SUPPORTING INFORMED COASTAL LANDSCAPES: AN ASSESSMENT OF PREFERENCES IN CAROLINA TIDAL CREEK COMMUNITIES

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1 ABSTRACT

This study assessed the values, attitudes, and knowledge that influence residential landscaping decisions in coastal areas. This effort represents the initial step of a larger initiative to engage, educate and transform tidal creek communities to foster healthy ecologies through a strategic alignment with resident behaviors.Homeowners located in two single-family neighborhoods adjacent to tidal creeks were surveyed to evaluate factors such as existing site conditions and perceptions, landscape preferences, willingness-to-pay, and level of satisfaction. Surveys also assessed homeowner knowledge of and preferences for native and invasive species common to their areas. Findings indicate good potential for small to moderate sustainable landscape interventions based on an additive combination of: low-levels of satisfaction with current landscape, clear characterization of desired improvements, and a modest willingness to pay. Findings support a need for educational programs to improve understanding of stormwater management, use of native plants, and landscape strategies to increase resilience to hurricanes and flooding.

1.1 Keywords

Landscape Preferences, Coastal Resiliency, Residential Landscapes, Survey, Watershed Development

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2 INTRODUCTION

North Carolina's coastal areas are home to some of the most ecologically diverse and significant ecotones in the United States. The state's coastlines support diverse habitats and fishing economies, making them tourism and recreation centers for millions of visitors each year. As outlying coastlands face increasing threats from flooding and sea-level rise, many coastal areas continue to experience increasing commercial and residential development. Along with increased development come myriad environmental impacts, including habitat loss and reduced water quality caused by non-point sedimentation and nitrification generated by poor site development and landscaping practices.

Coastal North Carolina is developing at the fastest rate ever recorded, with near exponential growth in the majority of coastal counties (Figure 1). Because the majority of coastal development is residential (Moser et al. 2014), addressing the negative ecological impacts of these land use changes requires the development of high-performance, residential-scale landscape solutions capable of simultaneously satisfying resident preferences and promoting landscaping practices that support healthy local ecologies.

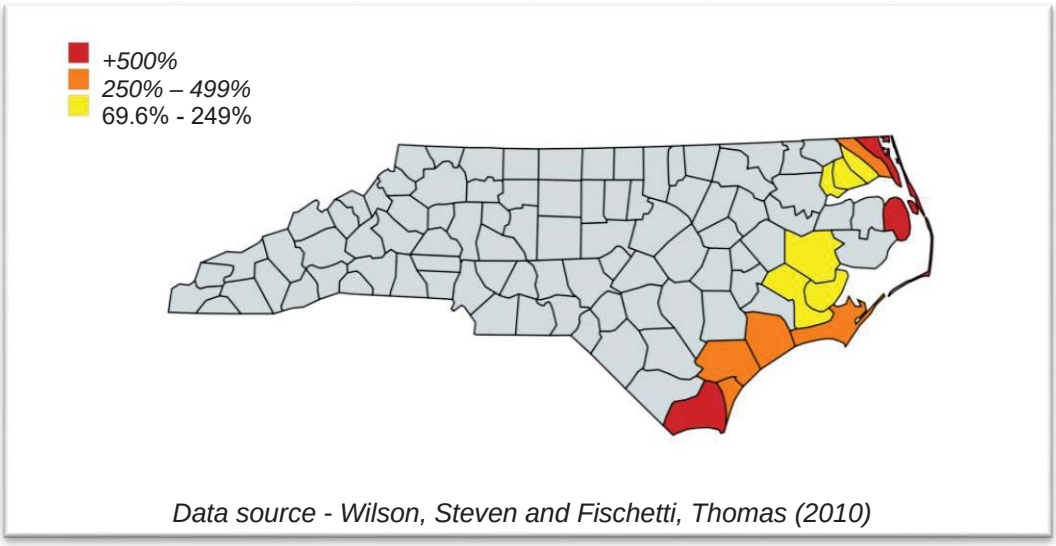

Figure 1. Population growth in coastal North Carolina counties - 1960 to 2008

North Carolina is home to more than 12,000 miles of shoreline in the transition between fresh and salt water. These shorelines encompass large estuarine bodies like the Albemarle and Pamlico Sounds, while much of these interstitial waters represent hundreds of tidal creeks that are incubators of species diversity. Tidal creeks and marshes not only provide important habitat and ecological functions but also serve as "mini-estuaries" that are ideal test beds for research that would be expensive and unwieldy at the large estuary scale (Troy Alphin, Secrets of Tidal Creeks). A champion for healthy tidal creeks, Fred Holland expertly describes the delicate relationship between development and the future health of intertidal areas.

> *The estuaries of the southeastern United States are dynamic environments characterized by low relief, shallow depth, broad fluctuations in water quality and expansive intertidal areas dominated by shallow tidal creeks and salt marshes. These creeks and marshes provide nursery habitat and feeding grounds for fish, shellfish and wading birds. Over the next several decades [cited in 1990], the human population in the watersheds that drain into southeastern estuaries is expected to increase by over 60% from the 1960 levels. This growth will result in conversion of substantial portions of the existing forested and agricultural ecosystems into low and high-density suburban housing, transportation infrastructure, shopping centers, resorts, and industrial sites. These land cover changes are projected to adversely affect the productivity, biodiversity, and ecological*

functioning of coastal ecosystems, particularly the tidal creeks which are the first-order connections between uplands and estuaries. (Holland et al, 2004, pg.152)

While substantial research supports the need for integrating human preference and ecologic function in residential landscapes (Mozingo 1997, Nassauer 2009, Nassauer 1995, Peterson et. al. 2012, Tallamy 2007), findings that characterize residential landscape preferences in the coastal context do not yet exist. Although in form and function coastal residential landscapes are similar to other areas, powerful environmental factors like directional winds, flooding, salt-water intrusion—paired with unique proximity and potential impact on key habitats—give tidal creek communities a unique need for resilience and emphasis the reality of environmental consequence. Hefland (2005) and Nassauer (1997) found that there is latent potential for sustainable landscapes both regarding willingness-to-pay indicators as well as stated desire for landscape characteristics that accept sustainable landscape practices.

Historically, residential landscapes have been designed and managed with the primary objectives of creating aesthetically pleasing views and spaces. More recently there has been increasing and consistent interest in creating landscapes that go beyond aesthetics, in addition offering depth and breadth of ecosystem service function (Lovell and Johnston 2009). As early as 1969, Ian McHarg proclaimed the imperative that our constructed landscapes must consider natural processes. Since then, theory has turned to practice, taking form in development and regulatory frameworks across the world, including conceptual frameworks like Low Impact Development (LID), Water Sensitive Urban Design (WSUD), and Green Infrastructure. The impetus to consider ecological function and stewardship is now well establish not only as a conceptual framework but also as a cross-disciplinary best practice. Certification programs like the Sustainable Sites Initiative™ (SITES®), Leadership in Energy and Environmental Design™ (LEED®), Landscape Architecture Foundation Landscape Performance Series, and Living Building Challenge have all helped to establish consensus metrics for best practices.

Despite a movement toward ecological design, the majority of American home sites demonstrate popular design of landscapes primarily driven by long-standing cultural norms and conventional aesthetics (Nassauer 1997) and traditional landscape maintenance industry standards (Ingram 2006). Over the years, agencies and organizations have been inspired and mandated to improve human-induced, or anthropogenic, impacts of constructed landscapes. Much of this work has been centered on reducing stormwater volume, peak flows, and associated pollution (i.e., sediments, nutrients, and chemicals). These efforts have resulted in the creation of numerous supporting tools, regulatory policies, and programs. Although many of these organizations have the technical understanding required to improve environmental quality, they may not have experience or expertise in designing, implementing, or managing successful, community-scale, residential landscape improvement programs (Booth and Skelton 2011).

3 OBJECTIVES & METRICS

The goal of this study was to evaluate public attitudes towards ecological landscaping practices near tidal creeks. Specifically, the study conducted a landscape preferences survey of households within Broad and Hawkins Creeks near Swansboro, North Carolina (Figure 2). These two communities were selected because they represent typical and uniform residential land development patterns that characterize the landscape/tidal creek interface. The Hawkins and Broad creek communities share many similarities (land-use, density, location, and landscape form) but have specific differences that make for a potentially revealing study (differences in average household income, lot size, and housing use).

Study objectives included capturing resident landscape preferences related to five categories that describe conditions commonly found in the waterfront residential context:

1. Low impact stormwater quality interventions,
2. Native plant communities of high ecological value,
3. Transitional shoreline characteristics,
4. Low-maintenance and water-saving landscapes, and
5. Resilience to and mitigation of storm-related impacts.

The survey was designed to elicit responses related to four metrics:

1. Satisfaction with current landscape(s) and willingness-to-pay for improvements,
2. Individual landscape preferences related to plant types and percent land coverage of turf versus planted areas,
3. Desired landscape improvements, and
4. Barriers to improvement.

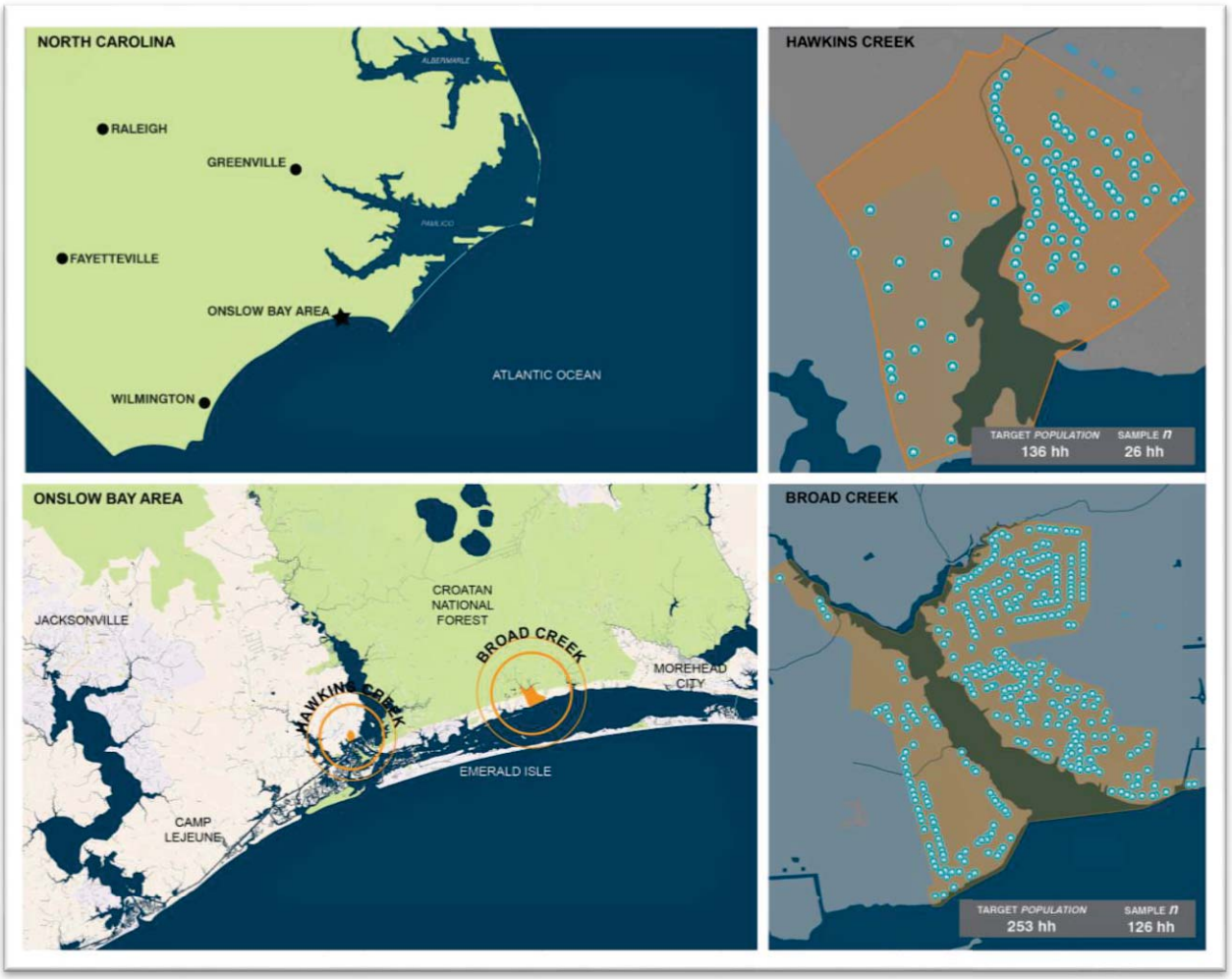

Figure 2. Study Area Context Maps

4 METHODS

4.1 Site Selection and Inventory

Project partners at North Carolina Sea Grant identified two candidate tidal creek communities based on size, proximity to waterways, and known threats to water quality. Both tidal creek watersheds have considerable residential development in their lower drainages and are representative of coastal development patterns occurring along the U.S. Atlantic coast. The development style in both communities is uniformly detached, single-family housing built between the years 1950–2000. Homes in the study areas have an average size of 1,800 square feet, with values from $170,000–$500,000+. Information for the study populations within each community was gathered from Onslow County (NC) tax records and filtered to exclude: undeveloped property, multiple properties with the same ownership *(selected only one for mailing),* non-residential use, and multi-family housing. An initial site visit was made to inventory existing conditions and plant palette, capture images to be used in photo simulations, and to conduct

informal meetings with several residents in each community to better understand local character and context.

4.2 Survey Development

A digital survey tool was developed in Qualtrics® using images and plant inventory from a visit to each community. The survey tool was designed to elicit resident landscape preferences divided among three landscape areas: front yard, back yard, and waterfront edge. Within each of the three areas, survey participants were presented with graphic renderings showing a range of landscape characteristics and asked to select the image they would most prefer for their home (Figure 3). The base images for graphic rendering were photos from homes located within the study communities to increase visual legibility for the participants. The graphic renderings were presented achromatically (black and white) to abstract from details and encourage the user to respond based on more general elements of form, texture, and spatial characteristics (Nassauer 1983, Peterson et al. 2012).

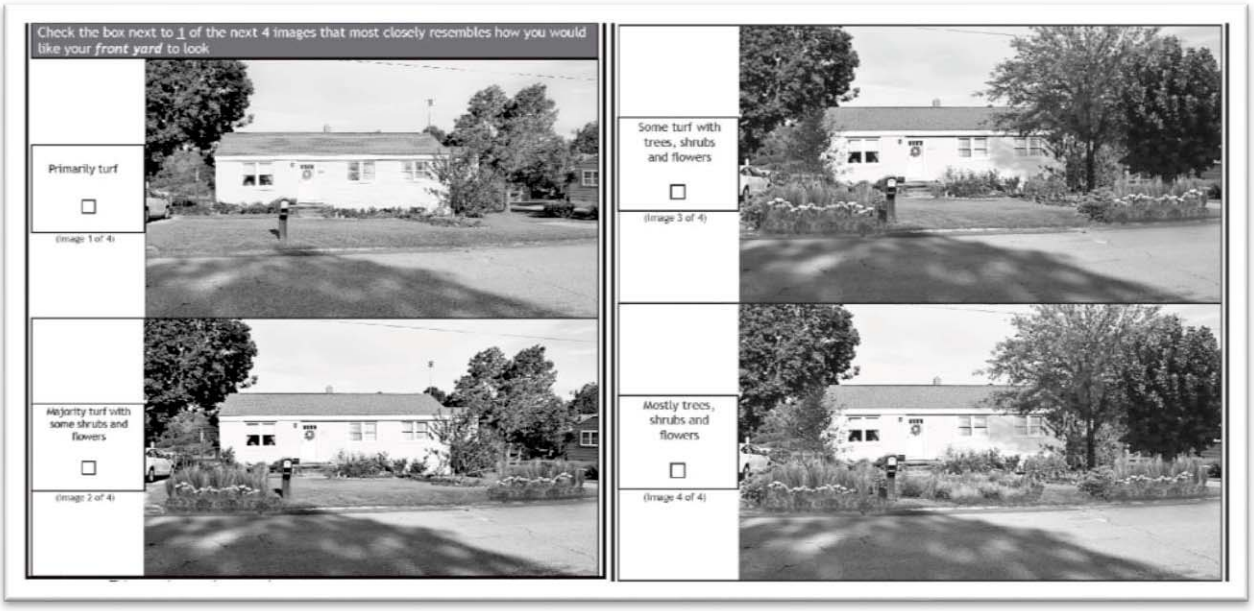

Figure 3. Example of Graphic Illustrations used in Survey Tool to Elicit Landscape Preferences

In addition to the preferences section, the survey used images of common native and non-native landscape plants to collect responses related to both existing plants and desired plants (Figure 4). The division between native and non-native plant images allowed for additional measurement of each respondent's capacity to differentiate between the two plant types. Several non-graphic survey questions were also developed to capture current level of satisfaction, willingness-to-pay, types of desired improvements, more detailed characterization of existing conditions and maintenance practices, and basic demographic data. The content of these are reported in the following results section.

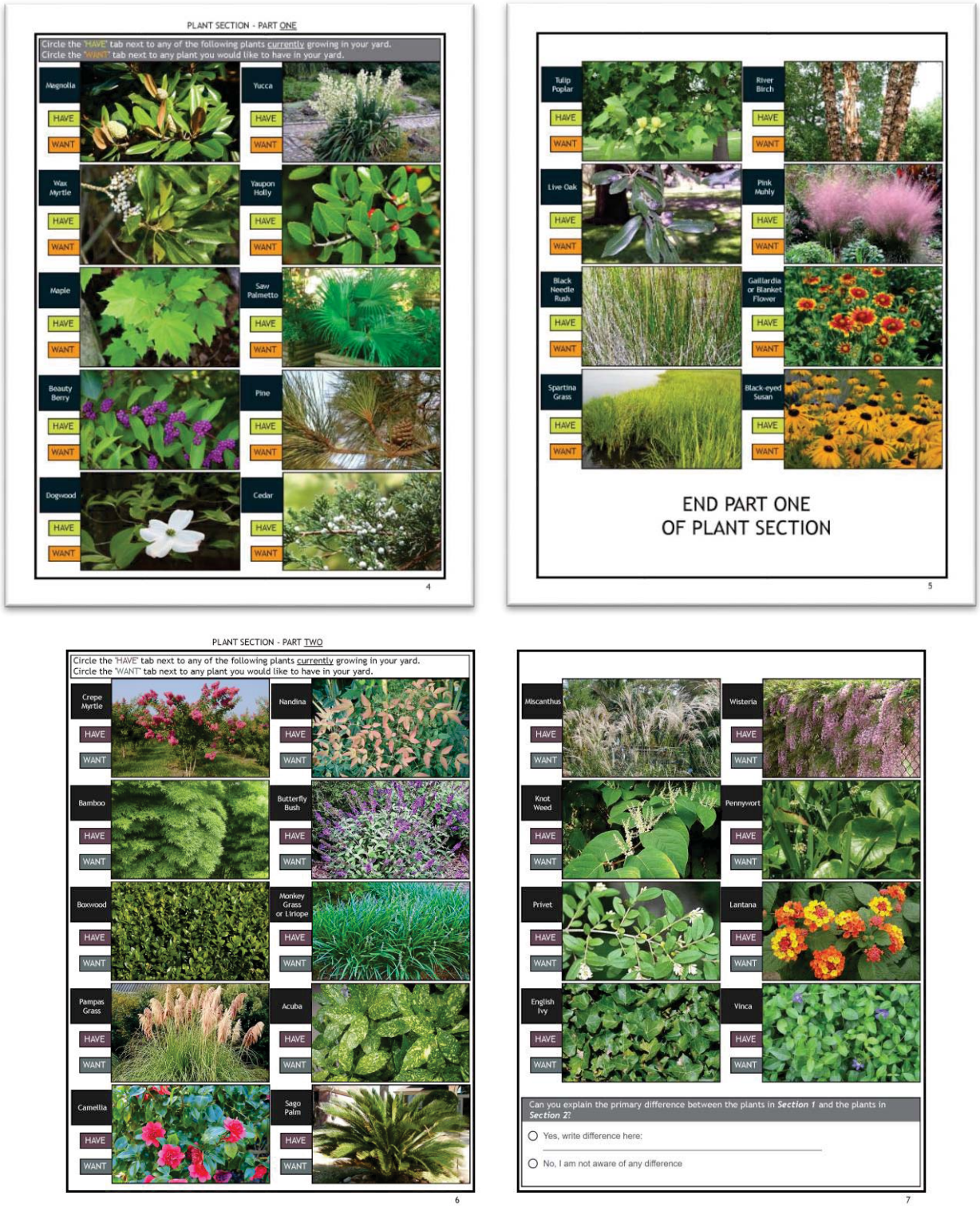

Figure 4. HAVE/WANT Graphic Matrix

4.3 Survey Implementation

Based on age-range demographics in the participating communities, as well as feedback from the initial site visit, the survey tool was administered using a mailed, printed survey. The survey distribution method employed a cash incentive strategy based on the Dillman Total Design Survey Method (Hoddintott 1986). A $2 cash incentive was included in the survey mailer to communicate the importance and value of the participants' time and attention to the survey. Survey packets (N=389) were mailed to residents in the target communities, with a return period of ten weeks. Typical survey response rates average 10-15% (Fryrear 2015). The use of a cash incentive, alongside a visually appealing (color) and easy-to-understand survey, enabled this survey to achieve a 38% response rate (N=196), tripling the average response rate for external mail surveys. After the response window closed, a team of data entry assistants were trained to enter data into the Qualtrics® interface. All surveys were initially reviewed for completeness by the study leader, then data entry assistants entered data directly to the digital Qualtrics® instrument. Upon preliminary review of the returned surveys it became clear that the responses to the ranking questions associated with landscape preferences section reflected a misinterpretation of the ranked response input. The decision was made to remove all four ranking questions from the results due to the confused responses. Assistants were instructed to make note and report any uncertain response to the survey lead. Upon validating all returned surveys, 152 were entered into the original, digital Qualtrics® instrument. The first phase of data analysis was completed using Qualtrics® analytics, and a second level of data analysis was completed to extract and highlight findings most relevant to project objectives.

5 RESULTS

5.1 Satisfaction and Change

Study results found homeowners generally dissatisfied with their current landscapes (-27.3 Net Promoter® Score[1]) with many respondents noting difficulty maintaining quality turf, controlling invasive plants, and poor drainage around their home. When polled about barriers to improving their landscapes, a large majority of respondents stated a need for additional funding (70%) and personal free time (49%). In addition, very few respondents reported paying for landscape-related services, with 85% of homeowners installing their own new materials and 72% performing their own maintenance. Willingness-to-pay for landscape improvements reflects a high level of Do-It-Yourself (DIY) activities, with 76% of respondents interested in small to medium-sized (≤$2000) projects (Table 1). Reflecting the stated desire for more funding as a barrier to change, less than half of respondents (47%) thought their willingness-to-pay for desired improvements would result in a satisfactory landscape. Many respondents (63%) reported a desire for more vegetation, including turf, with some noting a need for structural improvements to their bulkheads (seawall) and drainage solutions.

Table 1. Willingness to Pay for Landscape Improvements.

WTP Range	*Percentage*	*Count*
<$100	16%	21
$100 - $499	30%	40
$500 - $1999	28%	37
$2000 - $4999	16%	21
$5000 – $10000	4%	5
>$10000	*3%*	*4*

5.2 Landscape Preferences and Values

Although the survey tool separated landscape preferences between front and back yards, the stated preferences were nearly identical between the two areas. On a four-point scale from *mostly turf* to *mostly shrubs and flowers*, the large majority of respondents chose the middle-ground preferring some turf with shrubs and flowers, and majority turf with some shrubs and flowers (32% and 43% respectively). Interestingly, waterfront planting preferences were significantly different from the front and back yard preferences with an even spread across the four options (from turf to trees and shrub dominated: 29%, 29%, 25%, and 17%) (Figure 5). Improving the drainage of house-adjacent landscapes was a stated priority, with residents citing a desire to decrease water-related pests and avoid stormwater intrusion into their homes. Similarly, when asked to rank value statements regarding their landscape, respondents indicated a strong preference (85%) for waterfront improvements that address flood and hurricane resilience. This preference for resilient landscapes preceded other common, highly valued characteristics like low-maintenance landscapes and aesthetic appeal.

A primary driver for waterfront property owners was the long view from their home out to tidal creek waters and, when possible, across tidal creek waters into the sound. This desire adds value to low-growing vegetation like turf, however, creates exposure to wind and sun while exacerbating high-velocity stormwater drainage into the creeks.

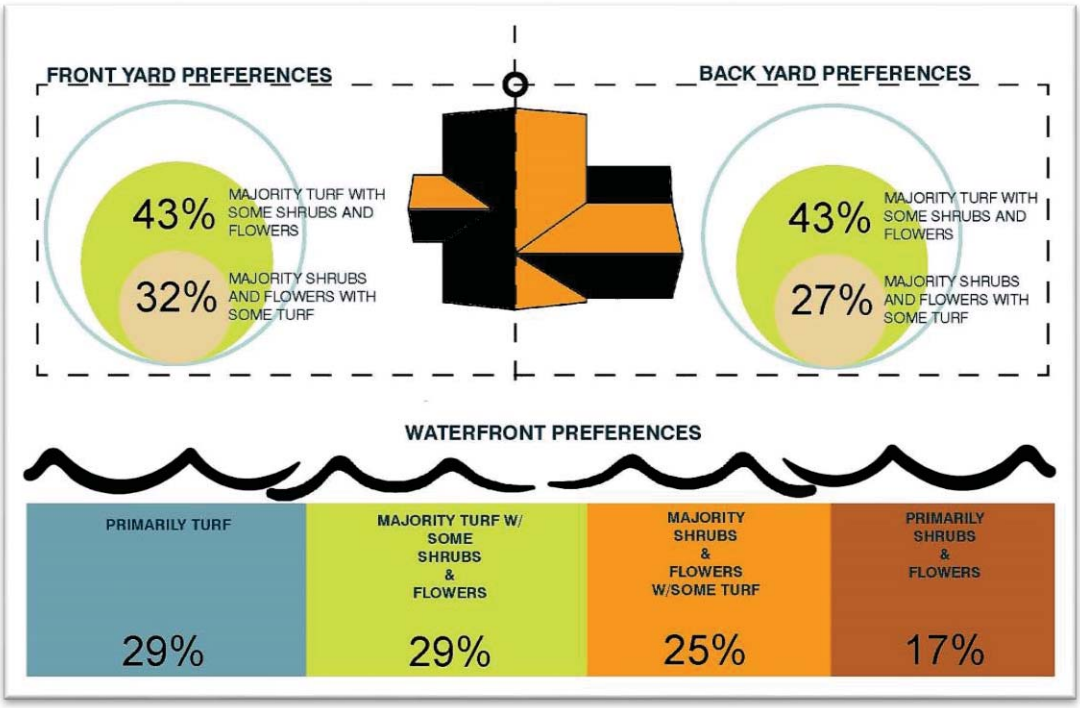

Figure 5. Landscape Preferences by Area for Broad and Hawkins Study Areas

5.3 Existing and Desired Landscape Plants

Responses from the "want/have" graphic matrix of plant types found clear trends both in existing and desired landscape plant types. More than half of the respondents reported existing loblolly pine (59%), crepe myrtle (70%), dollar weed (60%), and live oak (54%) on their property, with more than a third of respondents reporting existing dogwood (37%), cedar (37%), wax myrtle (37%), magnolia (36%), maple (41%), boxwood (37%), lantana (32%), and camellia (32%). Respondent wants/desires did not poll over 50% for any species, however, more than 30% of respondents reported wanting crepe myrtle, butterfly bush, camellia, lantana, dogwood, palmetto, muhley grass, gallardia, and black-eyed susan. Plants selected for the graphic matrix were based on three criteria: 1) they were observed in the study area

during site visits; 2) they are common native landscape plants viable in the study areas; or 3) they are commonly available from commercial landscape supply retailers in the region. The plant type graphic matrix (Figure 4) was conspicuously divided evenly into native and non-native invasive plant sections ('Part One' and 'Part Two') allowing a follow-up question that helped determine the level of plant knowledge respondents had. The survey found the majority of respondents were either 1) unable to distinguish between the two plant categories (74%), or 2) incorrectly identified the distinction (18%).

6 CONCLUSIONS

6.1 Findings & Implications

A key finding was the value respondents placed on the role landscapes serve as buffers from natural hazards related to wind and water. This finding, in unison with low levels of satisfaction related to existing conditions, suggest that education campaigns specifically focused on the role of sustainable landscape practices in protection and buffering from erosion, wind damage, and poor drainage may be met with interest, participation, and investment. Likewise, stated landscape desires and willingness-to-pay attitudes indicate that landscape interventions should focus on sections of the yard that enhance drainage and wind-buffering functions and add structural and compositional variety, without reducing healthy turf or obstructing important viewsheds. Functional and appropriately scaled residential landscape interventions that are transferrable to the tidal creek context include: gutter gardens, streetscape improvements, bioretention swales, and perimeter buffer zones. Based on study findings, the authors recommend that community education and/or design assistance activities be structured to strategically address three essential elements: function, desire, and availability.

Landscape improvements along tidal creek waterfronts should first address flood and hurricane resilience. Design assistance and education related to waterfront edges should promote options other than bulkhead (hard) installations as a means of flood protection. Naturalized (soft) edge transitions with piers or a combination of bulkhead and naturalized edge treatments can improve resiliency and ecologic function without jeopardizing accessibility to the tidal creek (Dugan et al. 2017). Many of the study's home sites currently have open turf areas between water's edge and house, thus achieving little to no protection from prevailing winds or summer sun.

6.2 Design Strategies

Strategies for creating understanding and desire for ecologically responsive landscapes must include developing education programs that acknowledge and address the priorities of landowners. Within waterfront and water-adjacent communities, these priorities include framing water views in a manner that strikes a balance between ecologic functions and maintaining valuable viewsheds. Key program elements should address basic stormwater best practices and landscape plantings that provide desired design characteristics such as color and texture across the seasons as well as ecosystem services (i.e., habitat, erosion control, etc.). Thus, landscape improvements should prioritize plant functionality, installation techniques, careful consideration of native/exotic/invasive species, and maintenance practices such as proper and/or reduced application of fertilizers, pesticides and herbicides.

Both communities show a desire for design assistance. This suggests that a set of templates that provide guidance could be influential in educating and incentivizing residents to implement sustainable, resilient, attractive, and affordable improvements.

Collectively, the study indicates a critical need to support community awareness of a*ttractive, available, and adaptable* landscape plants. This step is essential because the implementation of high-performing, coastal landscape solutions is reliant on aligning two factors: 1) consumer understanding of and value for ecologically high-performing native plant communities (demand), and 2) locally available nursery stock and knowledgeable contractors (supply). Aligning these factors can be challenging—the retail supply of plant species is market-driven and often limited to selections that neither reflect ecological diversity, nor recognize the ecosystem services provided by native and/or adapted non-native, non-invasive species for coastal environments. Strategies for addressing these issues include: develop demonstration gardens in high-visibility locations to raise awareness of both the functional and aesthetic characteristics of native and/or coastal-adapted ornamentals; deliver cooperative extension training programs for both homeowners and green industry professionals (growers, distributors, designers, and

contractors); and conduct horticultural research trials to test in-situ plant performance and market viability (ease of propagation through end-point sales).

6.3 Transferability

Although this study focused on North Carolina tidal creek communities, the methods employed and findings can inform efforts to improve residential landscapes in many contexts. The research processes used provide important and useful knowledge pertaining to both existing physical conditions and cultural norms, including local residents' desires for and capacities to enact localized environmental function. This knowledge lays the groundwork for continued efforts across the landscape industry sectors of design services, wholesale and retail growing, contracting and maintenance, and research and education. Working collectively and collaboratively, efforts to engage industry-wide best practices aspire to improve landscape performance across the realms of resiliency, ecological health, community aesthetics, and quality of life. Toward these ends, the information revealed in this study creates pathways for improving the health, safety, and well-being of constructed landscapes and their impact on the ecological diversity and vitality of the larger environmental systems.

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[1] The Net Promoter Score is an index ranging from -100 to 100 that is used as a proxy for gauging the overall satisfaction with a product or service. The metric was originally created by Fred Reicheld and Bain & Company and is primarily used by companies to gauge client or consumer satisfaction.