The Value and Configuration of Coastal Natural Capital

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Abstract

Coastal beaches along the US east coast present compelling case studies to examine how the configuration of natural assets influences their valuation. Using high-resolution, remotely sensed imagery and property transactions I compare estimates from pocket beaches in Connecticut to case studies of different configurations of beach sand in North Carolina and Florida. 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 or Florida. Whereas transferring estimates from one location to another may miss important factors for beach sand valuation 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 balance sheet of coastal homes, and demonstrates ways forward for natural capital accounting.

I. Introduction

Ecosystem degradation, species loss, and other changes to the natural environment are linked to changes in economically valuable services. For at least two decades, a quorum of researchers and policymakers have worked together – for example, through the Millennium Ecosystem Assessment – to better understand the links between nature, the economy, and human well-being (Mooney et al., 2004). However, effective policymaking in response to ecosystem change will require the methods and data to comparably measure changes in the extent and condition of ecosystems over time.

In recent years, increased data availability has enabled the development of ecosystem accounts (*System of Environmental-Economic Accounting-- Ecosystem Accounting (SEEA EA)*, 2021) to track the physical quantities and, ideally, the economic value of natural assets. The US, for example, will assemble natural capital accounts and attempt to disentangle the

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.

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 provide useful information about changes in the quantity of natural assets. Physical accounts can serve as proxies for monetary accounts to describe 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 that provide different sets of ecosystem services. Policy based on misleading indices, in turn, can compromise progress toward sustainability.

Coastal areas are a useful setting to explore the heterogeneity of service flows and values for natural assets. For one, coastal areas are on the frontline of climate impacts. Rising seas and more frequent storms imperil property and the sustainability of coastal cities will depend on adaptation decisions in the face of climate risk. Second, coastal ecosystems are where valuable produced and natural assets interact. While seawalls and other forms of 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 is 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 costs of seawall construction or dune restoration. 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 understanding of how the configuration of coastal beach sand relates to service provision in coastal systems can help improve planners' decision making. 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 levers.

Here, I provide three case studies to demonstrate the heterogeneity in value of coastal natural capital assets and their associated service flows. Sand, in comparison to fish stocks or bird populations, is immobile (of its own accord) and relatively homogeneous and substitutable. Despite these two simplifying features of beach sand, aggregation of sand values along the US east coast using a benefits transfer approach would be ill advised given the heterogeneity in capitalization rates and service flows resulting from sand and produced capital configurations. Given this, other, more complicated assets (e.g. populations of migratory species or acres of wetland) require particular 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 Studies I and II summarize key results from Addicott (2022a) from North Carolina and Florida respectively. 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 this impacts 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 of the case studies, 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 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 remainder of the paper is organized as follows. Sections II and III describe 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 of hedonic valuation of beach sand to illustrate the spatial distribution of values for an otherwise homogeneous asset. Section VII offers discussion toward improving 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, in particular, can reside above or below water and contribute to the provision of spatially dependent services, like coastal protection and recreation, or disservices, like impeding coastal navigation in the form of a sand bar or shoal.

Coastal beaches have been a focus of the recreation demand and non-market valuation literature for decades (Bell & Leeworthy, 1986, 1990; Landry & Hindsley, 2011; McConnell, 1977; Parsons & Powell, 2001). The literature has typically characterized a single service provided by coastal beaches – either recreation or coastal protection. However, beach sand plays many roles at once, contributing to the production of different service flows along coastal beaches and above and below the ocean. When an additional unit of sand is allocated to beach width, it 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) protect from flooding and windstorm-induced property damage through their interactions with beach width.

Stated preference methods (Bell 1986, McConnell 1977, Silberman *et al.* 1992) can provide useful, but highly sensitive (Boxall *et al.* 1996) estimates of the value of service flows generated from coastal natural capital. Hedonics, for example, has been used across different locations to estimate the value of beaches as capitalized in adjacent and other nearby property values. 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). Benefits transfer is one option for elevating these estimates to inform natural capital accounts of coastal assets; however, as the case studies here demonstrate, how sand is configured within a cross-section of beach and along different arrangements of properties and coastline can imperil the wide external validity of benefits transfer to estimate service flow values. In coastal areas where beaches are periodically nourished, property values and beach width are codetermined. Gopalakrishnan *et al.* (2011)

are the first to tackle the endogeneity in the system 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, calling into question previous work in nourished locations.

This paper addresses how sand may be valued differently when varying 1) its configuration from offshore to onshore at a particular 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. Coasts are dynamic systems; however, I take 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

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[1] of six inlets[2] on the Atlantic coast of Florida. The economic data are property transaction data and housing characteristics for sales of properties within 10 km of the coastline from 2008-2017 derived from parcel-level

[1] Adjacent to the shoreline (200 meters inland) and within a 600 meter buffer of the inlet centroid
[2] Boca Raton, Ft Pierce, Jupiter, Lake Worth, Ponce de Leon, and South Lake Worth

tax and deed data from CoreLogic (for North Carolina counties) and 2004-2022 from Zillow's ZTRAX data for Connecticut and Florida (2020).

The geophysical data are derived from the USGS Coastal LIDAR Dataset[3], Connecticut Department of Energy & Environmental Protection GIS Open Data, and PlanetLabs (Team Planet, 2017). These LIDAR data record dune features at high resolution and beach slope: important for variable erosion rates and converting linear feet of beach width into volumetric measures of sand needed. 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. The high-resolution information allows me to implement the first continuous measure of dune height 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. Being on the coast and being near a sandy beach go hand in hand. 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. Replicating the instrumental variable approach, I confirm this estimate 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, 2022b) . In doing so, I elicit marginal values for attributes of beach-dune ecosystems and attribute the values to service and amenity flows – namely coastal protection, recreation, and viewsheds. I estimate the following first-stage hedonic model where 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

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

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:

$$\ln(P_{ij}) = \alpha X_{ij} + \beta_1 w_{ij} + \beta_2 D^h_{ij} + \beta_3 D^w_{ij} + \tau_1 SaleMonth_{ij} + \tau_2 SaleYear_{ij} + \delta_1 County_j + \delta_2 BlocksfromOcean_{ij} + \epsilon_{ij} \quad (1)$$

Here I emphasize that 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, 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) 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 disamenity 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(2022b). 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 inlets which interrupt the coastline. 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 in (Addicott, 2022a) 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 as Addicott (2022a); however, here I include 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 (2022b) 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-time varying 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.

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. 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 to 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. Although repeat sales over time series of remotely observed coastal characteristics is not used here, future work can make use of increasingly spatially and temporally resolved data to do so. 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)

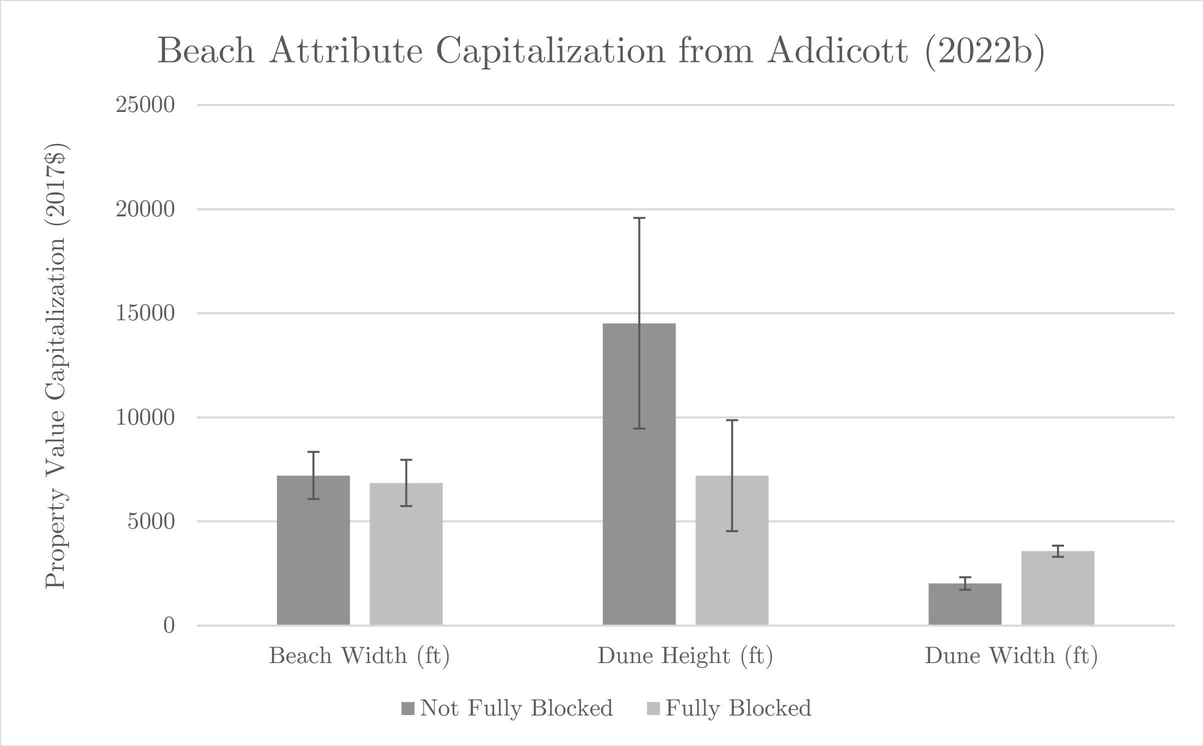

Figure 2. Summary of capitalization of coastal attributes in property values from Addicott (2022b) across properties with fully-blocked and not fully-blocked viewsheds. See Addicott (2022b) Tables 1 and 5 for corresponding summary statistics and regression tables.

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