures (available through ORSA) into travel time values that belong under the household production boundary. We calculate the total value of travel time for outdoor recreation, estimate the γ scaling parameter, and apply it to generate regional household production account estimates.

To estimate the ratio of travel time expenditure to market expenditure γ we calculate the total value of travel time spent on outdoor recreation using the DWH data. This represents the time households invest in "producing" recreation trips to the 83 shoreline sites, which we refer to as the total travel time expenditure,

$$\Theta_{DWH} = \sum_i \sum_s w_i \rho_i t_{is} x_{is} \tag{6}$$

where ρ_i is the monetary value of time for individual i, t_{is} is round-trip travel time to site s, and x_{is} is the number of trips. We use sampling weights w_i so that Θ_{DWH} represents the total value of travel time to the 83 sites for the contiguous U.S. We estimate standard errors using the nonparametric bootstrap method with 10,000 replications.

To scale these results to the regional level, we again use the ORSA, building on our approach to adjusting the ORSA to include local trips. We estimate γ as the ratio of travel time expenditure (now converted to a monetary unit) to market expenditures, allowing us to use ORSA's gasoline and accommodation expenditure as the scalable market expenditure. This approach is necessary because household production satellite accounts are only available at the national level, preventing direct regional adjustments. Additionally, there is no existing non-market value of recreation in the household production satellite account available to scale, because recreation is completely excluded.

The relationship $\gamma E = \Theta$ assumes that market expenditures on gasoline and accommodations, E, can be scaled to equal travel time expenditure. This assumption is supported by the strong correlation between travel distance, market costs, and travel time costs (see Figure 2). We estimate this scaling parameter using

our DWH data,

$$\hat{\gamma} = \frac{\Theta_{DWH}}{E_{DWH}} \tag{7}$$

where E_{DWH} is the total market expenditure on driving costs and accommodations (Equation 1) and Θ_{DWH} is the total travel time expenditure measured in a monetary unit (Equation 6). We estimate standard errors for $\hat{\gamma}$ using the delta method.

Having estimated both $\hat{\gamma}$ and the adjusted regional expenditure on out-of-pocket driving costs and accommodation for recreation $\hat{E}^r$ from Equation 4 (which now includes local recreation) we can calculate regional household production values for travel time,

$$\hat{H}^r = \hat{\gamma} \cdot \hat{E}^r. \tag{8}$$

We also calculate this household production value as a share of regional GDP,

$$\hat{V}^r = \hat{H}^r / GDP^r. \tag{9}$$

The standard errors for $\hat{H}^r$ and $\hat{V}^r$ are calculated using the delta method.

We estimate $\hat{\gamma}$ using two different approaches to valuing time, reflecting different methodological perspectives. We use one-third of the wage rate as the opportunity cost of time, which is standard in the travel cost literature and used by the DWH research team (Lupi et al., 2020; English et al., 2018). Additionally, we estimate $\hat{\gamma}$ using a wage-replacement rate of \$15.44 per hour for general-purpose domestic workers (in 2022 dollars, deflated from 2023 BLS data (Bureau of Labor Statistics, 2024)). This replacement wage represents the recommended approach for populating household production accounts as they capture the market cost of replacing household time with hired services. These different time valuations allow us to assess the sensitivity of our household production estimates to alternative approaches for converting time to monetary values. The opportunity cost approach reflects forgone earnings, while the replacement cost approaches reflect the market value of household time in production activities. We use the general-purpose domestic workers' wage at the replacement wage because it is currently used in the Household Production Satellite Account.

We calculate all results for the Gulf region and each state within. We extrapolate our estimates for the whole country as a demonstrative exercise to benchmark the orders of magnitude of our estimates. However, the country-wide extrapolation is only externally valid if the Gulf region were representative of the country.

5 Results

Our central finding is that outdoor recreation is primarily a household-produced service: travel time, not market purchases, represents the major expenditure. The estimated adjustment parameters α and γ quantify the gaps in current satellite accounts and reveal a striking asymmetry. Including local recreation increases market expenditure estimates modestly ($\alpha = 1.08$, a 1% adjustment to ORSA), but household production values are approximately twice market expenditures ($\gamma \approx 2$). Because the larger measurement gap lies in household production rather than market expenditure, analyses that rely only on market spending systematically underestimate recreation's value by roughly threefold.

We present results at regional, state, and national levels for both accounting boundaries. Section 5.1 estimates market expenditure adjustments under the SNA boundary using the α parameter, quantifying the gap created by ORSA's exclusion of local trips. Section 5.2 estimates household production values using the

Table 1: **SNA Boundary Results: Market Expenditure Adjustment Parameters**

Region	E^r (Mill. $)	SE	$\hat{\alpha}$	SE	Local Expend. (Mill. $)	SE	Orig. S^r (%)	Adjusted S^r (%)	Change (%)	SE	N
Gulf Region	6127.71	328.05	1.08	0.01	1454.53	137.99	2.49	2.52	1.10	0.10	7621.00
AL	263.64	51.83	1.03	0.01	24.96	7.59	1.96	1.97	0.45	0.14	639.00
FL	5196.09	313.77	1.08	0.01	552.89	54.49	3.64	3.68	1.06	0.10	5563.00
GA	18.18	2.93	1.37	0.15	749.51	300.45	2.05	2.15	4.76	1.91	179.00
LA	125.02	30.49	1.05	0.02	54.67	20.76	2.71	2.72	0.69	0.26	216.00
MS	113.60	36.50	1.07	0.03	32.57	15.03	2.41	2.43	0.97	0.45	454.00
TX	411.17	57.75	1.17	0.07	1032.89	416.23	1.98	2.03	2.17	0.87	570.00
United States			1.08	0.01	6171.24	585.47	2.21	2.24	1.10	0.10	7621.00

Notes: E^r represents regional expenditure on gasoline and accommodation for recreation including local trips (Equation 4). S^r is the share of regional GDP contributed by this expenditure (Equation 5). "Orig. S^r" shows ORSA's current value excluding local trips; "Adjusted S^r" includes local recreation expenditure. Standard errors calculated using the delta method.

γ parameter, revealing the substantially larger measurement gap from ignoring travel time for recreation entirely.

Our Gulf Coast recreation data illustrates why both boundaries matter. Seventy-seven percent of trips occur within 50 miles of home (Figure 2), and thus are excluded from the ORSA due to its travel and tourism focus. These local trips exhibit the low market expenditures characteristic of most outdoor recreation: median spending is only $3.11 per trip (average $39), which is comparable to Berry et al. (2018)'s findings for the value of a local outdoor recreation trip. However, these same low-expenditure trips require substantial travel time investment (median 36 minutes round-trip). This creates the foundation for significant household production values despite minimal market transactions, highlighting that market expenditures alone provide an incomplete picture of recreation's contribution to welfare.

5.1 Expenditure under SNA Boundary

Results for market expenditure that falls under the SNA boundary are reported in Table 1. We find that market expenditure for the 83 sites observed equals $6 billion for the Gulf Region. The $\hat{\alpha}$ multiplier for gas and accommodation expenditure in the ORSA is 1.08 and is significantly different from 1.00 at the 99 percent confidence level. After scaling using marginal expenditures on gas and accommodations in the ORSA, we estimate that local recreation drives an additional $1.5 billion in spending on gas and accommodations in the Gulf region that is not included in the ORSA. Including this additional local recreation value in the ORSA would cause a one percent increase in its regional value, from 2.49 percent of regional GDP to 2.52 percent. The percent change increase is significantly different from zero at the 99 percent confidence level.

The results for the adjustment parameter for states in the Gulf region vary from 1.03 in Alabama to 1.37 in Georgia. All are statistically different from one at the 99 percent confidence level. Maintaining our assumption that shoreline recreation behavior can scale to represent the ratio of local trips for all recreation, we estimate that local recreation by state contributes between $25 million in spending on gas and accommodations in Alabama and $1 billion in Texas. Including expenditure on gas and accommodations for local recreation increases the value of the ORSA between 0.45 percent in Alabama and 4.76 percent in Georgia. All percent increases are significantly different from zero at the 99 percent confidence level.

If we extrapolate our results to the entire U.S., we find that local outdoor recreation may be responsible for the order of $6 billion in spending on gasoline and accommodations, raising the contribution of outdoor recreation from 2.21 percent to 2.24 percent of GDP when local recreation is included.

Table 2: **Household Production Boundary Results: Travel Time Expenditure (1/3 Wage Rate)**

Region	Θ^r (Mill. $)	SE	$\hat{\gamma}$	SE	H^r (Mill. $)	SE	V^r (%)	SE	Δ Sat. Acct. 2020 (%)	SE	Δ Sat. Acct. 2017 (%)	SE	N
Gulf Region	12417.26	1195.87	2.03	0.13	37925.57	2426.27	0.71	0.05	4.85	0.31	5.40	0.35	7621.00
AL	569.54	162.59	2.16	0.41	1603.05	306.95	0.57	0.11	3.87	0.74	4.31	0.83	639.00
FL	10582.52	1143.47	2.04	0.15	15013.12	1109.49	1.04	0.08	7.10	0.52	7.90	0.58	5563.00
GA	37.09	7.09	2.04	0.23	5704.87	884.43	0.74	0.12	5.06	0.78	5.63	0.87	179.00
LA	204.84	60.77	1.64	0.30	1774.00	331.67	0.61	0.11	4.13	0.77	4.60	0.86	216.00
MS	177.97	43.62	1.57	0.34	738.96	160.36	0.53	0.11	3.59	0.78	4.00	0.87	454.00
TX	845.31	141.73	2.06	0.24	14883.72	1908.57	0.62	0.08	4.21	0.54	4.69	0.60	570.00
United States			2.03	0.13	160910.12	10294.16	0.63	0.04	4.30	0.28	4.79	0.31	7621.00

Notes: ρ is the value-of-travel-time approach used. Θ^r is travel time expenditure to the 83 DWH sites (Equation 6). $\hat{\gamma}$ is the scaling parameter converting market expenditures to household production values (Equation 7). H^r represents scaled regional household production value for all recreation (Equation 8). V^r is recreation's household production value as share of regional GDP (Equation 9). Δ Sat. Acct. shows the percent increase in the Household Production Satellite Account if recreation were included, calculated for 2020 and 2017.

5.2 Expenditure under Household-Production Boundary

The results for the expenditure of travel time when using one-third of the wage rate as the value of travel time are presented in Table 2. We find that the travel time expenditure to the 83 sites is $12 billion for the Gulf Region. If we use the expenditure on gas and accommodations in the ORSA to scale this result from the 83 sites to all recreation sites in the region, we find that the expenditure of travel time for all recreation sites in the Gulf Region is $38 billion, which is equivalent to 0.71 percent of regional GDP. If household-produced services are equivalent to the same percent of the Gulf region's GDP as the United States, including the expenditure of travel time in the household-produced services satellite account would increase its value by 4.3 percent in 2020 and 4.8 percent in 2017. Both percent increases in the value of the household-produced services account are significantly different from zero at the 99 percent significance level.

The expenditure of travel time is equivalent to approximately twice the expenditure on market goods for all states in the Gulf region. We estimate that the expenditure on travel time to recreation sites as a share of GDP V^r in each individual state is between 0.57 percent in Alabama and 1.04 percent in Florida. Because the Household Production Satellite Account is only available nationally, we assume state-level household production represents 14.7 percent of state GDP (the national ratio). Under this assumption, including recreation travel time would increase the value of household-produced non-market services by between 3.59 percent in Mississippi and 7.1 percent in Florida in 2020. In 2017, this increase would be between 4.0 percent and 7.9 percent. All percent increases in the value of the household-produced non-market services account are significantly different from zero at the 99 percent confidence level.

The national implications of our household production estimates are substantial. Extrapolating our Gulf Coast results to the entire U.S., we suggest a total household production value for outdoor recreation on the order of $161 billion annually (0.6% of national GDP). To put this in perspective, including this previously unmeasured recreation activity would increase the Household Production Satellite Account by 4.3% in 2020 and 4.8% in 2017. Both increases are statistically significant at the 99% confidence level.

These findings highlight a fundamental measurement gap in current national accounts. The Household Production Satellite Account, designed to capture non-market economic activity, currently omits a major household production activity by ignoring the time traveling required to access outdoor recreation. Our estimates suggest that this omission substantially understates the economic contribution of household production to national welfare. When benefit-cost analyses rely on market expenditures alone, they systematically undervalue infrastructure investments that facilitate recreation access (*e.g.,* roads, trails, and park facilities) because the time savings and recreation benefits these investments generate remain unmeasured. Similarly,

Table 3: **Household Production Boundary Results: Travel Time Expenditure (general-purpose domestic worker)**

Region	Θ^r (Mill. $)	SE	$\hat{\gamma}$	SE	H^r (Mill. $)	SE	V^r (%)	SE	Δ Sat. Acct. 2020 (%)	SE	Δ Sat. Acct. 2017 (%)	SE	N
Gulf Region	10765.64	525.44	1.69	0.01	31573.50	364.58	0.59	0.01	4.04	0.05	4.49	0.05	7621.00
AL	481.91	86.66	1.76	0.04	1306.19	35.97	0.46	0.01	3.16	0.09	3.51	0.10	639.00
FL	8928.35	497.95	1.65	0.01	12142.96	136.75	0.84	0.01	5.74	0.06	6.39	0.07	5563.00
GA	44.69	6.82	2.36	0.05	6599.76	722.72	0.86	0.09	5.85	0.64	6.52	0.71	179.00
LA	225.23	51.75	1.73	0.04	1871.36	56.23	0.64	0.02	4.36	0.13	4.86	0.15	216.00
MS	220.35	59.08	1.86	0.12	875.45	62.60	0.63	0.04	4.25	0.30	4.74	0.34	454.00
TX	865.11	126.67	2.02	0.07	14594.71	977.47	0.61	0.04	4.13	0.28	4.60	0.31	570.00
United States			1.69	0.01	133959.66	1546.83	0.53	0.01	3.58	0.04	3.99	0.05	7621.00

Notes: ρ is the value-of-travel-time approach used (general-purpose domestic worker wage: $15.44/hour in 2022 dollars). Θ^r is travel time expenditure to the 83 DWH sites (Equation 6). $\hat{\gamma}$ is the scaling parameter converting market expenditures to household production values (Equation 7). H^r represents scaled regional household production value for all recreation (Equation 8). V^r is household production value as share of regional GDP (Equation 9). ΔH^r shows the percent increase in the Household Production Satellite Account if recreation were included, calculated for 2020 and 2017 baseline values. Standard errors calculated using the delta method.

environmental protection decisions may underweight the recreational benefits of conserving natural areas if those benefits are assessed only through market transactions rather than the full household production value. Finally, sustainable development planning requires accurate tracking of welfare changes over time; omitting household production means that declines in recreation access or quality may go undetected in expenditure-based economic indicators.

In alternative analyses, we use the wage rate of a general-purpose domestic worker for the value of travel time (Table 3). For comparison, the average value of one-third of an individual's wage rate is $15.72, and the median value is $10.85. This implies that most individuals in our dataset earn approximately twice as much as a general-purpose domestic worker and, on average, earn three times the wage rate. The wage-replacement rates lead to smaller estimates of the value of travel time under the household production boundary for the Gulf region when compared to one-third of the wage rate. When using the general-purpose domestic worker wage replacement rate, travel time expenditure is equivalent to 0.59 percent of GDP in the Gulf Region. Including this travel time expenditure in the household-production satellite account would increase its value for non-market services by 4 (4.5) percent in 2020 (2017). Using a replacement wage rather than one-third the wage rate as the monetary value of travel times does not lead to economically significantly different estimates for individual states.

6 Discussion

Using Gulf Coast recreation data, we demonstrate that outdoor recreation generates substantial economic value across multiple accounting boundaries. However, current U.S. satellite accounts systematically understate this value due to excluding outdoor recreation from the Household Production Satellite Account and excluding local outdoor recreation's value from the ORSA.

Our key finding is a striking asymmetry in measurement gaps across accounting boundaries. While including local recreation in the Outdoor Recreation Satellite Account requires only modest adjustments (1% increase in regional value of ORSA), the household production boundary reveals larger unmeasured welfare-relevant expenditure. Nationally, we estimate $12.4 billion in time expenditure for outdoor recreation in the Gulf Region. This is equivalent to 0.7% of regional GDP, which would increase the Household Production Satellite Account by nearly 5%. In comparison, the market expenditure on outdoor recreation (including local trips) is $6.1 billion. This difference underscores the importance of including time expenditure for recreation

under the household production accounting boundary. Travel time, not market purchases, represents the primary welfare-relevant expenditure for outdoor recreation trips.

These findings address the welfare measurement challenges highlighted in our introduction. As Nordhaus and Tobin (1973) and Arrow et al. (2004) emphasized, measuring true national welfare requires accounting for both market and non-market economic activity. Our results demonstrate that current satellite accounts provide incomplete measures of recreation's economic contribution precisely because they fail to partition required travel cost expenditure, consisting of market spending and travel time, comprehensively across the SNA and household production accounting boundaries.

The policy implications extend beyond national accounting methodology. If economic accounts are to support sustainable development evaluation, they must jointly consider SNA and household production boundaries to estimate real national income and its connection to underlying natural assets. Our estimates suggest that policy decisions affecting outdoor recreation access (*e.g.,* infrastructure investments, environmental protection) have economic impacts roughly three times larger than current ORSA-based assessments would suggest. This measurement gap is particularly relevant for budget decisions regarding public natural assets that serve as inputs into household-produced recreation activities.

6.1 Adjustments to the Outdoor Recreation Satellite Account

Despite 77% of recreation trips occurring within 50 miles of home including these trips increases the Gulf region's ORSA value by only 0.03 percentage points of GDP (from 2.49% to 2.52%). This modest impact reflects the fundamental characteristic of local recreation: high trip frequency but minimal market expenditures per trip (median $3.11).

The small magnitude of this adjustment means that the current ORSA provides a reasonable approximation of market recreation expenditures despite its methodological exclusion of local trips. Local recreation's low marginal costs mean that the 77% of excluded trips contribute proportionally little to total market expenditure, even though they represent the majority of recreation activity by trip count.

However, this finding reveals a more fundamental measurement challenge within the SNA boundary itself. ORSA already captures substantial fixed-cost expenditures (*e.g.,* outdoor gear, apparel, and equipment) that are used for local recreation trips, even while excluding the marginal costs of those same trips. Given that 77% of trips occur locally, a significant portion of gear purchases presumably supports local recreation sites. This creates an internal inconsistency within ORSA. It includes the durable goods used for local recreation while excluding the variable costs of accessing recreation sites.

This measurement inconsistency poses challenges for natural capital accounting, which requires linking service flows to their enabling assets. ORSA's current structure captures market expenditures without geographic attribution, preventing the linkage between recreation spending and the specific natural assets that support recreational activities. We can measure total outdoor recreation expenditure under the SNA boundary, but we cannot determine which natural assets generate which expenditure flows.

The prevalence of local recreation also highlights additional SNA boundary expenditures that current accounts may miss. Our finding that 77% of trips occur within 50 miles suggests substantial residential sorting toward recreation amenities. Households seeking recreation access may pay housing premiums for proximity to outdoor recreation sites, representing additional market expenditures under the SNA boundary that are conceptually distinct from both marginal trip costs and household production time expenditure.

Comprehensive natural capital accounting would need to capture these location-based premiums alongside travel costs and household production time to fully represent recreation's economic footprint. This points

toward an integration of travel cost and hedonic approaches, but such integration requires careful partitioning to avoid double-counting expenditures across model types.

6.2 Adjustments to the Household Production Satellite Account

The magnitude of household production adjustments confirms that travel time represents the major expense for outdoor recreation. Using the welfare-theoretic opportunity cost approach (one-third the wage rate), we estimate household production values of $12.4 billion for the Gulf region: two times larger than the regional market expenditure measured by the SNA boundary of $6.1 billion. When using the replacement wage approach currently used in the Household Production Satellite Account, the household production value is $10.7 billion, which is 1.75 times larger than the market expenditure. This dramatic difference highlights that outdoor recreation is fundamentally a household production activity where time investment, not market purchases, drives welfare-relevant expenditure.

In the Gulf region, these estimates suggest including outdoor recreation would increase the Household Production Satellite Account by 4.9% (2020) to 5.4% (2017). Unlike the minimal ORSA adjustment (0.03 percentage points, 1 percent increase), these represent economically significant changes that would substantially alter how national accounts capture non-market economic activity. The current exclusion of outdoor recreation from household production accounts thus represents a major measurement gap in capturing household-produced services.

However, incorporating outdoor recreation into household production accounts requires resolving a fundamental methodological tension. The welfare economics literature typically values recreation travel time using opportunity cost approaches. Most commonly, one-third the wage rate is used to capture forgone earnings (Lupi et al., 2020). However, there is ongoing debate about whether this is the "correct" value of travel time to use (Lloyd-Smith et al., 2019; Fezzi et al., 2014; Wolff, 2014). The one-third the average wage rate approach also conflicts with household production accounting methodology, which requires replacement wages approaches for consistency with other non-market activities (Landefeld et al., 2009; National Research Council, 2005).

The Household Production Satellite Account follows the principle that household time should be valued using comparable market services (Nordhaus, 2006). Currently, it uses the wage of general-purpose domestic workers ($15.44/hour in 2022 dollars) as the replacement cost for household production time. This creates a methodological choice for recreation: use the welfare-theoretic opportunity cost that aligns with recreation demand literature, or use the replacement cost approach that ensures internal consistency within household production accounts.

Using the replacement wage approach yields somewhat smaller but still substantial estimates: 0.59% of regional GDP, representing a 4.04% to 4.49% increase in household production accounts in the Gulf region. Importantly, both approaches produce estimates within the same order of magnitude, suggesting that methodological choice, while consequential, does not fundamentally alter the conclusion that outdoor recreation represents a major unmeasured component of household production.

This methodological choice has broader implications for integrating environmental economics with national accounting. Adopting replacement cost approaches for recreation time valuation would align travel cost methods with existing household production accounting standards, potentially facilitating more systematic integration of environmental services into national accounts. However, it would require recreation economists to adopt accounting consistency over welfare-theoretic measures, which is a trade-off that merits careful consideration as environmental accounting frameworks continue to develop.

7 Conclusion

This paper addresses a fundamental gap in measuring national welfare: the systematic exclusion of outdoor recreation from household production accounts despite its substantial non-market contribution. Our expenditure-based approach demonstrates how to partition recreation costs across accounting boundaries, revealing that current satellite accounts dramatically understate the economic significance of outdoor recreation by capturing market transactions while ignoring the household production of recreation services.

The empirical evidence shows that outdoor recreation is primarily a household production activity. While including local recreation's market expenditures in the ORSA requires only modest adjustments ($1.5 billion of missing expenditure in the Gulf region), household production represents a major unmeasured economic component, equivalent to $12 billion in the Gulf region, or 4-5% of the entire Household Production Satellite Account. This finding has immediate consequences for policy evaluation, because analyses that only consider market activity will severely underestimate welfare-relevant expenditure on outdoor recreation and thus may underestimate its benefit.

Looking forward, comprehensive environmental accounting will require expanding this boundary-based approach beyond outdoor recreation to other ecosystem services that span market and non-market domains. This paper underscores the importance of household production accounts in capturing the true contribution of natural assets to national welfare. Until these measurement gaps are addressed, national accounts will provide incomplete guidance for policies affecting environmental quality and sustainable development.

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