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

Abstract: Outdoor recreation is a popular leisure activity and a major service derived from natural assets like beaches, local parks, and other green or blue spaces. To assess sustainability, it is crucial to understand how such recreation impacts the wealth of natural assets and that variation over time. This involves distinguishing between the traditional Systems of National Accounts (SNA) production boundary and the household production boundary. Our study utilizes U.S. coastal recreation data to analyze costs related to market expenses (SNA boundary) and travel time (household production boundary). We find that market expenditures account for about one-third of the total travel cost, the majority of which is travel time. We examine how these expenditures are represented in two satellite accounts—the Outdoor Recreation Satellite Account (ORSA) and the Household Production Satellite Account. We find that local recreation contributes 77 percent of trips taken, but the associated market expenditure has a small impact on the value of the ORSA. Including travel time significantly increases the valuation of non-market services by 4 to 5 percent, corresponding to 0.58 to 0.71 percent of regional GDP. We discuss the importance of accounting boundaries and how travel time should be considered under the household production boundary.

Keywords: Recreation, Household Production, Accounting Boundaries, Satellite Accounts

JEL Classification Numbers: Q51, Q56, E01

1. Introduction

Natural areas such as forests, beaches, and green or blue spaces are essential to outdoor recreation, an important service. Outdoor-dependent leisure is financially accessible to most, and popular with many people. Outdoor recreation is a broad class of services, from taking children to the local park to climbing a distant mountain. The government and private industry recognize the benefits of outdoor recreation and invest in it. Major U.S. initiatives include the passage of the Great American Outdoors Act (Lewis 2020), the America the Beautiful Initiative (Exec. Ord. 14008 2021), and business coalitions organized around outdoor recreation (Headwaters Economics 2021). Measuring the value of outdoor recreation is helpful for estimating the value of assets in natural capital accounts, such as natural open space and surface water, because providing space for outdoor recreation is a major service of these natural assets.

In 2022, the U.S. initiated the development of natural capital accounts and associated environmental-economic statistics to measure the changes in value stored in natural assets (Office of Science and Technology Policy, Office of Management and Budget, and Department of Commerce 2023). Natural capital accounts are vital to evaluating sustainable development goals of non-declining wealth (Dasgupta and Treasury 2021; Arrow et al. 2004). Major advances have been made in establishing how to measure the value of natural resources when the target benefit is well-defined (Boyd and Banzhaf 2007; Fenichel and Abbott 2014; Barbier 2013; United Nations Statistical Commission 2021). However, clarity is needed for how to value natural resources' when the benefits vary across uses and applications. To address variation in benefits across applications, the U.S. strategy for developing natural capital accounts recommends considering three specific accounting boundaries: the System of National Accounts (SNA, aligned with the National Income Production Accounts, NIPA), household production, and defensive expenditures. Before evaluating sustainable development goals, economists and accountants must be clear on what benefits are under consideration and choose an accounting boundary. Aligning services with boundaries is important for various principle uses, such as estimating tax revenue or assessing welfare change, all while avoiding double counting.

Valuing outdoor recreation illustrates how to consider multiple accounting boundaries and partition benefits across them. For example, outdoor recreation drives economic activity like purchasing

market goods and employment. It is also a leisure activity that can be a household-produced service and substitute for market alternatives (e.g., taking kids to the park rather than the movie theater). For exercise-based outdoor recreation activities, individuals enjoy better health outcomes that can prevent costly medical interventions, which may be thought of as defensive expenditures. These are all real benefits of outdoor recreation, but each would fall under a different accounting boundary. These benefits should be disaggregated and accounted for separately under different boundaries so questions that concern a single boundary only include the relevant value from recreation. If expenditures are correctly partitioned into their respective boundaries, these account values are additively separable because they account for different expenditures. Therefore, the account values can be added together for questions about welfare and sustainable development goals that consider multiple boundaries.

First, consider the contribution of outdoor recreation under the SNA boundary. Market goods that complement the natural assets in the production of outdoor recreation, like marginal energy consumption (traditionally gasoline) or specialized equipment (e.g., hiking shoes), are purchased to participate in recreation. Because they are complements, the purchase price increases with quantity or quality improvements in the outdoor recreational opportunities provided by natural assets. Such complementary goods are already captured in the SNA's accounting boundary. Valuing outdoor recreation's contribution to the economy through complementary goods is a question of reorganizational accounting, not estimating an unmeasured value. Environmental-economic accounts can reorganize these expenditures to illustrate environmental-related production and help measure the value of natural assets. The Bureau of Economic Analysis (BEA) already maintains the Outdoor Recreation Satellite Account (ORSA), partially achieving this.

The ORSA was created in 2018 to measure the economic activity generated by outdoor recreation that otherwise would be attributed to other industries (Highfill et al. 2018). It is available for 2017 to 2022. The ORSA finds that as much as 2 percent of GDP annually can be attributed to the outdoor recreation industry, ranging from 1.4 percent in Connecticut to 5.6 percent in Hawaii (Bureau of Economic Analysis 2023). The ORSA provides the details necessary to track the presence and growth of the outdoor recreation industry as state governments, outdoor businesses, and outdoor advocates attempt to develop the industry as an economic driver. The ORSA's

methodology is consistent with the BEA's Travel and Tourism Satellite Account (Highfill et al. 2018), and international standards (United Nations Department of Economic and Social Affairs and Statistics Division 2010). The ORSA measures fixed and marginal expenditures for outdoor recreation. Fixed expenditures include apparel and gear, and marginal expenditures include goods like gasoline and accommodations required for individual trips. The travel and tourism standards, and thus the ORSA, only track marginal expenditure on trips that occur at least 50 miles from a participant's home. Trips within 50 miles of home, hereafter referred to as local trips, make up 77 percent of the trips taken in our sample (Figure 2.B).[1] This travel and tourism standard excludes local recreation's marginal expenditures from the value of the ORSA. However, any fixed-cost purchases for local recreation are included in the ORSA.

Second, consider the household production boundary. The value of travel time is outside the SNA's accounting boundary, but travel time for nature-based leisure and recreation can be included in the household production of services (Figure 1, Office of Science and Technology Policy, Office of Management and Budget, and Department of Commerce 2023). The BEA maintains the household production satellite account that tracks the value of non-market services that are outside the SNA boundary but part of consumers' consumption (Landefeld, Fraumeni, and Vojtech 2009). The SNA recognizes that household production is an important contributor to consumer consumption but does not include these goods in the SNA boundary so that disequilibrium macroeconomic indicators like inflation remain focused on market transactions (pg 6-7, European Commission et al. 2008).

The household production account differs from other satellite accounts because it deals with unmeasured value (Bureau of Economic Analysis 2018b). The value of household-produced services is not captured in GDP because there is no market transaction to track (Bureau of Economic Analysis 2018d). The U.S. household production satellite account uses the American Time Use Survey to track time spent cooking, cleaning, taking care of children, and odd jobs around the house (Landefeld, Fraumeni, and Vojtech 2009; Bureau of Economic Analysis 2018a). This account includes the travel time related to these activities (Bureau of Economic Analysis

[1] Furthermore, local recreation is likely to capitalize into home prices to a certain degree and lead to residential sorting.

2018c). The use of travel time is a well-established method for estimating the value of outdoor recreation (Lupi, Phaneuf, and von Haefen 2020). The value of time in the household production account, including travel, is estimated using the wages of general-purpose domestic workers (Bureau of Economic Analysis 2018a), which differs from individual wage-based valuations of travel time typically used in recreation demand (Phaneuf and Smith 2005). The household production satellite account uses this wage-replacement value of time because an individual can produce goods and services for their own consumption, or they could sell those goods and services on the market. The wage replacement value of time is meant to capture what price the market would offer for time spent on household production. The value of nonmarket services was 14.7 percent of GDP in 2020 (Bridgman, Craig, and Kanal 2022) and 13.2 percent in 2017 (Kanal and Kornegay 2019).

We estimate the expenditure on outdoor recreation at shoreline sites in the Gulf region under the SNA and household production boundaries. We scale these results to estimate the value of local recreation that remains unaccounted for in the ORSA. We also estimate the expenditure of the travel time for outdoor recreation that is unmeasured in the household production account. This value is not measured in the household production account, which does consider the travel time required to produce household services like cooking and cleaning. And, like all valuations in the household-produced services account, travel time for outdoor recreation is excluded from GDP. The exercise of estimating this result clarifies how travel time should be considered under the household production boundary to support the construction of natural capital accounts. This is important because travel time is frequently used to estimate the welfare value of outdoor recreation (Freeman, Herriges, and Kling 2014; Parsons 2017; Phaneuf and Requate 2017; Lloyd-Smith et al. 2019; Lupi, Phaneuf, and von Haefen 2020). Additionally, the theoretical net and gross domestic product (GDP) measures that bridge national accounts to welfare and sustainability assume that the nonmarket production of goods and services is within the accounting boundary (Weitzman 1976; Sefton and Weale 2006).

2. Data

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,

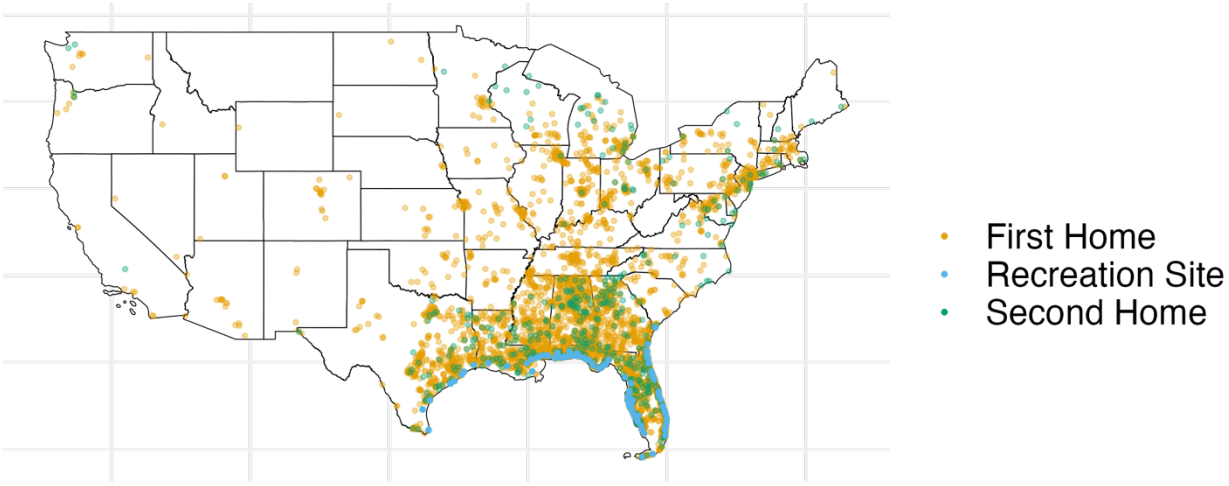

Figure 1: *Recreation Sites and Origins*

Recreator's home origins are concentrated in the five states surrounding the Gulf of Mexico, but they are visiting from origins across the country. The spread of origin locations allows us to observe the expenditure and time spent on near and far trips.

Alabama, Florida, and Georgia (hereout 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 1).

We use the final dataset used by the DWH for their shoreline model, which includes local and national trips for 6,383 unique individuals who take 7,747 trips. We observe total travel costs, one-way distance, market expenditure, and round-trip travel time for 7,621 of these trips. We also observe one-way distance and round-trip travel time for these trips (Figure 2). For the NOAA project, English et al. (2018) constructed exogenous travel costs "[…] as a weighted average of driving and flying costs, where the weights are based on the observed share of respondents who fly versus drive […]" (p. 12) that includes expenditure on market goods and the cost of travel time. We partition the expenditure on market goods and the travel time using additional data from the Deepwater Horizon (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 hotel

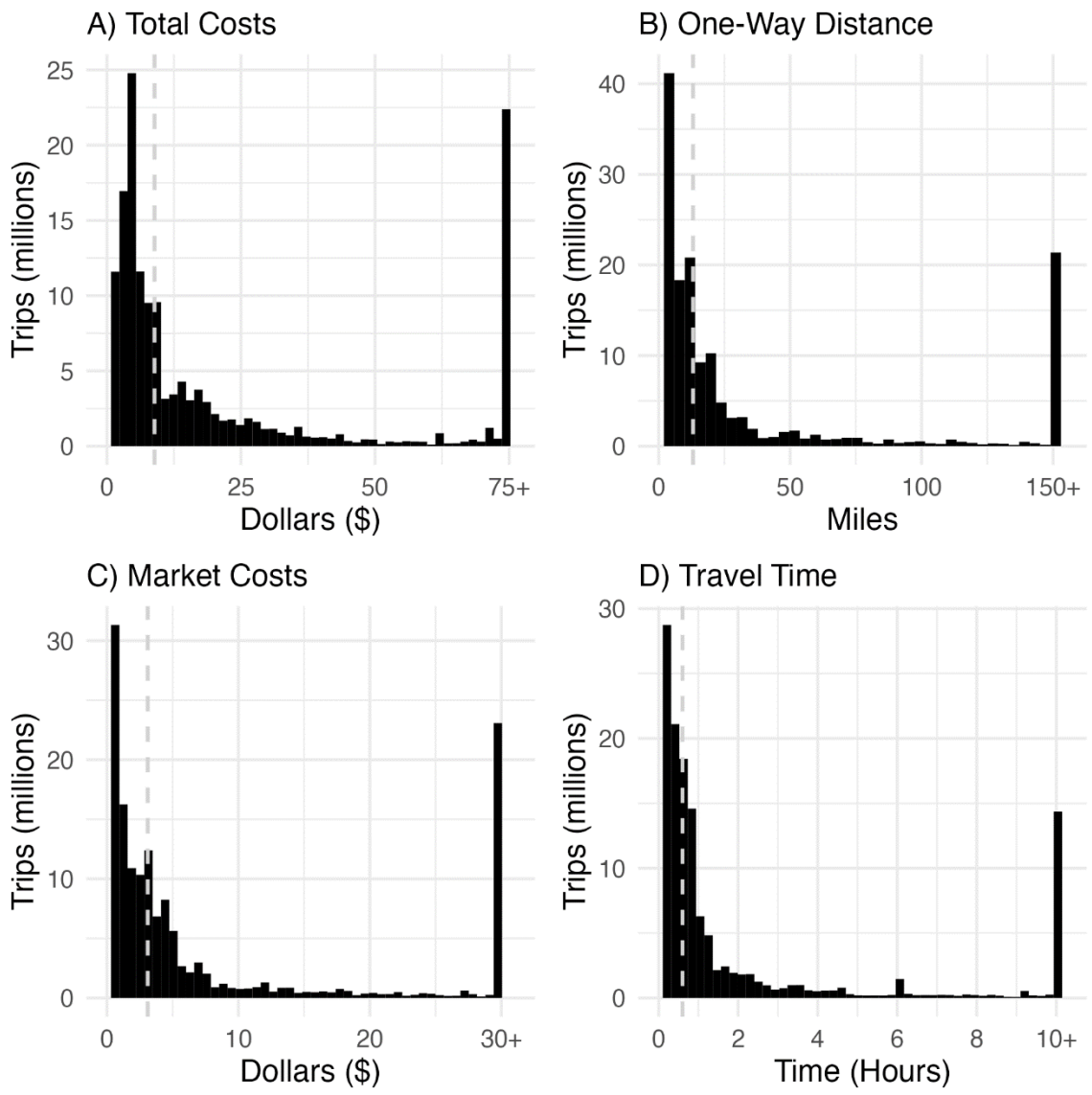

Figure 2: *The Distribution of Market Expenditure and Travel Time*

Caption: A) The median recreation trip costs $8.88 in 2022 dollars. This includes the cost of market expenditures and the cost of travel time (valued at one-third of an individual's wage rate). The average total cost is $119. The difference between the median and average shows that while most recreation trips are low-cost, a few high-cost trips greatly influence the mean. B) The median trip is 13 miles from a recreator's origin (home or a second home). 77 percent of trips are within 50 miles of a recreator's origin. The average trip is 133 miles from the recreator's origin, again demonstrating the influence of a few far-distance trips. C) The median expenditure on market goods is $3.11, and the average is $39. D) The median time spent traveling for an outdoor recreation trip is 36 minutes, and the average is 4 hours and 17 minutes.

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. 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, Fraumeni, and Vojtech 2009). We use the average hourly wage of taxi drivers, $15.20 in 2022 dollars, and general-purpose domestic workers, $14.66 in 2022 dollars, to calculate outdoor recreation's contribution to the household production satellite account if included (ONet 2024b; 2024a).

We use the most recent ORSA reports by state provided by the Bureau of Economic Analysis (BEA) from 2022 (Bureau of Economic Analysis 2023) to scale our results. The ORSA is available by state. It 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 (Bureau of Economic Analysis 2024).

3. Conceptual Framework

Evaluating sustainable development goals will require tracking changes in welfare through time. Travel cost models typically estimate the welfare gained from recreation compared to a counterfactual scenario where zero recreation trips are taken, akin to a site closure or elimination. The relevant counterfactual scenario to evaluate welfare changes through time is to compare the welfare in period t to the welfare in period $t-1$.

We illustrate this point by considering a simple single-site travel cost model (Parsons 2003),

$$Trips_i = \beta_1(e_i + v_i) + \beta_2 y_i + \beta_3 z_i + \epsilon_i \qquad 1$$

where e and v are the travel cost components of market and time expenditure for individual i, y and z are income and other demographic characteristics, and ϵ is the residual mean-zero error term. The representative change in consumer surplus associated with the model (1), relative to a zero-trip counterfactual, is

$$CS = \frac{1}{2}\left(\frac{-\beta_2\bar{y}-\beta_3\bar{z}}{\beta_1} - (\bar{e}+\bar{v})\right)\overline{Trips}, \qquad 2$$

where the first term in the parenthesis is the choke price and the second term in the parenthesis is the expected realized per-trip expenditure. Expression (2) is commonly scaled to the population for the total change in consumer surplus or total change in welfare relative to eliminating the site. However, that is not the relevant change in consumer surplus for assessing sustainability. The relevant change is the change in welfare over time, perhaps approximated by the change in consumer surplus over time.

Several challenges emerge immediately with the simple single-site model, and most of these challenges persist with multiple-site models, such as the random utility model (RUM) specifications. First, one would need to repeat this exercise over two periods and take the difference to assess the change in welfare over time. Second, this partial equilibrium approach does not handle price and quantity changes of complementary goods, such as gasoline for travel or outdoor recreation gear. Methods for considering substitute sites also do not reflect broader economic changes that could lead to market price changes of relevant complementary goods. Third, the regular identification challenges emerge if the model is fit using panel or repeat cross-section data. Exploiting time series variation to identify parameters cannot be used for identification if the research question regards sustainable development because questions about sustainability require using that same time variation to estimate changes through time. Fourth, travel cost models only use marginal cost and do not account for fixed-cost purchases of durable goods for outdoor recreation (*e.g.,* a boat, skis, or hiking shoes). In short, it is considerable work to estimate the change in welfare over time from the primal utility theory framework.

The common recreation demand approach is not necessary to assess the realized welfare changes through time associated with changing patterns of outdoor recreation because an approach grounded in duality theory is available. Changes in the expenditure function evaluated while holding prices constant using superlative index numbers provide *ex-post* equivalent variation up to a second-order approximation (Fenichel, Obst, and Wentland 2024; Dynan and Sheiner 2018; Diewert 1992). In this case, the "counterfactual" for the current period is that there had been no change from the prior period, which is the appropriate counterfactual for measuring sustainable development.

4. Estimation Methods

When considering what determines consumer behavior, we assume consumers solve the dual problem and minimize expenditures for a given utility level by choosing their market consumption, household production for consumption, and leisure. These choices, specifically money spent on market consumption and time spent on household production, can be partitioned into the SNA or household production boundaries. Partitioning time and money implies separability in the utility function. We assume that participating in outdoor recreation, a form of leisure, requires purchasing marketing goods and travel time. The expenditure on outdoor recreation can be accounted for by measuring these required inputs. Some trips require no purchases and no travel time (e.g., going to the beach from a beach house). These trips contribute to welfare but are not captured in our approach to valuing outdoor recreation, leading our estimates to be a lower bound for a welfare interpretation. The data we use does not allow for intertemporal analyses, and we do not report changes in expenditure over time, which are required to approximate changes in welfare. Instead, we illustrate partitioning expenditures across the SNA and household production boundaries. This is the first step to tracking changes in welfare from outdoor recreation through time.

4.1 Estimating Expenditures Under SNA Boundary

First, we estimate the total amount of market expenditure spent on complementary goods for outdoor recreation at shoreline sites in the Gulf,

$$E_{sites} = \sum_{i} \sum_{s} p_{is} x_{si} + \epsilon_{is} \qquad 3$$

where we sum over all types of individuals i and sites s, p_{is} is expenditure on complementary goods for trips to site s by individual i, and x_{si} is the number of trips taken to site s by individuals of type i. We use the sampling weights for x_{si} so that the number of trips represents trip-taking behavior for the contiguous U.S. This requires reweighting trips from the original DWH dataset due to losing 126 observations because of missing data. We scale the weights of each type of individual so that the total number of trips in our dataset is the same as the original, for a total of 156 million trips taken to the 83 sites. We find the standard errors for $\hat{E}$ using the nonparametric bootstrap method, resampling our dataset with replacement 10,000 times.

We estimate how much marginal expenditure on gasoline and accommodations measured in the ORSA would need to be scaled to capture marginal expenditures for local recreation – a value currently excluded due to the ORSA following travel and tourism standards. Scaling our results using the ORSA assumes that shoreline recreation trips are representative of all recreation in the Gulf region. Adjustments to existing satellite accounts would likely require more representative data, but this exercise allows us to estimate the order of magnitude of these changes.

To adjust the ORSA, we separate equation (1) into expenditure on local and other recreation trips

$$E_{sites} = \sum_i \sum_s \mathbf{1}\left(l_{x_{is}} < 50\right) * p_{is} x_{si} + \sum_i \sum_s \mathbf{1}\left(l_{x_{is}} \geq 50\right) * p_{is} x_{si} + \epsilon_i, \quad 4$$

$$E_{sites} = L_{sites} + F_{sites}, \quad 5$$

where **1** is an indicator function for whether the one-way travel distance of a trip l is within 50 miles of home. The market-driving expenditures in our dataset consist of out-of-pocket driving expenses and hotel stays. In the ORSA, expenditure on "petroleum and coal products" and "Accommodation" is available at the national level. This expenditure contributes 13 percent of market expenditure in all years except 2017 (12 percent) and 2020 (11 percent). Therefore, to scale our estimates to the state, Gulf, and national levels, we assume that marginal expenditure on non-local trips is equal to 13 percent of the total ORSA value, F_{ORSA}.

We assume that F can be scaled to find E, introducing the adjustment parameter α where $\alpha F = E$. This defines our adjustment parameter as $\alpha = E/F$. We estimate the adjustment parameter,

$$\hat{\alpha} = \left(\sum_i \sum_s p_{is} x_{si}\right) \times \left(\sum_i \sum_s \mathbf{1}\left(l_{x_{is}} \geq 50\right) * p_{is} x_{si}\right)^{-1}. \quad 6$$

We find the standard errors for $\hat{\alpha}$ using the nonparametric bootstrap method, resampling our dataset with replacement 10,000 times. We calculate the regional expenditure on out-of-pocket driving costs and accommodation for recreation, now including local recreation, as

$$\hat{E}_{region} = \hat{\alpha}\, F_{ORSA}. \quad 7$$

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

$$\hat{S} = \frac{\widehat{E_x}}{GDP}. \quad 8$$

We calculate the standard error for $\hat{S}$ using the delta method.

4.2 Estimating Value under Household-Production Boundary

Next, we measure the expenditure for outdoor recreation under the household-production boundary by estimating the total time spent traveling. This is the time that households put towards "producing" outdoor recreation trips at the 83 outdoor recreation sites,

$$\omega_{sites} = \sum_{i} \sum_{s} \delta_i t_{is} x_{is} + \epsilon_{is} \qquad 9$$

where δ_i is the conversation of time to dollars for individuals of type i, t is the amount of time spent traveling to site s by individuals of type i, and x_{is} is the number of outdoor recreation trips. We use the sampling weights again so that ω represents the value of total travel time to the 83 sites for the contiguous U.S. We find the standard errors for $\widehat{\omega}$ using the nonparametric bootstrap method, resampling our dataset with replacement 10,000 times.

To scale results to the regional level, we again rely on the ORSA. Like the above estimation strategy, we use the marginal expenditures in the ORSA on driving costs and accommodation and assume that these market expenditures can be scaled to equal the expenditure on travel time, $\gamma E = \omega$. We rely on these marginal costs in the ORSA because no values are tracked in the household production satellite accounts that can be adjusted to find the value of travel time for recreation. The assumption that market expenditure associated with travel can be scaled to equal the value of travel time is supported by the fact that the two are highly affected by travel distance and, therefore, correlated. Following a similar methodology to estimate $\hat{\alpha}$, we estimate the multiplier using out data

$$\hat{\gamma} = \widehat{\omega}_{sites} / \hat{E}_{sites} \qquad 10$$

We use the delta method to find the standard errors for $\hat{\gamma}$. We use the ORSA expenditure on gasoline and accommodations to calculate the regional expenditure on travel time as

$$\widehat{\omega}_{region} = \hat{\gamma} \hat{E}_{region}. \qquad 11$$

We estimate the value of the time spent traveling for outdoor recreation trips as a share of GDP,

$$\hat{V} = \frac{\widehat{\omega}_{region}}{GDP}. \qquad 12$$

and use the delta method to get the standard errors of $\hat{V}$.

We use three different values of δ to convert time to dollars when calculating in $\widehat{\omega}$, $\hat{\gamma}$ and $\hat{V}$. We use one-third of the wage rate as the opportunity cost of time, which is typical in the travel cost literature (Lupi, Phaneuf, and von Haefen 2020) and is used by the DWH team (English et al. 2018). We also use two different wage-replacement rates because this is the recommended method for populating the household production accounts (Landefeld, Fraumeni, and Vojtech 2009).

An analyst interested in welfare or sustainable development may consider summing the expenditure for outdoor recreation under the SNA and household production boundaries together, $E + \omega$. Furthermore, an analyst interested in welfare might consider the estimates a lower bound because the expenditure approach does not measure the welfare from trips that require zero travel time or market expenditure.

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 would only be externally valid if the Gulf region were representative of the country.

5. Results

Seventy-seven percent of trips are within 50 miles of an individual's home after adjusting for sampling weights (Figure 2.B). Figure 2.C shows that most outdoor recreation trips require little market expenditure. The median market expenditure is $3.11 per trip, and the average is $39. The median expenditure per trip is on par with the value per trip found by Berry et al. (2018), although their travel cost approach used only travel time rather than market expenditure. The minimum market expenditure for a trip in our dataset is $0, and the maximum is $1,087. The minimum roundtrip travel time is 0 hours, and the maximum is 106 hours (Figure 2.D). The median roundtrip travel time is 36 minutes.

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.

5.2 Expenditure under Household-Production Boundary

The expenditure on outdoor recreation under the household-production boundary is considerably larger than that under the SNA boundary. The cost of travel time contributes two-thirds of the total travel cost when travel time is valued at one-third of the wage rate. The value of travel time is not captured under the SNA boundary. It is important to recognize that this estimated value of travel time for recreation is an additional value, not an adjusted value. In other words, if an economic boundary combined the SNA and household production boundaries, the expenditure on outdoor recreation under this new boundary would consider the total travel cost that includes market expenditure and travel time required to produce a recreation trip. We estimate the expenditure of

travel time with three different values of travel time (VOTTs): one-third the wage rate, the hourly wage of taxi drivers, and the hourly wage of general-purpose domestic workers.

The results for the expenditure of travel time when using one-third of the wage rate as the VOTT 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.[2] 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 4.85 percent in 2020 and 5.40 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 (Table 1 and 2). After using the ORSA expenditure on gas and accommodations to scale results, we estimate that the expenditure on travel time to recreation sites in each individual state is between 0.57 percent of state GDP in Alabama, and 1.04 percent in Florida (Table 2). If the value of household-produced services in each state is equivalent to the same percent of state GDP as for the U.S., including the travel time required to produce an outdoor recreation trip 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.

If we extrapolate our results to the country level, we estimate that the value of travel time for all recreation is $161 billion. This is equivalent to 0.6 percent of the national GDP. Including this travel time expenditure for recreation in the household-production satellite account would increase

[2] Here, rather than parsing GDP, GDP is simply used to gauge magnitude.

its value by 4.3 percent in 2020 and 4.8 percent in 2017. These percent increases are significantly different from zero at the 99 percent confidence level.

In alternative analyses, we use the wage rate of a taxi driver or a general-purpose domestic worker for the VOTT. The two wages, $15.20 and $14.66 in 2022 dollars, respectively, are similar enough in value to not cause a significant difference in point estimates for the Gulf region (Tables 3 and 4). 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 taxi driver and, on average, earn three times the wage rate. Both 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. The differences are significant at the 99 percent significance level (Table 5). When using the taxi driver wage replacement rate, travel time expenditure is equivalent to 0.58 percent of GDP (Table 3) and 0.56 percent when using the general-purpose domestic worker (Table 4). Including this travel time expenditure in the household-production satellite account would increase its value for non-market services by approximately 4 percent in 2020 and 2017, regardless of which wage replacement rate is used. Apart from Florida, for which the wage replacement rate lowers the value of travel time expended, using these VOTTs does not lead to significantly different estimates for individual states (Table 5).

6. Discussion

We estimate the value of outdoor recreation under two of the three accounting boundaries recommended in the U.S. national strategy for developing natural capital accounts. We show that different costs for outdoor recreation can be partitioned into the SNA or household-production boundary. This partitioning is not double counting. Instead, the values under each boundary are measured from separate expenses of either money or time. We discuss the small change to the ORSA to include local recreation and the need for larger changes to the household production account, two satellite accounts currently kept by the BEA.

Various national economic statistics are used for different purposes. Satellite accounts are not typically used to measure broad inflation or other disequilibrium measures. Furthermore, it is reasonable to exclude services that households produce and consume for themselves from tax

revenue forecasts and inflation statistics. However, if economic accounts are to provide metrics for evaluating broad sustainable development goals, then jointly considering the SNA boundary and the household-production boundary is important for estimating real national income and how that income is connected to changes in wealth from the underlying assets. These adjustments are not only relevant to sustainable development. Many policies might be interested in the share of real income or welfare generated. These may include budget expenditures on public natural assets that are part of the private production process of household-produced services.

6.1 Adjustments to the Outdoor Recreation Satellite Account

We find that excluding the marginal market expenses on gasoline and accommodations for local recreation makes little difference in the value of the ORSA and estimate that including these expenditures would increase the value of the ORSA for the Gulf region from 2.49 percent of GDP to 2.52 percent of GDP. Local recreation trips do make up the majority of recreation trips, with 77 percent of recreation trips occurring within 50 miles of a recreator's home. However, the median marginal market cost of a trip is $3.11. Including the expenditure on gas and accommodations for these frequent trips does not make an economically significant difference in the value of the ORSA for the Gulf region.

It is important to recognize that fixed-cost market expenditures on gear that may be used for local recreation trips are already included in the ORSA despite its methodology excluding the marginal expenditures of local trips. The majority of expenses included in the ORSA are not marginal and instead are the purchases of durable goods like outdoor gear, apparel, and other supporting goods. Presumably, with 77 percent of trips occurring locally, these supporting goods are at least partially used at local recreation sites. With the information currently available, we know that some marginal expenses associated with local recreation are excluded, but we cannot determine how much of the expenditure measured in the ORSA is associated with local sites. This highlights a barrier to using the data available in the ORSA for natural capital accounting.

Natural capital accounting will require linking service flows to the enabling asset. In the case of valuing the service flows of recreation when using an expenditure approach, this requires knowing where someone went and what market goods they purchased or used for that trip. The ORSA

allows us to measure the expenditure on market goods for outdoor recreation under the SNA boundary. However, because we do not know where recreators went, we cannot link the expenditures measured to the underlying asset.

Separately, the high percentage of trips taken locally highlights the importance of considering sorting when valuing recreation. Individuals who prefer to be able to access outdoor recreation easily may seek better access to recreation opportunities when choosing where to live. Sorting oneself near recreation would lead to small marginal costs for individual trips. These individuals may need to pay a premium in housing price or rent for this improved access. The premium paid is an additional market expenditure that falls under the SNA boundary. If accounts are to price natural assets that enable recreation, they will need to consider all the expenditures that individuals incur under the SNA boundary for recreation. These expenditures include the marginal costs typically used in travel cost models, like gasoline and accommodation, as well as fixed-cost expenditures like the premiums paid for housing or gear purchased. This highlights the need for travel costs and hedonic models when pricing these enable assets. However, analysts must take care to partition these market expenditures for use in one model or the other (but not both) to avoid double counting.

6.2 Adjustments to the Household Production Satellite Account

Our primary analysis uses one-third of the wage rate when estimating the value of outdoor recreation under the household production boundary. This estimate of the expenditure of travel time for outdoor recreation is equivalent to 0.71 percent of GDP in the Gulf region, which is significantly larger than the expenditure on marginal expenses (gasoline and accommodations) for outdoor recreation under the SNA boundary. The household production account is not maintained for individual states like the ORSA. However, if the value of the Gulf region's household production of nonmarket services is similar to the country's, which was equivalent to 14.7 percent of GDP in 2020, then including the travel time required to produce a recreation trip would increase the value of household produced services to 15.41 percent of GDP, a 4.85 percent increase. The estimate for 2017 would rise from 13.2 percent to 13.91 percent, a 5.4 percent increase.

However, adjusting the household production satellite account to include the value of outdoor recreation requires careful consideration of how to convert travel time into a monetary unit. One-third of the wage rate is the most common VOTT used in the recreation demand literature (Lupi, Phaneuf, and von Haefen 2020), but there is an ongoing discussion on whether it is the "correct" value of travel time to use (Lloyd-Smith et al. 2019; Fezzi, Bateman, and Ferrini 2014; Wolff 2014). Moreover, the household production account recommends against this method for valuing time (Landefeld, Fraumeni, and Vojtech 2009; Council et al. 2005).

The household production satellite account follows the recommendation that household-produced goods and services should be priced based on comparable market goods or services (Landefeld, Fraumeni, and Vojtech 2009), mirroring similar recommendations for non-market accounts (Nordhaus 2006). Currently, the average wage of general-purpose domestic workers is used in the household production satellite account to value the time spent producing non-market services (Bureau of Economic Analysis 2018a). This wage is considered a replacement wage because individuals doing homemaking services at their own homes could instead sell the same service on the market and receive this wage. We use the average wage of a taxi driver in our alternative analyses, as well as the average wage for a general-purpose domestic worker because this is the VOTT currently used in the household production satellite account. We believe the taxi driver wage would be the conceptually correct wage to use to value travel time for outdoor recreation in the household production satellite account because individuals can drive themselves to recreate, or they can sell the service of driving on the market for that wage. Furthermore, the prevalence of ride-share services does make this a credible opportunity cost for driving.

When using the replacement wages of the average taxi driver, we estimate the value of outdoor recreation under the household production boundary to be 0.58 percent of the regional GDP in the Gulf. Including this value in the household production satellite account under nonmarket services would increase the value of nonmarket services in 2020 and 2017 by approximately 4 percent. Valuing the travel time expenditure for outdoor recreation under the household production accounting boundary provides a lower bound for welfare provided by outdoor recreation under this same boundary. A four percent increase in the value of non-market services in the household-production satellite account is an economically significant increase.

Including outdoor recreation in the household production satellite accounts may require moving away from a VOTT that is a function of the individual's wage. This does not require rejecting the premise that individuals make an endogenous choice when they choose how much time they will work and how much they will use for household production and leisure, as that choice regards the budget constraint. The choice of VOTT is instead about what weight to place on minutes when comparing them to dollars, which is a question of accounting. Using a VOTT like the average taxi driver's wage would align the VOTT used for travel cost models with the methods used for the household production accounts. In our analyses, the use of a wage replacement VOTT rather than one-third of the wage rate leads to a difference in regional estimates that is statistically significant. However, the point estimates are within the same order of magnitude.

7. Conclusion

Knowing the value of outdoor recreation under the SNA boundary and the household production boundary is important for assessing sustainable development goals. Tracking the changes in value under each boundary is critical to correctly accounting for changes in welfare through time. We demonstrate the first step to achieving this by partitioning expenditures between the SNA and household-production boundaries. When considering the SNA boundary, we find that marginal market expenditures for local recreation currently excluded from the ORSA contribute $1.4 billion in the Gulf region. However, including these market expenditures in the ORSA does not have an economically significant effect despite 77 percent of recreation trips being local. Under the household-production accounting boundary, we estimated the value of outdoor recreation is 0.71 percent of the region's GDP using a travel time expenditure approach and one-third of an individual's wage rate. Including travel time expenditure for outdoor recreation in the Household Production Satellite Account would increase the value of non-market services by approximately 5 percent. When using the average wage of taxi drivers as the replacement wage for the value of travel time, as is recommended for the household production accounts, we estimate that the value of outdoor recreation under the household production boundary is 0.58 percent of GDP. Including this value in the household production satellite account would increase its non-market service value by around four percent. Combining the expenditure measured under the SNA and household-

produced services accounting boundaries can provide a pathway for including the welfare of outdoor recreation when evaluating if sustainable development goals have been accomplished.

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9. Tables

Region	Market Expenditure at Sites ($millions)	α	Local Market Expenditure for Region ($millions)	ORSA's Share of Regional GDP (unadjusted)	ORSA's Adjusted Share of Region GDP	% Change	n
Gulf Region	6,127.71 (323.87)	1.08 (0.01)	1,454.53 (137.99)	2.49	2.52	1.10 (0.10)	7,621
AL	263.64 (52.17)	1.03 (0.01)	24.96 (7.59)	1.96	1.97	0.45 (0.14)	639
FL	5,196.09 (318.56)	1.08 (0.01)	552.89 (54.49)	3.64	3.68	1.06 (0.10)	5,563
GA	18.18 (2.92)	1.37 (0.15)	749.51 (300.45)	2.05	2.15	4.76 (1.91)	179
LA	125.02 (30.13)	1.05 (0.02)	54.67 (20.76)	2.71	2.72	0.69 (0.26)	216
MS	113.60 (36.74)	1.07 (0.03)	32.57 (15.03)	2.41	2.43	0.97 (0.45)	454
TX	411.17 (58.25)	1.17 (0.07)	1,032.89 (416.23)	1.98	2.03	2.17 (0.87)	570
United States		1.08 (0.01)	6,171.24 (585.47)	2.21	2.24	1.10 (0.10)	7,621

Table 1: Expenditure Under the SNA Boundary

Region	Time Expenditure at Sites ($millions)	γ	Time Expenditure for Region ($millions)	% of Region GDP	2020 % Change	2017 % Change	n
Gulf	12,417.26	2.03	37,925.57	0.71	4.85	5.4	
Region	(1,196.40)	(0.13)	(2,463.39)	(0.05)	(0.31)	(0.35)	7,621
	569.54	2.16	1,603.05	0.57	3.87	4.31	
AL	(166.18)	(0.41)	(308.43)	(0.11)	(0.75)	(0.83)	639
	10,582.52	2.04	15,013.12	1.04	7.10	7.9	
FL	(1,151.59)	(0.15)	(1,102.17)	(0.08)	(0.52)	(0.58)	5,563
	37.09	2.04	5,704.87	0.74	5.06	5.63	
GA	(7.21)	(0.23)	(890.50)	(0.12)	(0.79)	(0.88)	179
	204.84	1.64	1,774.00	0.61	4.13	4.6	
LA	(61.80)	(0.30)	(329.52)	(0.11)	(0.77)	(0.86)	216
	177.97	1.57	738.96	0.53	3.59	4.00	
MS	(43.15)	(0.34)	(159.43)	(0.11)	(0.77)	(0.86)	454
	845.31	2.06	14,883.72	0.62	4.21	4.69	
TX	(141.44)	(0.23)	(1,895.67)	(0.08)	(0.54)	(0.60)	570
United		2.03	160,910.12	0.63	4.30	4.79	
States		(0.13)	(10,451.65)	(0.04)	(0.28)	(0.31)	7,621

Table 2: Expenditure under Household-Production Boundary with One-Third Wage Rate

Region	Market Expenditure at Sites ($millions)	γ	Time Expenditure for Region ($millions)	% Region GDP	2020 % Change	2017 % Change	n
Gulf	10,176.48	1.66	31,013.02	0.58	3.96	4.41	
Region	(498.88)	(0.01)	(347.68)	(0.01)	(0.04)	(0.05)	7,621
	455.54	1.73	1,283.92	0.46	3.10	3.45	
AL	(80.36)	(0.04)	(35.88)	(0.01)	(0.09)	(0.10)	639
	8,439.73	1.62	11,922.18	0.83	5.64	6.28	
FL	(473.63)	(0.01)	(135.68)	(0.01)	(0.06)	(0.07)	5,563
	42.25	2.32	6487.90	0.85	5.75	6.41	
GA	(6.40)	(0.05)	(711.49)	(0.09)	(0.63)	(0.70)	179
	212.91	1.70	1,838.91	0.63	4.28	4.77	
LA	(48.23)	(0.04)	(55.00)	(0.02)	(0.13)	(0.14)	216
	208.29	1.83	861.33	0.62	4.19	4.66	
MS	(55.35)	(0.12)	(61.13)	(0.04)	(0.30)	(0.33)	454
	817.76	1.99	14,377.96	0.60	4.07	4.53	
TX	(120.63)	(0.07)	(963.05)	(0.04)	(0.27)	(0.30)	570
United		1.66	13,1581.68	0.52	3.52	3.92	
States		(0.01)	(1475.14)	(0.01)	(0.04)	(0.04)	7,621

Table 3: Expenditure under Household-Production Boundary with Taxi Replacement-Wage Rate

Region	Market Expenditure at Sites ($millions)	γ	Time Expenditure for Region ($millions)	% Region GDP	2020 % Change	2017 % Change	n
Gulf	9,814.94	1.60	29,892.07	0.56	3.82	4.26	
Region	(484.64)	(0.01)	(342.28)	(0.01)	(0.04)	(0.05)	7,621
	439.35	1.67	1,239.39	0.44	2.99	3.33	
AL	(78.33)	(0.04)	(34.34)	(0.01)	(0.08)	(0.09)	639
	8,139.90	1.57	11,554.21	0.80	5.46	6.08	
FL	(455.48)	(0.01)	(128.35)	(0.01)	(0.06)	(0.07)	5,563
	40.75	2.24	6,264.18	0.82	5.55	6.18	
GA	(6.19)	(0.05)	(686.27)	(0.09)	(0.61)	(0.68)	179
	205.34	1.64	1,774.00	0.61	4.13	4.60	
LA	(47.32)	(0.04)	(53.37)	(0.02)	(0.12)	(0.14)	216
	200.89	1.77	833.09	0.60	4.05	4.51	
MS	(53.19)	(0.11)	(59.04)	(0.04)	(0.29)	(0.32)	454
	788.71	1.92	13,872.20	0.58	3.93	4.37	
TX	(117.74)	(0.07)	(930.62)	(0.04)	(0.26)	(0.29)	570
United		1.60	126,825.71	0.50	3.39	3.78	
States		(0.01)	(1452.24)	(0.01)	(0.04)	(0.04)	7,621

Table 4: Expenditure under Household-Production Boundary with General-Purpose Domestic Worker Replacement-Wage Rate

Region	Taxi vs. One-Third Wage	Domestic Worker vs. One-Third Wage	n
Gulf Region	2.78	3.23	7,621
AL	1.03	1.17	639
FL	2.78	3.12	5,563
GA	0.69	0.50	179
LA	0.19	0.00	216
MS	0.72	0.55	454
TX	0.24	0.48	570
United States	2.78	3.23	7,621

Table 5: Test Statistics Comparing Shares of Region GDP Using Different VOTTs