Chapter 5: The Value and Configuration of Coastal Natural Capital

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Abstract

Location is a key determinant of the value and productivity of natural assets. Coastal beaches are a particularly important class of natural asset for local economies and ecosystems; however, the magnitude of beaches' importance is mediated by the arrangements of sand along the coastline and from sea to shore. Using high-resolution, remotely sensed data and information on property attributes and transactions, I compare estimates from three case studies along the US east coast. The capitalization of a foot of beach width in coastal Connecticut house prices is orders of magnitude lower, 0.04% of mean sale price, than that in North Carolina (1.3%) or Florida (0.8%). Whereas transferring estimates from one location to another may miss important factors for beach sand valuation that I identify (e.g. inlets and public beach access), the burgeoning availability of environmental and economic data allow replicable and scalable context-specific valuation. This exercise pieces out the contribution of a coastal environmental attribute—beach width—embedded in the capitalized value of coastal homes and demonstrates ways forward for natural capital accounting.

I. Introduction

The increasing availability of data has enabled operational ecosystem accounts (*SEEA EA*, 2021) that track physical quantities and, ideally, the economic value of natural assets. The US, for example, will assemble natural capital accounts and attempt to disentangle the contribution of natural assets to various sectors of the economy in the coming decade (Office of Science and Technology Policy et al., 2023). In the absence of market prices, systematic physical accounts of natural assets can serve as proxies for monetary accounts to describe the

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[1] Data provided by Zillow through the Zillow Transaction and Assessment Dataset (ZTRAX). More information on accessing the data can be found at http://www.zillow.com/ztrax . The results and opinions are those of the author(s) and do not reflect the position of Zillow Group.

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changes in the economic value of natural assets. However, physical indicators can also provide poor indices of the state of the environment if they aggregate units of natural capital generating different bundles of ecosystem services. For example, measuring physical stocks of a tree species distributed across a woodland with stocks of the same species planted more sparsely in urban areas masks important heterogeneity in the services these trees provide in situ. Using such measurements as proxies for service flows will overstate urban noise mitigation services (Fletcher et al., 2022) and understate the habitat provisioning services for woodland fauna. Policy based on misleading indices, in turn, can compromise progress toward sustainability.

Here, I use beach sand as an example to explore the heterogeneity in value flows from natural assets along the US east coast. I build on previous work from North Carolina (Addicott, 2022) and Florida that characterizes the marginal value of coastal beach attributes, and provide an additional empirical example from Connecticut. I present summaries of the three case studies as evidence that associated service flows stemming from different configurations of natural assets drive heterogeneity in their economic value. Accounting for heterogeneity in service flows from natural assets can improve the quality of environmental-economic accounts, assist with targeting of policy interventions to mitigate impacts of climate change and sea-level rise, and identify important omitted variables in determining natural asset values. In the discussion, I use the 2022 FEMA Ecosystem Service Value Updates as an example where recognizing service flow heterogeneity for coastal assets can improve policy and adaptation investments going forward (*FEMA*, 2022).

Coastal areas are useful exemplars of the heterogeneity in service flows and values for natural assets because of their policy relevance and value. Coasts are on the frontlines of the climate crisis and understanding factors important for valuing coastal natural assets can inform high-impact decisions. The sustainability of coastal cities will depend on making effective adaptation decisions in the face of climate risk. Rising seas and more frequent storms imperil the intertwined produced and natural assets along coasts. While seawalls and other produced capital investments can help protect coastal properties from rising seas (Yohe *et al.* 1996), so too can robust beach-dune ecosystems. However, the value of natural capital assets – like sandy beaches and dune systems – and their associated ecosystem service flows are not well characterized. Consequentially, unmeasured natural assets and ecosystem services may, in practice, receive zero weight by planners and lead to inefficient policy decisions.

Coastal planners are tasked with assessing the cost-effectiveness of adaptation strategies in the face of coastal erosion and sea-level rise. It is not sufficient to know the direct costs of seawall construction or dune restoration because of linkages between produced and natural assets (Rouhi Rad et al., 2021). There is evidence, for example, that produced defensive expenditures in coastal areas might diminish the resilience of coastal beaches and therefore their value (Berry *et al.* 2013). An informed link between the configuration of coastal beach sand and ecosystem service provision will improve independently assessed values for produced and natural solutions to climate risks and aid planners' decisions in the coastal zone. If we can value natural assets more accurately, then we will be in a better position to assess the costs and benefits of different policy responses.

Sand, in contrast to fish stocks or bird populations, is immobile (of its own accord). It is relatively homogeneous and substitutable. Despite the simplifying features of beach sand, aggregating sand values along the US east coast using a benefits-transfer approach would be ill advised when there are the systematic differences in capitalization rates and service flows demonstrated here that are otherwise unaccounted for. Given this, other, more complicated assets (e.g. populations of migratory species or acres of wetland) require careful attention when included in natural capital accounts to avoid aggregation bias. The upside is that the data and methods to capture the extent, condition, and value of ecosystems at high-resolution are increasingly available, obviating extensive reliance on poor physical indices or benefits transfer for policymaking.

Case Study I summarizes key results from (Addicott, 2022) from North Carolina. Case Study II focuses on inlets in Florida. For these first two study areas, beaches and the coastline are synonymous. Everywhere in the sample that is coastline is sandy beach. In Case Study II: Florida, I restrict the sample to portions of the coastline where the beach is interrupted at an inlet. This partition of the coastline interrupts the flows of sand along the shore and the case provides suggestive evidence that the interrupted service flows impact the capitalized value of beach sand in coastal properties. The third case study provides new evidence of the heterogeneity in the value of coastal beach sand along the US east coast.

In Case Study III: Connecticut, I highlight pocket beaches where being adjacent to the coast is not synonymous with being adjacent to a beach. A mix of public and private access beaches, each with varying angles along the coast (e.g. east-facing compared to south-facing), and at a higher latitude provide results for the capitalization of beach sand in coastal properties that are characteristically different from the other two case studies.

In each case study, I derive estimates of the marginal capitalization of beach width in coastal property values using the hedonic property value method. The literature on hedonic pricing of environmental amenities provides ample evidence that context is important for valuation (e.g. White & Leefers, 2007). This paper shows that high resolution geophysical, remotely-sensed data can be used to scale up valuation efforts that otherwise faced the challenge of limited data (Barbier, 2012; Mooney et al., 2004). By leveraging remotely-sensed data for each of the three case studies along the US east coast, I show that we can get more accurate measures of the value of natural assets to inform policymaking (e.g. via cost-benefit analysis) and that these measures reflect important heterogeneity within cross-sections of the coast and between coastal areas. The estimates I provide assume a time-invariant hedonic price schedule and that the configuration of coastal assets are important and salient for bidders and buyers of the properties included in the sample. Identification strategies in each case study vary according to the available data and applicable tools for each setting. While the fixed-effects specifications are cross-sectional in nature, the results support the key idea that the arrangement of the portfolio of natural and produced assets along the coast drives differential provision of services and hence heterogeneity in natural asset values.

The remainder of the paper is organized as follows. Sections II and III provide background, describing the context of beach-dune ecosystems along the US east coast, previous efforts in the literature to value coastal beach sand, and the data for the analysis. Sections IV– VI present case studies using hedonic property valuation of beach sand to illustrate the spatial distribution of values for an otherwise homogeneous asset. Section VII offers discussion toward improved national accounts of natural assets.

II. Background and Setting

Coastal beaches are on the front lines of global change. Natural processes in coastal zones, and the services they generate, vary non-linearly across time and space (Barbier et al., 2008). Winds, tides, currents, waves, and eddies arrange and rearrange produced and non-produced assets in the coastal zone from ocean plastic and seaweed to nutrients and grains of sand. Sand exists above and below the surface of the ocean and contributes to the provision of spatially dependent services, like coastal protection and recreation, and disservices, like impeded coastal navigation (as a sand bar or shoal).

Sea level rise, storm damage and climate change motivate increased attention to coastal beaches, however they have long been featured prominently in the recreation demand and non-market valuation literatures (Bell & Leeworthy, 1986, 1990; Landry & Hindsley, 2011;

McConnell, 1977; Parsons & Powell, 2001). While this literature focuses on coastal beaches as amenities that produce a single service – either recreation or coastal protection, more recently, sandy beaches have been studied as inputs to the production of multiple service flows (Addicott, 2022; Dundas, 2017) . When an additional unit of sand is allocated to beach width, this sand provides recreation opportunities to beachgoers as well as coastal protection services to the owners of nearby property. Beach sand allocated to coastal dunes and their attributes (i.e., width, height, location) protects from flooding and windstorm-induced property damage through interactions with beach width.

The hedonic property valuation method has been used to estimate the value of beaches capitalized in nearby property values at specific beach locations around the world. These values are then used to assess the cost-effectiveness of widening beaches through beach nourishment (Parsons and Powell 2001), principally motivated by recreation values (Edwards and Gable 1991) or erosion/coastal protection (Landry *et al.* 2003, Pompe and Rinehart 1994). This same methodology is used and expanded upon in the case studies that follow because of the availability of property data (via e.g. ZTRAX and CoreLogic) and high-resolution environmental data. These data can be used to value an environmental amenity through property transactions (Gindelsky et al., 2022; White & Leefers, 2007). Benefits transfer is one option for elevating these estimates to inform natural capital accounts of coastal assets. This paper contributes to our understanding of how the capitalized value of natural assets can be reliably estimated across space when given reliable data. The case studies illustrate the degree to which the configuration of sand, within a cross-section of beach and along different arrangements of properties and coastline, can imperil the wide external validity of the hedonic approach when unaccounted for. In coastal areas where beaches are periodically nourished, property values and beach width are codetermined. Gopalakrishnan *et al.* (2011) first tackled this endogeneity resulting from nourishment decisions and find that their instrumental variables estimation (using distance to the continental shelf as an instrument for beach width) produces a beach width coefficient that is six times larger than the OLS estimate.

The three case studies demonstrate different ways to configure sand– the asset of interest – along coastlines and with respect to coastal properties. I address how sand may be valued differently when varying 1) its configuration from offshore to onshore at a specific location and 2) its configuration across locations along the coast. The three configurations of beach sand considered here are contiguous stretches of beach sand with prominent dunes (NC), inlet areas (FL), and pocket beaches (CT) (Figure 1). I define these sand configurations on a macro scale. Since coasts are dynamic systems, I use beach measures as close to the time of sale as the data allow with the idea that beach width/dune features do change but are slow variables relative to property transactions. The Connecticut pocket beach example adds important richness to the previously explored Florida and North Carolina cases. Whereas in North Carolina and Florida, public beaches are ubiquitous with access points well-distributed, in Connecticut, pocket beaches may or may not have public amenities and access.

III. Data and Methods

The data for these analyses include economic and biogeophysical data for all coastal counties in North Carolina and Connecticut as well as the surrounding area[2] of six inlets[3] on the Atlantic coast of Florida. The economic data are property transactions data and housing characteristics for sales of properties within 10 km of the coastline from 2008-2017 derived from parcel-level tax and deed data from CoreLogic (for North Carolina counties) and 2004-2022 from Zillow's ZTRAX data for Connecticut and Florida (2020).

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[2] Adjacent to the shoreline (200 meters inland) and within a 600 meter buffer of the inlet centroid

[3] Boca Raton, Ft Pierce, Jupiter, Lake Worth, Ponce de Leon, and South Lake Worth

The geophysical data are derived from the USGS Coastal LiDAR Dataset[4], Connecticut Department of Energy & Environmental Protection GIS Open Data, and PlanetLabs (Team Planet, 2017). USGS LiDAR data record dune features at high resolution and beach slope. The dune feature data consist of the horizontal position and elevation of the dune crest, dune toe, and shoreline on a 5-meter grid. The dune toe is the point on the dune with the maximum increase in slope. This high-resolution information allows me to implement a continuous measure of beach attributes into the hedonic property value framework.

IV. Case Study I: North Carolina

In North Carolina, sandy beaches line almost the entire Atlantic coast of the state. For this sample, proximity (or adjacency) to the coast implies proximity (adjacency) to a sandy beach. Previous work by Gopalakrishnan et al. (2011) demonstrates that the capitalization of an additional foot of beach width for coastal properties is about 1% of property transactions price. Due to the frequency of beach nourishment projects—which artificially widen beaches —along North Carolina's coast, beach width is an endogenous variable. Replicating the approach from Gopalakrishnan et al. (2011), I use distance to the continental shelf (an isobath) as an instrument for beach width. Distance to an undersea isobath, or contour line, is plausibly exogeneous and only impacts the bidder's decision insofar as it mediates beach width. I confirm their estimates and go on to show that beach sand, configured as dune features capitalizes into property values differently than when allocated to a marginal foot of beach width (Addicott, 2022) . I elicit marginal values for different attributes of beach-dune ecosystems and attribute the values to service and amenity flows – namely coastal protection, recreation, and viewsheds.

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[4] Located at https://coastal.er.usgs.gov/data-release/doi-F7GF0S0Z/

For all case studies, I estimate similar first-stage semi-log hedonic models. For this case study, the , P_{ij} is the 2017 CPI-adjusted sale price of property i located in county j, X_{ij} are characteristics of the property, including flood risk and the number of blocks away from the ocean, w_{ij} is the beach width at the closest coastal profile to each property, D^h and D^w are the dune width and dune height for the dune associated with the closest coastal profile:

$$\ln \ln \left(P_{ij}\right) = \alpha X_{ij} + \beta_1 w_{ij} + \beta_2 D^h_{ij} + \beta_3 D^w_{ij} + \tau_1 SaleMonth_{ij} + \tau_2 SaleYear_{ij} + \delta_1 County_j \quad (1)$$

Within each cross-shore slice of coast, from the closure depth at which nearshore sand fluctuations attenuate, to the far side of a coastal dune, the allocation and configuration of beach sand contribute to different suites of ecosystem services. As a result, the asset value of a unit of beach sand depends on where along the coastal profile it is located. In addition, the configuration of produced capital—the height of coastal properties—interacts with coastal dunes such that properties taller than dune can have valuable viewshed obstructed by a marginal increase in dune height. Therefore, for these homes, taller dunes provide a viewshed reduction hand-in-hand with an increase in coastal protection.

In my preferred specification from this work, an additional foot of beach width capitalizes at about 1% of property values and a marginally taller dune or marginally wider dune capitalize in property values differently depending on whether the property's viewshed is fully blocked by the dune (i.e. the property is shorter than the dune). Figure 2 presents the key result from Addicott (2022b) as exposition for the following novel cases. The figure shows that the marginal capitalization in terms of feet of beach width/dune height/dune width depends on whether a property's viewshed is fully-blocked by a dune. For properties with a fully-blocked viewshed, a marginally taller dune does not provide an additional viewshed disamenity in the same way as it would for a property with an unobstructed view of the shore. I find that the marginal value of a foot of dune height for coastal protection is approximately

$12,200/ft; however, that additional foot of dune height imposes a viewshed dis-amenity of over twice that magnitude (approx. -$28,900/ft). Whereas the marginal value of beach width is uniformly positive for fully-blocked and not fully-blocked properties, the marginal value of dune height is not. In addition, depending on the shape of the dune and coastal profile, different volumes of sand will be needed to realize the horizontal or vertical foot of dune or beach. These volumetric results are presented in Addicott (2022).

I emphasize here as a starting point that the value of beach sand within a cross-section of beach depends on the configuration of coastal natural and produced capital (beaches, buildings, and dunes). A uniform investment in a volume of beach sand will realize different levels of ecosystem services depending on the dimensions of the coastal profile and the location along the (cross-shore) profile where the sand is allocated. Taking the framework from this setting and comparable high-resolution remotely sensed data to inlet areas in Florida and pocket beaches in Connecticut, I can consider the heterogeneity in the capitalization of beach width elsewhere along the coast.

V. Case Study II: Florida

Whereas in the North Carolina case study the stretches of beach considered were contiguous, in Florida I focus on the interruption of the coastline by inlets. Inlets are a particularly important configuration of coastal sand in that they embody produced/natural asset substitution. For one, inlets allow vessels to navigate between the ocean and inland waters. On the other hand, they also interrupt the north to south flow of sand that would otherwise occur in their absence. As a result, inlet areas in Florida are managed via sand bypass, human-mediated sand transfers from the sand-rich side of an inlet to the sand-poor side.

Using property sales from 2004-2020 around five inlet areas in Florida, I show that inlets deserve special consideration for understanding the marginal value of coastal natural capital. There are two results to support this. First, controlling for structural characteristics properties on the sand-starved side of inlets sell for less than properties on the sand-fed side. Second, beach width capitalizes at a higher rate on the sand-fed side of inlets than on the sand-starved side.

Table 2 presents both results using a similar hedonic first stage to Case Study I; however, here there is a more limited sample of property transactions for coastal adjacent homes within one half mile of the midpoint of six coastal inlets on Florida's east coast: Boca Raton Inlet, Ft Pierce Inlet, Jupiter Inlet, Lake Worth Inlet, Ponce de Leon Inlet, and South Lake Worth Inlet. Again, as in Addicott (2022) and Gopalakrishnan et al. (2011) an additional foot of beach width capitalizes in coastal properties at about 1% of their value all else equal. Column (2) includes an indicator for whether a coastal property is located on the sand-starved south side of an inlet area. This indicates there is a 22.4% discount for properties on the sand-starved south side of inlets. While the inlet area fixed effects help address non-timevarying unobservable characteristics in each inlet area, the results here are not causal—merely illustrative of the difference in property transactions values for properties sited on the south side of inlets across 19 inlets on the state's east coast. Ideally, an event study using plausibly exogenous storm events could help address standard concerns with a cross-sectional hedonic approach.

Column (3) shows that an additional foot of beach width on the sand-starved south side of inlets capitalizes at a discount relative to an additional foot of beach width on the sand-fed north side of an inlet. One potential explanation for this difference in capitalization is that each of these inlets undergo regular sand-bypass transfers, moving sand from the north to the south side of the inlet. Column (5) controls for annualized sand supplements due to bypass at inlet sites. Narrower beaches on the south side of inlets, relative to the north side of inlets, realize greater quantities of transferred sand. These results suggest that the human-mediated sand transfers and interruptions to the natural north-south flow of sand are important factors for determining the flows of benefits each unit of sand provides nearby property owners.

VI. Case Study III: Connecticut

In Connecticut, pocket beaches mean that properties can be adjacent to the coast without being near a sandy beach. Pocket beaches represent a different configuration of sand than the contiguous stretches of barrier island along the Florida or North Carolina coastline, and may be enjoyed differently due to their structure.

Again, using a sample of property transactions, I estimate a first stage hedonic model to understand how pocket beaches capitalize into coastal property values. Table 3 shows capitalization estimates that include fixed effects by county, sale year, sale month, and nearest public beach. Column 5 clusters the standard errors at the county level.

Strikingly, these estimates for the marginal capitalization of beach width are smaller than the Florida and North Carolina case studies. Back-transforming to marginal capitalization from Column (6), a foot of beach width has a mean capitalization of $267/ft (95 pct CI $231-$303) in Connecticut. A back-of-the-envelope calculation using average cooling-degree days (27.25% ratio of cooling degree days between North Carolina and Connecticut) weights the capitalization in Connecticut to account for fewer warm beachgoing days since cooling degree days reflect the number of days the average temperature is above 75 F. However, the reweighted capitalization in Connecticut, $980/ft, still leaves a large gap compared to the $4,838/ft-$5,692/ft capitalization in North Carolina. One possible explanation for the smaller magnitude of capitalization is that beachgoing amenities and recreation opportunities associated with beach sand are seasonally limited and therefore the recreation services they provide command less of a premium in coastal property sales.

A second important feature from this case study is that the capitalization of beach width attenuates rapidly. Whereas in North Carolina, the market size in which there was evidence that beach width capitalized positively in property values extended for some counties as far out as 3 miles from the coast, in Connecticut the capitalization of beach width attenuates to zero for properties with centroids beyond 500 feet from the beach. Further, Table 3 Columns (3-6) introduce controls for distance to a public beach. The coefficients on this regressor in each of the specifications is greater than zero, suggesting that the premium for being within 500 feet of the beach can be offset by being too close to a public beach. Greater distances from public beaches, conditional on being near the coast, are associated with higher property values.

Table 3 Column (6) provides suggestive evidence that properties prone to inundation from SLR, in areas that have experienced past shoreline retreat, sell at a discount. Shoreline retreat, or shore movement, data describe the net movement of the shoreline between 1880 and 2006 (O'Brien et al., 2014). This association has the same order of magnitude as the capitalization of a foot of beach width (per foot of long term coastal retreat) and also the aspect (or angle) of the coast.

VII. Discussion

Non-market valuation methods can be used to fill gaps in measurement of the value of ecosystem service flows from natural assets. Such economic tools provide policymakers with improvements to null/zero valued assets so that the value of natural assets are—at a minimum—partially accounted for in policy decision making. Whereas the non-market valuation literature includes estimates of the value of coastal natural assets and services, these estimates have typically required labour-intensive field-data collection (e.g. Gopalakrishnan et al., 2011) and therefore were more limited in scope. The bespoke nature of non-market valuation studies means that scaling results for policy requires applying estimates from one context to similar, often neighbouring locales. This process, known as benefits transfer, maximizes the application of outputs from costly data collection and analysis.

As an example, consider the United States Federal Emergency Management Agency (FEMA) policies for incorporating ecosystem services in the Benefit-Cost Analysis (BCA) process. The first ecosystem services policy was implemented in 2013 and allowed monetization of ecosystem services for riparian and green open space for BCA. The policy was updated in 2016 and again in 2022 to cover more land cover types and include more service flows. The policy favors values from meta-analyses as they are intended to be used for "streamlined" BCA as part of the agency's BCA toolkit and applicable to any project in the US. As values for land cover types and their associated ecosystem services are added or updated, zero-values for investments in natural assets and ecosystem services are improved and nature-based solutions are given credence in BCA. In the 2022 update, nine land cover types and fourteen ecosystem services are considered, though not all combinations are populated with estimates. Beaches and dunes, for example, were assigned $223,840 (2021 USD) in aesthetic value per acre per year and $76,809/acre/year (2021 USD) for a total of $300,649/acre/year (2021 USD).

The three case studies exemplify several points regarding FEMA's streamlined estimates of ecosystem service flows for BCA. The first is already reflected in the fact that some land cover types are distinguished by more than just an ecological definition. Urban Green Open Space is distinguished from Rural Green Open Space. Coastal Wetland is distinguished from Inland Wetland. The latter distinction has to do with the configuration of natural assets in the land cover type across space. The former has to do with the relative configuration of produced and natural assets (i.e. rural vs. urban). The heterogeneity across estimates in Florida, North Carolina, and Connecticut support the idea that ecosystem service estimates should comport with *socio*ecological boundaries, tackling the differential provision of different service flows in different settings. The recreational service flows from of an acre of beach in the Northeast US and in the Southeast US over a year might vary seasonally with temperature, for example, and as a result a similar differentiation to that used for green open space (rural vs. urban) may be justified.

Paths Forward for Natural Capital Accounting

Recently, remotely-sensed data and the digitization of economic data – such as property characteristics and transactions – have replaced the need for labour-intensive data collection and enabled bespoke estimates to be generated at scale, reliably, and credibly, obviating the need for benefits transfer and enabling efforts to develop balance sheets of natural assets to track wealth changes.

The past focus on a particular place and service flow can now be broadened to develop a broad balance sheet of natural assets that is enabled by new remote sensing tools. This work demonstrates the spatial scalability of valuation tools for coastal natural capital that is enabled by reliable remotely-sensed and economic data. Although repeat sales over time series of remotely observed coastal characteristics are not used here, future work should focus on the repeatability of this valuation pipeline, making use of increasingly spatially and temporally resolved data. However, as the North Carolina case study exemplifies, the mapping between the suite of services and the portfolio of natural and produced assets that produce them is an important consideration for appropriately attributing values to context-specific service flows. Natural assets within ecosystems provide different flows of benefits and the classification of units, the definition of the sampling grid, must be carefully decided on an asset-by-asset basis.

Future work expanding to isolated coastal communities in Georgia and lakeside dunes in Michigan will help reveal how different configurations of natural and produced assets generate different service flows in context. A Michigan-dunes case study would move the work away from the US east coast and consider the recreation, viewshed, and protection roles dunes and beach sand provide to properties exposed to climate impacts on lakeshores rather than the Atlantic seaboard. Whereas estimates for this project reflect economic values embedded in property values, this does not capture the value of coastal beach sand in more remote areas. Other approaches, for example travel cost methods, could be used to identify use values in these contexts.

Understanding the attribution of natural capital assets to various services flows, and how they are captured in existing accounts, will not only aid ecosystem accounting efforts, but also help determine optimal investment decisions as natural capital is depreciated. While different portfolios of assets can provide the same service flows, the per unit value of the assets would be individual different, thereby driving aggregation bias in accounts. The function of natural assets is context-dependent and arbitrage of natural assets can be costly (Addicott & Fenichel, 2019). With high transactions costs, the exchange value of the services they provide are also context-dependent and spatially heterogeneous.

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Tables

Table 1. Summary Statistics by Inlet Side

	(1) Full sample	(2) North of Inlet	(3) South of Inlet
Sale Price	1,121,914	1,037,294	1,294,479
	(1,219,885)	(1,092,342)	(1,430,657)
Bedrooms	2.74	2.57	3.10
	(0.992)	(0.726)	(1.316)
Bathrooms	2.94	2.76	3.31
	(1.215)	(0.892)	(1.632)
Dist. to Shore	607.77	452.46	924.51
	(480.5)	(375.0)	(515.5)
Building Sq Ft	2666.20	2402.32	3204.32
	(2078.3)	(1535.1)	(2810.0)
Beach Width (ft)	112.37	98.07	144.04
	(54.15)	(33.38)	(74.30)
N	3249	2180	1069

Standard deviations in parentheses.

Table 2. Florida Inlet Regression Results

Dependent variable: Log Sale Price (2017$)	(1)	(2)	(3)	(4)
Bedrooms	0.638***	0.644***	0.628***	0.548***
	(0.061)	(0.061)	(0.061)	(0.062)
Bedrooms Sq.	-0.088***	-0.086***	-0.083***	-0.077***
	(0.009)	(0.009)	(0.009)	(0.009)
Bathrooms	0.258***	0.268***	0.268***	0.305***
	(0.059)	(0.058)	(0.058)	(0.058)
Bath Sq.	-0.013	-0.012	-0.012	-0.018*
	(0.007)	(0.007)	(0.007)	(0.007)
Building Sq Ft	2.34e-04***	2.25 e-04***	2.21 e-04***	2.19 e-04***
	(1.40e-05)	(1.41e-05)	(1.40e-05)	(1.39e-05)
Beach Width (ft)	0.008***	0.009***	0.018***	0.019***
	(0.001)	(0.001)	(0.002)	(0.002)
1(South)		-0.224***	0.276*	0.028
		(0.046)	(0.108)	(0.116)
1(South) x Beach Width (ft)			-0.014***	-0.015***
			(0.003)	(0.003)
Annualized Bypass (cu ft)				2.67e-06***
				(4.79e-07)
Constant	10.99***	10.89***	10.64***	10.69***
	(0.140)	(0.140)	(0.148)	(0.147)
N	3249	3249	3249	3249
R^2	0.555	0.560	0.566	0.572

Standard errors in parentheses. All columns include inlet area, sale year, and season of year fixed effects.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3. Pocket Beach Sales Regression Results

Log Sale Price (2017$)	(1)	(2)	(3)	(4)	(5)	(6)
Bedrooms	0.153***	0.239***	0.238***	0.236***	0.243***	0.248***
	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Bedrooms Sq.	-0.011***	-0.028***	-0.028***	-0.028***	-0.028***	-0.029***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Bathrooms	0.525***	0.366***	0.364***	0.363***	0.345***	0.338***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)
Baths Sq.	-0.030***	-0.028***	-0.028***	-0.028***	-0.027***	-0.026***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Ppty Sq Ft.	6.259e-05***	9.727e-05***	9.730e-05***	9.473e-05***	9.338e-05***	9.434e-05***
	(1.167e-06)	(1.249e-06)	(1.246e-06)	(1.249e-06)	(1.234e-06)	(1.397e-06)
Beach Width (ft)	-8.215e-04***	5.403e-05*	1.885e-04***	1.807e-04***	1.586e-04***	4.552e-04***
	(1.724e-05)	(2.334e-05)	(2.372e-05)	(2.363e-05)	(2.330e-05)	(3.132e-05)
Coast Angle	-1.242e-03***	-4.322e-04***	-5.390e-04***	-6.244e-04***	-6.466e-04***	-4.585e-04***
	(3.983e-05)	(4.353e-05)	(4.397e-05)	(4.406e-05)	(4.318e-05)	(5.769e-05)
Dist to Public Beach (ft)			6.264e-05***	5.795e-05***	6.017e-05***	8.675e-05***
			(3.267e-06)	(3.289e-06)	(3.193e-06)	(4.028e-06)
Dist to Coast (ft)				4.680e-05***	5.750e-05***	7.671e-05***
				(1.902e-06)	(1.917e-06)	(2.300e-06)
1(Near Coast)					6.047e-01***	2.664e-01***
					(1.648e-02)	(7.951e-03)
1(Near Coast) X Coast Dist					-2.954e-03***	
					(2.122e-04)	
1(Near Coast) X PublicBch Dist					-7.759e-05***	
					(4.074e-06)	
SLR Shore Retreat (ft)						-2.087e-04***
						(2.733e-05)
PublicBeach FE		X	X	X	X	X
N	197940	197940	197940	197940	197940	148309
R^2	0.526	0.632	0.633	0.634	0.642	0.662

Standard errors in parentheses. All columns include sale year, month of year, and county fixed effects. Number of stories and building vintage are also controlled.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figures

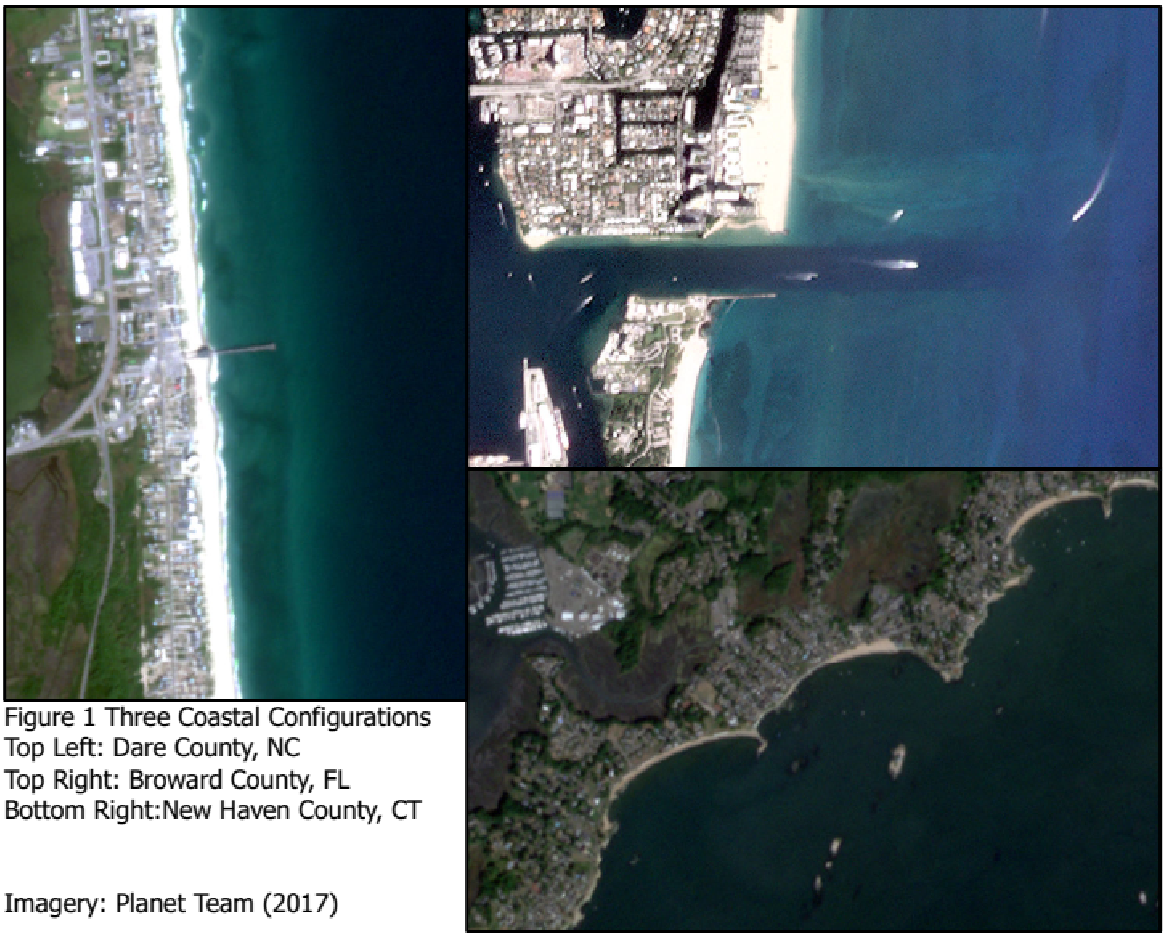

Figure 1 Three Coastal Configurations
Top Left: Dare County, NC
Top Right: Broward County, FL
Bottom Right:New Haven County, CT

Imagery: Planet Team (2017)

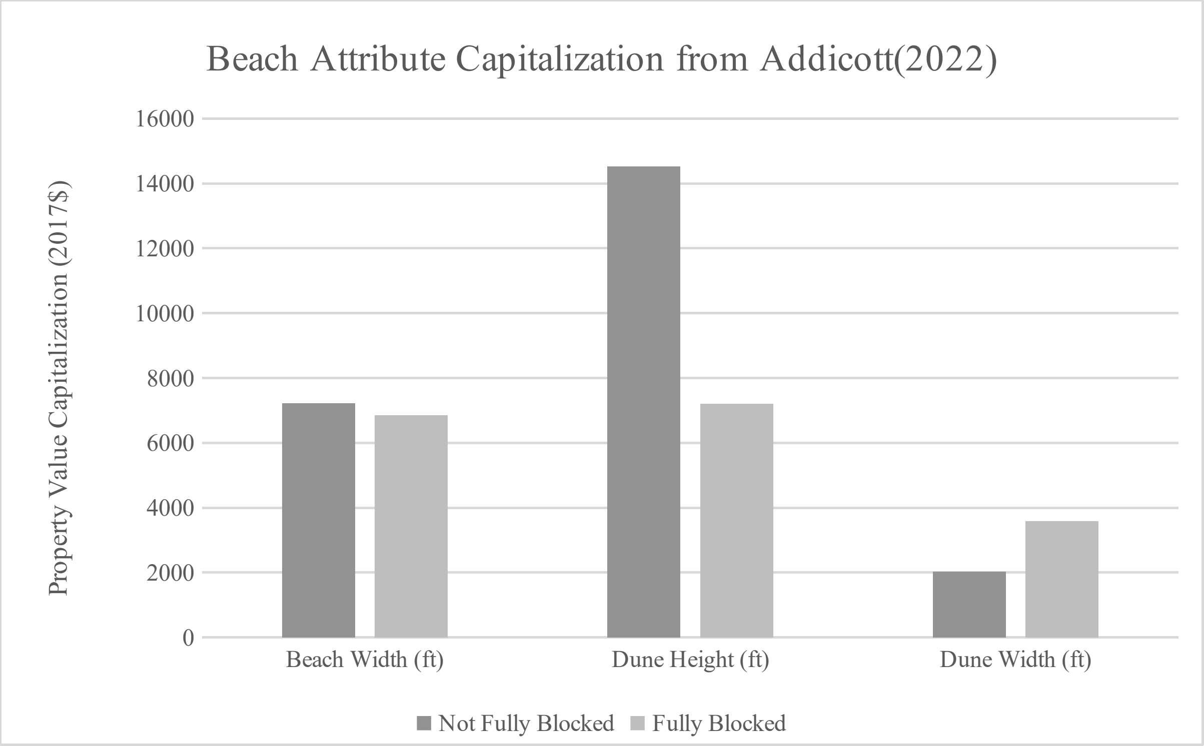

Figure 2. Summary of capitalization of coastal attributes in property values from Addicott (2022) across properties with fully-blocked and not fully-blocked viewsheds. See Addicott (2022) Tables 1 and 5 for corresponding summary statistics and regression tables.

Appendix

Table A1. Summary Statistics for Connecticut Property Transactions

Variable	Obs	Mean	Std. Dev.	Min	Max
Sale Price (2017$)	145,271	436,507	341,526	82,915	1,398,300
Bedrooms	145,271	2.88	1	0	5
Bathrooms	145,271	2.09	.92	0	5
Property Sq Feet	145,271	2897.22	2067.45	285	369364
Beach Width (ft.)	145,271	145	65.65	33.09	543.44
Near (Coast Dist < 330ft)	145,271	.05	.22	0	1
Dist to Beach (ft)	145,271	4211.73	2952.95	.11	13,054.62
Dist to Public Beach (ft)	145,271	4454.45	2884.66	9.27	13,168.81
SLR Shore Movement (ft)	145,271	16.3	57.01	-311.87	699.25
Dist to Coast (ft)	145,271	1603.18	1345.52	.01	5546.56
Angle of Nearest Coast	145,271	153.29	36.2	33.08	356.38