1-1-2022

Mapping Emotional Attachment as a Measure of Sense of Place to Identify Coastal Restoration Priority Areas

Timothy L. Hawthorne
University of Central Florida

Kayla R. Toohy
University of Central Florida

Bo Yang
San Jose State University, bo.yang02@sjsu.edu

Lain Graham
ESRI

Elise M. Lorenzo
University of Central Florida

See next page for additional authors

Timothy L. Hawthorne, Kayla R. Toohy, Bo Yang, Lain Graham, Elise M. Lorenzo, Hannah Torres, Morgan McDonald, Fernando Rivera, Kirsten Bouck, and Linda J. Walters

Applied Geography 138 (2022) 102608

Contents lists available at ScienceDirect

Applied Geography

journal homepage: www.elsevier.com/locate/apgeog

Mapping Emotional Attachment as a Measure of Sense of Place to Identify Coastal Restoration Priority Areas

Timothy L. Hawthorne [a,*], Kayla R. Toohy [a], Bo Yang [b], Lain Graham [c], Elise M. Lorenzo [a], Hannah Torres [d], Morgan McDonald [a], Fernando Rivera [a], Kirsten Bouck [a], Linda J. Walters [e]

[a] *Department of Sociology, University of Central Florida, USA*
[b] *Department of Urban and Regional Planning, San José State University, USA*
[c] *Esri, USA*
[d] *Faculty Research Development Office, University of New Mexico, USA*
[e] *Department of Biology, University of Central Florida, USA*

ARTICLE INFO

Keywords:
Coastal restoration
Emotional attachment
Geographic information systems
Indian river lagoon
Sense of place

ABSTRACT

Our applied case study demonstrates how knowledge from community stakeholders about emotional attachment (as a key component of sense of place) can inform and influence future coastal restoration priorities at various scales in the Indian River Lagoon, Florida (USA). We map aggregate measures of emotional attachment from community stakeholders using Geographic Information Systems. We then analyze this human systems level data with kernel density estimation measures at the broader lagoon scale and with inverse distance weighted measures at more localized scales. By connecting these mapped results back to the primary reasons that participants provided for having high or low emotional attachment in a location, we show how varying spatial patterns of emotional attachment as a primary component of sense of place within and across broader geographic regions can be represented, mapped, and visualized to enhance future restoration priorities. We demonstrate how aggregate results gained from community stakeholders can help restoration teams prioritize their science communication and education strategies to align human systems level data with natural systems level data.

Author statement

All authors were involved In different stages of the writing and review process. Larger conceptual ideas for the emotional attachment mapping sections of the manuscript were primarily conceptualized by Hawthorne, Toohy, Yang, Torres, and Graham.

1. Introduction

Applied geographers, environmental scientists, community stakeholders, and policy makers have long been interested in understanding *sense of place* (Massey, 1993; Tuan, 1975, 1977). Sense of place considers the complex relationship created through the interactions that occur between people and the places that they frequent that convert our perceived feelings, meanings, and symbols, as well as the individual characteristics of a space, into a place with special behavioral and emotional characteristics that we find suitable for our intended purposes (Hashemnezhad, Heidari, & Mohammad Hoseini, 2013; Quazimi, 2014; Steele, 1981). The sense of place literature contends that as a person interacts with a location, such interactions alter their sense of place based on these first-hand experiences. As a result of such experiences, sense of place is often said to influence future behaviors, interactions, and choices about a location relative to other locations with lower feelings of sense of place.

Previous literature identifies emotional attachment as one aspect of sense of place which is a result of the dynamic relationship between individuals and the physical environment (Tuan, 1975; Low & Altman, 1992; Hashemnezhad et al., 2013; Quazimi, 2014). To operationalize and map sense of place in this applied case study with community stakeholders, we ask participants questions about their level of emotional attachment in particular locations they identify throughout the study site. In this way, we demonstrate how sense of place and GIS methods taken together can represent data on a series of maps to identify restoration areas where community input about emotional attachment as a measure of sense of place can be prioritized.

Researchers note that emotional attachment as a component of sense

* Corresponding author.
E-mail address: timothy.hawthorne@ucf.edu (T.L. Hawthorne).

https://doi.org/10.1016/j.apgeog.2021.102608
Received 31 May 2021; Received in revised form 5 November 2021; Accepted 15 November 2021
Available online 30 November 2021

of place can be more clearly considered in studies of coastal restoration (Kibler et al., 2018). Often, applied researchers leading coastal restoration projects and the funding agencies supporting these endeavors rightfully prioritize proposals in locations with significant environmental challenges (e.g. locations with eroding shorelines, poor water quality, wildlife vulnerability) as well as on public lands. Leaders of such projects often seek public input (with varying results) to gauge support for and opposition to future restoration at particular locations.

Applied researchers recognize the pivotal role sense of place often plays in the behaviors that community stakeholders exhibit to support or oppose coastal restoration work (e.g. volunteering in restoration projects, donating to restoration causes, voting for/against restoration-minded candidates/policies, or engaging in public discourses about restoration). In some cases where public participation processes are critically questioned by community stakeholders, a problematic dichotomy results that implies the priorities of science and society are not aligned. Situations where science teams and their restoration projects are challenged by a perceived lack of public input can be improved by more overt, visual approaches that prioritize measures of sense of place using Geographic Information Systems (GIS).

With these points in mind, our article aims to address two applied geography questions in the Indian River Lagoon, along the east coast of central Florida (USA):

1. How can varying spatial patterns of emotional attachment as a measure of sense of place be represented, mapped, and visualized to align science and community needs to support coastal restoration?
2. How can applied science teams and public participation processes aimed at understanding coastal restoration priorities be enhanced by GIS analytical techniques?

We address these research questions in our study area by mapping and visualizing emotional attachment as a primary component of sense of place from geographic information provided by community stakeholders to show how to prioritize such human systems level data in future restoration decision-making. In doing so, we identify broad areas where aggregate support for restoration is potentially stronger based on high emotional attachment and where there may be weaker support for restoration based on low emotional attachment.

Our article is organized in the following manner. We first situate our work in the broader literature with a particular emphasis on exploring applied work on sense of place and mapping. We then provide a detailed look at our case study area and methods. Next, we turn to our results and a discussion of their implications for the study area and the broader literature. We then consider our study's limitations and potential future directions. We conclude by emphasizing our contributions to the work of applied geographers wishing to incorporate emotional attachment data into their public participation processes.

2. Literature review

Recent sense of place research has brought together elements of many different disciplines (Shrestha & Medley, 2016; Kibler et al., 2018; Pérez-Ramírez, García-Llorente, Benito, & Castro, 2019; Hamzei, Winter, & Tomko, 2020). Like these empirical studies, our current work seeks to bridge disparate areas of empirical literature to provide a framework for the integration of sense of place research with the extant literature regarding place attachment, place identity theory, mapping, and restoration efforts of coastal ecosystems. Place attachment, often viewed as a component of sense of place, is used to operationalize a concept measuring the emotional attachment individuals feel about particular environmental areas (Tuan, 1975; Low and Altman, 1992; Hashemnezhad et al., 2013; Quazimi, 2014). Place identity theory brings together the concepts of sense of place and place attachment using a theoretical orientation focused on highlighting and creating a better understanding of the dynamic relationship that occurs between human beings and their physical environment (Proshansky, 1978; Hauge, 2007; Proshansky, Fabian, & Kaminoff, 1983; Quazimi, 2014; Rollero & De Piccoli, 2010).

2.1. Sense of place

Sense of place has different meanings within the geographical, sociological, cultural, and psychological sciences literature. Integral to the concept of sense of place is the emphasis put upon the difference between the terms space and place, with space representing the physical dimensions of height, depth, and width in which all objects exist and place representing the subjective perception of human beings based upon their lived experiences and the context of their interaction within that place (Entrikin, 1991; Merschdorf & Blaschke, 2018; Westerholt, 2019).

The concept of place, while recently gaining popularity within the GIScience community (Purves, Winter, & Kuhn, 2019; Wagner, Zipf, & Westerholt, 2020), is abstract (Couclelis, 1992; Hamzei et al., 2020). It has been defined as an object with attributed meaning (Relph, 1976; Tuan, 1977) and attachment to singular persons (Cresswell, 2014) or groups within society (Turner & Turner, 2006) resulting from the shared identification of a location (Purves et al., 2019). A place is considered to be an object functioning within a network that may also participate in events (Purves et al., 2019).

Sense of place is described as encompassing psychological and physical characteristics of a space (Steele, 1981) that incorporate both cognitive and perceptual factors; and it is best understood as a process rather than a state (Kibler et al., 2018). Sense of place encapsulates all of the behaviors, emotions, memories, thoughts, and feelings we have about a place and informs the association between our five senses and physical places (Tuan, 1977). Westerholt (2019) provides empirical support for the view of places as containers, where places hold characteristics attributed to them by individuals who interact with these spaces, which provide context for emergent phenomena related to various ongoing spatial processes. Gieryn (2000) identifies three core characteristics of our individual sense of place, including 1) the geographic location of a place, 2) the physical parameters of that place, and 3) the identity of said place.

The concept of sense of place is not only an individual process of attaching feeling and emotion to a physical space, these feelings are shared and experienced on a social level as well (Massey, 1995). Contributing to the subjective nature of sense of place are the various cultural perspectives and experiences occurring not only within that particular space, but also relative to the spaces surrounding the location in question (Cross, 2001; Purves et al., 2019). For example, memories of an event or gathering can contribute to the ways in which we attach feelings to a specific area. Quazimi (2014) shows that we attribute feelings of belonging, safety, and refuge with social spaces that formulate how we feel about our experiences within them at the individual, local, or regional level.

2.2. Place attachment and place identity

Place attachment is a concept that refers to the bonds that people develop with places (Quazimi, 2014). Some regard place attachment as a subset of sense of place research (Hashemnezhad et al., 2013). Place attachment is a symbolic individual relationship, which changes over the lifetime, to geographic spaces that through formed cultural, social, and individual bonds leads to the formation of emotional attachment (Blake, 1974; Low & Altman, 1992). This symbolic relationship explains how the perception of an area is related to an individual's experience and the memories they have of a place (Childress, 1994; Hidalgo & Hernandez, 2001). For a place to hold significance to an individual, bonds must be created between person and place which leads to the formation of attachment to that particular area (Seamon, 1993; Mesch & Manor, 1998), and may even promote social ties within communities

(Low & Altman, 1992). These bonds occurring between the human and natural systems form in three different dimensions of interaction; *cognitive* (spatial perceptions of the world), *behavioral* (informs activities and the functional relationship between people and their environment), and *emotional interaction* (identification of satisfaction with and attachment to particular places) (Low & Altman, 1992).

Place identity theory has been used to understand particular components of sense of place and the relationship between people and the environment (Proshansky et al., 1983; Hauge, 2007; Rollero & De Piccoli, 2010; Quazimi, 2014). We use "place identity" as a cognitive database where we compare each physical setting to our own experience aiding in the formulation of an individual's sense of identity and their attachment to place (Proshansky et al., 1983). Place identity theory has been utilized in tandem with other theoretical constructs to investigate the relationship individuals feel to their physical spaces (Hauge, 2007; Quazimi, 2014; Rollero & De Piccoli, 2010).

2.3. Mapping emotional attachment as a component of sense of place

Case studies mapping sense of place have evolved throughout the past few decades. Seminal work conducted by Brown and colleagues from the 1990s through the late 2010s has shaped the current methodological avenues researchers have used to record sense of place data and analyze it in an interdisciplinary manner. In early stages of his research on sense of place, Brown (2004) stated that an "operational bridge is needed to connect special place locations (geography of place) with their underlying perceptual rationale (psychology of place) for ecological planning and resource management purposes" (p.19). Brown and Raymond (2007) used early conceptions of place values to demonstrate that they can be used as a proxy measure for place attachment by collecting place-specific information on environmental characteristics, in addition to constructed place related meanings and place attachment, considered to be the positive emotional bonds individuals develop with their environment (Low & Altman, 1992). Additional research in this area has used a two-dimensional model of place attachment which considers the concept of place identity in addition to place dependence to inform research oriented on understanding the biophysical dimension of place (Brown & Raymond, 2007; Jorgensen & Stedman, 2006; Williams, Patterson, Roggenbuck, & Watson, 1992). Raymond, Brown, and Weber (2010) identify a few limitations with this model, stating that important connections to the natural and social environment are overlooked which are crucial to our understanding of the role that place identity and dependency have on the formulation of our constructed place meanings.

In an effort to advance the precise and accurate nature of conducting sense of place research to inform conservation and restoration management efforts of remote coastal zones (Kobryn, Brown, Munro, & Moore, 2018), urban parks (Brown et al., 2014, 2018), protected areas, and forested land (Brown, 2013), Brown and others furthered the advancement of socio-ecological hotspot mapping which has created highly visual opportunities to integrate many disciplinary techniques in the pursuit of environmental restoration research. Plieninger, Dijks, Oteros-Rozas, and Bieling (2013) argue that the collection and use of preferences and perceptions in cartographic representations help researchers localize the most highly valued ecosystems within a landscape and identify critical areas for cultural services management. One limitation to be aware of in the mapping of these preferences and perceptions is the difficulty in showing the depth of complex emotional meaning and the value of spatial locations where often qualitative information is simplified in aggregated heat or cluster maps (Ryfield, Cabana, Brannigan, & Crowe, 2019; Van Noy, 2003).

Components of sense of place, such as place attachment, and place identity can also be used to inform our understanding of the complex relationship between human and natural systems. Kibler et al. (2018) proposed an identify-visualize-create (IVC) framework which offers a methodology for restoration stakeholders to incorporate "human attachment to place into restoration planning, and emphasizes system understanding on a dual plane of coupled human and natural system attributes" (p. 6). The IVC framework takes into account an area's sense of place along with the current state of the ecosystem in that area using two scales arranged from low to high. In the IVC framework, four combinations of sense of place and ecosystem function are analyzed for likelihood of success for restoration efforts. These include: high sense of place and high ecosystem function, high sense of place and low ecosystem function, low sense of place and high ecosystem function, and low sense of place with low ecosystem function.

2.4. Sense of place and restoration

The concept of sense of place has been useful in a wide variety of restoration projects to integrate social and cultural values of study areas into research programs in order to holistically evaluate the relationships that exist between people and the natural and biological elements of ecosystems (Ostrom, 2009; Leslie et al., 2015; Levin et al., 2016; Poe, Donatuto, & Satterfield, 2016). In one study, a strong sense of place, developed through engagement in recreational activities (e.g., kayaking, bird watching, and swimming) was linked to public support for restoration (Poe et al., 2016). Additional research in this area has shown that human perceptions are important dimensions regarding successful restoration endeavors of both rivers and coral reefs (Westling, Surridge, Sharp, & Lerner, 2014; Kittinger et al., 2016). Coastal restoration and sense of place work by Sakurai, Ota, and Uehara (2017) was conducted to better understand the reasons why local residents engage in sustainable management of their coastal ecosystems. One core component of resident's willingness to engage in place-protective behavior was identified by their sense of place (Halpenny, 2010; Sakurai et al., 2016, 2017; Tonge et al., 2014). Additionally, place attachment was stated to have an impact on the strength of the relationship between people and their environment (Halpenny, 2010; Hashemnezhad et al., 2013; Stedman, 2002, 2003). Using these concepts of sense of place and place attachment in tandem with theoretical components of place identity theory to inform restoration efforts is useful in incorporating the human element of ecosystems within the environmental process of restoring coastal habitats.

3. Case study and methods

3.1. Case study

The Indian River Lagoon (IRL) system, located on the Atlantic coast of central Florida, serves as the primary field site for this research (Fig. 1). The IRL extends 250 km along Florida's east coast from the Ponce de Leon Inlet in Volusia County to the Jupiter Inlet in Palm Beach County. As such, it includes 40% of the east coast of Florida, and includes 38 incorporated cities and 1.6 million residents (IRLNEP CCMP, 2019). The waters of the IRL cover 353 square miles, while the watershed covers 2284 square miles (IRLNEP CCMP, 2019). The IRL system consists of a series of coastal lagoons: Mosquito Lagoon, Banana River Lagoon, and Indian River Lagoon. This estuary includes both temperate and tropical–subtropical climates, and this results in high regional biodiversity (Swain et al., 1995). A 2016 economic valuation study found the IRL to be worth $9.9 billion annually (IRLNEP CCMP, 2019).

There is growing concern that anthropogenic actions (Brandt et al., 2019) threaten the future of the IRL (IRLNEP CCMP, 2019). Foundation species such as oysters, mangroves, seagrasses, and marshgrasses have been lost to eutrophication, dredge-and-fill efforts, mosquito control, and recreational boating practices (Garvis, Sacks, & Walters, 2015; Brockmeyer et al., 2017; Morris et al., 2021; Walters, Sacks, & Campbell, 2021). Media attention has additionally focused on changes associated with fish and marine mammal kills, sea level rise and changing climates, harmful algal blooms, and invasive species (e.g., Yuan, Hoffman, & Walters, 2016; Lewis et al., submitted; Phlips et al., 2015; McClenachan,

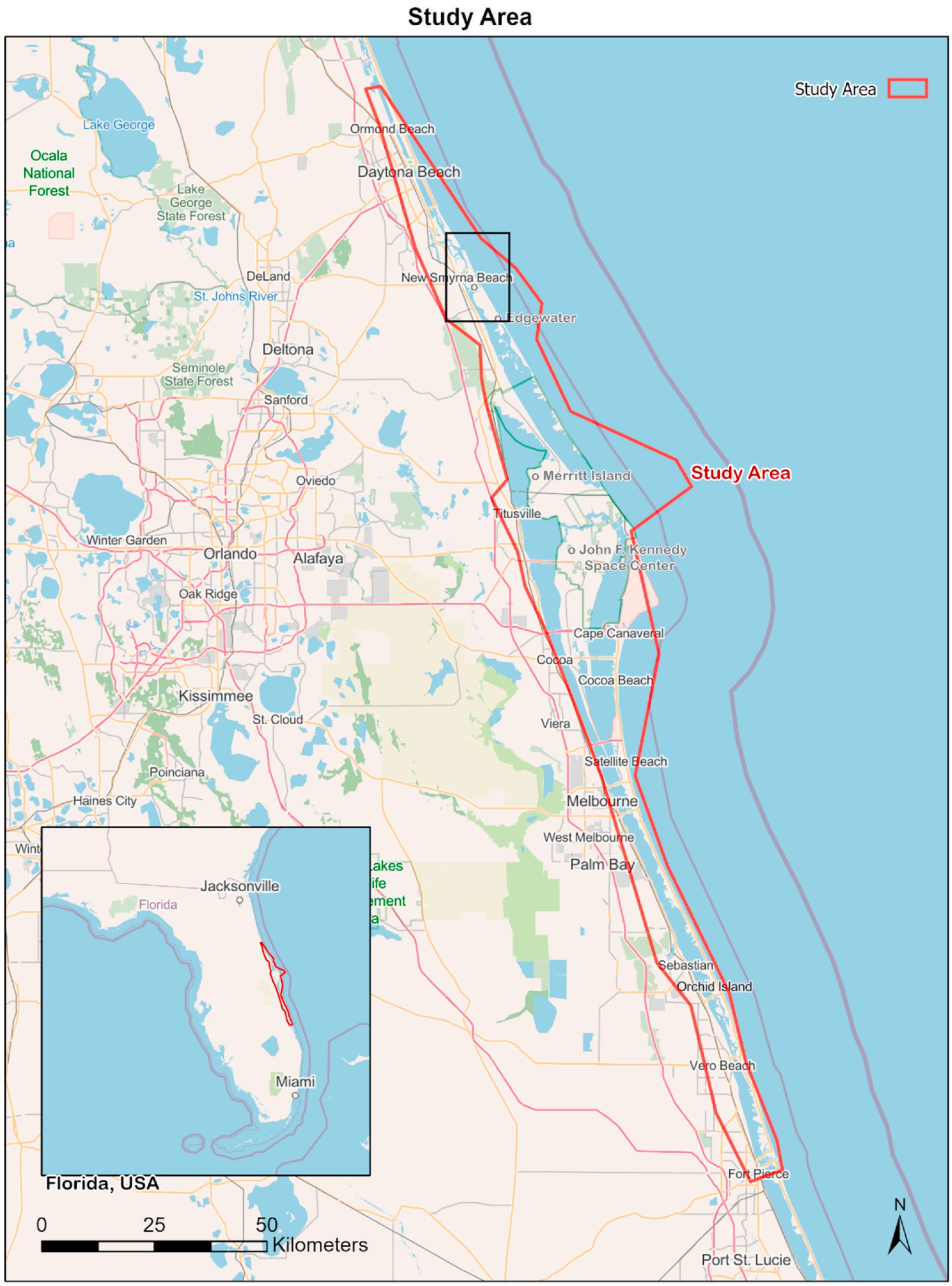

Fig. 1. General reference map of indian river lagoon study area.

Witt, & Walters, 2020; Walters, Sacks, & Campbell, 2021, b). To change the trajectory of this estuary, the IRL National Estuary Program has funded numerous scientific, restoration and outreach projects in the Lagoon to support its stabilization and to increase public participation in the Lagoon's planning (Indian River Lagoon National Estuary Program, 2021).

Three types of restoration have occurred in recent years in Mosquito Lagoon (northern IRL). Mosquito impoundment restoration has removed dikes and ditches placed in this shallow estuary in the 1950s through the 1970s to limit breeding by salt marsh mosquitoes (Brockmeyer et al., 2017). Taylor (2012) reported that these impoundments, ditches and additional development resulted in the loss of 75–90% of salt marsh and mangroves along the length of the IRL system. Approximately 80% of the impounded areas have now been reconnected to the IRL by St. Johns River Water Management District and numerous federal, state, and local partners (Brockmeyer et al., 2017). The two other types of restoration that have and continue to occur in Mosquito Lagoon are "living shoreline" stabilization and intertidal oyster reef restoration. The former occurs where shoreline erosion has become severe due to wind and boat wakes, and involves deployment of native vegetation and bagged oyster shell seaward of the plants to promote development of a living oyster wavebreak (e.g., Donnelly, Shaffer, Connor, Sacks, & Walters, 2017; Walters, Donnell, Sacks, & Campbel, 2017). Approximately 20% of the patch and fringe oyster reefs in Mosquito Lagoon have been degraded by boat strikes and recreational boat wakes (Garvis et al., 2015). These dead reefs have been restored by volunteers who deploy stabilized oyster shells at the correct elevation to promote new recruitment of oysters (Walters, Sacks, & Campbell, 2021). Both of these community-based efforts have found public support in the documentation of over 61,000 volunteer participants. The only aspect of these two community efforts that has not actually involved the community are decisions on where to restore oyster reefs or deploy a living shoreline. Those decisions have traditionally come from science/restoration teams in consultation with state and federal resource management specialists.

The work reported here contributes to a multi-year, interdisciplinary U.S. National Science Foundation (NSF) grant. A key objective of the grant is to map and visualize restoration priority areas to understand high and low values of emotional attachment as a measure of sense of place across the study site, with a later goal of integrating such human systems data with broader natural systems data about biological processes and degradation in the Lagoon. Coupling such data allows for the science team to consider both human systems level data and natural systems level data as outlined in a framework proposed by Kibler et al. (2018). We aimed to visualize community level interest in future restoration sites by employing a mapping framework to enable our team to answer very practical, applied questions to guide future restoration in the IRL. *First, were high levels of emotional attachment present at the broader lagoon scale*? If so, then it was presumed that future restoration sites might benefit from being more closely situated within areas with these high levels of emotional attachment to show the connections between scientist views and community stakeholder views. If not, the group recognized that new communication strategies would be needed for outreach and education efforts to show how restoration could potentially improve locations with lower levels of emotional attachment. *Second, could we pinpoint more localized areas of high and low emotional attachment in the Lagoon and visualize reasons for attachment?* If so, then we could demonstrate the important alignment of future restoration sites with areas that exhibited high levels of emotional attachment as opposed to focusing only on obvious signs of coastal degradation (e.g., shoreline scarps, dead oyster reefs). We also could potentially identify areas with low emotional attachment, but in strong need of restoration, that might need greater communication and outreach strategies in order to gain public support for future restoration.

3.2. Methods

We mapped emotional attachment across the Indian River Lagoon using geographic information collected through an Esri ArcGIS Online mapping application following the workflow outlined in Fig. 2. The study area historically has high levels of stakeholder engagement in community meetings and through public input at the local, regional, and state levels. Yet to date, no singular mapping application has attempted to prioritize knowledge about emotional attachment from community stakeholders to support future restoration in the IRL.

All data were collected with a university approved Institutional Review Board protocol. Participation occurred in two ways: 1) from a convenience sample taken as a result of participant proximity to the IRL during researcher canvassing windows aligning with community events in the IRL and 2) from an online mapping application on our project website and social media channels. Participants were asked to include locations on the map where they felt an emotional attachment. In early pilot data collection with stakeholders, we found the phrase “emotional attachment” to be more understandable than “sense of place” for community stakeholders. They were also asked questions about their willingness to volunteer in future restoration, and the likelihood of restoration success to improve the IRL.

A total of 1051 points were collected from participants in the mapping application. Most participants mapped one location, and some mapped as many as five locations. Participants mapping data in the field were provided with electronic tablets to include their mapped locations connected to a mobile hotspot. In a short demonstration (often less than five minutes in the field), participants were introduced to zoom functionalities on the tablet within the mapping application. The basemap

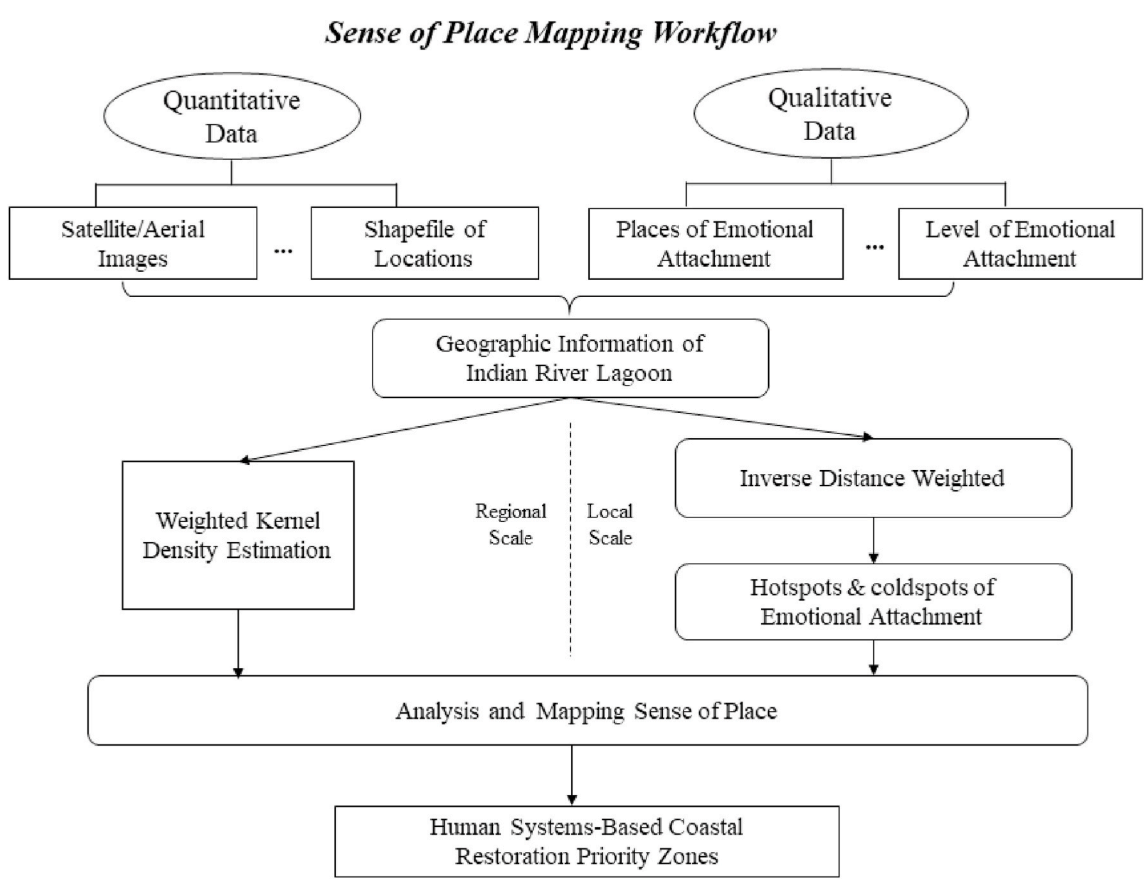

Fig. 2. Workflow for applied case study mapping methodology.

was set to hybrid satellite imagery rather than a topographic or street network basemap to provide more details and reference points for participants. As part of basic orientation to the mapping application, field researchers pointed participants to the case study boundaries on the map, and the general study area. Researchers also demonstrated how to place point data and include attribute information for each point (either as a closed response or open-ended text response). The strong majority of participants felt comfortable adding their own data to the map without further assistance from field research assistants; yet some asked that field researchers assist in zoom functionalities and placement of data points. In such cases, this resulted in the participant showing the researcher where to zoom and place the point, and the researcher confirming that the location represented the participant's desired location through a collaborative process. Data cleaning was performed on these 1051 points to remove any points entered outside of the study region of interest illustrated in Fig. 1, e.g., a point entered in Atlanta, GA. After data cleaning, 1005 points were included within the boundaries of the study area and were used for further GIS analysis.

Each mapped location included a level of attachment identified by the participant to serve as a proxy for sense of place. Level of attachment was ranked on a Likert scale from 1 to 5 (one being the least attached and five being the most attached). Participants were then asked to identify their primary, secondary, and tertiary reasons for their level of attachment. Table 1 displays the categories provided for primary reason of attachment and the percentage of participant responses for each category.

The categories and methods for selection outlined in Table 1 were drawn largely from Brown and Raymond (2007). Building from Jorgensen and Stedman (2006), Brown and Raymond (2007) find that aesthetic, recreation, economic, spiritual, and therapeutic values were spatially correlated with 'special places' and that mapping special places "provides a reasonable proxy for scale-based measures of place attachment while providing richer, place-based information for land use planning" (p.89). We adapt these categories for use in this case study, while recognizing the trade-off between closed-response categories which limit participants to predetermined rankings grounded in the literature and open-ended categories which can provide participants with more freedom to expand on their reasons for emotional attachment. The compromise in our study is that participants were also provided with the option for an "other" category.

Participants were also asked for the zip code of their primary residence which was mapped in proximity to the IRL. Participants were asked the frequency of visits to each location mapped. Responses included: *daily*, *weekly*, *monthly*, *every few months*, *annually*, *less than once a year*, and *I have never visited this location*. Questions were asked of participants regarding volunteering in the IRL including whether they had previously volunteered in the IRL (*Yes/No*) or if they were interested in volunteering in future restoration efforts (*Yes/No/Unsure*). Participants were able to provide additional comments in an open text box in the mapping application. Additionally, participants were asked their opinion of the likelihood of restoration success regarding the areas they identified within the IRL. Likert scale answers were provided for participants using the answer categories: (1) *very unlikely*, (2) *unlikely*, (3) *neutral*, (4) *likely*, and (5) *very likely*.

Table 1
Primary reasons for emotional attachment identified by participants.

Reasons for Attachment *(1st Response)*	Rank	Response Rate	# of Points
"It is the best place for me to do the activities I enjoy."	1st	25.57%	257
"It is beautiful."	2nd	24.58%	247
"I feel at home here."	3rd	19.50%	196
"It is ecologically important."	4th	15.12%	152
"It supports my job."	5th	5.97%	60
"Other."	6th	4.08%	41
"It reflects who I am."	7th	2.59%	26
"It supports the local economy."	8th	2.59%	26
Total		**100%**	**1005**

Weighted kernel density estimations (KDE) were used to extract emotional attachment areas over the broader Lagoon-wide scale so the research team could first address the question of whether or not their restoration priorities would be overlapping with areas of high or low emotional attachment. KDE of space use are typically constructed assuming that data arise from a simple random sample. However, location data are usually collected with different levels of variable intensity. The main algorithm in this study follows the weighted KDE function proposed by Fieberg et al. (2007). To match the data collection protocol, the fitting surface of the weighted function was simplified from a density surface to the population at the sample location. That is, the level of emotional attachment was treated as the population of the random sample and duplicated by the level of response. In this case, higher levels of emotional attachment are given a higher weight in the calculation of the KDE, while lower levels of emotional attachment are given a lower weight. KDE was adopted in this research for the regional scale spatial auto-correlation. We used the flat earth (planar) method to estimate the distances between the features (Xie & Yan, 2008). The population field was set to the points mapped by participants. The search radius was 10 km to fit the study region size.

Inverse distance weighted (IDW) interpolation was used to depict areas of high and low emotional attachment at more localized scales within the study site, especially the spatial patterns of emotional attachment within the broader areas extracted from our weighted KDE at the Lagoon scale. The IDW method allowed our research team to address whether we could pinpoint more localized areas of high and low emotional attachment in the Lagoon, while understanding general reasons for such attachment. IDW assumes that each measured point has a local influence that diminishes with distance under the assumption of the first law of geography, "everything is related to everything else, but near things are more related than distant things" (Tobler, 1970, p. 236). It gives greater weights to points less distant to predicting locations, and the weights decrease as a function of distance. In practice, Kriging could replace IDW pending the actual spatial statistics of the data. IDW directly uses the neighbors divided by the distance between predicting and surrounding observations, while Kriging uses a fitted function (e.g., Gaussian, Exponential) through a variogram to fit the spatial distribution (Shiode & Shiode, 2011). There is no consensus in the literature on how the spatial variogram is distributed for emotional attachment data, hence we use IDW here to keep the method general and expandable. Both methods calculate the weights of the spatial surrounding observations to derive a predictor for the targeting predicting locations.

We ran five IDW analyses. First, we ran an overall IDW analysis for all 1005 participant points, followed by four separate IDW analyses for subsets of points based on the most frequently mentioned primary reason for emotional attachment given by each participant. Separating the analyses in this way allowed for more contextualized IDW results to be shared for the study site, which can be useful for restoration scientists as they work to identify and explore future restoration priority areas in the site that account for emotional attachment and the primary reasons behind that emotional attachment.

4. Results and discussion

4.1. Kernel density estimation results

The left panel of Fig. 3 shows the weighted KDE map for all 1005 points mapped in the study area. The black bounding box in Fig. 3 represents the primary area where coastal scientists from the grant team have engaged in previous restoration projects and where they have proposed future restoration projects. Individual restoration sites are not included in this article to protect the ongoing work in these locations from theft or destruction and are represented as a general area in the

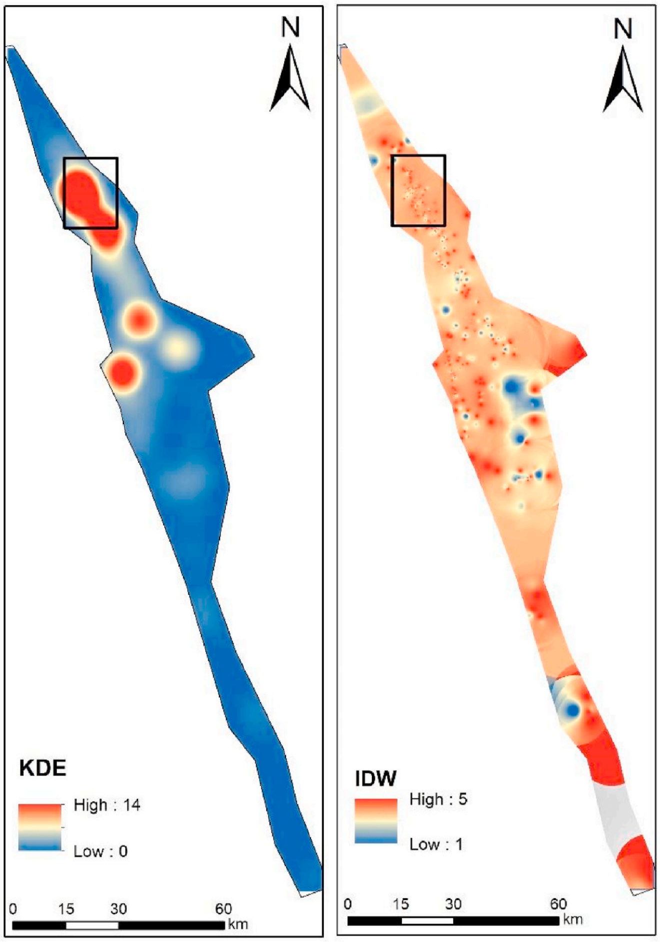

Fig. 3. Sense of Place Mapping Results (all participant points) for Indian River Lagoon. Kernel density mapped on left; inverse distance weighted interpolation mapped on right.

black bounding box of Fig. 3. This weighted KDE map not only accounts for the spatial distribution of emotional attachment locations mapped by participants, but also considers the attachment level ranked on a Likert scale from 1 to 5 (one being the least attached and five being the most attached). Particularly high levels of emotional attachment included the locations of Edgewater (with a large boat ramp often used by participants as an entry point into the Lagoon), Shipyard Island (where participants must boat to from within the Lagoon), and Orange Island (where participants must boat to/from within the Lagoon). This type of weighted KDE affords a more comprehensive view of spatial information at a broader case-study scale to provide a rapid assessment of participant data. Several current and planned restoration sites are within these areas of high emotional attachment suggesting that scientists are engaging in restoration activities occurring in areas that have high levels of emotional attachment. Such results demonstrate the alignment of natural system-based restoration priorities identified by restoration scientists and human system based priorities identified by participants.

4.2. Inverse distance weighted interpolation results

The right panel of Fig. 3 shows an IDW map from all 1005 mapped locations from participants with the black bounding box focused on the primary area of restoration from the grant team. It is important to note that the study area depicted on the map represents the watershed boundaries of the IRL, not just the IRL proper. Warmer colors (in red and orange) represent the interpolated high emotional attachment areas, while colder colors (greys and blues) represent low emotional attachment areas. There are multiple high emotional attachment hotspots inside of the lagoon, distributed along the intersection or the turning point of Lagoon waterways, and concentrated around boat ramps or shelters.

For each point in the mapping application, participants provided their primary reason for emotional attachment at a location, choosing the primary reasons for attachment from a list of choices (Table 1). The four most common reasons mapped by participants included: *it is the best place for me to do the activities I enjoy* (25.57%); *it is beautiful* (24.58%)*; I feel at home here* (19.5%)*; it is ecologically important* (15.12%).

The top row of Fig. 4 shows the IDW interpolation results separately for each of the four primary reasons. The Jenks natural breaks algorithm was used to estimate the higher emotional attachment (hotspots) and lower emotional attachment (coldspots) from the interpolated map, shown in the lower row of Fig. 4. We used a dashed line to show the hotspots with higher interpolated emotional attachment in red polygons, and coldspots with lower interpolated emotional attachment in blue polygons. The Jenks natural breaks algorithm is a widely-recognized data clustering method in GIS that is able to determine the reasonable arrangement of values into classes (North, 2009).

These maps are particularly useful for restoration scientists as they consider science communication and outreach strategies to show how and where their current and future restoration activities may overlap with areas of high and low emotional attachment. For example, as restoration scientists choose where to begin a new restoration site in the future, they might consider connecting that site to highly visible locations mapped where participants expressed that they can do the activities they enjoy. On the other hand, access to a location may be limited for the public as restoration activities occur. And it should be noted that some stakeholders at times prefer heavily degraded, barren areas where fishing may be easier. Considering these types of data from public participation processes like ours can support science communication efforts allowing scientists to promote how lagoon restoration in one of the red mapped areas either supports or enhances key activities, such as fishing, kayaking, swimming (key enjoyable activities mentioned by participants in this study). In this way, scientists can more clearly articulate the direct impacts the underlying biological processes being restored will have on one's ability to engage in the activities they enjoy in high emotional attachment areas. Furthermore, prioritizing future restoration in areas with higher emotional attachment, may allow restoration scientists to gain more early community buy-in in their work with sites that connect the science back to participant priorities. Working on restoration sites with stronger emotional attachment and community support first, scientists can gain some momentum and then turn to more challenging restoration sites with lower emotional attachment values (noted in the blue-shaded areas).

In thinking about our mapping results, it is important to consider the profiles of our participants, while recognizing that as in any mixed method study that combines human systems level data from stakeholders with GIS, our results are limited to the responses of participants. Of all participant responses, 351 entries were noted as "I have volunteered in IRL restoration before." 654 entries were noted as "I have never volunteered in IRL restoration before." Additionally, participants were asked their opinion of the likelihood of restoration success regarding the areas they identified within the IRL. Likert scale answers were provided for participants using the answer categories: (1) *very unlikely*, (2) *unlikely*, (3) *neutral*, (4) *likely*, and (5) *very likely.* Most participants indicated that they felt the area was likely (390) or very likely (214) to be restored, while a significant portion (244) of respondents replied neutrally to this question and a smaller group of participants indicated that it was either very unlikely (51) or unlikely (106) that the area indicated would be successfully restored. Finally, by analyzing the zip code entries within the collected data, we were able to show where participants resided in relation to our study area. Approximately 33% of our participants reported living within a zip code in Volusia County, FL, while 18% reported living in a zip code located

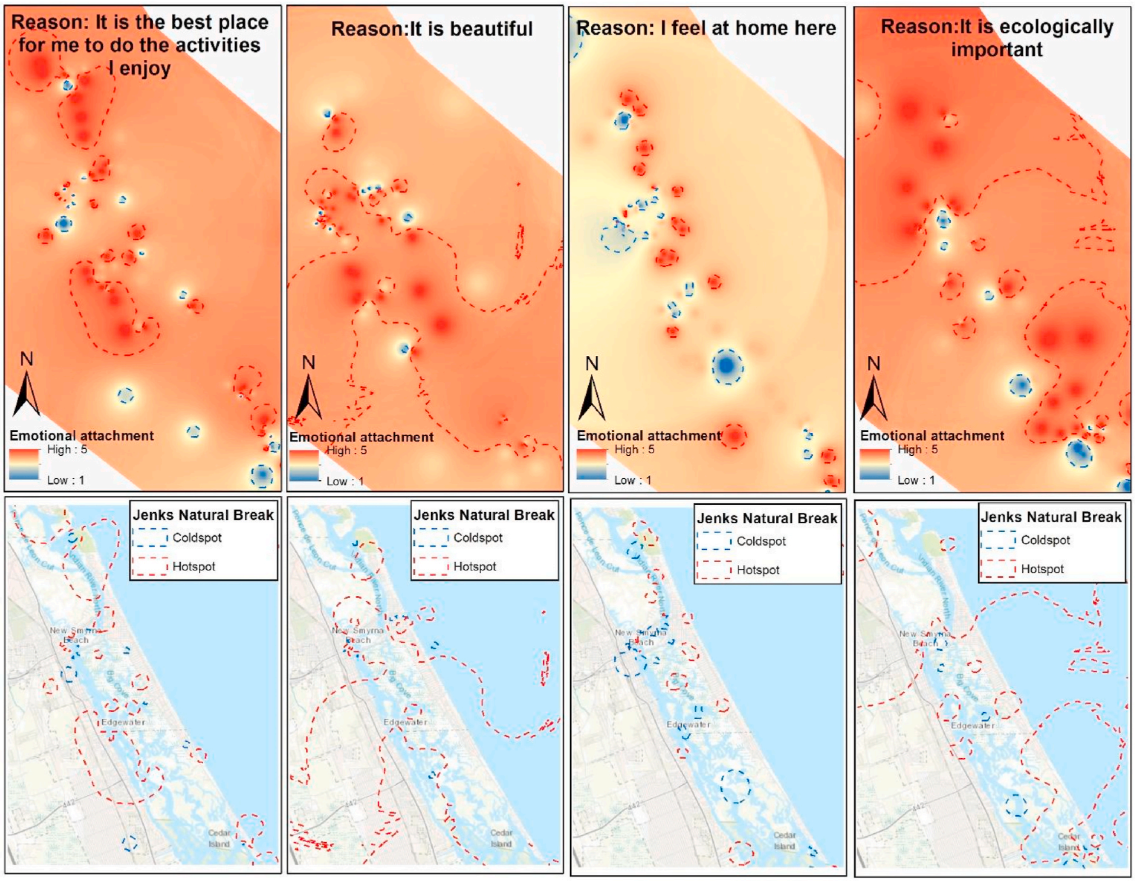

Fig. 4. Map of points highlighting individual reasons for emotional attachment in Indian River Lagoon.

within Brevard County, FL. This data shows that over 50% of our respondents lived in close proximity to the IRL locations indicated in the survey responses.

4.3. Discussion

Soliciting stakeholder input through the mapping framework we present in this article may increase connections between science and society, while allowing restoration scientists to engage in their work in areas with higher levels of public support first, and then working on science communication efforts next to build more public support for areas with lower emotional attachment for potential future work. Our results offer insights into where aggregate estimated levels of high and low emotional attachment are present at the broader Lagoon scale (kernel density results), and at more localized scales within the study site (IDW results). The KDE results are useful at the larger case study scale to show whether broad areas of emotional attachment are present and can be tied into restoration priorities in the future. Put another way, the KDE maps provide an overall "big picture" snapshot of the case study site to see whether or not people have high emotional attachment in and near locations being considered for future restoration. In an applied sense, then if a KDE analysis returned low values and did not identify any broader areas of high attachment, then a restoration team might choose to work in another location. Conversely, if a KDE analysis identified high values across a broader case study scale (like in this study), then the restoration team would be more comfortable proceeding to work in the study area. In such a case, our mapping framework would then suggest a team examine emotional attachment across more localized scales using IDW analyses to pinpoint more specific locations for restoration priorities. This part of our mapping framework would allow a team to either: a) tie into areas with high emotional attachment so that restoration priority areas align with areas of high emotional attachment or b) identify new communication and education strategies to show how restoration could potentially enhance locations with lower levels of emotional attachment. Using the KDE and IDW results to inform such decisions strikes a balance in future restoration prioritization and decision making between human systems level data focused on public input and natural systems level data from biological monitoring and ecological processes.

Our applied case study contributes to the literature on sense of place in fundamental ways. First, by utilizing GIS methods to analyze geographic information about stakeholder perceptions we are able to highlight the knowledge of community stakeholders in the process of coastal restoration. Our framework allows human systems level data from participants mapped in GIS to inform future restoration work in the study site. It prioritizes areas where individuals feel a high emotional attachment to geographic locations as a measure of sense of place. By engaging stakeholders in data collection efforts to document and visualize priority areas, important information can be gathered to analyze and understand the influence of sense of place and place attachment (Kar, Sieber, Haklay, & Ghose, 2016; Brandt et al., 2019) on stakeholder's feelings regarding coastal restoration (Mitsova, Wissinger, Esnard, Shankar, & Gies, 2013). This inclusion of human systems data from stakeholders on their thoughts, feelings, and reasons in the process of developing future restoration projects can balance the priorities of science teams and the individuals who inhabit these geographic locations.

Additionally, our integration of both quantitative and qualitative data strengthens our study by providing a variety of data to explore our primary research questions. By collecting data from participants, we were able to gauge their level of emotional attachment to specific areas within the IRL using online mapping to analyze this information with two advanced GIS analysis techniques. First, we used kernel density estimations to identify hotspots and coldspots of emotional attachment. After identifying these priority zones based on the level of attachment provided by participants, we then used IDW interpolations to examine areas within each hotspot of the individual reasons participants recorded for their emotional attachment. After conducting this analysis, we could see that identified zones of high emotional attachment aligned with current and planned restoration sites first represented in the black bounding box of Fig. 3, showing an alignment between priority areas identified by both scientific researchers and community stakeholders within the IRL. By including public input in the process of scientific research, connections may be bridged between science and society that better enable and support coastal restoration efforts in areas with high levels of community engagement and involvement.

4.4. Study limitations and future directions

While this study introduces a framework for visualizing emotional attachment in relation to coastal restoration efforts, a few inherent limitations exist. First, as a result of the data collection, the sample size of our study was concentrated within a few specific areas located throughout the IRL. This narrows our study to a few isolated locations within the broader study area which limits our ability to generalize findings outside of the identified coastal restoration areas. Second, because of the way data was collected throughout the initial stages of the project development, some respondents were quick to enter in information which produced some errors in data collection (i.e. incorrect zip code data, failure to answer all questions, etc.). Additionally, the zoom levels of our mapping window on tablets may have influenced individual's plotting of points within our mapping application. This may have affected the accuracy of the points that were entered into the mapping application; the averaging of point data across a surface in both methods accounts for such small variations to provide an aggregate look at sense of place across the study site. Fourth, emotional attachment is often mapped at the individual level, rather than aggregated to the size of a larger group. In this study, participants mapped their own emotional attachment at individual locations, our analysis aggregates emotional attachment across the collection of responses to provide general priority zones with high and low levels of emotional attachment from a broad group of community stakeholders. We acknowledge that some nuance and context is lost in aggregating the data in this manner. Furthermore, both KDE and IDW methods were adopted in this research under the assumption that emotional attachment is spatially continuous. Previous research uses such interpolation methods to model emotional predictions under the assumption that such data can be treated as spatially continuous (Sikder & Züfle, 2019). Similarly, there are studies that use (co)Kriging to model the spatial distribution of societal activities, such as criminal activities (Yang et al., 2020). Therefore, we use a similar method to model emotional attachment under the assumption that such data can be treated as spatially continuous. We acknowledge this limitation in our analysis and hope future studies by our team and others can further examine this issue. Finally, we recognize that mapping emotional attachment at the individual and aggregate level is complex. Using data collection methods with stakeholders, we aimed to engage in the first, rapid assessment of emotional attachment mapping in the study area using predetermined categories grounded in the literature. Future studies may consider the tradeoff between this approach and that of a more iterative, participatory process where community stakeholders are provided with opportunities to define their own categories of emotional attachment.

Future work in this area should focus on further establishing the relationship that exists between those who spend time within areas targeted for restoration and the scientific response to that restoration. Much is yet to be developed in this area, specifically regarding standardization of methodological approaches to gathering and interpreting human systems level data like ours for use in GIS-based restoration efforts. Additional research in this area may couple GIS data collection efforts with in-depth qualitative techniques to understand a more contextualized and detailed narrative behind the primary reasons for emotional attachment.

5. Conclusions

Our applied case study in the Indian River Lagoon provides new insights into understanding emotional attachment as a measure of sense of place across the study site. Furthermore, the work infuses such data into maps that allow restoration scientists to visualize areas of high and low emotional attachment. Our work demonstrates how knowledge from community stakeholders can inform and influence future coastal restoration priorities at various scales. In this case, we map emotional attachment at the broader Lagoon scale through KDE measures and at more localized scales through IDW measurements. By connecting the mapped results back to the primary reasons that participants provided for having high or low emotional attachment in a location, we show how varying spatial patterns of participant data within and across broader geographic regions can be represented, mapped, and visualized to enhance future restoration priorities. Results gained from the mapping framework allow restoration teams to prioritize their science communication and education strategies to align human systems level data with natural systems level data. It is our hope that future studies will consider the ways in which mapping data about emotional attachment as a measure of sense of place can allow for future restoration priorities to be informed by human systems level data. Such data from a broad range of participants can complement the natural systems level data already driving restoration work in our site and beyond.

Acknowledgements

The authors would like to thank the associate editor and anonymous reviewers for their helpful feedback. This work is funded by U.S. National Science Foundation Grant #1617374 and in part by the University of Central Florida Preeminent Postdoctoral Program. We thank the community stakeholders who shared their time and knowledge with us.

References

Blake, B. F. (1974). *Topophilia: A Study of Environmental Perception, Attitudes and Values.* By Yi-Fu Tuan.

Brandt, K., Graham, L., Hawthorne, T., Jeanty, J., Burkholder, B., Munisteri, C., et al. (2019). Integrating sketch mapping and hot spot analysis to enhance capacity for community-level flood and disaster risk management. *The Geographical Journal, 186* (2), 198–212. https://doi.org/10.1111/geoj.12330

Brockmeyer, R., Beal, J., Sharpe, B., Hedgepeth, M., Tucker, J., Cho, H., et al. (2017). Indian River Lagoon: Coastal habitat integrated mapping and monitoring program report for the state of Florida. In K. Radabaugh, C. Powell, R. Moyer, & Pages (Eds.), *Coastal habitat integrated Mapping and monitoring program Report for the State of Florida, Published by Florida fish and wildlife conservation Commission fish and wildlife research Institute* (pp. 134–143).

Brown, G. (2004). Mapping spatial attributes in survey research for natural resource management: Methods and applications. *Society & Natural Resources, 18*(1), 17–39. https://doi.org/10.1080/08941920590881853

Brown, G. (2013). The relationship between social values for ecosystem services and global land cover: An empirical analysis. *Ecosystem Services, 5*, 58–68. https://doi.org/10.1016/j.ecoser.2013.06.004

Brown, G., & Raymond, C. (2007). The relationship between place attachment and landscape values: Toward mapping place attachment. *Applied Geography, 27*(2), 89–111. https://doi.org/10.1016/j.apgeog.2006.11.002

Brown, G., Rhodes, J., & Dade, M. (2018). An evaluation of participatory mapping methods to assess urban park benefits. *Landscape and Urban Planning, 178*, 18–31. https://doi.org/10.1016/j.landurbplan.2018.05.018

Brown, G., Schebella, M. F., & Weber, D. (2014). Using participatory GIS to measure physical activity and urban park benefits. *Landscape and Urban Planning, 121*, 34–44. https://doi.org/10.1016/j.landurbplan.2013.09.006

Childress, H. (1994). Place, narrative, and relationship: A new approach to place attachment. *Banking on Design*, 55–61.

Couclelis, H. (1992). People manipulate objects (but cultivate fields): Beyond the raster-vector debate in GIS. In *Theories and methods of spatio-temporal reasoning in geographic space* (pp. 65–77). Berlin, Heidelberg: Springer. https://doi.org/10.1007/3-540-55966-3_3.

Cresswell, T. (2014). *Place: An introduction.* John Wiley & Sons.

Cross, J. E. (2001). *What is sense of place?* Libraries: Doctoral dissertation, Colorado State University.
Donnelly, M., Shaffer, M., Connor, S., Sacks, P., & Walters, L. (2017). Using mangroves to stabilize coastal historic sites: Deployment success versus natural recruitment. *Hydrobiologia, 803*(1), 389–401.
Entrikin, J. N. (1991). The betweenness of place. In *The Betweenness of place* (pp. 6–26). London: Palgrave. https://doi.org/10.1007/978-1-349-21086-2_2.
Fieberg, J. (2007). Kernel density estimators of home range: Smoothing and the autocorrelation red herring. *Ecology, 88*(4), 1059–1066. https://doi.org/10.1890/06-0930
Garvis, S., Sacks, P., & Walters, L. (2015). Assessing the formation, movement, and restoration of dead intertidal oyster reefs over time using remote sensing in Canaveral National Seashore and Mosquito Lagoon, Florida. *Journal of Shellfish Research, 34*, 251–258.
Gieryn, T. F. (2000). A space for place in sociology. *Annual Review of Sociology, 26*(1), 463–496. https://doi.org/10.1146/annurev.soc.26.1.463
Halpenny, E. A. (2010). Pro-environmental behaviours and park visitors: The effect of place attachment. *Journal of Environmental Psychology, 30*(4), 409–421. https://doi.org/10.1016/j.jenvp.2010.04.006
Hamzei, E., Winter, S., & Tomko, M. (2020). Place facets: A systematic literature review. *Spatial Cognition and Computation, 20*(1), 33–81. https://doi.org/10.1080/13875868.2019.1688332
Hashemnezhad, H., Heidari, A. A., & Mohammad Hoseini, P. (2013). Sense of place" and "place attachment. *International Journal of Architecture and Urban Development, 3*(1), 5–12.
Hauge, Å. L. (2007). Identity and place: A critical comparison of three identity theories. *Architectural Science Review, 50*(1), 44–51. https://doi.org/10.3763/asre.2007.5007
Hidalgo, M. C., & Hernandez, B. (2001). Place attachment: Conceptual and empirical questions. *Journal of Environmental Psychology, 21*(3), 273–281. https://doi.org/10.1006/jevp.2001.0221
Indian River Lagoon National Estuary Program. (2019). *Indian River Lagoon comprehensive and conservation management plan Update* (Palm Bay, Florida).
Indian River Lagoon National Estuary Program. (2021). https://onelagoon.org/.Visited on 5/11/21.
Jorgensen, B. S., & Stedman, R. C. (2006). A comparative analysis of predictors of sense of place dimensions: Attachment to, dependence on, and identification with lakeshore properties. *Journal of Environmental Management, 79*(3), 316–327. https://doi.org/10.1016/j.jenvman.2005.08.003
Kar, B., Sieber, R., Haklay, M., & Ghose, R. (2016). Public participation GIS and participatory GIS in the era of GeoWeb. *The Cartographic Journal, 53*(4), 296–299. https://doi.org/10.1080/00087041.2016.1256963
Kibler, K., Cook, G., Chambers, L., Donnelly, M., Hawthorne, T., Rivera, F., et al. (2018). Integrating sense of place into ecosystem restoration: A novel approach to achieve synergistic social-ecological impact. *Ecology and Society, 23*(4). https://doi.org/10.5751/ES-10542-230425
Kittinger, J. N., Bambico, T. M., Minton, D., Miller, A., Mejia, M., Kalei, N., & Glazier, E. W. (2016). Restoring ecosystems, restoring community: Socioeconomic and cultural dimensions of a community-based coral reef restoration project. *Regional Environmental Change, 16*(2), 301–313. https://doi.org/10.1007/s10113-013-0572-x
Kobryn, H. T., Brown, G., Munro, J., & Moore, S. A. (2018). Cultural ecosystem values of the Kimberley coastline: An empirical analysis with implications for coastal and marine policy. *Ocean & Coastal Management, 162*, 71–84. https://doi.org/10.1016/j.ocecoaman.2017.09.002
Leslie, H. M., Basurto, X., Nenadovic, M., Sievanen, L., Cavanaugh, K. C., Cota-Nieto, J. J., et al. (2015). Operationalizing the social-ecological systems framework to assess sustainability. *Proceedings of the National Academy of Sciences, 112*(19), 5979–5984. https://doi.org/10.1073/pnas.1414640112
Levin, P. S., Breslow, S. J., Harvey, C. J., Norman, K. C., Poe, M. R., Williams, G. D., et al. (2016). Conceptualization of social-ecological systems of the California current: An examination of interdisciplinary science supporting ecosystem-based management. *Coastal Management, 44*(5), 397–408.
Low, S. M., & Altman, I. (1992). Place attachment. In *Place attachment* (pp. 1–12). Boston, MA: Springer. https://doi.org/10.1007/978-1-4684-8753-4_1.
Massey, D. (1993). In J. Bird, & B. Curtis T (Eds.), *Power-geometry and a progressive sense of place*.
Massey, D. (1995). *Spatial divisions of labour: Social structures and the geography of production* (2nd ed.). Macmillan International Higher Education.
McClenachan, G., Witt, M., & Walters, L. (2020). Replacement of oyster reefs by mangroves: Unexpected climate-driven ecosystem shifts. *Global change Biology*. https://doi.org/10.1111/gcb.15494
Merschdorf, H., & Blaschke, T. (2018). Revisiting the role of place in geographic information science. *ISPRS International Journal of Geo-Information, 7*(9), 364. https://doi.org/10.3390/ijgi7090364
Mesch, G. S., & Manor, O. (1998). Social ties, environmental perception, and local attachment. *Environment and Behavior, 30*(4), 504–519. https://doi.org/10.1177/2F001391659803000405
Mitsova, D., Wissinger, F., Esnard, A. M., Shankar, R., & Gies, P. (2013). A collaborative geospatial shoreline inventory tool to guide coastal development and habitat conservation. *ISPRS International Journal of Geo-Information, 2*(2), 385–404. https://doi.org/10.3390/ijgi2020385
Morris, L., Hall, L., Miller, J., Lasi, M., Virnstein, R., & Jacoby, C. (2021). *Dynamic diversity of seagrasses in the Indian River Lagoon* (Florida Scientist).
North, M. A. (2009). A method for implementing a statistically significant number of data classes in the Jenks algorithm. In *2009 Sixth International Conference on Fuzzy Systems and Knowledge Discovery, 1* pp. 35–38). IEEE. https://doi.org/10.1109/FSKD.2009.319. August.
Ostrom, E. (2009). A general framework for analyzing sustainability of social-ecological systems. *Science, 325*(5939), 419–422. https://doi.org/10.1126/science.1172133
Pérez-Ramírez, I., García-Llorente, M., Benito, A., & Castro, A. J. (2019). Exploring sense of place across cultivated lands through public participatory mapping. *Landscape Ecology, 34*(7), 1675–1692. https://doi.org/10.1007/s10980-019-00816-9
Phlips, E., Badylak, S., Lasi, M., Chamberlain, R., Green, W., Hall, L., et al. (2015). From red tides to green and brown tides: Bloom dynamics in a restricted subtropical lagoon under shifting climatic conditions. *Estuaries and Coasts, 38*, 886–904.
Plieninger, T., Dijks, S., Oteros-Rozas, E., & Bieling, C. (2013). Assessing, mapping, and quantifying cultural ecosystem services at community level. *Land Use Policy, 33*, 118–129. https://doi.org/10.1016/j.landusepol.2012.12.013
Poe, M. R., Donatuto, J., & Satterfield, T. (2016). "Sense of place": Human wellbeing considerations for ecological restoration in puget sound. *Coastal Management, 44*(5), 409–426. https://doi.org/10.1080/08920753.2016.1208037
Proshansky, H. M. (1978). The city and self-identity. *Environment and Behavior, 10*(2), 147–169. https://doi.org/10.1177/2F0013916578102002
Proshansky, H. M., Fabian, A. K., & Kaminoff, R. (1983). Place-identity: Physical world socialization of the self. *Journal of Environmental Psychology, 3*(1), 57–83. https://doi.org/10.1016/S0272-4944(83)80021-8
Purves, R. S., Winter, S., & Kuhn, W. (2019). Places in information science. *Journal of the Association for Information Science and Technology, 70*(11), 1173–1182. https://doi.org/10.1002/asi.24194
Qazimi, S. (2014). Sense of place and place identity. *European Journal of Social Science Education and Research, 1*(1), 306–310. https://doi.org/10.26417/ejser.v1i1.p306-310
Raymond, C. M., Brown, G., & Weber, D. (2010). The measurement of place attachment: Personal, community, and environmental connections. *Journal of Environmental Psychology, 30*(4), 422–434. https://doi.org/10.1016/j.jenvp.2010.08.002
Relph, E. (1976). *Place and placelessness*. London: Pion.
Rollero, C., & De Piccoli, N. (2010). Place attachment, identification and environment perception: An empirical study. *Journal of Environmental Psychology, 30*(2), 198–205. https://doi.org/10.1016/j.jenvp.2009.12.003
Ryfield, F., Cabana, D., Brannigan, J., & Crowe, T. (2019). Conceptualizing 'sense of place' in cultural ecosystem services: A framework for interdisciplinary research. *Ecosystem Services, 36*, 100907. https://doi.org/10.1016/j.ecoser.2019.100907
Sakurai, R., Ota, T., & Uehara, T. (2017). Sense of place and attitudes towards future generations for conservation of coastal areas in the Satoumi of Japan. *Biological Conservation, 209*, 332–340. https://doi.org/10.1016/j.biocon.2017.02.041
Sakurai, R., Ota, T., Uehara, T., & Nakagami, K. I. (2016). Factors affecting residents' behavioral intentions for coastal conservation: Case study at Shizugawa Bay, Miyagi, Japan. *Marine Policy, 67*, 1–9. https://doi.org/10.1016/j.marpol.2016.01.006
Seamon, D. (1993). Different worlds coming together: A phenomenology of relationship as portrayed in doris lessing's diaries of jane somers. In D. Seamon (Ed.), *Dwelling, seeing and designing: Toward a phenomenological ecology* (pp. 219–246).
Shiode, N., & Shiode, S. (2011). Street-level spatial interpolation using network-based IDW and ordinary kriging. *Transactions in GIS, 15*(4), 457–477.
Shrestha, S., & Medley, K. E. (2016). Landscape mapping: Gaining "sense of place" for conservation in the manaslu conservation area, Nepal. *Journal of Ethnobiology, 36*(2), 326–347. https://doi.org/10.2993/0278-0771-36.2.326
Sikder, A., & Züfle, A. (2019). Emotion predictions in geo-textual data using spatial statistics and recommendation systems. In *In Proceedings of the 3rd ACM SIGSPATIAL International Workshop on Location-based Recommendations, Geosocial Networks and Geoadvertising* (pp. 1–4).
Stedman, R. C. (2002). Toward a social psychology of place: Predicting behavior from place- based cognitions, attitude, and identity. *Environment and Behavior, 34*(5), 561–581. https://doi.org/10.1177/2F0013916502034005001
Stedman, R. C. (2003). Is it really just a social construction?: The contribution of the physical environment to sense of place. *Society & Natural Resources, 16*(8), 671–685. https://doi.org/10.1080/08941920309189
Steele, F. (1981). *The sense of place*. Boston, MA: Cbi Pub Co.
Swain, H., Breininger, D., Busby, D., Clark, K., Cook, S., & Day, R. (1995). Introduction to the Indian river biodiversity conference. *Bulletin of Marine Science, 57*, 1–7.
Taylor, D. (2012). Removing the sands (sins?) of our past: Dredge spoil removal and saltmarsh restoration along the Indian River Lagoon, Florida (USA). *Wetlands Ecology and Management, 20*, 213–218.
Tobler, W. R. (1970). A computer movie simulating urban growth in the Detroit region. *Economic Geography, 46*(sup1), 234–240.
Tonge, J., Ryan, M. M., Moore, S. A., & Beckley, L. E. (2014). The effect of place attachment on pro-environment behavioral intentions of visitors to coastal natural area tourist destinations. *Journal of Travel Research, 54*(6), 730–743. https://doi.org/10.1177/2F0047287514533010
Tuan, Y. F. (1975). Place: An experiential perspective. *Geographical Review, 65*(2), 151–165. https://doi.org/10.2307/213970
Tuan, Y. F. (1977). *Space and place: The perspective of experience*. London: Edward Arnold.
Turner, P., & Turner, S. (2006). Place, sense of place, and presence. *Presence: Teleoperators and Virtual Environments, 15*(2), 204–217. https://doi.org/10.1162/pres.2006.15.2.204
Van Noy, R. (2003). *Surveying the interior: Literary Cartographers and the sense of place*. Reno, NV: University of Nevada Press.
Wagner, D., Zipf, A., & Westerholt, R. (2020). Place in the GIScience community–an indicative and preliminary systematic literature review. In *Proceedings of the 2nd International Symposium on Platial information science* (pp. 13–22). https://doi.org/10.5281/zenodo.3628855. PLATIAL'19.

Walters, L., Donnell, y M., Sacks, P., & Campbel, l D. (2017). Lessons learned from living shoreline stabilization in popular tourist areas: Boat wakes, volunteer support and protecting historic structures. In D. Bilkovic, M. Mitchell, M. La Peyre, & J. Toft (Eds.), *Living shorelines: The science and management of nature-based coastal protection* (pp. 233–246). CRC Press.
Walters, L., Phlips, E., Badylak, S., McClenachan, G., Sacks, P., & Donnelly, M. (2021b). *Field observations of the negative association between recruitment of the eastern oyster Crassostrea virginica and the brown tide Aureoumbra lagunensis in Mosquito Lagoon*. Florida Scientist: FL.
Walters, L., Sacks, P., & Campbell, D. (2021a). *Boating impacts and boat-wake resilient restoration of the eastern oyster Crassostrea virginica in Mosquito Lagoon*. Florida, USA: Florida Scientist.
Westerholt, R. (2019). Methodological aspects of the spatial analysis of geosocial media feeds: From locations towards places. GIS. *Science: Die Zeitschrift für Geoinformatik, 31*(31), 65–76.
Westling, E. L., Surridge, B. J., Sharp, L., & Lerner, D. N. (2014). Making sense of landscape change: Long-term perceptions among local residents following river restoration. *Journal of Hydrology, 519*, 2613–2623. https://doi.org/10.1016/j.jhydrol.2014.09.029
Williams, D. R., Patterson, M. E., Roggenbuck, J. W., & Watson, A. E. (1992). Beyond the commodity metaphor: Examining emotional and symbolic attachment to place. *Leisure Sciences, 14*(1), 29–46. https://doi.org/10.1080/01490409209513155
Yang, B., Liu, L., Lan, M., Wang, Z., Zhou, H., & Yu, H. (2020). A spatio-temporal method for crime prediction using historical crime data and transitional zones identified from nightlight imagery. *Int. J. Geogr. Inf. Sci., 34*(9), 1740–1764.
Yuan, W., Hoffman, E., & Walters, L. (2016). Effects of nonnative invertebrates on two life stages of the native eastern oyster *Crassostrea virginica*. *Biological Invasions, 18*, 689–701.