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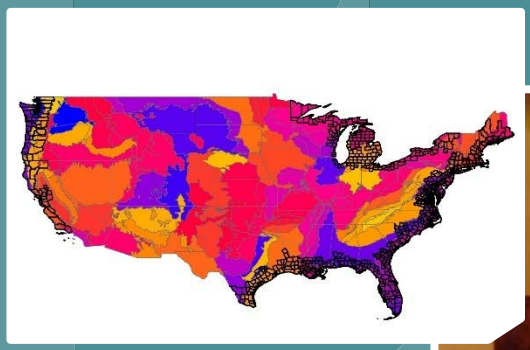
Sustainability at the Community Level: Searching for Common Ground as a Part of a National Strategy for Decision Support



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Sustainability at the Community Level: Searching for Common Ground as a Part of a National Strategy for Decision Support

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Notice/disclaimer statement

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Foreword

The U.S. Environmental Protection Agency (EPA) is charged by Congress with protecting the Nation's land, air, and water resources. Under a mandate of national environmental laws, the Agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. To meet this mandate, EPA's research program is providing data and technical support for solving environmental problems today and building a science knowledge base necessary to manage our ecological resources wisely, understand how pollutants affect our health, and prevent or reduce environmental risks in the future.

The National Health and Environmental Effects Research Laboratory (NHEERL) within the Office of Research and Development (ORD) is the Agency's center for investigation of technological and management approaches for reducing anthropogenic effects that threaten human health and the environment. The focus of the Laboratory's research program is on models, tools, and approaches for identification, understanding, measurement, and prevention of anthropogenic effects to air, land, water, and subsurface resources; protection of air, water, sediments, and ground water; and restoration of ecosystems. NHEERL collaborates with both public and private sector partners to foster new tools and approaches that address existing issues and anticipate emerging problems. NHEERL’s research provides solutions to environmental problems by: developing and promoting technologies that protect and improve the environment; advancing scientific and engineering information to support regulatory and policy decisions; and providing the technical support and information transfer to ensure implementation of environmental regulations and strategies at the national, state, and community levels.

This report describes NHEERL’s investment into local decision support through examination of community characteristics that are associated with decision priorities, local available resources, and meaningful measures of human well-being. This comparison directly supports NHEERL’s research priorities through the examination of transferability and utility of existing tools and approaches for decision support at the community level.

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Acronyms and abbreviations

ACS	American Community Survey
ANOVA	Analysis of Variance
CBDS	Community-Based Decision Support
CCS	Community Classification System
CIC	Community Indicators Consortium
CN	Curve Number
CR	Caribbean Regions
EAB	Ecosystems Assessment Branch
EGS	Ecosystem Goods and Services
EPA	Environmental Protection Agency
GED	Gulf Ecology Division
GIS	Geographic Information System
GOM	Gulf of Mexico
HWB	Human Well-Being
HWBI	Human Well-Being Index
ICMA	International City/County Management Association
LM	Lifemode
LQ	Location Quotient
LULC	Land Use Land Cover
MUKEY	Map Unit Key
NAICS	North American Industry Classification System
NHEERL	National Health and Environmental Effects Research Laboratory
NLCD	National Land Cover Dataset
NOAA	National Oceanic and Atmospheric Administration
OECD	Organization for Economic Co-Operation and Development
ORD	Office of Research and Development
RESES	Regional Sustainable Environmental Science
RIVs	Relative Importance Values
SHC	Sustainable and Healthy Communities
SSURGO	Soil Survey Geographic Database
USDA	United States Department of Agriculture
USFS	United States Forest Service
USGS	United States Geological Survey

Executive summary

The Sustainable and Healthy Communities (SHC) research program is intended to support resource sustainability and decision making at the community level. Sustainability is defined as the ability of a community to meet present needs without compromising the ability of society and the environment to meet the economic, social, and environmental needs of future generations. The USEPA and its partners seek a national strategy that maximizes impacts by identifying common ground among communities that can inform the decision process. In this report, communities are compared based on four distinct metrics (community type; human well-being index; stakeholder priorities; and availability of ecosystem goods and services) with the purpose of seeking common ground for defining and measuring sustainability at the local scale. Overlying this comparison is the question of the usefulness of a community classification system (CCS) for generalizing the findings to new communities.

Community type was found to be informative regarding the relative importance of elements of well-being. Two major delineations of community type are considered here. First is geographic, or simply asking if a place defines how communities measure well-being. The second was the CCS described in debate in Chapter 2. We then examine whether values of a specific measure of well-being, the human well-being index (HWBI), differ either geographically or by community type. Stakeholder priorities are then examined in Chapter 4, with two methods, both involving elements of the HWBI. The objective was to link stakeholder priorities to HWBI and look for differences in these priorities among communities. Finally, we examined if available ecosystem resources differ either geographically or by community type and provide some recommendations for using all of the information as a part of a national strategy for classifying communities in support of decision making for sustainability.

The analysis in Chapters 2 and 3 involves the description of a CCS and the amount of information regarding human well-being (HWB) contained in the CCS. This is important because community decision makers may use the CCS to help identify baseline well-being values from which to assess the impact of decisions as shifts in community-specific HWB. Measures of community-specific HWB also allow communities to restore, achieve and sustain what matters most to them in terms of human well-being. The environmental components (e.g., ecoregion) of the CCS were less informative about community type than the economic and social components (i.e., Lifemode and Location Quotient), yet the differences in community type were strongly driven by economic and social dependence on local environmental resources either through employment or through land use. This finding points to a clear link between environmental service flows and HWB.

The approach of setting local HWB reference points based on community classification assumes that common ground is important for describing community priorities. The limitations of this approach are that specific factors important to individual communities are not considered and are likely to change in importance across communities and at different spatial scales than considered here. Decision makers wishing to set reference points for HWB will need to consider the consistency of the group assignments to their situation, but in cases where this is an effective approach, much will be gained by allowing similar communities to compare their HWB values.

The community classification system developed during this study was also intended to inform decision makers about a community's priorities. The association of these priorities with human well-being is a tool for informing decision makers about sustainable decision outcomes in a community-specific context. Stakeholder engagement is an important tool for understanding the priorities of a community. In

Chapter 4, two methods for stakeholder engagement were explored with the HWBI as an engagement framework in each case. In Chapter 4.1, a workshop approach is described based on structured decision making (Structured Decision Making; accessed 14 September 2016), while in Chapter 4.2 an automated analysis of strategic planning documents is described based on keyword counting method. Key differences were observed in the outcomes of these two methods. The workshop method generated more diverse findings that nonetheless consistently reported high importance in the domains of *Education* and *Social Cohesion*. In contrast, the keyword method was always dominated by *Living Standards*, which is the primary economic domain of HWBI. In terms of meaning, the keyword results are based on strategic planning, which is predictably action-focused and heavily weighted to economic aspects of a community's well-being. In contrast, workshop results show a broader influence and this is likely the result of facilitation and the separation of community priorities from a particular action (Chapter 4.1). The findings of the keyword analysis can be thought of as hierarchical with the secondary outcomes being more similar to workshop outcomes. There is, thus, strong support for the complementarity of the two methods. Consistent results across the two approaches provide good support for the complementary nature of the data and the value of applying both methods simultaneously to identify community priorities.

The stakeholder workshops held as a part of this study generated important insights into the nature and hierarchical structure of core community values and implications for indices of sustainability. Communities participating in the workshops demonstrated an innate capacity for systems thinking, and this suggests that in the context of community decisions and action, values associated with the most fundamental aspects of well-being could be the highest priorities. Practical sustainability indices will need to be adaptable to changes in a way that measures and emphasizes core values that remain high priorities over time and values associated more immediate priorities. The workshops also afforded an opportunity to explore the elements of the HWBI, particularly the relative importance values (RIV), the factors used to weight different domain scores to derive element scores (e.g., economic well-being) and an overall HWBI value. Workshop findings suggest that, from a community perspective, a set of indices or indicators, rather than aggregated indices, may be more responsive to community needs. The RIVs could also change over time. This suggests the need to periodically update RIVs.

There is always a question regarding the within-community generalizability of workshop findings with respect to core community values. In this case, there were promising linear associations between the priority placed on *Education* (based on mapping and ranking exercises) and the shares of households in the four participating communities with children and youth; as well as between the priority placed on *Health* (based on mapping and/or dot voting), a critical factor affecting household expenses, and the unemployment rates and percentages of owner-occupied and renter households that spend 35% or more of their income on housing costs in the four communities. The analysis of workshop data also revealed no significant bias in terms of higher prioritization of goals and values that are most closely aligned with the central issues. The ability to generalize the results of community engagement workshops to the whole community can be improved by holding multiple workshops at different times of the day, week and year and by holding workshops in different forums.

Similar to workshops, keyword analysis of strategic planning documents shows great promise as a contributing method for clarifying the long-term priorities of stakeholders. Clarifying community priorities from document analysis is limited by the scope of the document, as well as the level to which the document reflects community input rather than the input of elected officials or hired external experts. Yet, these issues can largely be minimized by appropriate document selection. A key consistency among communities in this analysis was the importance of quality of life metrics to stakeholder priorities. Across communities and community types the consistently dominant domains, in terms of total number

of keyword hits, were *Living Standards* followed by *Safety and Security* followed closely by *Social Cohesion* and *Leisure Time*. An interest in quality of life seems to be a common community attribute, which is not surprising. The consistent low scores for either *Connection to Nature* and *Health* were surprising, but suggest these are not community-level priorities but may be important at a different scale (e.g., personal/family). For instance, even in cases where an action may directly benefit human health (e.g., investment in hospitals) the community-scale priority for the action may not be directly tied to health, but rather to ancillary benefits more aligned with community-scale priorities such as job creation, reductions in burden on public services, or community reputation. These differences can be important to setting measures of success at the appropriate scale. It is also important to understand if these results differ among community types.

The dominant delineations for stakeholder priorities at the community level were between states and CCS groups. States differed most for *Safety* and *Social Cohesion*, while CCS groups differed most in *Living Standards* and *Leisure* time. The less commonly mentioned domains such as *Connection to Nature* were more important in specific categories such as median age and ethnic composition of the community. The value of understanding these differences among groups is to identify the domains of human well-being for which the CCS or geographic delineations are the most informative. These most informative differences lie on a gradient from an emphasis on *Safety* and *Living Standards* on one end to an emphasis on *Leisure Time* and *Social Cohesion* on the other end. This gradient is also consistent with an urban to rural gradient in that it is directly related to population size, and demographics as 'ruralness' tends to be related to an increased emphasis on social connectivity. As communities become more urban, more diverse, or less dependent on local natural resources they seem to prioritize *Safety, Living Standards* and *Connection to Nature*; and reduce priorities for *Social Cohesion* and *Education*. The most informative delineation of keyword data at the community scale is for CCS groups followed by state differences, but other delineations become more important at smaller scales within the community. Domains such as *Connection to Nature* and *Education* do not parse out very well at the community scale, as indicated by the lack of difference among communities for these domains, and the lack of information about them contained in categories such as CCS and geography. Nonetheless, they can be quite important in driving individual priorities and so have a collective influence at the community level not well captured by review of community planning documents. As such, it is not advised that any conclusions can be drawn about community priorities for these domains with a keyword-based method. These findings strongly suggest that keyword analysis combined with a CCS based comparison can be very informative regarding differences in the relative importance of community-scale priorities such as *Social Cohesion, Living Standards, Leisure Time,* and *Safety*.

Beyond the specifics, it is evident that communities differ in how they rank and prioritize the domains of human well-being and these differences are predictable based on community type. This indicates the value of community delineations for informing the decision process. However, it also indicates that measures of success can only be partially generalized and the very definition of human well-being may differ among community types. Such differences must be kept in mind when comparing the objective well-being across communities, particularly along the urban to rural gradient. Therefore, use of this technique in the future should focus on improving the understanding of how community type may inform differences in the importance of the domains of human well-being that can be used to both develop and assess decision options at the community level.

Overall, stakeholder priorities were more consistent across communities than across community types. For both analytical methods, community type was most informative about the relative importance of low scoring domains of HWBI such as *Connection to Nature* and *Cultural Fulfillment*. This is important information for scoring HWBI and will be used to explore relative weighting within HWBI, but the

dominance of *Living Standards*, *Safety*, *Education*, and *Social Cohesion* was consistent in both stakeholder engagement approaches and so seems robust to categorization. Community-specific deviations were more evident. However, community-level differences are to be expected and the overarching consistency of multiple domains across communities suggests important common themes that should be explored for their value in informing and measuring the success of community level decision support.

Alongside delineation of HWB and stakeholder priorities are measurable differences among communities in the production and availability of ecosystem goods and services (EGS) that support decision making (Smith et al. 2013). Ecosystem goods and services represent a community's ties to the local environment and as such contribute to economic stability, sense of place, and community identity (Smith et al. 2013). In Chapter 5, we examine how well two delineations of communities (i.e., CCS, state) inform about community priorities and therefore aid efforts to inform the local decision process.

The largest difference in EGS value between groups was for CCS with the exception of useable water, which differed more by U.S. state. Urban (CCS type 1) communities in both LA and FL had higher specific value for usable air and flood protection, while more rural (CCS type 3) communities were consistently lower in total area of both developed land and forest, and highest in wetlands, the latter which provide higher denitrification but the former provide more carbon burial and water retention during flood events. These differences suggest tradeoffs exist between EGS categories in terms of benefits to humans. In the abstract it seems plausible that flood protection, high denitrification, and high carbon burial could co-exist at the spatial scale of this analysis (10-100 km), but in practice different land cover types contributed to each and that land cover types were both distributed differently and affected differently by human development linked to changes in impervious surface and canopy cover. Carbon burial, which contributes to a more stable climate, and flood protection are clearly affected by development and the level of urbanization in a community. Denitrification, which contributes to clean water, differed more by state than CCS group indicating a lower impact from development but a stronger regional influence. These realized tradeoffs are important in that they can help clarify differences in the impacts of development likely to affect decision outcomes. These trade-offs also support the conclusion that local priorities for sustainability may differ based on the existing high value services they need to sustain and/or improve and thus CCS groups can help inform the prioritization process. This conclusion is tied to the notion that spatial demand for ecosystem services is the reciprocal of spatial supply.

An important overarching question for this report is how the USEPA and its partners should make use of CCS and HWBI as a part of a national strategy for local decision support. Community-based decision support is a national scale issue in that the collective impacts of multiple local decisions can have large and pervasive results on resource sustainability particularly in coastal areas. Central to the question of national- or regional-scale community decision support is the balance between treating all communities the same or focusing on the unique issues of each individual community. Treating all communities the same in the design of metrics and tools is risky because it allows for avoidable variability in community characteristics to bias the evaluation of metrics and tools, and the resulting tools may be viewed as 'externally driven', which limits the acceptability of the support by community stakeholders. In contrast, treating each community as totally unique is inefficient and ignores potentially valuable commonalities. A key focus of this work has been to consider how this balance should be struck in practice, and the outcome is that a CCS can be a valuable way to approach the issue. The CCS examined in this report shows promise as a generalizing tool for decision support and more importantly linking it to HWBI allows for structured local input 'what matters', so that the approach is transferable and adaptable as needed. Yet, well-being is a moving target and measuring human benefit is tied to tradeoffs in access to

natural resources and most importantly changes across the rural to urban gradient. Therefore, a balance is proposed between subjective and objective criteria in measuring well-being sustainability at the local level that may be best achieved through use of the weighted HWBI examined in Chapter 3. Exploration of methods for effectively applying HWBI/CCS at the community level is an important research question. The collective outcome of this report strongly supports exploration of a balanced approach for local decision support that begins with identification of community type and the calculation of weighted HWBI. Community-level decision support is a national scale issue and should be approached with a coherent national strategy by seeking common tools to inform similar decisions across multiple communities. Doing so will maximize the impact of EPA-led efforts and can result in a more effective and accepted measure of community sustainability.

1 Introduction

Photo courtesy of USEPA

The Sustainable and Healthy Communities (SHC) national research program is intended to support sustainable decision making at the community level. The goal of this SHC study was to provide scientifically sound and user-friendly guidance on the sustainability of current and proposed community actions to stakeholder groups, including planners, decision makers, and the general public. Decision support at the community level can have far-reaching implications for environmental quality and human health and well-being. At the local level, community decision making impacts important issues like changes in land use-land cover, which in turn affects air and water quality (Abdul-Aziz and Al-Amin 2016, Fruet et al. 2016). More importantly, at the regional- and national-scale decisions made by multiple communities can have cumulative effects that are more far-reaching than the boundaries of the communities that make them (Tanaka et al. 2016). Community-based decision support is a national issue that requires common ground for advising all communities about the implications of their actions. Yet, all communities have important differences in composition, priorities, and issues that create challenges for forging a coherent national strategy for decision support. Simply "recreating the wheel" in each community is costly and inefficient, and it is the goal in this report to explore the similarities among communities in key areas to produce a roadmap for comparability useful for informing local decision support in environmental planning and protection.

In making comparisons it is important to have a clear understanding of what defines a community and what communities mean by sustainability. Both terms have been widely used and are not consistently or easily defined (Portney 2013). For the purposes of this report, a community is defined as any area under the authority of municipal decision making. This definition is focused on the spatial scope of the decision maker rather than that of the effects of the decision, which may be much broader (e.g., watershed). This choice of scope is purposeful and is tied to the definition of sustainability. Sustainability is broadly defined as the ability of a community to meet present needs without compromising the ability of society and the environment to meet the economic, social, and environmental needs of future generations, but here we focus on actions that support the long-term provision of human well-being. Human well-being will be more formally defined in a later chapter but generally represents the collective benefit to community stakeholders from social, economic, and environmental capital. In other words, a sustainable outcome of community decision making is one that conserves or restores capital services to community stakeholders.

Community sustainability defined in this way is highly dependent on community characteristics and the definition of services provided by available social, economic, and environmental capital. Communities differ in both their available resources and how they value the services they receive from those resources. For instance, coastal communities may value aesthetics very highly, particularly if they are economically dependent on seasonal residency or coastal-based tourism, yet other coastal communities

focused more on fishery exploitation may value water access as an economic resource over the aesthetic qualities of the shoreline. Thinking more broadly, the strength and type of community dependence on natural capital may be the defining feature allowing for meaningful comparisons of what is meant by sustainability. The critical element is a collective measure of human well-being that accounts for these differences, but in a consistent way that allows for the examination of common ground among communities. Such a collective measure that can suitably account for differences in how stakeholders value available services represents a measure of how an action might contribute to human well-being and ultimately a collective measure of sustainability.

The importance of links between of local decision making and sustainability has long been recognized in seminal documents, including the 1987 Brundtland Commission report; the "Agenda 21" resolution passed during the 1992 Earth Summit; and U.S. environmental policy documents, including EPA's 1999 Framework for Community-Based Environmental Protection (Portney 2001). Interest in establishing local sustainability programs began to take root in the U.S. in the late 1980s and early 1990s in communities like Jacksonville, Florida; Seattle, Washington; and Boston, Massachusetts (Portney 2014). Of more than 2,000 local governments in the U.S. that responded to a 2010 International City/County Management Association (ICMA) survey, 15.6% had a budget specifically for sustainability efforts and 26.8% had devoted staff to a sustainability efforts (ICMA 2010). Subsequent analyses of the ICMA data found that larger municipalities were more likely to have sustainability programs than smaller municipalities (Nye and Mulvaney 2016, Portney 2014).

Cross-sectional studies of local sustainability programs find that most communities consider the "three pillars" of sustainability (i.e., environment, economy, and social) in strategic planning, as well as the intersections among the pillars (i.e., livability, viability, equity, and sustainability) (Portney 2014, Tanguay et al. 2009). A common focus of community sustainability programs is the environment, though there is a wide range in the way that environmental sustainability is defined across local programs. Programs emphasize environmental outcomes that the community can directly influence (e.g., land use), issues that are beyond a community's control (e.g., regional air quality), or issues across this continuum. Programs also differ with respect to their focus on issues with direct local impact (e.g., wastewater management) to issues with global implications (e.g., greenhouse gas emissions).

A key component of more advanced local sustainability efforts is the development of "sustainability indicators" that define the focus of the program and provide a way to measure progress. The EPA defines sustainability indicators as "a measurable aspect of environmental, economic, or social systems that is useful for monitoring changes in system characteristics relevant to the continuation of human and environmental wellbeing" (Fiksel et al. 2013). In an analysis of 17 studies of local sustainability indicators programs in the U.S., Canada, and Europe, Tanguay et al. (2009) compiled 188 uniquely defined indicators in use by local governments. The study found the greatest consistency among communities in the economic indicators used (e.g., employment status and income). The study found great variation in how communities measure environmental and social sustainability. Portney (2014) found similar patterns in a study of a national cross-section of local indicator projects.

Sustainability indicators used by local communities often serve multiple purposes and are communicated in different ways. Sustainability indicators are used to identify and diagnose issues, raise awareness, build grassroots support, influence local decision making, measure and communicate progress, and manage sustainability efforts (Lubell et al. 2009, Portney 2014). Local sustainability programs may include development of indicators, regular progress reporting based on indicators, and integration of indicators into program evaluation through development of actionable targets (Portney 2001, Portney 2014). Progress reports can include a consistent set of indicators or can change focus over time. The Community Indicators Consortium (CIC) maintains extensive examples of community sustainability

indicators projects, progress reports, tools, and other resources (Community Indicators Consortium 2015). What is needed is synthesis and a consideration of how broadly suites of indicators can be applied to the measuring success across community types.

This report focuses on four key areas for comparison of communities: community composition, stakeholder priorities, availability and quality of ecological resources, and measures of human well-being. First, the make-up of communities based on socio-demographic, economic, and ecological composition are examined. This is an objective description of both resource availability and dependencies in a community, and combines characteristics of both people and place into one classification. Second, the community priorities as reported by the stakeholders are considered. This comparison explores commonalities in the decision context and fundamental objectives of community stakeholders as the starting place for decisions. Third, a geographic information system (GIS) mapping approach is used to consider similarities and differences in the availability of important index ecosystem goods and services (EGS). This element directly compares across communities the type and amount of benefit humans are receiving from their environment at the local scale. Finally, similarities are explored in a measure of human well-being as an estimate of the impact of environmental decisions on overall quality of life. Combined, these four elements of comparison represent the major components of decision support from factors driving decision priorities, probable pathways for environmental impacts of decisions, and finally to probable impacts on beneficiaries. This analysis will consider each of these four elements in turn, and then synthesize the outcome into recommendations for use of community similarities in a national strategy for community-based decision support.

The analysis is also split into two parts based on the specific community focus. The first part is a general examination of all coastal communities in the contiguous United States and includes the examination of community classification and the HWBI. The second part is focused specifically on a set of four index communities selected based on the classification system. A comparison of data from these index communities will include stakeholder priorities and availability of EGS resources.

The objective of this comparison is to find common ground among local communities in the four elements that may be informative regarding decision support. For the purposes of this analysis, a community is defined as a municipality, however the influence on municipal level decisions may extend as far out as the county level, so the data used in this analysis is confined between municipal and county level with the specific data scale defined in each chapter. All of the data used in this analysis are applied at county level or lower. The comparisons in this report are intended to demonstrate the value of national-scale community comparisons for working on local-scale decision support. This report highlights both data and approaches for this purpose in order to better support EPA goals.

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2 Community classification system

The Sustainable and Healthy Communities (SHC) research program is intended to support sustainable decision making at the community level. The SHC program defines communities as those people that reside within the jurisdiction of one or more local governments or tribal nations; and stakeholders include community decision makers and other groups that share interest in SHC research. Sustainability is defined as the ability of a community to meet present needs without compromising the ability of society and the environment to meet the economic, social, and environmental needs of future generations. Need is defined, both present and future, as delivery of ecosystem goods and services (EGS). The term decision is used here generally to consider all actions that may be taken by a community that may affect the sustainability of EGS delivery. Decision support tools or approaches encompass all of these elements and provide a link between available resources and community objectives. Such tools, based on a common set of definitions are valuable for comparing results across communities and community types.

Once decision tools or approaches have been developed and validated within multiple communities, the question of their transferability and generality becomes an important element of tool utility. All communities are different, but they may possess common elements that are informative regarding both how a decision tool may be used and how effective a tool developed in a different community may be in this novel application. A clear objective of transferability in decision support is to develop methods for delineation of coastal communities that are informative regarding similarities and differences in links between available EGS, community priorities, and the sustainability of community decisions. An analytical community-classification system (CCS) is intended to delineate communities according to their environmental, social, and economic composition (Harris 2010, Nye and Weden et al. 2011, Mulvaney 2016). This CCS is a critical element for assessment of transferability and supports research in proceeding chapters of this report through the facilitation of cross-community comparisons. In this chapter we describe a CCS based on three distinct sets of data, which will be the basis for comparisons among communities in all subsequent chapters.

2.1 Methods

2.1.1 Input data

The CCS was constructed from three sources of data intended to describe a community with respect to three pillars of sustainability (social, economic, and environmental). While the CCS is not intended to describe the sustainability of a community, it is intended to delineate communities with respect to their priorities and available resources, and the CCS will be more informative if that description is well linked to sustainability measures. The three data types are: social/demographic composition; employment location quotient; and ecoregion.

The chosen measure of community social/demographic composition was the Tapestry dataset (ESRI Corporation; accessed 27 April 2012) that is a multivariate analysis of census data at the zip code+4 level (e.g., street level; United States Postal Service; accessed 15 September 2016). Data included in this measure include population size and density, median income, education level, age distribution, and median home values. The raw data were transformed into summary groups with a principle components analysis to summarize the variability into a suite of 12 orthogonal variables labeled ‘dataset’ (ESRI Corporation; accessed 27 April 2012). The Tapestry data were then summarized at the county level as

the proportion of each of the 12 Lifemode categories represented in a county. Qualitative descriptions of the 12 tapestry categories are available from ESRI along with the dataset and are summarized in the Results.

The employment Location Quotient (LQ) is a measure of proportion of local employment within North American Industry Classification System (NAICS) sectors compared to the national average. The LQ is available from the Bureau of Labor Statistics (Bureau of Labor Statistics; accessed 10 October 2012) by economic quarter at the county level. For the purposes of this analysis the employment data were apportioned into three categories based on NAICS supersectors. The first category was labeled 'Local Dependence' and was comprised of employment data for forestry, fishing, agriculture, mining, oil and gas extraction, and tourism (NAICS 11, 21, 713, and 721). Locally-dependent tourism employment was separated from more general hospitality sectors jobs and included in the Local Dependence category, but this was incomplete as some NAICS sectors that could not be clearly separated were excluded (e.g., NAICS 72 'Accommodation and food service' can be subdivided between tourism and non-tourism components, but NAICS 48 'Transportation' cannot). The second category was labeled 'Throughput' and represented all manufacturing (NAICS 31-33) jobs held by residents of the county. Manufacturing is meant here to summarize employment that is only partially locally based (e.g., factory infrastructure) but is also dependent on raw materials obtained outside the community and could be relocated and/or replaced with another equivalent employer. The third LQ category is labeled 'Service' (NAICS 51-56, 61-62, 81) and is comprised of service sector employment not associated with tourism or the public sector. The LQ data are comprised of three dimensionless ratio values (> 0; Local, Throughput, and Service) and an LQ value > 1.5 is considered a deviation from the national average (Riddington Gibson and Anderson 2006).

The final data category, 'Ecoregion', represents the environmental resources available to a community. This is not an inventory, but an index based on a suite of environmental variables including topography, geologic composition, and climate (U.S. Geological Survey 2012). Ecoregion data are organized into a set of 85 categories that describe the conterminous United States and CCS input data are the proportion of each county comprised of each category. Overall, 70 variables were used in the CCS (Social/Demographic – 12, Employment – 3, Ecological region – 55).

The target scope of this analysis is coastal communities and is intended to be comparative and examine features of coastal communities that are distinctive and relevant to community decisions involving ecosystem services (Weden et al. 2011, Mikelbank 2004). This analysis is also constrained by current availability of data. For these reasons the scope of the analysis is all coastal counties in the conterminous United States. The scale of this analysis is the county level. This choice is partially driven by data constraints as all information needed is available at the county level. That said, the county scale is a useful upper limit for defining community boundaries. Many decisions at the community level are made by county commissions (e.g., millage rates), making the county a partner in many cases. In addition, state level dynamics are a summation of all counties within the state, so the county level of analysis can be viewed as modular for shifting to coarser scales of analysis. The definition used here for a coastal county is that used by NOAA (NOAA's List of Coastal Counties for the Bureau of the Census; accessed 14 September 2016) and includes 662 counties nationwide and 158 in the GOM region (Figure 2.1).

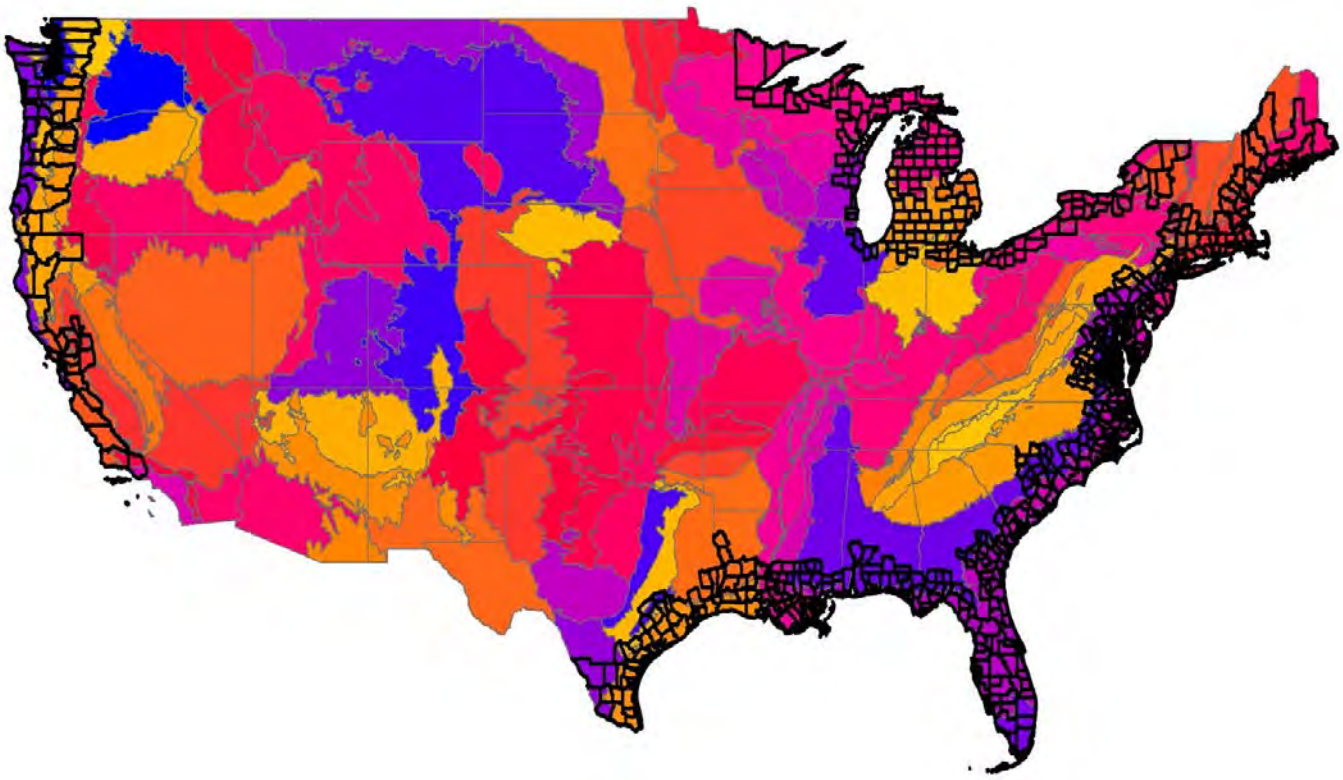

Figure 2.1 Map indicating the counties in the conterminous United States defined as coastal counties for this analysis (black outline). The definition is from the NOAA classification of coastal counties. Variation on base map is Ecoregion data used in the community classification system.

2.1.2 Data analysis

The data were analyzed for a parameter reduction and delineation of county-level data into groups based on multivariate patterns. The data from the three elements of the CCS were tabulated by coastal county and initially analyzed with a Bayesian model-based cluster analysis to identify the most likely cluster pattern in the dataset. The data were then analyzed with a hierarchical agglomerative cluster analysis of Euclidean distance. The number of groups for the hierarchical analysis was derived from the Bayesian outcome. Based on this analysis, all coastal counties were assigned to a group. A comparative analysis of variable mean (sd) values by the group was conducted to establish general differences between the characteristics of the groups and a mapping exercise was conducted to examine spatial distribution of coastal counties by group. All data analysis was conducted in R with the *pvclust* package (R Network; accessed 14 September 2016).

2.2 Results

2.2.1 Cluster analysis

Bayesian model analysis indicated that the optimal grouping number for all coastal counties was eight. Examination of the separation of groups indicates both strong (e.g., Groups 5 & 6) and weak (e.g., Groups 2 & 8) groups as measured by statistical distance (Figure 2.3) but clear separation. Examination of the group loadings across the eight principal components indicated a nearly balanced influence for all eight which supports the validity of eight cluster groups for the analysis (Figure 2.2).

	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8
SS LOADINGS	3.213	2.495	2.412	2.175	2.105	1.956	1.774	1.590
PROPORTION VARIABLES	0.058	0.045	0.044	0.040	0.038	0.03	0.036	0.029
CUMULATIVE VARIABLES	0.058	0.104	0.148	0.187	0.225	0.261	0.293	0.322

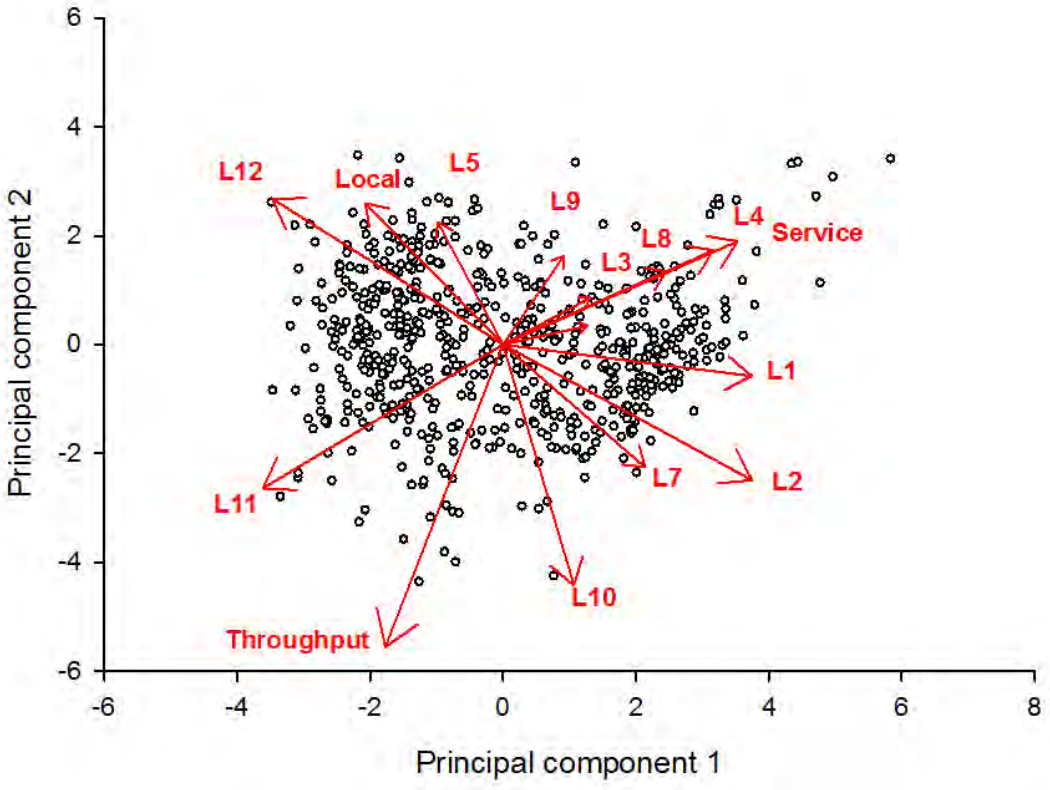

Figure 2.2 Scree plot indicating the distribution of 663 coastal counties with respect to the first two principal components. Red arrows indicate association and strength of variables for each principal component. The Lifemode variables are indicated by L1 through L12, the LQ variables are labeled Local, Throughput, and Service, and the Ecoregion variables are included in the analysis but not shown here for clarity. The inset table displays the loadings for all eight of the principal components along with the proportion of variance explained by each one. Lifemode labels are: High society (L1), Upscale avenues (L2), Metropolis (L3), Solo acts (L4), Senior styles (L5), Scholars and patriots (L6), High hopes (L7), Global roots (L8), Family portrait (L9), Traditional living (L10), Factories and farms (L11), and American quilt (L12). Lifemode descriptions can be found in the Tapestry segmentation reference guide (G53769; ESRI; accessed 19 September 2016).

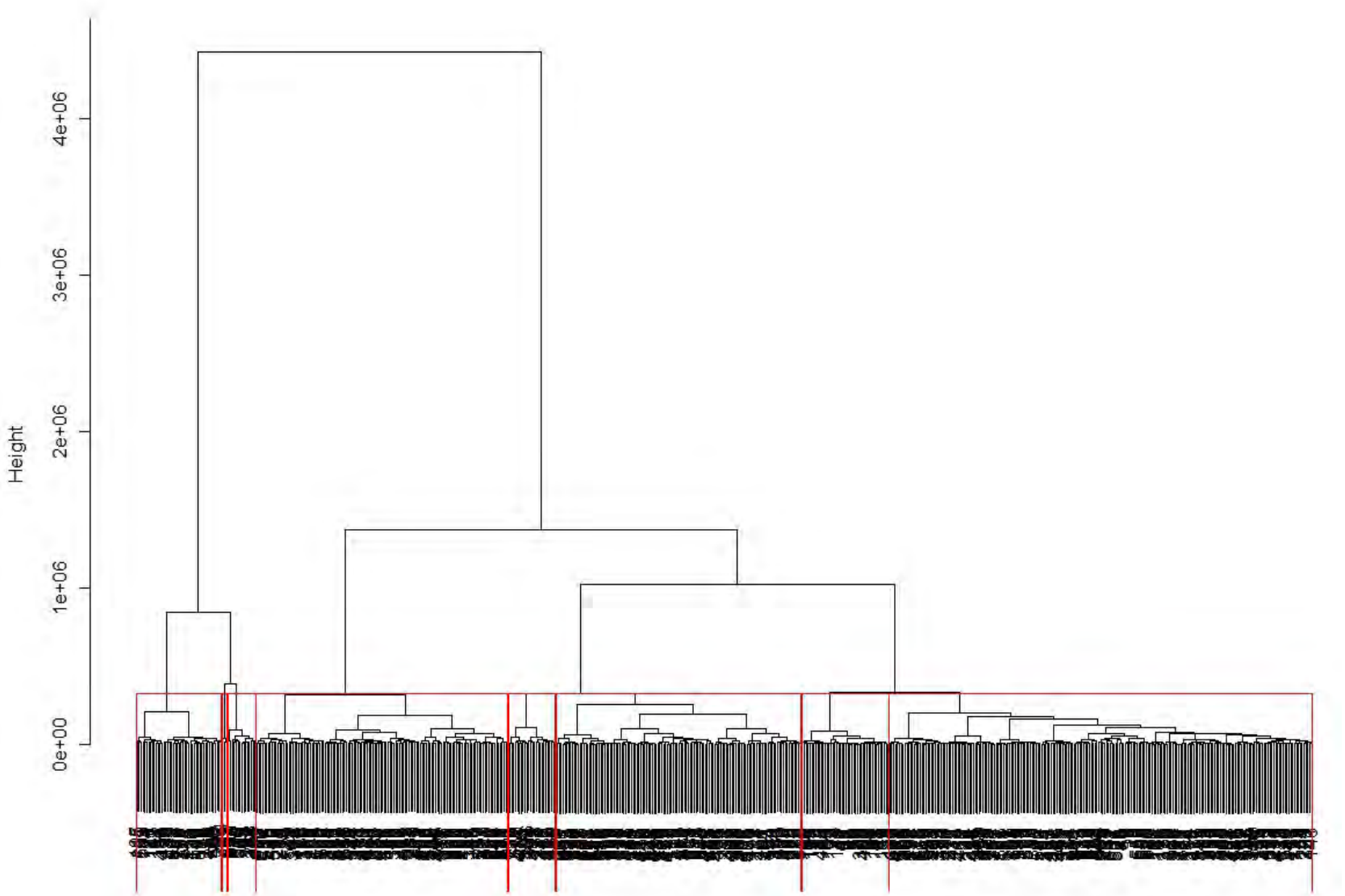

Figure 2.3 Tree plot indicating the eight cluster groups delineated for this analysis (cut point indicated in red). The y-axis is Euclidean distance. Group numbers (as reference in text) are shown below each group as they are not in order.

The relationship between social and economic variables was particularly evident in the analysis. Examination of the scree plot indicated the three economic dependence measures (Throughput, Local, and Service) were nearly orthogonal to each other. High local importance of service-based jobs loaded heavily with the urban, affluent, and ethnically-diverse Lifemodes. High dependence on local resources loaded closely with rural and young family Lifemodes, and while Throughput loaded well with rural communities as well, this economic variable was more closely associated with high median age and a salaried workforce (Figure 2.2). No clear trend was evident for environmental data with respect to the other two data elements as the Ecoregion variables were equally distributed across all principal components (Figure 2.2). There were both economic and demographic trends among the groups, but environmental variables were generally well balanced reducing their influence on group membership. The number and distribution of counties by group differed widely among groups (Table 2.1). In particular, Group 4 includes only three counties and Group 7 is almost completely within the state of Florida. Social variables such as population size and median home value showed a clear trend among groups with Groups 1 and 3 including all of the counties with a population density over 5,000 mi^{-2} (Figure 2.4a). The remaining groups displayed minimal variability with respect to population size indicating the most urban areas are all in Groups 1 and 3. The Economic variables also showed group bias with Group 4 having the highest value for Local Dependence (21.4) followed by Groups 6 (11.5) and 5 (6.8). All other groups had LQ values near or below the 1.5 threshold. The Throughput LQ score only exceeded 1.5 for Groups 8 (3.6) and 2 (1.8), and no group had a Service LQ score greater than 1.2 (Figure 2.4b; Table 2.1). Environmental variables were very balanced and not very influential on group membership with the exception of Group 7, which is heavily weighted towards Ecoregions in central Florida and the south Atlantic coast (Table 2.1; Figure 2.5). There was however, an evident geographic distribution of groups with Group 1 dominant in the northeast, Group 2 in the Midwest including the Great Lakes region, and Group 3 in Texas and California.

Photo courtesy of USEPA

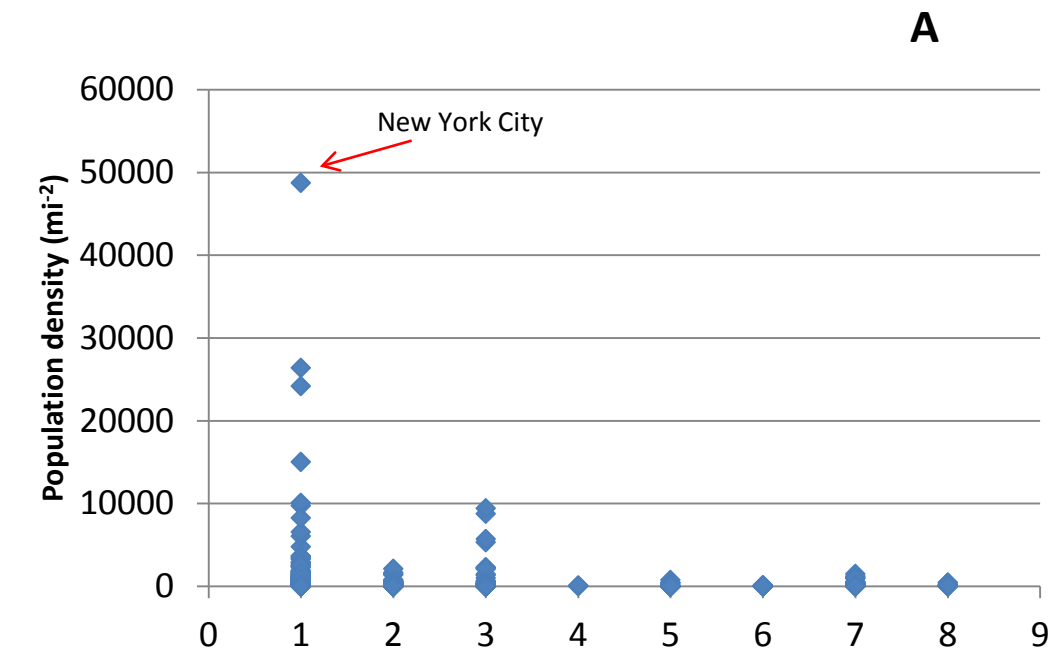

Figure 2.4a Summary plots showing the distribution of mean population density (mi^{-2}) for coastal counties by Group (A). Outlier County labeled for clarity.

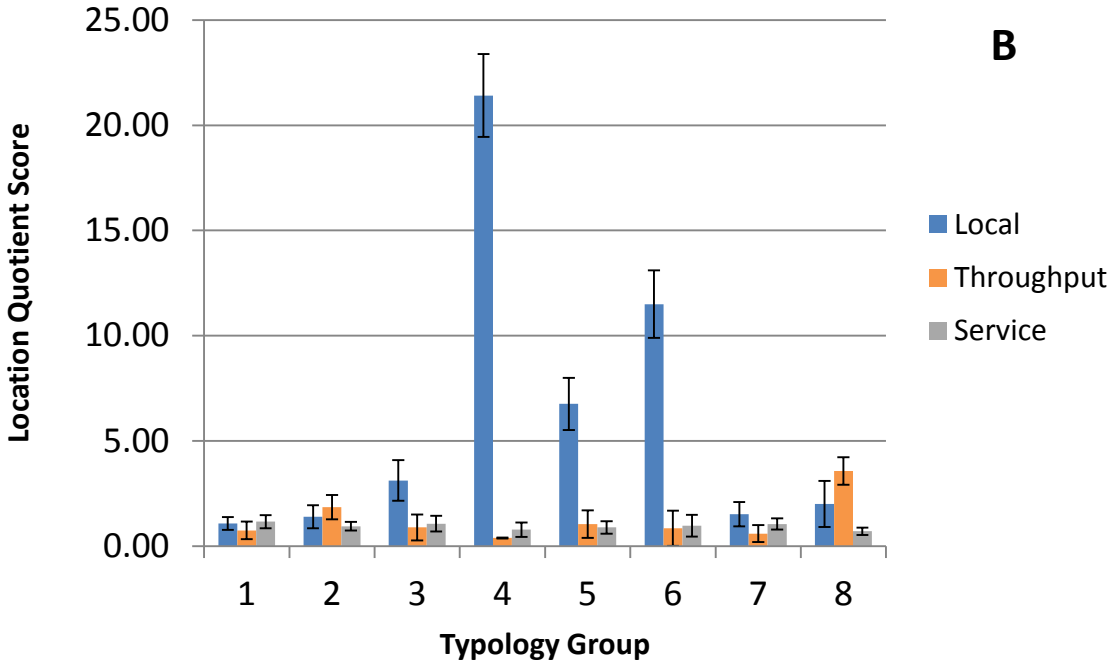

Figure 2.4b Summary plots showing the mean (SD) LQ scores for all three categories by Group (B).

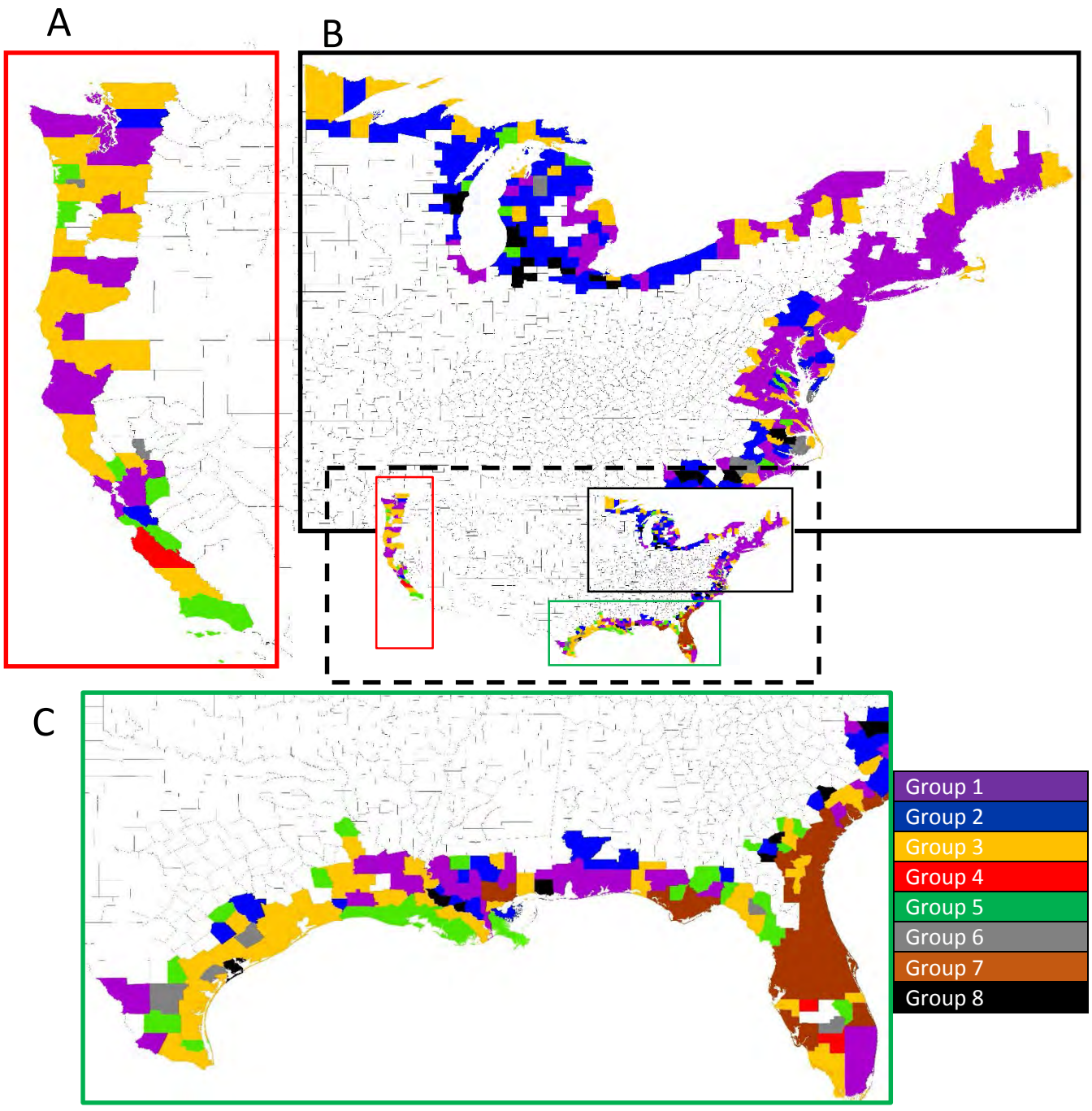

Figure 2.5 Map of coastal counties with group membership indicated by color. Legend gives group number and a qualitative description by group number is available in Table 2.1.

Table 2.1 Summary of community classification system data and results by group including a qualitative description of each group based on the data (Description), number of counties included in each group (n), states with counties in each group (flagged if only one county), highest and lowest Lifemode (LM) category for each county by percentage, mean (SD) LQ scores for each county by employment category (Throughput, Local Dependence, and Service), and the maximum percentage among the 85 Ecoregion categories indicating the evenness of coverage across the eight groups. The LQ scores in bold indicate values greater than 1.5 the national value**.**

GRP	Description	n	States	Highest LM (%)	Lowest LM (%)	Throughput	Local Dependence	Service	Ecoregion Maximum (%)
1	Largest populations and diverse in LM's	223	AL, CA, CT, DE, FL, IL, IN, LA, ME, MD, MA, MI, MS, NH, NJ, NY, NC, OH, OR, PA, SC, TX, VA, WA	High society	Working class, small comm.	0.8 (0.3)	1.1 (0.4)	1.2 (0.3)	13.6
2	Working class, rural, manufacturing, older	129	AL, CA, DE, GA, LA, MD, MI, MN, MS, NY, NC, OH, PA, SC, TX, VA, WA (1), WI	Middle age, middle income	Ethnic diversity	**1.9 (0.6)**	1.4 (0.6)	1.0 (0.2)	24.9
3	Suburban with high Local Dependence	133	AL (1), CA, DC, FL, GA, LA, ME, MD, MA, MI, MN, MS, NH, NJ, NY, NC, OH (1), OR, PA, SC, TX, VA, WA	n/a	n/a	0.9 (1.0)	**3.1 (0.6)**	1.1 (0.4)	13.7
4	Ethnic, young, max Local Dependence	3	CA (1), FL	Ethnic diversity	Young families	0.4 (2.0)	**21.4 (0.03)**	0.8 (0.4)	50.2
5	Working class, high local dep., younger families	45	CA, FL, GA, LA, MI, MS (1), NC, OR (1), TX, VA, WA (1), WI (1)	n/a	n/a	1.1 (1.2)	**6.8 (0.7)**	0.9 (0.3)	21.3
6	Most rural, lower income, young families, high Local Dependence	15	CA (1), FL, MI, NC, TX, VA(1), WA (1)	Young families	Urban singles	0.9 (1.6)	**11.5 (0.8)**	1.0 (0.5)	23.4
7	Senior, upscale suburban	46	FL, GA, LA (1), MS(1), SC (2)	Senior lifestyles	n/a	0.6 (0.6)	**1.5 (0.4)**	1.0 (0.3)	94.5
8	Working class, small town, manufacturing-local	25	GA, IN, LA, MI, MS (1), NC, OH, SC, TX(1), WI	Working class, small comm.	Senior lifestyles	**3.6 (1.1)**	**2.0 (0.7)**	0.7 (0.2)	21.7

2.2.2 Group description

Based on the analysis of key scores, groups were given a qualitative description to aid in interpretation of group membership (Table 2.1). Groups 1, 2, and 3 were the largest in terms of number of counties (Table 2.1). Groups 1 and 3 also contained the largest variability in population density (Figure 2.4a). Group 1 had the highest score for affluence and urbanization and lowest for rural community types. Group 3 was highest for suburban/small town categories and higher age groups including retirees. Both Groups 1 and 3 had LQ scores near 1.0 for Service and Throughput indicating they are well in line with the national averages. Group 3 had an LQ score of 3.1 for the Local Dependence category suggesting a higher dependence on natural resources in these counties. Group 2 scored high as working class, small town suggesting a lower mean income, lower median education, and a lower population density than Groups 1 and 3. The LQ scores for Group 2 were average for Local Dependence and Service, but higher (1.9) for Throughput suggesting the increased importance of manufacturing in the Group 2 counties. Only Groups 2 and 8 had Throughput LQ scores above 1.5 and Group 8 also included a high LQ score for Local Dependence and included fewer counties. Groups 3-6 all had a Local Dependence LQ score above 3.0 and showed an increasing trend in the Local Dependence LQ score suggesting a gradient for this characteristic across these groups (Table 2.1). Group 3 was the lowest of this set at 3.6, but increased in order for Groups 5, 6, and 4. Groups 5 and 6 displayed both high Local Dependence, as well as a high proportion of working class and rural characteristics. These two groups only differed by degrees of Local Dependence and 'ruralness' and were otherwise very similar. Group 4 had the highest level of Local Dependence and also the highest level of ethnic diversity reflecting the importance of immigration and farming in these counties. This was also the smallest group with only three counties. However, the LQ score for Local Dependence was greater than 21, indicating a substantially higher dependence on natural resources in these counties that accounts for the large 'distance' between Group 4 and other Groups (Figure 2.2). Finally, Group 7 was the most geographically distinct with most of the counties in central or eastern Florida (Figure 2.5). Group 7 counties were high in affluence, but also high in rural categories reflecting a lower mean population density and variability than observed in Group 1 (Figure 2.4a). Group 7 also included the highest mean score in percentage of senior residents and a higher median age in these counties. Group 7 counties also scored near the bottom in ethnic diversity and young families with children. The LQ scores were all ≤ 1.5 suggesting average employment patterns overall in Group 7.

2.3 Discussion

The CCS developed for this study delineates coastal counties well both by region of the country and within a region. The primary delineation is associated with population density in that highly-dense counties all fell into Group 1. As population density drops, the county type begins to become more specialized and as a result becomes easier to delineate. After population density, the next most informative level of delineation was primarily a function of employment LQ scores. The LQ scores indicate how specialized the local employment patterns are by comparison to the national average. Counties that display a high LQ score in one of the three LQ categories (Local, Throughput, and Service) are highly dependent on that category, at least for number of jobs. Counties with a low population density displayed an increasing trend in the Local Dependence LQ score suggesting a trend in dependence on local natural resources such as farming, fishing, mining, or oil and gas extraction. Tourism is also included in this LQ category, but its importance is hard to gauge as increased tourism employment is thought to go hand in hand with service sector jobs so should affect both Local Dependence and Service categories. As Local Dependence increases the most likely contributors are agriculture and fishing jobs. Local Dependence as much as 21 times the national average was observed within single counties, but most of these locally dependent counties were spread out with the largest

cluster in Louisiana and eastern Texas. In point of fact, Louisiana was the most diverse state with both high Local Dependence, high Throughput, and close to the full range of population densities.

Overall the demographic makeup of the counties was in line with the employment and population size patterns. More urban and suburban counties by population density were also more diverse in terms of ethnicity, affluence, and family composition. As communities became more dependent on certain employment sectors (higher LQ scores) and less dense they also became more demographically specialized suggesting a shift that comes along with higher Local Dependence. This finding has not been thoroughly evaluated but will be an important element of future study.

The effectiveness of the CCS for delineating coastal counties is constrained by the choice of variables to include. The intent of the variables included in the CCS was a link to both community priorities and available ecosystem services. The link to natural resources may be the weakest component of the CCS as Ecoregion was least important variable in the delineation at the county level as indicated by the loadings in the PCA. This may be because the Ecoregion variables differ more at larger scales and are not very important at the county level particularly along the coast (Figure 2.1). Inclusion of more 'non-coastal' counties may change this finding. The link to ecosystem goods and services is associated with a community's dependence on local resources and should influence a community's sense of importance for EGS. This has not been established and one major revision to the CCS will likely involve incorporation of a more informative measure of available natural resources, such as that described in Chapter 5. Another limitation of the current analysis is the use of data at the county scale in the CCS. Counties are typically diverse including both high and low density areas. As a result, the 'type' that best describes a county is an average and the result can be highly bifurcated in extreme cases between urban and rural areas (e.g., Palm Beach county contains both the richest and poorest people in Florida). This is the most likely cause of the negative trend between specialization and population density. However, the county scale is highly relevant to community decision making even for local municipalities. Analysis of specific communities will require a 'zooming in' of the data from the county scale, but this represents a viable mid-point between the scale of a communities decisions and the scale of their effects. Future work will also look critically at scale and whether the CCS should be applied across scales to better capture change.

The delineation based on the CCS is only partially consistent with the index of Human Well-Being (Smith et al. 2013). Overall, the mean HWBI score differed by only 5-6% across the CCS groups suggesting a weak trend at best. The variability in the HWBI nationwide is small however (< 10%), so small changes can reflect important differences in well-being. There was some pattern to the differences, small though they may be, suggesting that as Local Dependence increases the HWBI elements go down. Of the three HWBI elements, the environmental element showed the most variability across groups, but this was mainly the ranking of Groups 6 and 7, which were higher and lower respectively compared to the overall score and the other two element scores. The meaning of this change is unclear and represents an area for future study.

As the broader analysis of transferability of tools between communities moves forward, the next steps in the CCS analysis will include verification of county descriptions, as well as extended comparisons of this coastal CCS to other similar national-scale analyses and metrics. In the next chapter we will specifically examine how a measure of human well-being differs among CCS groups. Overall, the CCS is a useful tool for delineating coastal counties with respect to the three tiers of sustainability, particularly along an urban to rural gradient as indicated in Figure 2.4. The limitations of working at the county level need to be addressed and additional analysis needs to be expanded to include non-coastal

communities. The level of information contained in the CCS is currently undetermined, but it shows promise as a useful tool for the purpose of gauging the transferability of decision tools among coastal communities of similar type.

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3 Human well-being across community types

Human activity has growing impacts on the natural capital humans depend upon for existence (Condie et al. 2012, Pauly et al. 1998, Peterson et al. 2003). Many of these impacts are regional, national or international in scope such as air pollution (Likens et al. 1996) and climate change (Nelson et al. 2013, Piazza et al. 2010). Yet, there is an increasing understanding that decisions made at the local community level can have significant impacts and need to be understood both for their local impacts, as well as for their cumulative impacts across multiple communities (Israel et al. 1998, Tallis et al. 2008). Natural capital degradation because of human activity is more often being valued and measured in terms of its direct impact on human beneficiaries based on the production and supply of ecosystem goods and services (EGS) (Garcia-Llorente et al. 2011, Grabowski et al. 2012, O'Higgins et al. 2010). All communities have unique characteristics, but also have characteristics in common, such as beneficiaries (i.e., resource user groups), and can be classified into groups to aid in prioritizing conservation and utilization of natural capital. The community classification system (CCS) developed in this report (Chapter 2) is informative about a community's priorities, and the association of these priorities with human well-being provides a potentially valuable tool for measuring success in achieving local objectives and informing decision makers about sustainable decision outcomes in a community-specific context. This approach can aid decision makers in defining meaningful change in human benefit across different communities by establishing reference points and can provide a clear justification for investing in conservation, mitigation, and restoration of natural capital (Adeel and Safriel 2008, Pascual et al. 2012, Vaissiere et al. 2013).

Describing environmental degradation in terms of human endpoints also fosters discussion on tradeoffs and the concept of ecosystem sustainability. Loss of natural capital has differing values for different user groups; managers must rectify these conflicts in the context of other forms of capital (i.e., built, economic, and social) into a coherent plan that considers the synergistic outcome for all user groups (Butler et al. 2013, Green et al. 2014). Such a plan must also include measurable reference points to evaluate changes in capital as meaningful to beneficiaries. The most useful end point for this approach is the concept of ecosystem sustainability, which rather than focusing on each beneficiary individually, targets the maintenance of net benefits through time (Jorgenson et al. 2014). This is still an 'ecosystem-centric' approach; nonetheless it is dependent on understanding dependencies of human benefits to a broad range of EGS, as well as defining a clear and acceptable measure of overall sustainability (Abunge et al. 2013, Yang et al. 2013). Classifying communities in terms of their economic and social dependence on current delivery of EGS yields a potentially informative way of delineating communities for the purpose of establishing local reference points from which to measure change, if a community's type can be linked to differences in community sustainability.

Measuring sustainability requires knowing what stakeholders wish to sustain. Net delivery of EGS to humans provides a working model for sustainability but currently lacks a coherent framework. Numerous measures of sustainability exist (Krotscheck et al. 2000, Putzhuber and Hasenauer 2010), but most are single issue indicators, not necessarily tied to multiple human beneficiaries (e.g., Neset and Cordell 2012, Velasquez et al. 2011). Suites of indicators used to holistically measure human well-being (HWB) show promise as a synergistic measure of the outcome of net EGS production and delivery to humans (Smith et al. 2013b, Summers et al. 2012). Indices of HWB are a measure of benefit to humans, beyond just economic benefits, that are also more responsive to changes in EGS production (Canadian Index of Wellbeing 2012, Smith et al. 2013b). Indices of HWB include metrics of social cohesion, living

standards, personal safety, civic engagement, and connections to nature (Smith et al. 2013b and cites therein). Yet, HWB indicators are not an easily understood concept, and are not a direct measure of service delivery. The challenge in applying HWB measures at the community level is in linking such a broad indicator to community-specific issues and values. Different communities have different social, economic, and environmental dependencies, defined here as the three pillars of sustainability (NRC 2011), and communities require a demonstration of HWBI utility for measuring outcomes and a connection of HWB measures to local conditions. It is from these local index reference points that meaningful change in HWB can be measured. Commonalities do exist in the priorities and resources of communities and an examination of composite measures, such as a human well-being index (HWBI) (Smith et al. 2013a, Smith et al. 2013b, Smith et al. 2012) across community types, is an effective method to connect human well-being to community decision making.

In this chapter, the community classification system (CCS) is evaluated by combining it with the HWBI to find well-being references points. The objective is to ask whether the CCS is informative regarding HWBI reference points by examining whether HWBI-type indicator values differ by community type as a potential measure of sustainability. This comparison involves the 664 coastal counties described in Chapter 2. Additionally, the value of locally obtained data on community priorities is evaluated for the calculation of the HWBI by integrating data from the community workshops (described in Chapter 4). This more specific comparison will examine how local priorities may be used to alter the weight given to the different domains of the HWBI. The overall goal is to identify associations between local social/economic dependence on EGS and differences in human well-being that may suggest informative local reference points for decision making about EGS provisioning. The expectation is that community types will differ in their well-being and these differences will provide local well-being reference points informative for measuring changes in well-being. The outcome will be an understanding of how community classification based on EGS can be used to inform community decision making focused on sustaining or improving HWB.

3.1 Methods

3.1.1 Classifying communities

The community classification system used in this analysis is described in Chapter 2. It was constructed from three sources of data intended to describe a community with respect to three pillars of sustainability (social, economic, and environmental). While the CCS is not intended to describe the sustainability of a community, it is intended to delineate and describe communities with respect to their priorities, dependencies, and available natural resources.

3.1.2 Measuring human well-being

The Human Well-Being Index (HWBI) used in this study is a previously described U.S. index and is a composite of multiple indicators that characterize eight domains of human well-being: *Connection to Nature, Cultural Fulfillment, Health, Education, Leisure Time, Living Standards, Safety and Security*, and *Social Cohesion* as described by Smith et al. (2013b and 2012) and briefly summarized here. Each domain is described by indicators representing a combination of metric values. For each HWBI metric, objective and subjective data collected from various publically accessible sources were organized hierarchically by spatial and temporal resolution (e.g., national, regional, state, and county by year) for the years 2000-2010. When multiple spatial scales existed for a metric, the finest scale (e.g., county versus state) was selected for processing. Data source determination was primarily driven by temporal and spatial coverage, data reliability and credibility, historic data continuity, and future data accessibility. All data were standardized on a scale from 0.1 to 0.9 following the Organization for

Economic Co-operation and Development's (OECD) Better Life Index (OECD Better Life Index; accessed 14 September 2016) approach. A detailed description of the metrics used in the calculation of the HWBI can be found in the report entitled "Indicators and Methods for Constructing a U.S. Human Well-Being Index (HWBI) for Ecosystem Services Research" (Smith et al. 2012). The HWBI values were derived from indicator scores calculated as the population weighted average of the standardized metric values. Indicator scores were averaged to create each domain score. Finally, a scaled geometric mean was calculated across domain scores to produce the final inputs for the HWBI. Higher HWBI scores indicate greater levels of well-being. Methods have also been developed to incorporate community priorities into the index calculation by applying relative importance values (RIVs) as domain weighting factors (Smith et al. 2013a). The county-level HWBI values used in the analysis of all coastal counties were unweighted values.

3.1.3 Stakeholder-derived weightings for domains of human well-being index

Data were collected on stakeholder-derived weightings of the eight domains of the HWBI during a series of community workshops held in nine communities across the U.S. The workshops were designed to meet the following data quality objectives: validity, reliability, representativeness, and completeness. Critical to all of these objectives were efforts to ensure that a broad range of community voices were included in a meaningful way in the discussion of community values. The following subsections summarize the workshop design and implementation, as well as participation outcomes.

Overview of workshop design

The workshops were designed to produce reliable information about community priorities. The workshop design was developed based on the structured decision making approach (Gregory and Keeney 2002, Carriger et al. 2013), modified to account for the limited time available for each workshop. Part of each of the workshop was focused on exploring the relative importance of the eight domains of the HWBI using a series of structured discussions and exercises. A list of goals reflecting the domains of the HWBI (Smith et al. 2012) was used to frame these activities and enable comparison across workshops.

This structured approach was intentionally designed to introduce the participants to categories of community priorities in a stepwise fashion using non-technical language applied in a familiar context. Another critical element of the design of the workshop was the selection of participants to best represent the community. This affects the extent to which the HWBI data gathered in the workshops accurately represents the priorities of the community as a whole. The project team sought to maximize representativeness of workshop participants in the planning and implementation of the workshops.

Workshop implementation

Participants were provided with the list of domains used in the HWBI (Smith et al. 2013b) and were given time to review and ask clarifying questions about the domains. In small groups, participants were asked to map the qualities identified in the previous discussion to specific HWBI domains.

Using a multi-voting (dot voting) process, each participant was given the opportunity to identify the goals most important to him or her. Facilitators placed flip charts with the lists of goals on a wall in the room and participants were each given seven dots. Participants were asked to place their dots next to the goals that they felt were most important to the community. Participants were allowed to distribute the seven dots next to one or more goals, placing as many dots next to a goal as desired.

As a final exercise for the first part of the workshop, participants were asked to rank goal categories (e.g., *Health*, *Education*) based on their individual views of how important each category is to the well-being of members of the community. Participants were asked to use a scale from 1 (most important) to 8 (least important) with no ties.

The priority data collected during these workshops was used to consider changes to the RIVs used in calculation of the HWBI. A comparison of weighted and unweighted HWBI values in workshop communities was conducted based on data obtained during community workshops. These data were used to calculate RIVs for all eight domains and the HWBI was recalculated based on these RIVs for the nine counties in which a workshop was held. The recalculation of the HWBI was the weighted average of raw domain scores based on the workshop-based RIVs.

The unweighted HWBI was compared among CCS groups to examine patterns in well-being as a function of the community classification. The comparison was conducted for the overall HWBI and also separately for the eight domains of the HWBI. Patterns in the outcome were then examined with respect to CCS group characteristics. All statistical comparisons were conducted with a 1-way analysis of variance (ANOVA) with a type-I error rate of 5%. If the ANOVA results were significant, this test was followed by a Turkeys HSD multiple comparison to test for between group differences while preserving the experiment-wise type-I error rate (Zar 2010). The weighted HWBI was calculated from stakeholder engagement results for individual communities and these locally-weighted HWBI values were visually compared to the unweighted national HWBI.

3.2 Results

3.2.1 Human well-being and community type

Human well-being index values showed significant differences among CCS groups (ANOVA $F_{7,611}$= 6.6, $p < 0.001$). Post hoc comparisons indicated that the mean HWBI for Group 1 was significantly higher than Groups 4, 6, and 7 (Figure 3.1). Analysis of the eight domains of the HWBI (Figure 3.1) identified more specific differences between the CCS groups with respect to well-being elements. No significant difference was observed between classification groups for the *Connection to Nature* or *Cultural Fulfillment* domains. The remaining six domains indicated a significant difference at $\alpha = 0.05$ with five significant at the Bonferroni adjusted $\alpha = 0.0063$. For the *Health* domain, Groups 1, 2, and 3 were significantly higher than Groups 7 and 4 (Tukeys HSD, adjusted $p < 0.05$) and Groups 8 and 5 were also significantly higher than Group 4 (adjusted $p < 0.05$). Group 4 had the lowest score for *Health*. For the *Leisure Time* domain, Group 4 had the highest score and was significantly higher than Groups 6, 8, 2, and 5. Groups 7 and 1 also had a significantly higher *Leisure Time* score than Groups 6 and 8. Groups 5 and 2 were significantly higher than Group 6 for the *Leisure Time* domain. For the domain *Living Standards*, Group 1 had a significantly higher score than all other groups except Group 3. For the domain *Safety and Security*, Group 1 had a significantly higher score than both Groups 6 and 4. For the domain *Social Cohesion*, Group 6 had a significantly higher score than Groups 4, 7, 5, and 1 (Figure 3.1).

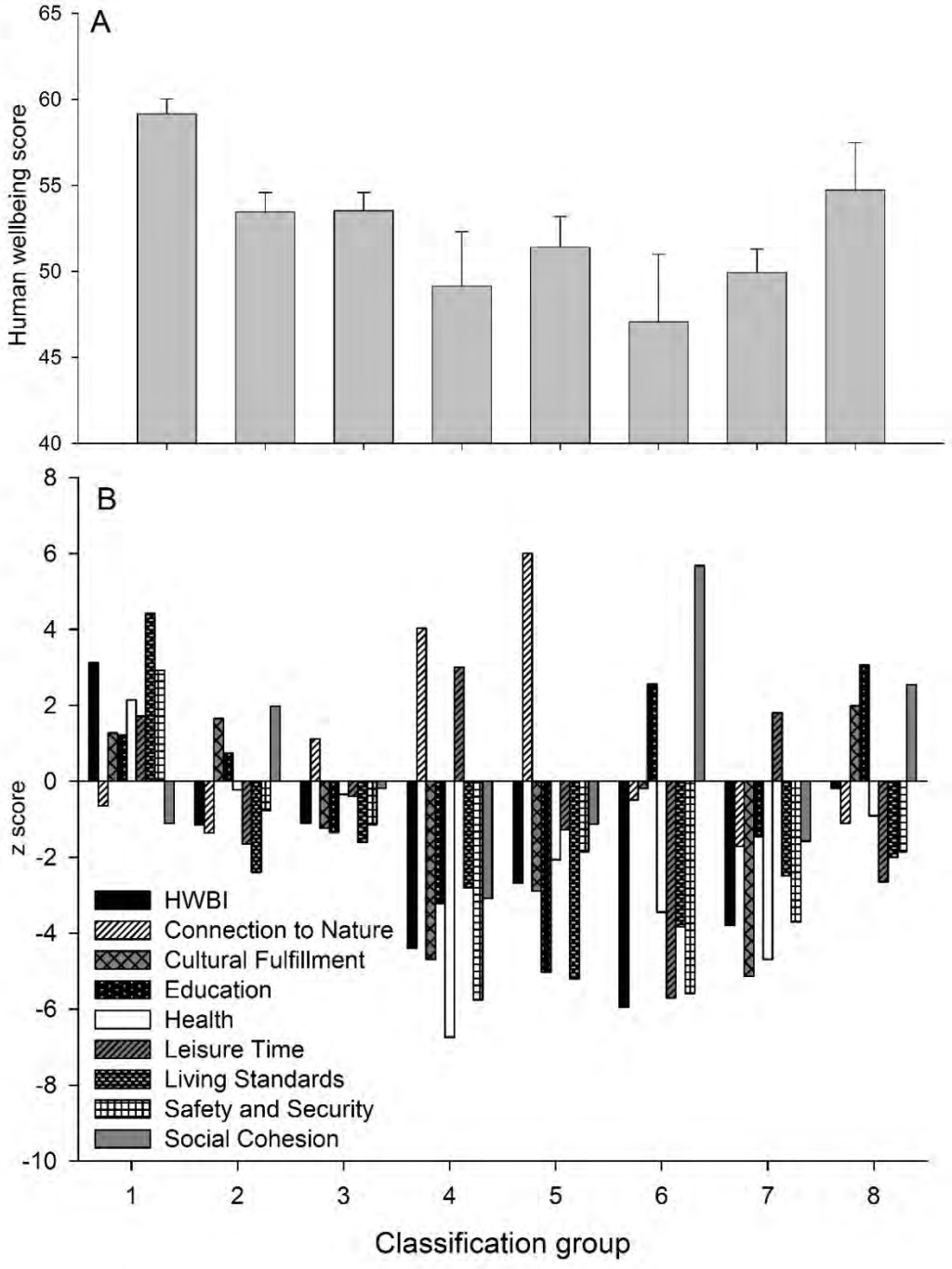

Figure 3.1 Summary of the human well-being index (HWBI) scores by community classification group. See Chapter 2 for details on the community classification system categories. Mean (sd) values are presented for the overall index (A) and z scores are presented separately for the eight domains of the HWBI (B), which describe deviation from the overall mean value.

3.2.2 Weighted vs. unweighted human well-being index

Weightings of HWBI domains based on stakeholder workshop data showed some clear trends across all communities (n= 9). The *Education*, *Health*, and *Social Cohesion* domains were consistently the top choices across all communities (Table 3.1). In contrast, *Connection to Nature* and *Cultural Fulfillment* were consistently the lowest ranked domains although Windsor Locks ranked *Connection to Nature* higher than the other eight communities.

The weighted HWBI score was higher in four of the nine communities examined (Table 3.2; Figure 3.2). The maximum increase occurred in Harrison County, IA (+3.2%), where the top two ranked domains (*Education* and *Health*) were also in the top three raw HWBI scores. In contrast, the weighted HWBI score had the largest drop compared to unweighted in St. Landry Parish, LA (-10%). In this community, over twice as much weight was placed on *Education* as on the other seven domains and *Education* had the lowest raw HWBI score. This disconnect resulted in a large drop in the overall weighted HWBI. Only one other community saw a change in the weighted HWBI of more than two percent (Forsyth County, NC; -2.2%) and again here the *Education* domain was ranked highly but had the lowest raw score.

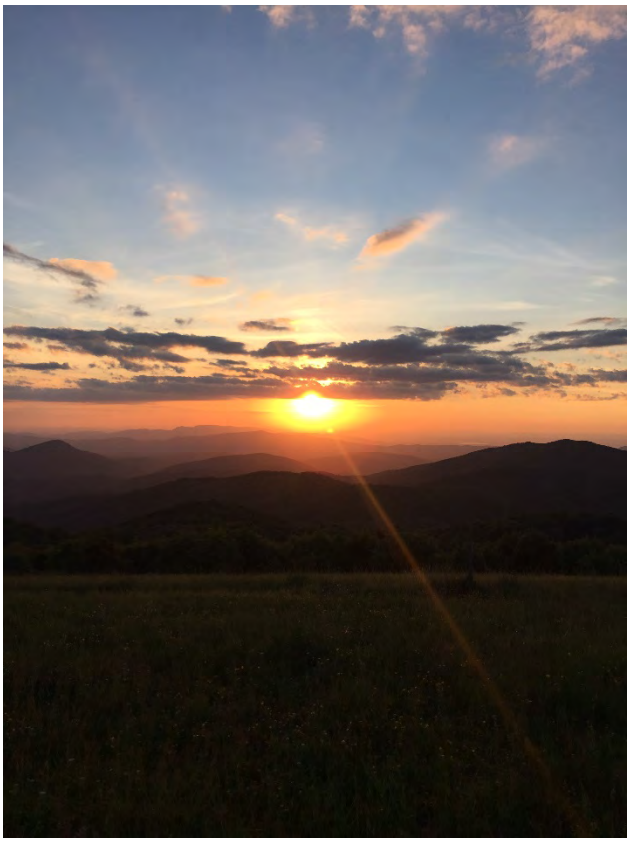

Photo courtesy of USEPA

Table 3.1 Relative frequency of goal categories receiving dot votes during workshop group voting exercise. Goal categories are identical to the domains of the human well-being index (HWBI).

HWBI Domain	Woodbine, IA	Pascagoula, MS	Lewisville, NC	Pensacola, FL	Vero Beach, FL	Freeport, NY	Windsor Locks, CT	Thibodaux, LA	Opelousas, LA
Education	24	5	14	24	16	26	14	22	17
Health	15	16	16	14	21	9	20	12	18
Work life balance	11	7	13	4	15	7	12	13	14
Living standards	15	11	11	21	13	15	5	14	15
Safety and security	10	12	16	13	8	17	8	14	12
Connection to nature	8	5	9	2	7	5	13	2	5
Cultural fulfillment	2	11	4	4	7	5	7	3	4
Social cohesion	16	21	19	19	14	16	18	21	14

Table 3.2 Summary of weighted (Wt) and unweighted (Uwt) scores for the human well-being index (HWBI). Labels in the first column are the eight domains of HWBI. See text for details.

Community	Pensacola Escambia Co FL		Vero Beach/Indian River FL		Thibodaux/ Lafourche Parish LA		Opelousas/ St. Landry Parish LA		Pascagoula/ Jackson Co. MS		Woodbine/ Harrison Co. IA		Lewisville/ Forsyth Co. NC		Freeport/ Nassau Co. NY		Windsor Locks/ Hartford Co, CT	
Domain	Wt	Uwt	Wt	Uwt	Wt	Uwt	Wt	Uwt	Wt	Uwt	Wt	Uwt	Wt	Uwt	Wt	Uwt	Wt	Uwt
Connection to nature	3.4	6.1	5.4	7.2	4.1	7.2	6.1	10.6	3.7	6.1	2.5	4.3	4.3	7.2	4.4	6.7	6.7	6.7
Cultural fulfillment	4.0	6.4	4.0	5.1	3.8	6.2	3.9	6.0	5.8	6.5	4.8	7.6	4.6	5.1	5.1	7.3	5.5	6.7
Education	8.7	5.8	4.8	4.7	6.6	4.2	8.5	3.6	7.0	6.3	13.9	7.5	4.8	4.3	7.3	5.5	4.9	5.3
Health	8.2	7.2	8.3	7.3	6.2	7.6	8.0	7.1	7.2	7.1	10.6	7.6	7.8	7.7	7.0	8.0	10.9	7.7
Leisure time	4.6	7.5	6.0	7.1	5.1	6.6	5.7	6.9	4.4	6.9	4.9	6.7	4.9	7.7	4.3	6.9	5.2	6.9
Living standards	6.3	6.2	6.8	6.6	7.0	6.6	5.0	6.0	8.0	6.3	5.6	6.5	7.7	6.1	7.5	7.5	4.7	6.8
Safety and security	7.5	6.2	9.6	7.2	10.3	7.4	4.5	5.7	8.8	7.0	8.7	8.4	8.7	6.9	14.5	9.5	9.4	8.0
Social cohesion	7.2	5.4	5.8	5.2	6.3	5.1	4.0	4.8	7.1	5.9	6.4	6.9	6.1	5.0	6.9	5.3	6.4	5.2
HWBI overall	49.8	50.7	50.7	50.4	49.4	51.0	45.7	50.7	52.0	52.0	57.4	55.6	48.9	50.0	56.9	56.7	53.6	53.3

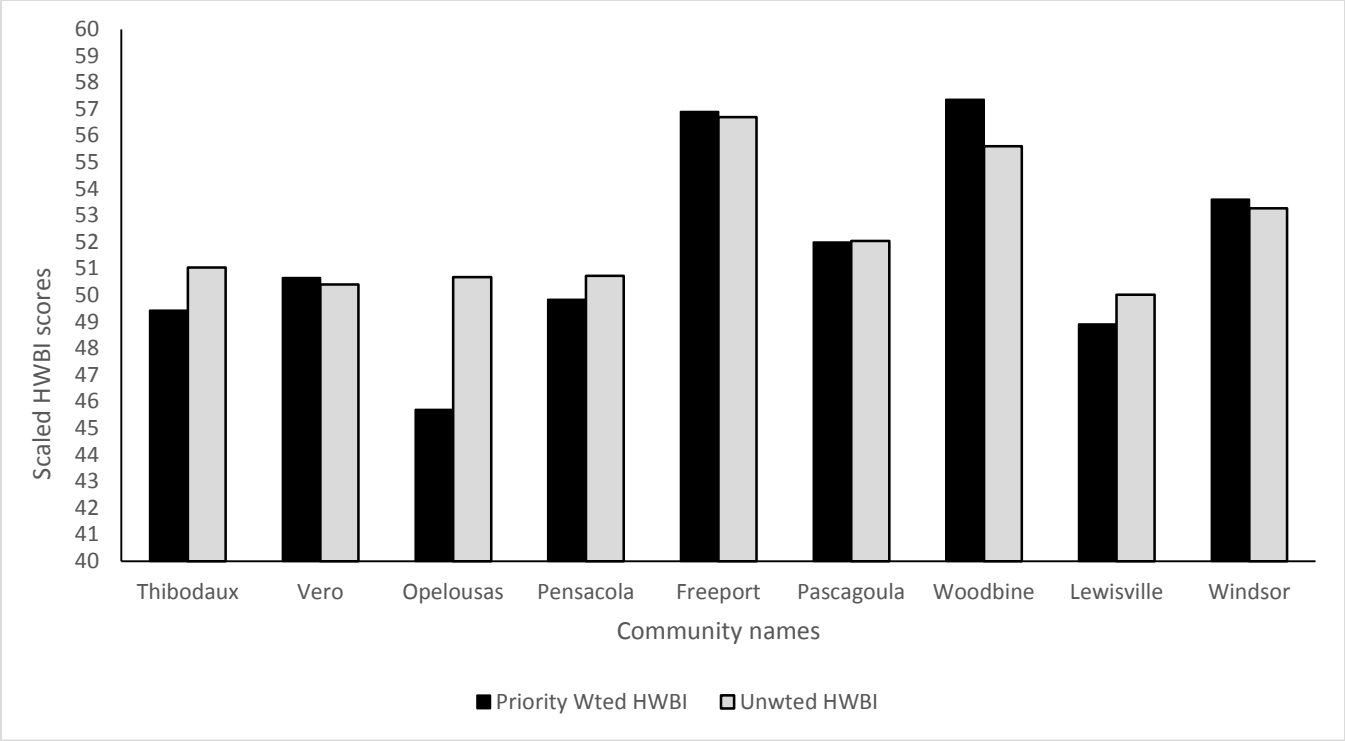

Figure 3.2 Comparison of mean weighted (wted) and unweighted (unwted) values of the human well-being index (HWBI) among the nine communities included in the study. Communities in the study are described in the text.

3.3 Discussion

Human well-being is a diverse topic that is increasingly utilized in assessing community sustainability (Jorgenson et al. 2014, Smith et al. 2013b), and is a viable alternative to monetary valuation for informing decision makers about the outcomes of their decisions in terms of worth to human beneficiaries (Tallis et al. 2008). However, it lacks a consistent definition and a clear reference point from which communities can measure change. Here the concept of HWB is linked to community type to inform the process of establishing reference values for HWB and also to better understand how a community's static features (e.g., composition and resources) impact HWB indicators. First, an index of community type is described and then one measure of HWB is examined as a function of community type.

The intended use of the HWBI is to evaluate the influence of social, economic and ecological service flows on human well-being and consequently how human well-being may change between communities and through time (Summers et al. 2012). Geographic differences in county-level HWBI values similar to the ones described here have been reported elsewhere (Smith et al. 2013b) and indicate these values may include important differences associated with different types of communities. Understanding these differences yields community-specific reference points for measuring meaningful change. High well-being scores were associated with high population density and with low dependence on local resources. The groups with the highest Local Dependence scores also had the lowest overall well-being score. In contrast, high economic dependence on manufacturing was not associated with lower overall well-being. The importance of population density may be an artifact of diversity as it has been reported elsewhere that population centers foster higher overall well-being because of access to resources (Smith et al. 2012). One surprising outcome was that this indicator of well-being did not associate well with community types high in individual affluence. The CCS group with the highest proportion of affluent

citizens was Group 1, which had a high well-being score, but the group with the next highest affluence score ranked near the bottom in well-being; and Group 8, with a well-being score nearly as high as Group 1, had the second lowest proportion of affluence. This is, of course, a cumulative measure of well-being that contains environmental, economic, and social indicators, and a cumulative measure should be most responsive to socio-economic diversity. This is an interesting pattern in the HWBI across community type, and separation of the cumulative score into its requisite categories may be informative about how available resources are associated with well-being, particularly for the smaller more homogenous CCS groups.

The overall HWBI score for a county can be separated into eight domains (Table 3.1) all of which produce separate scores that are combined into the composite score. Of the eight, five were meaningfully different among CCS groups with the most important separations between the high population density Group 1 and the rural, high Local Dependence Groups (4 and 6). The ranking of community types differed by well-being domain. The most urban group had the highest score for all elements of well-being except *Leisure Time*, *Connection to Nature*, and *Social Cohesion*. These three were all positively associated with decreases in population density and increases in resource dependence. The local resource dependent groups were split for the domain *Leisure Time* with the higher LQ Group 4 having the highest score for this domain and Group 6 the lowest. Group 4 is really a sub-group of 6 with the key differences associated with ethnic diversity and there may be a cultural factor in this separation, however this is not testable here. *Leisure Time* scores were above average for the high population density Group 1 and the high median age Group 7. This pattern is consistent with expectations and supports the association of more *Leisure Time* in areas with a high proportion of affluence, but the *Leisure Time* score was still higher in the more rural, resource dependent counties. The domains for *Living Standards* and *Safety and Security* were both heavily weighted to population density and diversity with clear separation between the urban group and the rest of the CCS groups. Nonetheless, the *Safety and Security* domain was another clear delineation of Group 1 between the rural, high Local Dependence groups. *Safety and Security* was significantly lower in Groups 4 and 6, suggesting an association of social vulnerability with rural resource dependent communities. This seems counterintuitive on the surface as low *Safety and Security* is often associated with urban environments (Gilbert 1999), but this domain is described by number of accidents, impacts of hazardous weather, and social vulnerability in combination with crime rates per 100,000 people. The results suggest the impact of the non-crime categories on *Safety and Security* cannot be dismissed with respect to well-being. *Social Cohesion* was expected to be highest in rural, specialized communities, and Group 6 had a significantly higher score for *Social Cohesion* than the denser and less locally dependent CCS groups. *Social Cohesion* was also high in the other two rural Groups (2 and 8) and low in high density Group 1. However, the smaller Group 4 had the lowest score for *Social Cohesion* of all CCS groups. Again this may be related to the combination of high local resource dependence and higher than average ethnic diversity. *Social Cohesion* is based on expressions of trust, political engagement, membership in community organizations, and volunteerism. The counties in Group 4 are all in California or Florida and strongly tied to agriculture, so the higher ethnic diversity may suggest a migrant labor force, which may reduce *Social Cohesion*, at least as it was measured in this study. Again this is a clear indication that although this group is small, the combined differences detected between groups with high resource dependence are real and important for delineating human well-being reference points for measuring the local impacts of decisions on HWB.

Overall, U.S. coastal counties increase in well-being as they increase in population density and socio-economic diversity. Yet, the more rural counties along the coast had higher scores for specific domains of well-being, such as *Social Cohesion* and *Leisure Time* suggesting there are elements of well-being not associated with high population density. However, urban centers had well-being scores that were more

consistently above average across the eight domains with only *Connection to Nature* below average and that score did not differ significantly across groups. A broader analysis of value to human beneficiaries like HWB tells a more complex story than a simple economic examination of community resources and may indicate a more complex relationship between resource dependence and well-being. In point of fact, a change in the weighting scheme (RIVs) (Smith et al. 2013a) used to calculate overall well-being could alter the relationship altogether. An examination of these 'relative importance values' by community type is ongoing and may bear important fruit for an understanding of human well-being in smaller rural counties.

The way individual communities ranked the eight domains of the HWBI gives us useful information on measuring success using local priorities. *Education* and *Safety* were consistently important as domains of HWB. Other domains that were more variable in importance across communities, such as *Social Cohesion* and *Health*, may be more dependent on current local conditions and therefore be more susceptible to change through time. This does not make them less informative regarding HWB but perhaps indicates they are less important for measuring long-term sustainability and more useful for measuring short-term improvements. The importance of *Education* and *Safety* were split somewhat among community classification categories and this is informative in that community classification has proven informative regarding community values and dependencies (Chapter 2). The unweighted HWBI also differs between classification groups with large differences in local resource dependence and these differences are compounded by apparent differences in HWB priorities. All classification categories were not fully evaluated with regards to RIVs and this should be a priority moving forward as present data strongly suggest the CCS delineation may be useful for localizing the HWBI in a repeatable way nationwide.

Shifts in the HWBI score as a function of domain weightings is an indication of where community priorities do not match up with community performance. The domain rankings were based on stakeholder input and represent a key element of 'localizing' the HWBI in a repeatable way. In most cases the community priorities lined up well with objective indicators of HWB across the domains, however in cases where this was not evident, such as St. Landry Parish, LA, it must be considered a prime target for sustainability planning at the community level. In the case of St. Landry Parish, workshop outcomes indicated *Education* is a high priority to the community, while indicators suggest that it is an area of relatively weak performance in comparison to other domains of HWB. A focus on education planning combined with a HWBI indicator RIV score emphasizing *Education* would allow for both strong improvement in local HWB and an effective measure of when this had been achieved.

The HWBI also has the potential to serve as a measure of sustainable human well-being when tracked through time and linked to alternative decisions that change the ecological, economic, and social states of defined populations (Summers et al. 2014). However, the trajectories may change as a function of community characteristics. For instance, the well-being of coastal communities is vulnerable to a variety of economic, environmental and social factors. These vulnerabilities may be highlighted based on community classification, particularly following episodic events such as hurricanes. Where affluence is a strong characteristic of a community, the ability of that community to rebound economically following such events may be much stronger than the abilities of less affluent areas, especially if local resource dependence is low. However, the lack of *Social Cohesion* in combination with higher population densities may result in an inequitable distribution of the restoration of services provisioning in those areas. Therefore, if only viewed from an economic perspective, community well-being in affluent communities may superficially seem to recover faster than in less affluent areas. On the other hand, those rural communities affected by disasters, where *Social Cohesion* is strong, may rely on the availability of human capital and require fewer external resources in order to rebound. These

communities may reflect the same level of well-being as the affluent communities, but well-being is derived from different levels of input and potentially more equitable (Cutter et al. 2008, Khazai et al. 2013).

3.4 Conclusions

Community decision makers can use the CCS to help identify baseline HWBI values from which to assess the impact of decisions as shifts in community-specific HWB. Measures of community-specific HWB also allow communities to restore, achieve, and sustain what matters most to them in terms of human well-being. Connecting HWB measures to specific service flows, particularly environmental service flows, is challenging, but the application of the CCS developed here can inform such a connection by tying service flows directly to the social and economic characteristics of the community. The environmental components (Ecoregion) of the CCS were less informative about community type than the economic and social components (i.e., Lifemode and Location Quotient), yet the differences in community type were strongly driven by economic and social dependence on local environmental resource either through employment or through land use. This finding points to a clear link between environmental service flows and HWB.

The approach of setting local HWB reference points based on community classification assumes that common ground is important for describing community priorities. The limitations of this approach are that specific factors important to individual communities are not considered and are likely to change in importance across communities and at different spatial scales than considered here. Decision makers wishing to set reference points for HWB will need to consider the consistency of the group assignments to their situation, but in cases where this is an effective approach, much will be gained by allowing similar communities to compare their HWBI values.

The community classification system developed during this study was also intended to inform decision makers about a community's priorities. The association of these priorities with human well-being is a tool for informing decision makers about sustainable decision outcomes in a community-specific context. Overall, the CCS is useful for delineating coastal counties with respect to the three tiers of sustainability. Local decision makers can identify a community's type based on CCS and then will have a reference HWBI value from which to measure change in the HWBI, as well as information on what dependencies are most important for their community. The limitations of working at the county level need to be addressed as community characteristics are frequently very different at the county and local scale. That said, the county scale is a natural starting place with clear linkages to local decision making. The level of information about human well-being contained in the CCS appears promising for future work and the CCS can be a useful tool for the purpose of setting needed HWBI benchmarks, as well as gauging the transferability of sustainable decisions among coastal communities of similar type.

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4 Stakeholder-derived priorities

A key element of community decision making is to establish priorities and set measures of success. In many cases this process is limited to a particular issue of current importance. For instance, a community interested in increasing downtown walkability might choose the mean number of people observed walking per hour as a measure of success. However, many communities have made significant investments in strategic planning in an effort to achieve broader goals that extend beyond the current issues of concern (e.g., Sustainable Communities; accessed 16 September 2016). These efforts present an opportunity to compare goals across communities in an effort to find common ground. In this chapter, two approaches are considered for identifying and classifying community priorities. The first approach is direct engagement with a representative set of stakeholders in select communities to define their fundamental objectives. Direct engagement with community stakeholders is more efficient for identifying stakeholder objectives, but is vulnerable to criticism when the results are generalized either to the entire community or to other communities. These vulnerabilities are addressed here and an attempt is made to generalize the outcomes by using a structured approach for engagement. The second approach is a more objective examination of strategic planning documents based on the identification keywords associated with pre-defined priority categories. This approach requires fewer resources and relies on the communities own efforts to set and define community priorities. However, the keyword approach is also subject to criticisms that keywords have to be pre-selected and that the documents analyzed do not follow a consistent format. An examination of community priorities will benefit from a merging of the two approaches. The research goal here is to define community-specific priorities that can be tied to environmental resources in later chapters to create useful measures of management success. The goal within this chapter is to use stakeholder input to identify and rank community priorities in a useful and consistent manner.

4.1 Direct stakeholder engagement

4.1.1 Introduction

From August 2014 through June 2015, the U.S. Environmental Protection Agency, Office of Research and Development, Gulf Ecology Division (GED) conducted four Community Engagement for Sustainability Workshops. The workshops focused on identifying stakeholder priorities and focused on a ‘central issue’ of concern identified by the communities themselves (e.g., downtown development).

Workshops were conducted in Pensacola, Florida; Thibodaux, Louisiana; Vero Beach, Florida; and Opelousas, Louisiana. Table 4.1 describes the four communities, dates on which the workshops were held, the number of community participants in each workshop, and the central issues addressed. Figure 4.1 identifies the four communities on a map. These workshops are a subset of those described in Chapter 3.1.3. These communities were chosen based on the Community Classification System (Chapter 2) and targeted for more in depth analysis of results. Pensacola, FL, and Opelousas, LA, are both in CCS Group 1 counties and Vero Beach, FL, and Thibodaux, LA, are both in Group 3 counties (Table 2.1) providing a CCS comparison, as well as a comparison between two states for this analysis.

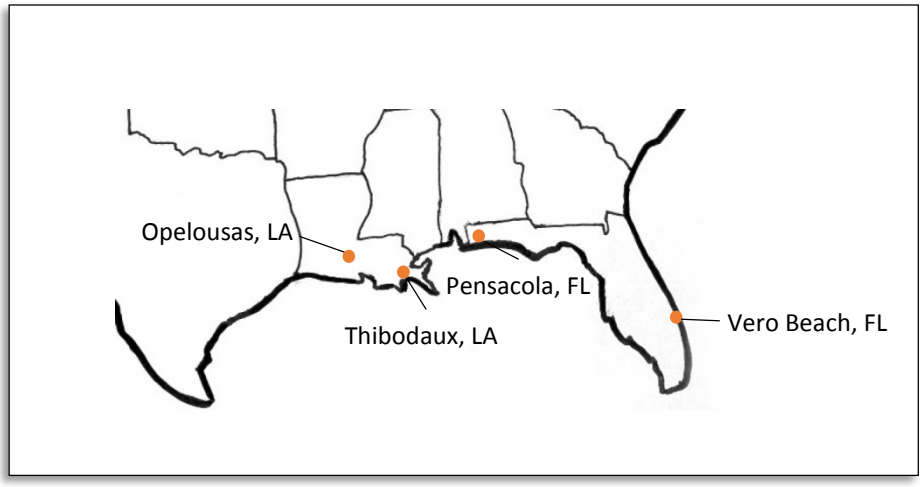

Figure 4.1 Communities participating in community engagement for sustainability workshops.

Table 4.1 Workshop communities and central issues.

Community	Workshop Date	Number of Participants	Central Issue
Pensacola, Florida	August 27, 2014	43	Strengthening existing neighborhoods for a more vibrant Pensacola
Thibodaux, Louisiana	October 30, 2014	36	Sustaining Thibodaux's quality of life – now and for the future
Vero Beach, Florida	February 24, 2015	32	Helping shape the growth and character of Vero's downtown
Opelousas, Louisiana	June 11, 2015	30	Helping re-energize Opelousas' recreational environment

Table 4.2 Key design elements and relationships to workshop objectives.

Design Element and Function	Objectives*			
	Val	Rel	Rep	Com
Pre-Workshop Planning and Organization				
Pre-workshop demographic analysis: review of social, economic, housing and other demographics to inform participant list	✓		✓	
Pre-workshop conference calls: engage community leaders as partners to support workshop; discuss expectations, agenda, and participation	✓		✓	
Work with community to develop participant list: provide advice and assist community in conducting broad, representative outreach	✓		✓	
Development of central issue: identify issue that is salient, will compel broad participation and will work with structured deliberative approach	✓	✓	✓	✓

Design Element and Function	Objectives*			
	Val	Rel	Rep	Com
Workshop Design				
Structured deliberative process: proceed through structured approach from open-ended discussions through prioritization and ranking exercises; allow adequate time for participants to understand goals; discuss basis for priorities including trade-offs, short-term influences and goals "taken for granted"	✓	✓		✓
Workshop flow and design: conclude values discussion before discussing more narrow central issue, and tie-in to goals hierarchy at end	✓	✓		✓
Central issue: include time for discussion of central issue to ensure usefulness of workshop to community; use discussion to validate goals hierarchy	✓		✓	
Workshop Materials				
Community-facing agenda: create accessible agenda to help communicate purpose, encourage participation and organize workshop flow	✓	✓	✓	✓
Goals starting-point document: translate HWBI indicators into structured goals (direction-value-context) using simple language and examples; ensure that participants understand goals and process accurately captures values	✓	✓		
Domain ranking worksheet: reproduce questionnaire used to develop HWBI RIVs to provide direct input for HWBI research	✓	✓		✓
Workshop presentation: use presentation to facilitate workshop discussion and flow and support participant understanding of instructions and concepts	✓	✓		✓
Workshop Facilitation				
Introduction and tone-setting: create "safe" environment with welcome from local leader, icebreakers and ground rules to encourage full participation	✓	✓	✓	
Instructions: clearly describe activities and ensure participant understanding; ensure that exercises and data reflect intentions	✓	✓	✓	✓
Active facilitation of break-out groups: monitor discussions and ensure that all participants have input; answer questions about exercises	✓	✓	✓	✓
Active facilitation of large group discussions: use techniques to encourage broad input, avoid pitfalls, clarify input and capture "community" perspective	✓	✓	✓	✓
Record and collect information: use/collect flipcharts, collect worksheets, take notes and produce an accurate and complete record of community input	✓	✓	✓	✓
Post-Workshop Analysis and Reporting				
Analyze workshop data: document workshop data, quantify rankings, link central issue to long-term goals and produce summaries	✓	✓		✓

Design Element and Function	Objectives*			
	Val	Rel	Rep	Com
Produce community report: document workshop data, summarize workshop findings and provide recommendations to encourage use of findings	✓	✓		✓
Identify sustainability indicators: identify indicators most relevant to short- and long-term goals; address community expectations				✓

* Key		
	Val:	*Validity or Accuracy:* extent to which the process measures and accurately conveys community values, goals, and priorities
	Rel:	*Reliability or Comparability:* extent to which the process will produce consistent results when applied in different contexts
	Rep	*Representativeness*: degree to which data represent characteristics of the entire community population (necessary but not sufficient for validity)
	Co	*Completeness*: extent to which enough information is gathered to achieve the research objective

4.1.2 Overall goals

The Community Engagement for Sustainability Workshops were designed to achieve the following:

- Collect information on community priorities to be used for the following:
  - Understand relationships between community priorities and available ecosystem goods and services.
  - Understand relationships between community priorities and human well-being.
  - Understand relationships between community priorities and sustainability indicators that could be useful to inform community decisions and monitor progress toward sustainability.
- Provide practical advice to communities on the development of sustainability indicators that are tailored to their core community priorities and critical needs.
- Demonstrate a workshop approach for stakeholder engagement based on a structured deliberative process that is applicable in multiple communities.

4.1.3 Methods

Workshop design, implementation, and participation

The workshops were designed to meet the following data quality objectives: validity, reliability, representativeness, and completeness. Critical to all of these objectives were efforts to ensure that a broad range of community voices were included in a meaningful way in the discussion of community values. The following subsections summarize the workshop design and implementation, as well as participation outcomes.

Overview of workshop design

The workshops were designed to produce reliable information about community priorities. The workshop design was developed based on the structured decision making approach (Gregory and Keeney 2002, Carriger et al. 2013), modified to account for the limited time available for each workshop. Each of the workshops was split into two distinct parts. The first part focused on exploring core community values using a series of structured discussions and exercises. A list of goals reflecting the components of human well-being (Smith et al. 2012) was used to frame these activities and enable comparison across workshops. The second part of each workshop focused on the community-defined central issue and was an opportunity to apply community priorities to a practical question (e.g., downtown development).

This structured approach was intentionally designed to introduce the participants to categories of community priorities in a stepwise fashion using non-technical language applied in a familiar context. Part 1 started with open ended discussions of important community qualities. Participants were then asked to "map" these qualities to the list of goals, which allowed the project team to capture the discussions in a structured way while providing participants with a solid working knowledge of the well-being categories. Subsequent exercises and discussions built on this foundation and asked participants to prioritize goals and apply the resulting list of priorities to a central issue. The order of the day was designed to encourage a broad discussion of core community values before narrowing the focus to the central issue. Appendix A presents the standard workshop agenda. Appendix B presents the list of the categories of human well-being derived that was used to structure workshop discussions and exercises.

Workshop implementation

The following subsection describes the different phases of the workshop. Each workshop followed the same design and the workshops were facilitated by the same team from SRA International, Inc. to ensure consistency and comparability of results. All workshops were conducted in a single day.

Pre-workshop planning and site visit

In the period leading up to each workshop, the facilitation team collaborated with local leaders to identify the central issue, create a representative list of workshop participants, develop the workshop invitation, and select an appropriate venue for the workshop. EPA encouraged the local leaders to identify and define a central issue that would encourage broad participation and would benefit from a structured discussion of community priorities. Local leaders were also encouraged to reach out and invite community leaders and members who, as a group, would provide a representative perspective on local community values.

The facilitation team met with local leaders multiple times prior to the workshop to assure workshop goals of representativeness were achieved.

Preliminary workshop activities

As participants arrived to the workshops, they were asked to sign in and identify their affiliation with a community organization or their self-described role as a member of the community. Each workshop started with welcoming remarks from a local leader followed by introductions, a review of the agenda, and a discussion of ground rules. Following this, each workshop followed the two-part agenda already described.

Workshop part 1: Building the foundation

As an "ice-breaker," the facilitators asked participants to describe their community as if they were meeting someone new to the community, thinking about what makes the community unique. After this open-ended discussion, participants worked in small groups of five to seven to identify the qualities of the community that they cared about most.

Participants were then provided with the list of goals developed based on the domains and indicators used in the HWBI (Smith et al. 2013) and were given time to review and ask clarifying questions about the goals. In small groups, participants were asked to map the qualities identified in the previous discussion to specific categories of goals (corresponding to HWBI categories).

Facilitators explained that goals associated with a community quality could be identified by asking "why" the quality was important to them. Facilitators explained that in some cases an iterative series of "why" questions might be needed to identify a goal and that more than one goal may apply. As an example, facilitators explained that walkable streets could be identified as important because they support health (physical activity), social cohesion (interactions with neighbors), safety and security (feeling safe), or a combination of these goals. Following the mapping exercise, each group reported out to the larger group.

Using a multi-voting (dot voting) process, each participant was given the opportunity to identify the goals most important to him or her. Facilitators placed flip charts with the lists of goals on a wall in the room and participants were each given seven dots. Participants were asked to place their dots next to the goals that they felt were most important to the community. Participants were allowed to distribute the seven dots next to one or more goals, placing as many dots next to a goal as desired.

The dot voting exercise was followed by a discussion with the large group about whether there were any surprises and other observations about the results. Participants were also asked whether during the mapping and voting exercises they identified any important goals that they felt were missing from the list.

As a final exercise for the first part of the workshop, participants were asked to rank goal categories (e.g., *Health, Education*) based on their individual views of how important each category is to the well-being of members of the community. Participants were asked to use a scale from 1 (most important) to 8 (least important) with no ties.

During large group discussions, facilitators used active techniques to encourage broad input, avoid pitfalls, clarify input and capture as broad a perspective as possible. Facilitators also monitored small group discussions and, when necessary, engaged the group to ensure that the discussions were focused and that all participants had the opportunity to provide input.

Workshop part 2: Central issue

During the second part of the workshop, participants discussed the community-specific central issue. These discussions started with an introduction by a community leader to frame the issue. Subsequent discussions were tailored to the specific needs of each community. The discussions generally involved brainstorming ideas for addressing the issue; identifying and prioritizing short- and longer-term actions that the community could take; and providing participants with an opportunity to identify commitments regarding how they would contribute to a solution.

At the outset of these discussions, the facilitators explained how the earlier discussions provided insights into the community's core values and suggested that participants draw on those insights when discussing the central issue. Participants subsequently noted how the earlier discussions about important community goals and values had helped them frame their discussions about the central issue.

Follow-up activities

Following each workshop, EPA collected the flip charts and ranking worksheets, calculated summary results for the different exercises, and developed and delivered to each community a workshop report. Each report documented group discussions about community values, breakout exercises, dot voting and ranking results, and discussions exploring the central issue. The workshop reports provided information to help each community interpret workshop results in terms of core community values. Each report also provided recommendations for using the results to help guide community decisions and actions to address the central issue and other issues facing the community.

Workshop participation

A critical element of the design of the workshop was the selection of participants to best represent the community. This affects the extent to which the information gathered in the workshops accurately represents the values, goals and priorities of the community as a whole. The project team sought to maximize representativeness of workshop participants in the planning and implementation of the workshops.

During the planning phase for each workshop, the project team collaborated with local leaders to identify, reach out, and secure the commitment of as diverse and representative a group of participants as possible. The project team recognized that some members of a community would not feel comfortable participating in this type of public forum and others would be precluded participating due to workshop timing (i.e., during a normal workday). To help address this, community leaders were encouraged to recruit participants to represent the voices of groups of community members who were less likely to participate or unable to attend. The team emphasized that in addition to public officials and others who normally participate in these type of forums, "community leaders" include others that are well-connected and respected within different parts of the community, such as church leaders and neighborhood association officers.

The facilitation team also asked participants to "wear different hats" during the workshop and try to represent not only their own viewpoints but also those of community members who could not attend. Participants were asked to report their affiliations when signing in at the start of the workshops. Table 4.3 summarizes the self-reported affiliations of workshop participants.

Table 4.3 Workshop participation for major interest groups by community. Number of persons attending each workshop given in parentheses.

Affiliation	Opelousas (30)	Pensacola (44)	Thibodaux (36)	Vero Beach (33)
City leadership	✓	✓	✓	✓
Local business owners	✓	✓	✓	✓
Civic organizations	✓	✓	✓	✓
Neighborhood associations		✓		✓
Other social organizations		✓		✓
Church leadership	✓		✓	
Regional planning organizations	✓	✓		✓
City agencies	✓	✓	✓	✓
Educators (K-12 and college)	✓	✓	✓	✓
Young professionals	✓	✓	✓	✓
Students (secondary, college)	✓			
Retirees	✓	✓	✓	✓

Table 4.4 Characteristics of four study communities. Data are given separately for change over time (2000-2013) in census data and the results of the American community survey (ACS) for the five year period ending in 2013.

Characteristic	Opelousas		Pensacola		Thibodaux		Vero Beach	
	Change 2000 to 2013	2013 5-yr ACS	Change 2000 to 2013	2013 5-yr ACS	Change 2000 to 2013	2013 5-yr ACS	Change 2000 to 2013	2013 5-yr ACS
People and Households								
Population demographics								
Total population	-27%	16,679	-7%	52,268	1%	14,576	-13%	15,475
Total households	-32%	5,927	-10%	22,150	-2%	5,400	-14%	7,312
Share of households that are family households	2%	67%	-7%	56%	-5%	58%	-12%	49%
Share of households with children and youth	1%	39%	-19%	23%	-13%	29%	-4%	19%
Share of population aged 20 to 34 years	-3%	18%	10%	20%	8%	26%	-13%	14%
Share of population 65 years and older	-11%	14%	1%	17%	2%	14%	-8%	27%
Generational mixing	18%	2.25	-15%	1.13	-21%	1.37	12%	0.61
Age diversity	0%	0.91	0%	0.91	0%	0.91	0%	0.91
Ethnic and racial diversity	-16%	0.37	3%	0.52	6%	0.51	27%	0.27
Factors affecting socioeconomic status								
Share of population that are high school graduates or higher	27%	73%	7%	91%	11%	77%	2%	86%
Share of population with bachelor's degree or higher	6%	12%	4%	34%	6%	23%	0%	32%
Share of younger population that are college graduates	-50%	5%	-16%	30%	-2%	26%	-56%	12%
Share of population with health insurance coverage	NA	81%	NA	81%	NA	83%	NA	79%

Characteristic	Opelousas		Pensacola		Thibodaux		Vero Beach	
	Change 2000 to 2013	2013 5-yr ACS	Change 2000 to 2013	2013 5-yr ACS	Change 2000 to 2013	2013 5-yr ACS	Change 2000 to 2013	2013 5-yr ACS
Share of population with a disability	NA	14%	NA	15%	NA	16%	NA	17%
Population stability								
Share of population in the same house as 1 year ago	NA	86%	NA	82%	NA	81%	NA	77%
Housing unit vacancy rate	42%	16%	54%	14%	38%	12%	68%	29%
Share of housing units that are owner-occupied	-9%	49%	-6%	59%	8%	56%	-3%	63%
Share of occupied housing that are rental units	1%	47%	5%	38%	-14%	41%	2%	35%
Population Density and Housing								
Population density (people per square mile)	-27%	2,110	-7%	2,319	1%	2,419	-13%	1,353
Number of housing units	-28%	7,034	-4%	25,797	2%	6,108	0%	10,286
Share of housing built 1990 or later	NA	16%	NA	15%	NA	26%	NA	20%
Share of housing built before 1940	NA	7%	NA	11%	NA	10%	NA	5%
Median value of owner-occupied housing units	39%	$75.1K	62%	$151.3K	106%	$148.6K	32%	$191.8K
Owner-occupied housing value diversity	NA	0.75	NA	0.83	NA	0.83	NA	0.85
Economy								
Employment and income								
Labor force participation rate	7%	48%	-2%	64%	-2%	58%	-1%	52%
Unemployment rate	-22%	13%	67%	10%	-39%	5%	317%	14%
Median household income	37%	$20,165	27%	$44,144	61%	$43,058	-4%	$37,051
Average household income	NA	$34,529	NA	$62,680	NA	$62,638	NA	$67,715
Household income diversity	1%	0.82	0%	0.82	-1%	0.82	1%	0.82
Gini index of income inequality	NA	0.52	NA	0.48	NA	0.50	NA	0.57
Share of families in poverty	91%	37%	94%	12%	-23%	9%	91%	12%
Share of individuals in poverty	57%	42%	91%	17%	-1%	16%	124%	20%
Affordability								
Share of owner-resident households with housing costs ≥ 35% of income	171%	29%	27%	27%	61%	11%	29%	35%
Share of renting households with gross rent ≥ 35% of income	34%	53%	22%	43%	9%	37%	91%	59%
Local economy								
Share of workforce in management, professional, and related occupations	-16%	22%	-30%	37%	-8%	30%	-4%	32%
Share of workforce in service	25%	31%	41%	20%	8%	20%	15%	23%

Characteristic	Opelousas		Pensacola		Thibodaux		Vero Beach	
	Change 2000 to 2013	2013 5-yr ACS	Change 2000 to 2013	2013 5-yr ACS	Change 2000 to 2013	2013 5-yr ACS	Change 2000 to 2013	2013 5-yr ACS
occupations								
Share of workforce in sales and office occupations	12%	24%	36%	28%	-9%	25%	12%	31%
Share of workforce in natural resources, construction, and maintenance occupations	-13%	9%	31%	9%	15%	10%	-8%	11%
Share of workforce in production, transportation, and material moving occupations	-17%	14%	-21%	7%	19%	14%	-50%	4%
Share of commuting workforce with travel time ≥ 45 minutes	9%	11%	-4%	7%	6%	12%	7%	7%
Share of workforce who worked in county of residence	-13%	77%	2%	90%	-27%	65%	-5%	89%

During the workshops, the facilitation team asked participants to comment on groups that were not adequately represented in the workshop. In all of the workshops, participants felt that lower income residents were underrepresented. Specific discussions regarding these and other underrepresented community members are summarized below:

- **Pensacola, FL**: Participants noted that two key challenges are the high school drop-out rate and the poverty level within the community. Participants felt that those who could represent these challenges first-hand (e.g., church leaders) were not well represented in the workshop. Additionally, participants noted that the ability of younger people to see opportunities in Pensacola was critical to the community's future. Participants felt that this segment of the community had some, but insufficient representation.
- **Thibodaux, LA**: Participants noted that the relatively significant low income population of the community was not well represented in the workshop.
- **Vero Beach, FL**: Participants noted that to sustain its vitality, the community will need to provide greater opportunities and amenities for young adults and young families. Participants discussed the belief that this group does not feel that they have an adequate voice in community decisions. Participants agreed that this group was not well-represented in the workshop.
- **Opelousas, LA**: Participants noted that a key to their success was to engage trusted leaders that represent the diverse age and socio-economic groups within the community. They believed that the workshop would have benefited from more church leaders and leaders who could represent different neighborhoods.

4.1.4 Results

Summary data on index communities

This subsection summarizes background information for the four index communities that participated in the workshops. It also provides a summary and comparison of the central issues addressed during the workshops. Combined, this information can be used to:

- Identify key stressors being faced by these communities, where the background data on social and economic details provide empirical evidence of social and economic stressors and the central issues provide an indication of the community's perceptions, drawing on local knowledge and experience.
- Conduct preliminary analyses of associations between socio-economic variables and workshop outcomes to inform future research on relationships between measurable community characteristics and the nature and structure of core community values.

Comparison of communities by socio-economic characteristics

To provide context for interpreting workshop results, socio-economic data were collected for the four participating communities. Socio-economic variables were selected based on potential relevance to community sustainability, including:

- Population demographics and trends, including the share of the population that is young professionals and families, age distribution, and ethnic, racial, and socio-economic diversity.
- Indicators of community resilience, including population stability, disability, health insurance coverage, economic diversity, and indicators of socio-economic status (e.g., educational attainment, income, and employment status).
- Economic setting and trends, including trends in income, poverty, and affordability and the nature of local economies and their dependence on natural resources.

Some of the more significant similarities and differences among the communities include:

- *Total population* — The population of Pensacola, FL, is three times larger than each of the other communities, which have similar total populations. The communities have similar population densities, except for Vero Beach, FL, which is less dense. Opelousas, LA, and Vero Beach, FL, underwent significant population declines between 2000 and the five-year period ending in 2013.
- *Population age* — In the 2013 American Community Survey (ACS; American Community Survey; accessed 16 September 2016), Opelousas, LA, had the highest concentration of households with children and youth and highest degree of generational mixing (i.e., the ratio of population under 17 and under to population 65 and over). Vero Beach, FL, has the lowest concentration of households with children and youth and the lowest degree of generational mixing. Pensacola, FL, and Thibodaux, LA, have most significant shares of population in 20 to 34 range.
- *Ethnic and racial diversity* — Opelousas, LA, and Vero Beach, FL, had lower levels of ethnic and racial diversity than the other two communities. The majority of residents in Opelousas identify themselves as Black or African American alone (not Hispanic or Latino) and the majority of residents in Vero Beach, FL, identify themselves as White alone (not Hispanic or Latino).

- *Housing occupancy and ownership* — Housing vacancy rates increased in all four communities from 2000 to the five-year period ending in 2013. Three of the four communities saw a decrease in the share of owner-occupied housing and an increase in the share of renter-occupied housing over this period. Thibodaux, LA, was the exception and experienced the opposite trend.
- *Income and wealth* — In the 2013 ACS, Opelousas, LA, had the lowest median home values, lowest median and mean incomes, and highest shares of families and individuals in poverty. Vero Beach, FL, had the third highest median income, highest mean income, highest GINI index (income distribution equity; The World Bank GINI index; accessed 16 September 2016) and highest housing value diversity indicating potential income and wealth disparities among households in the community. All of the communities except Thibodaux, LA, experienced increases in families and people in poverty from 2000 to the five-year period ending in 2013.
- *Affordability* — All of the communities experienced increases from 2000 to the five-year period ending in 2013 in the share of homeowners and renters who spend more than 35% of income on housing. In the 2013 ACS, Vero Beach, FL, had the highest share of owners and renters who paid 35% or more of their income on housing costs.
- *Occupations* — The 2013 ACS data indicate that Opelousas, LA, had the lowest share of the workforce in management, professional, and related occupations and highest share in service occupations. Of the four communities, the two Louisiana communities had the highest proportions of their workforce in production, transportation, and material moving occupations. Workers in the Louisiana communities also had the longest commutes, suggesting employment outside of their resident communities.

Presentation and comparison of central issues

The central issue was selected by each community based on its prominence as an issue being faced by the community and likelihood to resonate with and attract a representative group of participants. The choice of a central issue could tend to bias participation in a workshop by attracting people with a deeper interest in the issue. Therefore, it is important account for the choice of the central issue when interpreting workshop outcomes. The central issue could also be an indicator of the stressors and opportunities being faced by a community, with relevance for identifying meaningful community-specific sustainability indicators. The following subsections identify similarities and differences in the central issues addressed during the workshops.

Similar themes

While each of the central issues addressed distinct and different aspects of the community, there were some similar themes that emerged across the workshops:

- All of the communities believed that by addressing the central issue, a key outcome that will be achieved is improved *Social Cohesion*; building connections across the community that ultimately will support longer term resilience.
- Preserving or strengthening ties to the history and culture of the community was another key outcome related to each of the central issues.
- While each community's actions varied, improving safety was another common theme.
- Pensacola, FL; Thibodaux, LA; and Vero Beach, FL, stressed the importance of the central issue to the longer term economy of the community.

Significant differences:

Key differences in focus among the central issues addressed in the workshops include:

- *Pensacola, FL* — In this workshop, there was strong emphasis on *Living Standards* and the importance of vibrant neighborhoods in supporting youth and on improving the conditions for the least well off members of the community and instilling hope.
- *Thibodaux, LA* — While the central issue addressed many key goals, there was very little tie to *Education*, despite the fact that *Education* was viewed as one of the most important values.
- *Vero Beach, FL* — A unique concept that emerged from this workshop was that Vero Beach, FL, is a community without a clear identity. While participants were clear on who we "don't want to be" there was not a clear vision of "who we want to be" that can guide the development of the downtown.
- *Opelousas, LA* — The community is in the midst of a "rebuilding" era, still recovering from a significant hit by the economy and with new energy that the new mayor is bringing. The central issue can help the community overcome negative perceptions.

Comparison of index communities

Comparison of values mapping exercise

As discussed in Chapter 4.1.3, participants worked in small groups to identify the qualities of the community that they cared about most. Participants were then asked to map the qualities identified in the previous discussion to specific categories of goals corresponding to the HWBI domains. Table 4.5 and Figure 4.2 summarize the frequency with which a goal category was identified by the small groups during this exercise. Frequencies were calculated as the total number of times that a goal category was associated with a community quality by any small group divided by the total instances that any goal category was identified by any small group. For example, if the workshop included four small groups, each group listed five important community qualities during the open-ended exercise, and each group associated two goal categories with each quality, the total instances that goal categories were identified would be 40 (4*5*2). If one group identified the "health" category with two community qualities, another identified "health" with one quality, and none of the other groups identified health, the workshop-level frequency with which the "health" goal category was identified would be calculated as 7.5% (3/40).

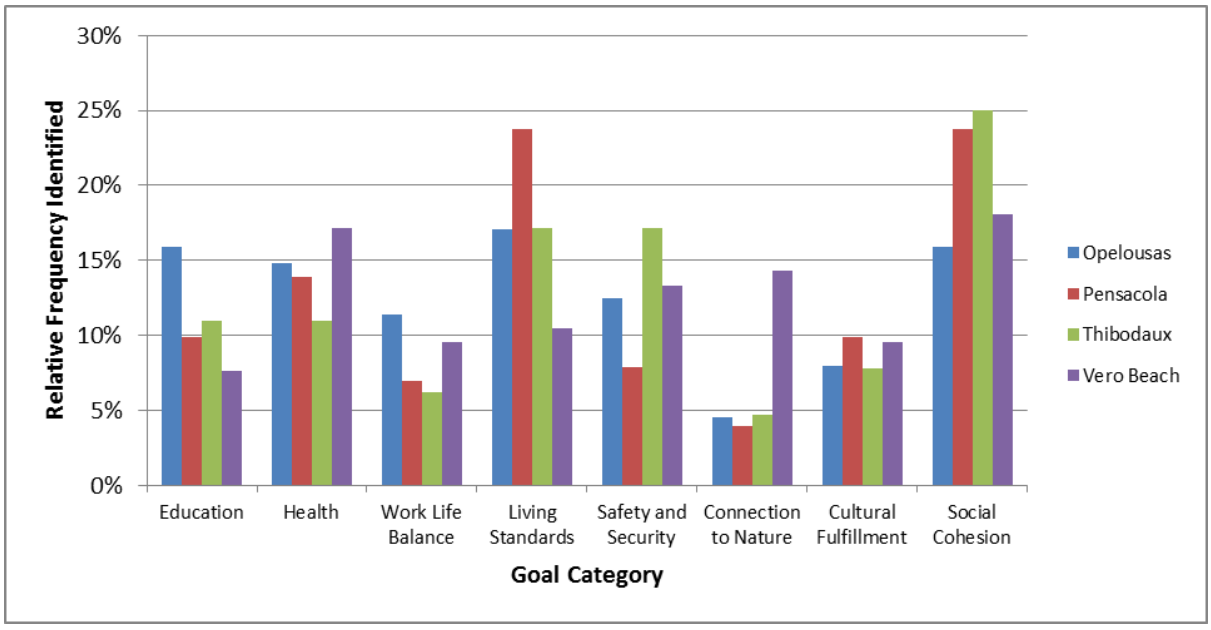

Figure 4.2 Relative frequency of reporting for goal categories identified during mapping exercises. The goal categories are identical to the domains of the human well-being index (HWBI).

Table 4.5 Relative frequency of reporting for goal categories identified during mapping exercises. The goal categories are identical to the domains of the human well-being index (HWBI).

Community	Education	Health	Work Life Balance	Living Standards	Safety and Security	Connection to Nature	Cultural Fulfillment	Social Cohesion
Opelousas	16%	15%	11%	17%	13%	5%	8%	16%
Pensacola	10%	14%	7%	24%	8%	4%	10%	24%
Thibodaux	11%	11%	6%	17%	17%	5%	8%	25%
Vero Beach	8%	17%	10%	10%	13%	14%	10%	18%

The categories *Living Standards* and *Social Cohesion* were most often associated with important community qualities based on the mapping exercise. In three of the four workshops, *Social Cohesion* was the most frequently identified goal category. In two of the four communities, *Living Standards* was the most frequently identified goal category. In three of the four communities, the category *Connection to Nature* was the least often identified during the mapping exercise.

Significant differences among workshops include:

- The Opelousas, LA, workshop stood out from the others based on the relatively high frequency that *Education* was identified during the mapping exercise.
- The Pensacola, FL, workshop stood out based on the relatively high frequency that *Living Standards* was identified and relatively low frequency that *Safety and Security* was identified.
- The Thibodaux, LA, workshop stood out based on the relatively low frequency that *Health* was mapped to important community qualities.
- The Vero Beach, FL, workshop stood out based on the relatively low frequency that *Living Standards* was identified and relatively high frequency that *Connection to Nature* was identified.

Participants in the Opelousas, LA, and Vero Beach, FL, workshops identified work life balance more frequently and *Social Cohesion* less frequently than participants in the Pensacola, FL, and Thibodaux, LA, workshops. Participants in the Opelousas, LA, and Thibodaux, LA, workshops similarly identified *Cultural Fulfilment* less frequently that participants in the workshops held in the two Florida communities.

Comparison of dot voting exercise

Following the mapping exercise, participants voted for the goals that they felt were most important to the community by placing dots next to the goals, as described in Chapter 4.1.3. For the purpose of this comparative analysis, the project team summed the goals to develop a total for each goal category. Table 4.6 and Figure 4.3 present the percentage of dot votes received by goals within each goal category during each workshop.

Table 4.6 Relative frequency of goal categories receiving dot votes during workshop group voting exercise. Each attendee was given eight dots. Goal categories are identical to the domains of the human well-being index (HWBI).

Community	Education	Health	Work Life Balance	Living Standards	Safety and Security	Connection to Nature	Cultural Fulfillment	Social Cohesion
Opelousas	17%	18%	14%	15%	12%	5%	4%	14%
Pensacola	24%	14%	4%	21%	13%	2%	4%	19%
Thibodaux	22%	12%	13%	14%	14%	2%	3%	20%
Vero Beach	16%	21%	15%	13%	8%	7%	7%	14%

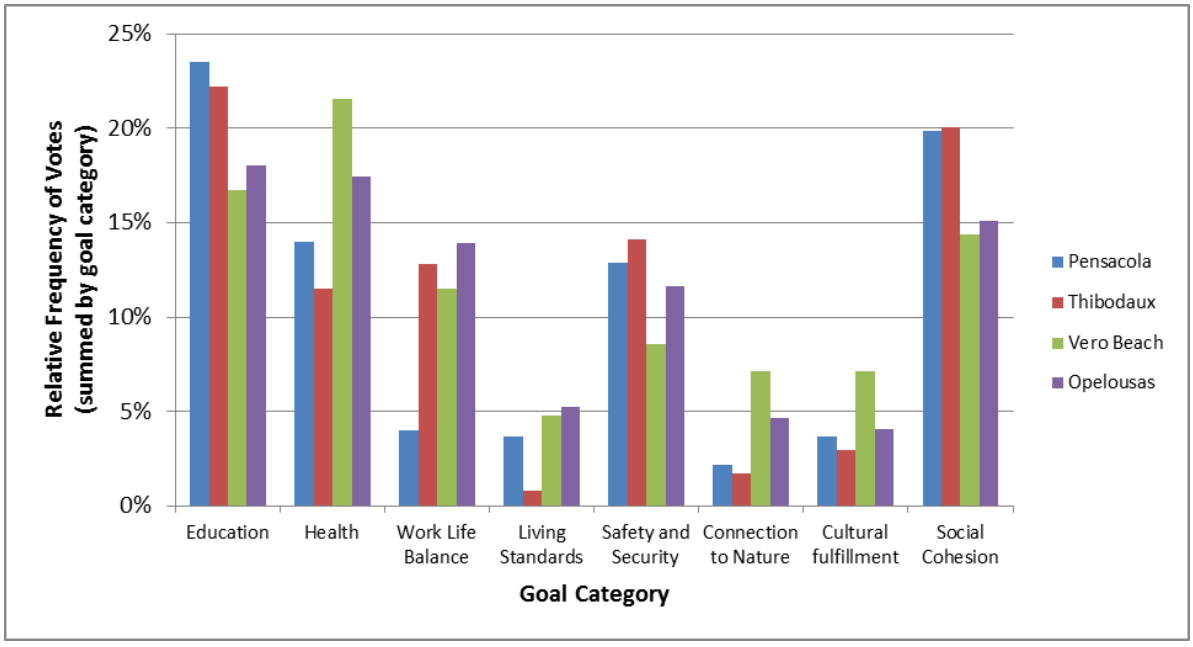

Figure 4.3 Relative frequency of goal categories receiving dot votes during workshop group voting exercise. Goal categories are identical to the domains of the human well-being index (HWBI).

Three of the four workshops identified *Education* as the most important goal category to the community when goal-specific dot votes were summed to the category level. *Education* was identified as the second most important goal category in the fourth workshop. *Social Cohesion* received the second or third highest number of summed votes in all four workshops, and *Health* received the first, second or third

highest number of summed votes in three of the workshops. *Living Standards*, *Connection to Nature*, and *Cultural Fulfillment* ranked sixth, seventh, or eighth compared to other goal categories based on summed dot votes in all four workshops. Significant differences among workshops were identified using an outlier analysis. The summary describes differences where the outcomes of the workshop were at least 1.4 standard deviations from the mean. Significant differences among workshops include:

- The Pensacola, FL, workshop stood out based on the relatively low number of votes that goals associated with *Work Life Balance* received.
- The Thibodaux, LA, workshop stood out based on the relatively low number of votes that goals associated with *Living Standards* received.
- The Vero Beach, FL, workshop stood out based on the relatively high number of votes for goals associated with the *Health*, *Connection to Nature*, and *Cultural Fulfillment* and relatively low number of votes for goals associated with *Safety and Security*.

Participants in the Pensacola, FL, and Thibodaux, LA, workshops cast a greater percentage of votes for goals associated with *Education* and goals associated with *Social Cohesion* than participants in the Opelousas, LA, and Vero Beach, FL, workshops. Community similarities in these rankings were analyzed using a simple univariate cluster analysis. Workshops were ranked based on the relative frequency that a goal category received dot votes. If the differences in frequency between the first and second ranked workshops and between the third and fourth ranked workshops exceeded the difference between the second and third ranked workshops by 10%, the workshops were considered clustered in pairs.

Comparison of domain ranking exercise

As a final exercise before discussing the central issue, participants were asked to rank goal categories (e.g., *Health*, *Education*) based on their individual views of how important each category is to the well-being of members of the community. Participants used a scale from 1 (most important) to 8 (least important) with no ties. Table 4.7 and Figure 4.4 summarize the likelihood that a workshop participant ranked a goal category as first, second or third most important. The likelihood is calculated as the total number of participants who ranked a goal category as first, second or third most important divided by the total number of first, second or third ranking instances, where the total instances equals the number of participants in the exercise times three.

Table 4.7 Likelihood a goal category was identified in top three during a workshop in an individual ranking exercise. Goal categories are identical to the domains of the human well-being index (HWBI).

Community	Education	Health	Work Life Balance	Living Standards	Safety and Security	Connection to Nature	Cultural Fulfillment	Social Cohesion
Opelousas	32%	21%	9%	11%	12%	2%	3%	11%
Pensacola	22%	18%	1%	13%	22%	0%	4%	21%
Thibodaux	26%	9%	5%	16%	22%	1%	1%	20%
Vero Beach	13%	17%	6%	16%	22%	6%	6%	14%

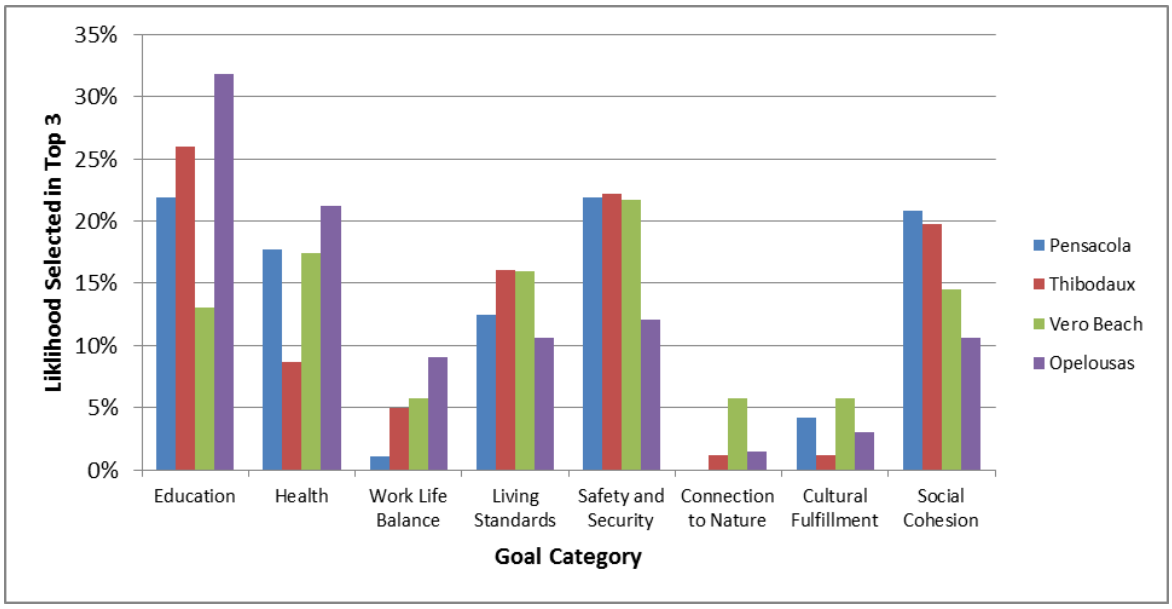

Figure 4.4 Likelihood a goal category was identified as top three priority during a workshop in an individual ranking exercise. Goal categories are identical to the domains of the human well-being index (HWBI).

Education was the goal category most likely to be ranked as one of the top three most important categories by individual participants in three of the four workshops. *Safety and Security* was the goal category most likely to be ranked as one of the top three by participants in two of the four workshops. *Health* was the second most likely category to be ranked in the top three in two workshops, and *Social Cohesion* was the third most likely to be ranked in the top three in two workshops. *Work Life Balance*, *Connection to Nature*, and *Cultural Fulfillment* were the among the three least likely goal categories to be ranked in the top three by participants in all four workshops. Significant differences among workshops were identified using an outlier analysis. The summary describes differences were the outcomes of the workshop were at least 1.4 standard deviations from the mean.

Significant differences among workshops include:

- The Opelousas, LA, workshop stood out from the others based on the relatively low rankings received for *Safety and Security* and *Social Cohesion*.
- The Pensacola, FL, workshop stood out based on the relatively low rankings received for *Work Life Balance*.
- The Thibodaux, LA, workshop stood out based on the relatively low rankings received for *Health*.
- The Vero Beach, FL, workshop stood out based on the relatively low rankings received for *Education* and the relatively high rankings received for *Connection to Nature*.

Participants in the Thibodaux, LA, and Vero Beach, FL, workshops ranked *Living Standards* as relatively more important than participants in the Opelousas, LA, and Pensacola, FL, workshops. Workshop pairings were analyzed using a simple univariate cluster analysis. Workshops were ranked based on the likelihood that a goal category was ranked as a first, second or third priority. If the differences in likelihood between the first and second ranked workshops and between the third and fourth ranked workshops exceeded the difference between the second and third ranked workshops by 10%, the workshops were considered clustered in pairs. Participants in the Pensacola, FL, and

Thibodaux, LA, workshops ranked *Social Cohesion* as relatively more important than participants in the Opelousas, LA, and Vero Beach, FL, workshops.

Comparison of mapping, dot voting, and ranking outcomes

Workshop data gathered using mapping, dot voting, and ranking exercises were compared to assess consistency and complementarity — in terms of identifying core community values — across the different types of exercises. When interpreting the comparative analysis, the project team considered the following key differences among the exercises:

- The exercises involved different levels of structuring. The mapping exercise asked participants to address an open-ended question (i.e., "what do you care about most in a community") and map goals retrospectively. The other two exercises asked participants to prioritize a specific list of goals and goal categories.
- The dot voting exercise asked participants to prioritize goals at the equivalent of the HWBI "indicator" level of resolution. The other two exercises involved mapping and ranking of the more aggregated goal categories, with a resolution equivalent to the HWBI "domain."
- The structured exercises (i.e., dot voting and ranking) differed in the anonymity afforded participants. Dot voting was a community activity where participants could observe and react to the choices of others and could expect others to observe their choices. The ranking activity was completed by participants individually and anonymously.
- The workshop was designed to incrementally introduce participants to the goals framework and concepts. When completing later exercises, participants benefited from a deeper understanding of the material and improved capacity to express their intent.

For comparison, the results of the mapping, dot voting and ranking exercises were expressed in terms of ranked goal categories. For example, the goal category that received the highest number of aggregated votes in dot voting was ranked first out of the eight goal categories and that receiving the lowest number was ranked eighth. A similar approach was used to rank goal categories based on frequency of identification during the mapping exercise and likelihood of being ranked as one of the top three categories in the ranking exercise. Figure 4.5 compares the ranking of the goal categories across the different exercises by community.

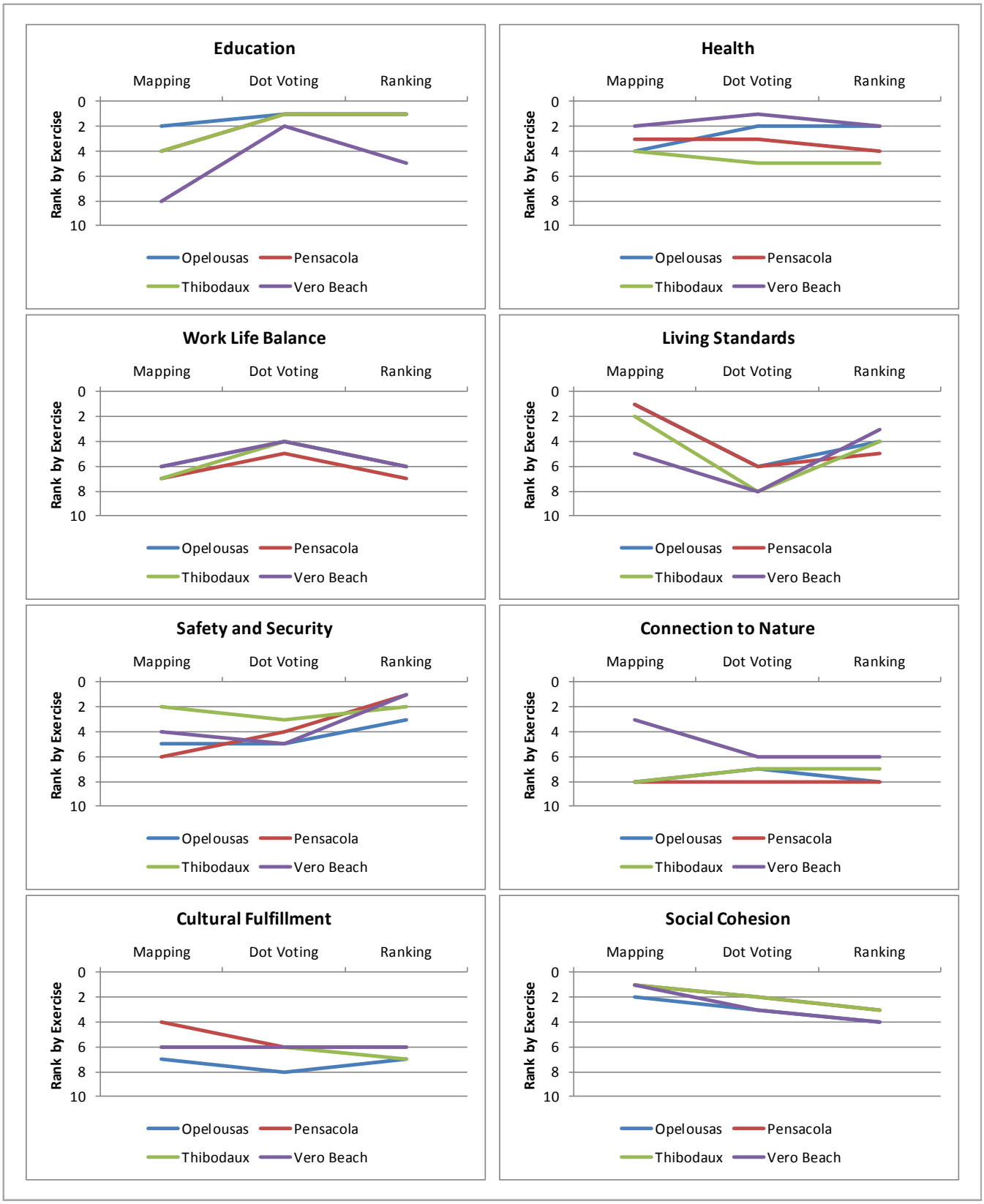

Figure 4.5 Comparison of workshop outcomes across the three weighting exercises. Data are given separately for workshops in each of the four communities.

Key findings from comparing the workshop outcomes across the different exercises include:

- *Education* and *Health* goal categories were ranked consistently high across the three exercises. In three communities, *Education* increased in ranking from mapping to dot voting and remained the top ranked goal category based on the ranking exercise. In one workshop, *Education* was identified as a relatively lower priority in the ranking exercise. From dot voting to ranking, the *Health* category shifted by no more than one rank.
- *Living Standards* and *Safety and Security* goal categories followed a similar pattern. Their relative rank based on the exercise-specific metrics decreased from mapping to dot voting and increased from dot voting to ranking. In all four workshops, these two goal categories were identified as relatively higher priorities during the ranking exercise than they were based on dot voting.
- *Work Life Balance* and *Social Cohesion* were identified as relatively lower priorities during the ranking exercise than they were based on dot voting.
- *Connection to Nature* and *Cultural Fulfillment* were associated relatively frequently with the important community qualities identified at the outset of the mapping exercise. They were identified as relatively lower priorities based on the dot voting and ranking exercises.

These preliminary findings and complementary observations made during the workshops suggest the following:

- The structured deliberative process is a useful tool for revealing core community values. When the goals framework was introduced, the focus of the workshops tended to shift from the natural and cultural qualities that establish a community's identity to core concerns such as safety and reasonable living standards.
- The ranking exercise may be a most accurate expression of core community values for the following reasons:
    - The exercise is less subject to the introduction of strategic considerations (e.g., trying to spread votes evenly across goal categories).
    - By the time participants complete the ranking exercise, they have a deeper understanding of the goal category definitions and have had greater opportunity to form their thoughts about priorities.
    - The anonymity in the ranking exercise helps to control for response bias, as participants are less likely to consider others' perceptions when expressing priorities.
- All three of the exercises provide useful and complementary information relative to a community's core values and useful sustainability indicators. The mapping and dot voting exercises complement the ranking exercise by revealing interrelationships between intermediate and end goals, stressors driving community priorities and action, and unique qualities of a community that can be leveraged to achieve end goals.

Analysis of socio-economic characteristics and workshop outcomes

Workshop and socio-economic data were analyzed to address questions about generalizing workshop outcomes within and across communities. These included simple cluster and regression analyses tailored to account for the limited number of workshops for which data are available.

Simple univariate cluster analyses were conducted to identify community pairings based on similarities in terms of socio-economic characteristics or workshop domain rankings. Bivariate cluster analyses were also conducted to explore possible interactions between socio-economic factors and workshop outcomes. Clustering based on each combination of one socio-economic factor and one workshop outcomes was analyzed in bivariate space using similar decision criteria as the univariate analysis (i.e., ranked pairs with at least a 10% separation). The analysis concluded that clusters were determined by either the socio-economic factor or the workshop outcome and that the bivariate analysis did not add to the findings from the univariate analyses. For the socio-economic analyses, communities were ranked based on each socio-economic factor. If the difference in the factor values between the first and second ranked communities and between the third and fourth ranked communities exceeded the difference between the second and third ranked communities by at least 10%, the communities were considered clustered in pairs. The same approach was used to assess clustering of workshops based on workshop outcomes. Table 4.8 summarizes the results of the univariate cluster analyses.

Table 4.8 Summary of univariate cluster analyses between communities.

Community Pairings	Observed Clustering: Clustered on Socio-economic Characteristics	Observed clustering: Clustered on Goal Categories*
Opelousas – Pensacola Thibodaux – Vero Beach	• Share of workforce in natural resources, construction, and maintenance occupations	• Living standards (R)
Opelousas – Thibodaux Pensacola – Vero Beach	• Share of population that are high school graduates or higher • Share of workforce in production, transportation, and material moving occupations • Share of commuting workforce with travel time >= 45 minutes	• Cultural fulfillment (M)
Opelousas – Vero Beach Pensacola – Thibodaux	• Ethnic and racial diversity • Share of population that is younger college graduates • Share of housing built before 1940 • Share of renting households with gross rent ≥ 35% of income	• Education (V) • Work life balance (M) • Social cohesion (MVR)

* Labels in parentheses denote the source of workshop outcome data in terms of type of workshop exercise as follows: M = mapping, V = dot voting, R = ranking.

Possible associations between socio-economic factors and workshop outcomes were explored using bivariate linear regression analysis with strong decision criteria. Each workshop outcome was regressed on each socio-economic factor using both the 2013 5-year ACS data and the change in value between the 2000 Decennial Census (U.S. Census 2010; accessed 14 September 2016) and the 2013 five-year ACS; and was tested for both consistency in rank and linearity ($R^2 > 0.8$). For example, the community with the highest value for a workshop outcome (e.g., relatively frequency of dot votes for a goal category) also had the highest value for a socio-economic factor, the community with the second highest value for a workshop outcome also had the second highest value for a socio-economic factor, etc. Inverse ranking relationships were also considered (i.e., highest-to-lowest corresponding to lowest-to-

highest). This approach was selected based on the small number of communities and workshops included in the analysis. It did not consider interactions among multiple socio-economic variables and is not intended to evaluate causality. Table 4.9 summarizes the results of the preliminary association analysis.

Table 4.9 Summary of associations' analysis across communities.

Characteristic	Observed Associations between Socio-Economic Factors and Workshop Outcomes*							
	Education	Health	Work Life Balance	Living Standards	Safety and Security	Connection to Nature	Cultural Fulfillment	Social Cohesion
People and Households								
Population demographics								
Share of households that are family households	P (MR)							
Share of households with children and youth	P (MR)							
Share of population aged 20 to 34 years		N (MV)			P (V)	N (V)		
Generational mixing	P (MR)							
Age diversity	P (MR)							
Ethnic and racial diversity	P (V)							
Factors affecting socioeconomic status								
Share of population that is younger college graduates								P (R)
Population stability								
Housing unit vacancy rate		P (V)			N (V)	P (V)	P (V)	
Share of housing units that are owner-occupied	N (M)							
Share of occupied housing that are rental units	P (MR)							
Population Density and Housing								
Population density (people per square mile)		N (V)			P (V)	N (V)	N (V)	
Share of housing built 1990 or later					P (M)			
Share of housing built before 1940	P (V)			P (M)				
Median value or owner-occupied housing units	N (M)							
Economy								
Employment and income								
Labor force participation rate								P (R)
Unemployment rate		P (MV)						
Median household income								P (R)
Average household income	N (M)							
Household income diversity		P (R)						
GINI index of income inequality	N (V)			N (M)		P (R)		
Affordability								
Share of owner HH with housing costs ≥ 35% of income		P (M)						

Characteristic	Observed Associations between Socio-Economic Factors and Workshop Outcomes*							
	Education	Health	Work Life Balance	Living Standards	Safety and Security	Connection to Nature	Cultural Fulfillment	Social Cohesion
Share of renting HH with gross rent ≥ 35% of income		P (MV)			N (V)	P (V)		N (V)
Local economy								
Share of workforce in sales and office occupations	N (M)							
Share of commuters with travel time ≥ 45 minutes							N (M)	
Share of workforce who worked in county of residence							P (M)	

* Key: Direction of association: P = positive linear association, N = negative linear association. Source of workshop data: M = mapping, V = dot voting, R = ranking

4.1.5 Discussion

Practical measures of sustainability

Key objectives of the Community Engagement for Sustainability Workshops were to provide practical advice to communities and to inform EPA research on sustainability indicators. The following subsections present the findings from the workshops relative to these objectives.

Description of spreadsheet tool for sustainability indicators

Measuring progress towards sustainability is a key challenge for communities. While a wealth of "sustainability indicators" are available (Fang et al. 2014, Holden 2013, Vackar et al. 2012), the challenge for many communities is deciding which sustainability indicators are most relevant to their situation. Defining sustainability indicators in terms of the core community values identified through the types of processes used in the workshops described herein offers a solution to this challenge. It allows communities to select indicators focused on the values-oriented goals that the community wishes to achieve or sustain and create a succinct and meaningful system of indicators tailored to these goals.

To demonstrate this approach, the project team identified community sustainability indicators that resonated with the information received during the workshops, including information on core values, associated near- and long-term goals, and strategies for achieving those goals. The team developed a spreadsheet and navigation tool using the central issues addressed in each workshop to show how communities could develop a set of interrelated indicators that is relevant to a specific issue and directly linked to core values and associated goals.

The approach is based on four types of indicators (Figure 4.6), each of which has a different relationship to factors affecting a community, community decisions and actions, and community well-being:

- *Indicators of external factors affecting the community (Type 1)* — Measures of forces affecting community sustainability that are beyond a community's direct control (e.g., climate change,

national economic trends). These indicators could be used to help communities understand the root causes behind existing and emerging challenges, target strategies to adapt, and communicate the need for action.

- *Indicators of consequences of external factors (Type 2)* — Measures of the effects of external factors on the ability of a community to sustain or achieve its goals, including measures of changes in conditions relative to intermediate goals and goals directly related to core values (e.g., highly ranked domains of the HWBI). These indicators vary by external factor and could be used to provide the rationale for community action, set priorities, and guide community action.
- *Indicators of possible community actions (Type 3)* — Measures of the status and immediate outcomes of community actions (e.g., acreage of greenspace added to a downtown). These indicators could be used to establish milestones for action, report progress, and demonstrate accountability to the public. These indicators recognize that immediate outcomes often depend on responses of key stakeholders and provide the most immediate feedback to help communities change course if an action is not working as intended.
- *Indicators of the outcomes of community actions (Type 4)* — These indicators align with indicators of consequences of external factors but they measure the effect of community actions on addressing those consequences (e.g., increases in community social cohesion resulting from greenspace). These indicators include measures relative to intermediate goals and goals directly related to core values and could be used to monitor outcomes, adaptively manage actions, demonstrate accountability, and engage the community's interest and support for sustainability.

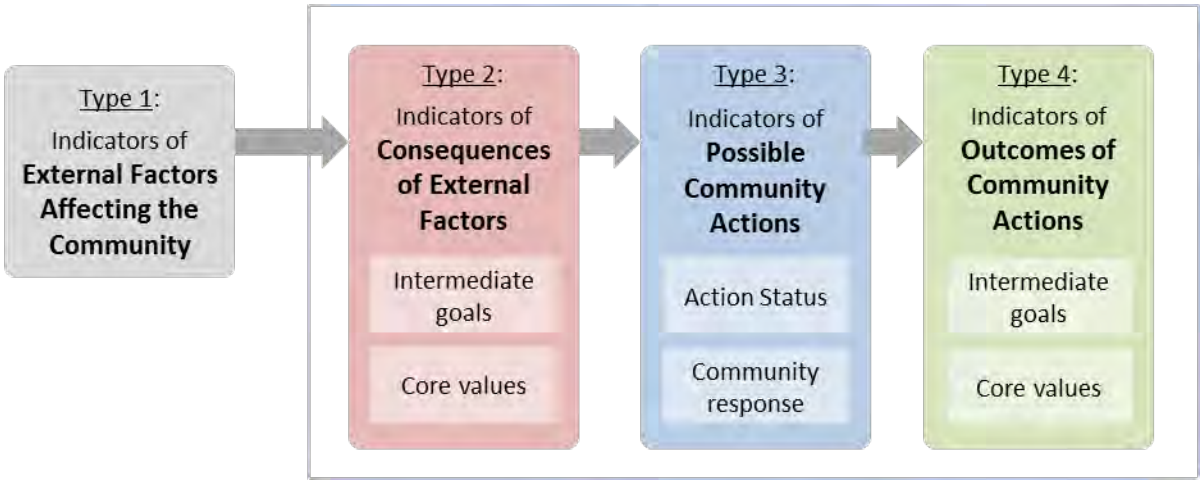

Figure 4.6 Relationship between four types of EPA-identified community sustainability indicators.

By combining these four types of indicators, a community can assess threats, identify priorities, target actions, demonstrate accountability, monitor results, make informed mid-course corrections, and, ultimately, measure the impact of the actions in terms of the goals that matter most to the community. Ultimately, sustainability indicators developed using this approach are expected to help communities assess whether their actions are helping to sustain and/or move their community toward its core values.

EPA created example frameworks for each of the participating communities as a way to illustrate how to translate the workshop discussions into a set of sustainability indicators for a community (available upon request).

Analysis of how to use workshop outcomes

In addition to providing practical advice on sustainability indicators, the workshops provided information that could be useful for EPA's research into sustainability indicators and community well-being.

Develop indices of sustainability

The workshops generated important preliminary insights into the nature and hierarchical structure of core community values and implications for indices of sustainability. These insights reinforced information obtained from the previous Regional Sustainable Environmental Science (RESES) workshops and could help inform further research on sustainability indices. The key findings were as follows:

- All of the communities participating in the workshops demonstrated an innate capacity for systems thinking. Without prompting, participants discussed their goals and values in terms of hierarchies that emphasized inter-relationships among goals and values. Participants consistently discussed the idea that some goals were "fundamental" or prerequisites for other goals. *Education* and *Health* were cited as goals that need to be achieved in order to attain reasonable *Living Standards*, maintain healthy relationships, and achieve other goals. In many cases, participants stated that all of the goals were important but that community efforts might best be spent on supporting the fundamental goals. This suggests that in the context of community decisions and action, values associated with the most fundamental aspects of well-being could be the highest priorities.
- The sample of communities included different cultural histories, natural settings, and socio-economic conditions and stressors. Applying the same workshop design to these different communities revealed the possibility that community values consist of core values that evolve slowly over time and other values that are prioritized in reaction to stressors or opportunities.
- At any point in time, these more transient values could be perceived as the same or higher priorities than more stable, core values. In some cases, these more transient priorities may represent "threshold conditions" that need to be achieved in order to meet other priorities. This suggests that the landscape of important community values changes over time.
- Participants noted that some important community values were "taken for granted," because they have been sustained over time. *Safety and Security* and *Social Cohesion* were cited as examples of this. This suggests that values associated with more pressing concerns may cause communities to lose sight of other important, potentially core community values.
- Practical sustainability indices will need to be adaptable to changes in a way that measures and emphasizes core values that remain high priorities over time and values associated more immediate priorities.

The workshops and subsequent analyses also afforded an opportunity to explore the elements of the HWBI (Smith et al. 2013). They also afforded an opportunity to examine the relative importance values (RIVs), the factors used to weight different domain scores to derive element scores (e.g., economic well-being) and an overall HWBI value. Key findings from the workshops are as follows:

- The changing landscape of values discussed above suggests that, from a community perspective, a set of indices or indicators, rather than aggregated indices, may be more responsive to community needs. This approach would allow for consistent measures addressing core values

and higher and lower prioritization of other indicators as required. The systems thinking manifested during the workshops suggests that this type of approach would be workable.

- The possibility that community values consist of core values that evolve slowly over time and other values that are prioritized in reaction to stressors or opportunities suggests that RIVs could also change over time. This suggests the need to periodically update RIVs. It also highlights the utility of a composite index for measuring well-being versus measuring well-being based on, for example, a single domain that was initially identified as a priority but may change in priority over time.
- The workshops revealed that different members of a community may have similar priorities with respect to indicator domains but differences in how they prioritize values associated with the more detailed indicators presented in the HWBI. Community-wide indicators may be more representative and stable at a domain level. This suggests that the scope of indicators within each domain should be adequate to capture differences in the meaning of the domain to different individuals and care should be taken in defining the scope and combining indicators when developing aggregate domain indices.
- Some participants instinctively made the connection between a healthy natural environment and human well-being, while other participants struggled with the HWBI definition of "connection to nature." The latter were more comfortable talking about a healthy natural world as an end in itself.
- Participants consistently suggested that "faith" should be more clearly articulated as possible core community value. They noted that "rate of congregational adherence" was part of the cultural fulfillment domain but felt that faith is separate and distinct. The workshop report for Thibodaux, LA, summarizes a representative discussion.
- The workshop discussions, demographic analyses, and community indicators discussion suggested that the following additional indicators or metrics might be applicable for local application of the HWBI, if data are available:
    - Metrics for physical and mental well-being: anxiety prevalence, physically unhealthy days, mentally unhealthy days, days with activity limitations due to chronic illness, and disability status.
    - Metrics for healthy lifestyle and behavior: physical activity among adults and youth, neighborhood walking, residential gardening, and adults and youth eating well.
    - Metrics for ability to afford basic necessities: share of income spent on rent and combined costs of housing and transportation.
    - Indicator for cultural fulfillment: connectedness to place (metric: sense of place-based identity).
    - Metrics for responsible engagement in democracy: trust in local government and local government responsiveness to stakeholders.
- The workshop discussions, demographic analyses, and community indicators development suggested that considerations of frequency of data updates, resolution (e.g., community versus county), and accessibility will be important in developing indices of well-being to guide community sustainability decisions and actions.

Generalize to the whole community

Engaging a representative group of participants is a critical challenge to be addressed if this type of workshop is to be effective in identifying the values that are most widely shared by the community. The methods chapter describes elements of the workshops that were designed to encourage representativeness, including pre-workshop organizing activities and active facilitation; the results chapter provides participant-reported assessments of the representativeness of the groups participating in each workshop; and the discussion chapter provides an analysis of workshop outcomes and socio-economic data.

The self-reported assessments and the analyses of socio-economic and workshop data provide the following insights into the within-community generalizability of workshop findings with respect to core community values:

- The analysis of associations between socio-economic characteristics and workshop outcomes identified associations that would be logically expected based on a broad community survey. While the analysis is preliminary and does not account for possible spuriousness, it does suggest that the workshops can be used to draw preliminary conclusions about broader community values. Examples of logical associations include:
    - Positive linear association between the priority placed on *Education* (based on mapping and ranking exercises) and the shares of households in the four participating communities with children and youth.
    - Positive linear association between the priority placed on *Health* (based on mapping and/or dot voting), a critical factor affecting household expenses, and the unemployment rates and percentages of owner-occupied and renter households that spend 35% or more of their income on housing costs in the four communities.
- The analysis of workshop data revealed no significant bias in terms of higher prioritization of goals and values that are most closely aligned with the central issues. Observations made during the workshops suggest that this finding is a result of careful attention to the issue of representativeness in pre-workshop activities, workshop design and flow, and active facilitation. Specifically:
    - The facilitation team noted that where the central issue had a relatively narrow emphasis (e.g., recreational environment) participants were more likely to focus on goals that were closely aligned with the central issue (e.g., *Health*).
    - With active facilitation, the team noted that even where participants started with a narrow focus, participants were willing and able to broaden their focus and, in general, understood and saw the value of "building the foundation" (i.e., Part 1 of the workshop) before focusing on the central issue.
- The comparative analysis of mapping, dot voting, and ranking exercises suggests that the different types of exercises provide useful and complementary information for generalizing workshop outcomes to the whole community. The ranking exercise may be a most accurate expression of core community values. The mapping and dot voting exercises complement the ranking exercise and provide information needed to develop sustainability indicators. The progression through the exercises builds understanding and improves the validity of the workshop outcomes.

Regardless of these preliminary findings, the ability to generalize the results of community engagement workshops, including community-led workshops, to the whole community will be improved by holding multiple workshops at different times of the day, week, and year and by holding workshops in different forums. This type of approach will allow for broader community input and will also help distinguish transient and more stable core community values. In order to support this approach, techniques would need to be developed for aggregating data across workshops to weigh input appropriately and account for temporal effects.

Generalize to communities of similar type

One of the goals of the community engagement workshops was to provide information to assess approaches for classifying communities in ways that link available ecosystem goods and services to core community values. While it is difficult to draw conclusions from the small number of workshops given the complexity of the research question, the community workshops highlighted the following considerations:

- Findings from the workshops affirm the logical presumption that community values are influenced by a complex mix of history, culture, setting and socio-economic characteristics, and trends. Workshop observations and data analyses suggest that community values are informed by historical, cultural, and environmental context; react to socio-economic trends; and involve systematic relationships among values associated with means versus end goals. This highlights the importance of a multi-dimensional approach to community classifications that link characteristics, such as the availability of ecosystem goods and services, and values.
- The strength of the relationship between ecosystem services and community values may be moderated by important factors, including factors that create inequities in benefits derived from ecosystem services. For example, comments made by participants in the Pensacola, FL, and Vero Beach, FL, workshops indicate that ecosystem services provided by the beach and other natural settings benefit residents unequally. This suggests the importance of accounting for these moderating factors in a CCS based on ecosystem goods and services.
- Workshop observations and data analyses suggest the importance of considering at least three different dimensions when considering community values hierarchies and associated classification systems:
    - Historical, cultural, and environmental contexts that define a common frame of reference for members of the community and could correspond to core values that remain relatively stable over time.
    - Demographic, economic, and other social characteristics that are more likely to change over time and affect the values hierarchy by emphasizing more transient, but important community values.
    - Foundational values that correspond to goals that communities believe are necessary prerequisites for achieving and sustaining other outcomes that correspond to important community values (e.g., *Education*, *Health*).
- The above findings suggest the following implications for the structure and substance of a classification system linking community characteristics and values:
    - Certain community socio-economic and other demographic characteristics could have strong influences on community values and may account for changes in values

hierarchies over time. Based on the preliminary analysis, these could include age distribution, population stability, urban form, socio-economic status, and affordability.

- Participant input during the workshops clearly suggests that historical, cultural, and environmental contexts provide a common framework for community values. However, the analysis of workshop outcomes suggests that these contextual factors may be eclipsed by more immediate and dynamic socio-economic concerns. A multi-level approach that groups of communities by context (level 1) and includes variables within grouping (level 2) could be effective in establishing a classification system that respects these important dimensions and accounts for temporal influences on community values.
- While certain contextual and socio-economic characteristics could help explain the most significant influences on community values, other factors could mediate the relative priorities of values. These could include factors associated with community-specific stressors that are viewed as "thresholds" to achieving core community goals. It is likely that a stronger evidence base would be needed to compile sufficient information for considering these factors.
- In developing a community classification system, it will be important to consider the metrics and data sources used to populate variables used to classify communities, including geographic resolution, data collection frequency, sensitivity, and recognized validity. The challenge for contextual variables may be defining metrics that sufficiently distinguish different settings. The challenge for socio-economic variables may be identifying data sources that capture information at an adequate geographic resolution and frequency to classify communities in a meaningful way.

- The CCS developed as a part of this study is consistent with these ideas. The context of a particular community will have to be taken into account in comparisons among CCS groupings.

4.2 Keyword-based analysis of community planning documents

4.2.1 Introduction

Many communities have invested significantly in the compilation of strategic planning documents intended to help support current and future decision making. These documents usually involve a thorough examination of the community including solicitation of stakeholder input similar to the workshops described in Chapter 4.1. It should be possible to describe stakeholder priorities and community fundamental objectives, and ultimately measures of sustainability success, from an examination of these documents. Text-based analysis and comparison of documents based on word frequency is a well-established technique in lexicographic research (Ball 1994, Berber Sardinha 1996). However, strategic planning documents are not standardized with respect to organization, content, or scope and these issues must be considered before any meaningful comparison is possible. In this chapter, a keyword analytical approach was used to examine community strategic planning documents with the objective of obtaining data on community fundamental objectives similar to that obtained in Chapter 4.1 from direct engagement. The objective in this chapter is to validate an analytical approach, use that approach to generate results for a core set of communities, and then compare the outcomes both between communities and to those reported in Chapter 4.1.

4.2.2 Methods

The keyword analysis of strategic planning documents proceeded in three steps. First, the keyword list was created and validated through comparison of outcomes from a test set of strategic planning

documents. Initial keyword selection was based on the eight domains of the human well-being index (HWBI, Chapter 3). Second, the keyword list was refined and finalized based on observed outcomes from this validation analysis. Finally, the completed keyword list was used to analyze a new set of comprehensive planning documents obtained for 58 communities (city or county level) in the southeastern United States. The keyword list was initially created based on an examination of five index community planning documents (Table 4.10). Keywords were extracted from these documents by a development group (n= 4 people) based on their expert knowledge of the domains in the HWBI. The development group created the initial keyword list through a line by line examination of a comprehensive plan for Moss Point, MS (Table 4.10). Word selection was based on previous keyword development experience of the expert group and a consensus that chosen words clearly reflected a community value or priority rather than a narrative or an external expert opinion. This initial list was then culled by collective discussion among the development group to create a test keyword list, which was then subjected to validation.

Table 4.10 Strategic planning documents used for the validation of the keyword list used in this analysis. See Chapter 4.2.2 for details. *Document for Moss Point, MS, is at the civic level and was used for initial assembly of the keyword list but not for validation.

County	State	Source Agency	Comprehensive Plan Link
*Moss Point	MS	Mississippi Gulf Coast Sustainable Communities Initiative	Moss Point Comprehensive Plan; accessed 15 September 2016
Jackson	MS	Jackson Planning Commission	Jackson County Planner Toolkit; accessed 15 September 2016
Jefferson	FL	Jefferson Planning Commission	Jefferson County Comprehensive Plan; accessed 15 September 2016
Terrebonne	LA	Terrebonne Parish Planning and Zoning	Terrebonne Parish Comprehensive Plan; accessed 15 September 2016
St. James	LA	St. James County	St. James Parish Comprehensive Plan; accessed 15 September 2016
Wayne	PA	County Commission	Wayne County Comprehensive Plan; accessed 15 September 2016

*civic plan rather than county

Validation of the test keyword list involved the comparison of manual (i.e., by a person) evaluation of new strategic planning documents to a keyword-based evaluation of the same documents. The test keyword list already described was evaluated by comparison of automated and manual reads of six strategic planning documents not previously used for development of the keyword list (Table 4.10). The automated read proceeded as described below with the test keyword list. The manual read was completed by a selected group of five validators each of which read one or two of the five documents. The validators were asked to extract any statement that they considered a match to a domain of the HWBI. The validators worked independently and were not given the keyword list prior to completing their analysis of a document.

Once the manual read was complete the validators met as a group to review and evaluate the results of the manual read. The results were reviewed for disparity between individual manual reads of the same document for any domain and questionable matches were discussed and reconsidered for inclusion by the group. The final results of the two manual reads were combined for each document and compared to

the results of the automated read. The manual and automated reads were compared and evaluated for agreement based on three metrics: relative importance of the eight domains for each document measured as proportion of total matches per read, number of statements per document found in both read types, number of statements per document found in manual but not automated read, and vice versa. These results were examined by the validator group and the keyword list was further amended to improve agreement between the manual and automated reads. For the purposes of amending the keyword list (Appendix D), the manual read results were considered most representative of HWBI domain categories.

Once the set of keywords was labelled as final by the validation group, a separate set of community comprehensive planning documents (Appendix C) was selected and examined using the automated keyword search combined with the final keyword list. This set of community planning documents was selected from a systematic search of all counties in the southeastern United States, bordering the Gulf of Mexico. The documents were found on county websites; if none were available, the county was excluded. Plans were downloadable in PDF format, either uploaded as images or text. When uploaded as images, Adobe Pro's Optical Character Recognition was used to change the PDF images into text format. In each case it was necessary to convert the PDF file (.pdf) into a text file (.txt) before keyword analysis. Formatting issues and unnecessary information (e.g., historical narrative) were manually corrected to minimize file conversion errors. Since the objective was to evaluate priorities for future community actions, narrative elements, such as tables, figures, background history, table of contents, and appendices, were all manually removed.

The refined documents were analyzed with an original text search algorithm written in the software package R (R Project; accessed 16 September 2016). The R-script was used to extract statements containing the selected keywords. The R-script (Appendix E) reformatted each document into one continuous text string and then separated the string into lines by periods, semi-colons, colons, tabs, question marks, and exclamation points. The R-script then searched the separated lines individually for select keywords. Selection was further parameterized by "near" and "exclude" words identified during the validation process. Phrases were only selected as hits if they included a keyword and a near word. If one of the exclude words was in the phrase it was not counted as a hit. Each HWBI domain had a unique set of keywords chosen to characterize that domain and each keyword had multiple near and exclude words to further refine domain-specific hits. Near and exclude words were initially identified during the examination of the manual reads, but were further refined during the automatic read. To accomplish that, all of the current near words were added to the exclude list. By eliminating the words typically returned, the remaining phrases could be evaluated to create a more thorough compilation of near words to better encompass the keyword.

Three different metrics were created by the R-script: a count of hits at the indicator level, a count of hits at the domain level, which comprised hits for all indicators nested under each domain, and a complete list of every statement categorized as a hit. During the validation phase, the last of these was manually reviewed to verify the R-script was pulling phrases that fit the intent of the keywords. If a keyword was pulling hits established as 'false' upon review, the near and exclude words were altered to maximize positive hits.

Duplicate hits (i.e., same phrase containing multiple keywords and chosen twice for the same domain) were removed via the R-script for each indicator and domain. The hits were totaled at the domain level for each separate planning document. To take into account varying lengths of planning documents, domain hits were normalized per 100 total hits per document. Data from all planning documents were then combined, summarized, and compared by U.S. state, CCS group (Chapter 2), and differences in population size, median income, median age, educational attainment, and racial composition of

communities. In addition, the combined dataset was analyzed with a principal components analysis (Zar 2010) in order to examine broader patterns involving multiple independent variables.

4.2.3 Results

Keyword list validation – Keyword selection proceeded as described with an initial list of words selected from a detailed review of the planning document for Moss Point, MS (Table 4.10). This document was selected as indicative of strategic planning efforts to be targeted for the general analysis and contained a maximum comprehensive list of focal areas under consideration. Review of this document resulted in a list of 122 keywords each having between one and 15 near and exclude words respectively. This initial list was reviewed by the panel and adapted into the test keyword list for validation (Appendix D).

Validation of the keyword list proceeded with analysis of six test planning documents selected randomly from a working list of publically-available planning documents (Table 4.10). Overall the largest normalized difference in hits between manual and keyword reads were observed in the *Living Standards* domain (Figure 4.7). This domain had a difference exceeding 20% for three documents and exceeding 30% for one (i.e., Wayne County, PA). Maximum normalized difference was below 15% for all other domains and documents. *Living Standards* also had the most overall hits among the eight domains with an average of 38 hits per document. Another notable difference was that for *Living Standards* the difference was positive for the manual read meaning the manual results were higher than the keyword results. With the exception of the Wayne County document, the majority of the other differences were negative for manual read. The greatest disagreement in results between documents occurred in the *Social Cohesion* and *Safety and Security* domains where three documents were positive for manual read and three were negative. For a specific document Wayne County showed the most disagreement with the other documents showing differences in both sign and magnitude for six of the eight domains.

Photo courtesy of USEPA

Figure 4.7 Summary of normalized differences between keyword and manual reads of selected test documents. Zero indicates perfect agreement, while positive and negative results indicate more or less hits respectively in the keyword analysis for a particular domain. Labels indicate county name followed by state abbreviation. Jackson County, MS, includes separate analyses at county and neighborhood scale.

To further look into the agreement between the human and automatic reads, a line by line examination was done to match individual phrases between read types (Table 4.11). Agreement is similar when comparing human and automatic reads to human and human reads when able. In most cases, there were only one to four matching phrases per domain and document between reads. Of three planning documents with two human reads each, there were three instances where human to human agreement was noticeably higher than human to automatic reads. Two of these occurred in the *Living Standards* domain while the other one was in *Leisure Time*. In contrast, there were five instances where human to automatic reads were noticeably higher than human to human reads. These occurred twice in *Health*, then once in each *Education*, *Safety and Security*, and *Social Cohesion*.

Table 4.11 Summary of line by line matches between keyword and manual reads of test documents organized by HWBI domains. See Chapter 4.2.2 for details.

	Keyword Only	Human Only	Both	Total
Connection to Nature	26	25	4	61
Cultural Fulfillment	20	28	3	55
Education	39	20	14	94
Health	19	31	13	77
Leisure Time	55	33	10	121
Living Standards	68	196	23	338
Safety and Security	43	63	29	180
Social Cohesion	57	101	15	195

In the *Connection to Nature*, *Cultural Fulfillment*, and *Education* domains, the final keyword list produced results that were more similar to the human read than the original keyword list. *Health*, *Safety and Security*, and *Social Cohesion* saw slight deviations, but all reads remained within about two hits of each other. Only in the *Leisure Time* and *Living Standards* domain were the original keyword results closer to the human reads than the final keyword results. Keyword list finalization involved selection of the list that generated maximum matches between human and automated reads with a primary focus on proportional importance of domains and a secondary focus on line matches.

Community comparison of keyword analysis – Keyword-based analysis of 58 planning documents indicated important differences among domains in a community's stated priorities based on normalized keyword hits for each HWBI domain (Table 4.12; Figure 4.8). Median proportion of hits across the eight domains were split into three levels of representation: low, medium, and high for comparison. *Cultural Fulfillment* (median value: 3.18) and *Health* (4.82) were consistently the least mentioned domains. By contrast, *Living Standards* (23.61), *Safety and Security* (17.36), and *Leisure Time* (15.32) were mentioned most often. In the middle were *Education* (8.46), *Connection to Nature* (9.45), and *Social Cohesion* (12.37). *Living Standards* consistently had the highest median value across all documents analyzed (Table 4.12).

Table 4.12 Summary of normalized keyword hits organized by domains of the human well-being index. See text for details.

	Min Value	First Quartile	Median Value	Third Quartile	Max Value
Connection	0.00	5.59	9.45	12.73	19.57
Cultural Fulfillment	0.00	1.66	3.18	6.16	15.00
Education	0.00	6.82	8.46	11.88	28.33
Health	0.67	3.22	4.82	6.49	12.55
Leisure Time	2.86	10.66	15.32	17.78	31.54
Living Standards	12.71	19.29	23.61	29.78	70.29
Safety and Security	0.00	12.83	17.36	22.72	35.51
Social Cohesion	3.43	8.00	12.37	18.69	33.15

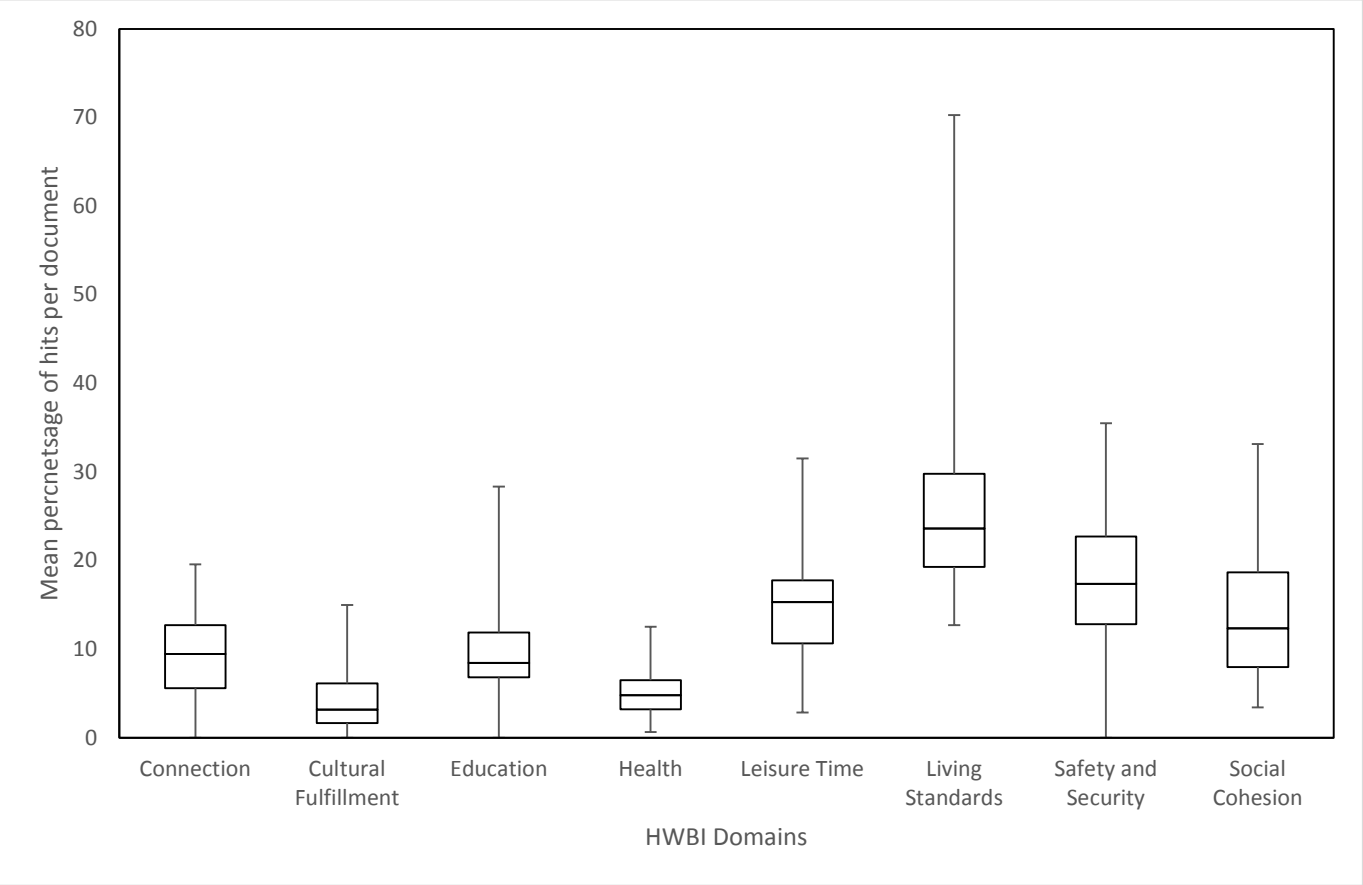

Figure 4.8 Summary of the median across all documents analyzed (58) for normalized hits per domain of the human well-being index. Bottom and top of boxes indicate 25th and 75th percentile respectively and bottom and top whiskers indicate the 5th and 95th percentile respectively.

Similar patterns among domains are seen when data are organized by state, but differences were evident between communities grouped by state (Table 4.13). Of the states with more than five documents analyzed (Florida, Mississippi, and Louisiana), each had *Living Standards* as the most represented domains. Florida and Mississippi both had *Safety and Security* as the second most represented domain, whereas Louisiana had *Social Cohesion* ranked second with *Safety and Security* ranked third near *Education*. Of the three states, Florida had the highest score for *Safety and Security* (19.92) compared to Mississippi (17.78) and Louisiana (12.44). In contrast, Louisiana had the highest score for *Social Cohesion* (19.40), with a notable difference for Florida (10.73) in this domain. An opposite difference was seen for *Leisure Time*, with Florida (16.96) and Louisiana (9.87). Louisiana also had the highest score for *Health* (6.19) and *Education* (12.31) in comparison to Florida, which had the highest score for *Connection to Nature* (10.65).

Table 4.13 Summary of mean normalized keyword hits for the domains of the human well-being index organized by U.S. state. See Chapter 4.2.2 for details.

State	FL	MS	LA	AL	GA	TX
Count	36	6	11	2	1	2
Connection	10.65	5.50	8.09	5.63	7.41	4.74
Cultural Fulfillment	3.60	6.14	6.05	2.11	3.17	5.11
Education	8.43	10.31	12.31	5.59	13.23	6.17
Health	4.90	5.53	6.19	4.16	2.65	4.30
Leisure Time	16.96	13.13	9.87	12.05	15.87	15.39
Living Standards	24.81	24.50	25.65	50.14	14.81	20.66
Safety and Security	19.92	17.78	12.44	10.48	17.46	20.40
Social Cohesion	10.73	17.12	19.40	9.84	25.40	23.24

When the data are compared among CCS groups as described in Chapter 2 (Table 4.14), *Living Standards* is either the most or second most represented domain in each CCS group, while *Cultural Fulfillment* and *Health* remain the least represented domains similar to the overall results. Yet, among the CCS groups with at least five documents (Groups 1, 3, 5, and 7) there also were some important differences. Community classification system Group 1 stands out for *Connection to Nature* with the lowest score of 6.57, whereas CCS Groups 3, 5, and 7 each have scores around 11. Community classification system Group 3 stands out in the *Cultural Fulfillment* domain with a higher score than Groups 1, 5, or 7. *Education* has a larger range among the typologies, with Group 5 (6.69), 7 (7.64), and 3 (8.69) lower than Group 1 (12.33). Wide ranges were present for both *Living Standards* and *Leisure Time* (Table 4.14). Classification system Group 5 was noticeably lower in the *Social Cohesion* but higher than the other groups in *Safety and Security*. Classification system Group 1 is the urban/suburban category, while Groups 3 and 5 are the most rural. Group 7 is largely suburban but is characterized by a higher median age and being located almost entirely in the Florida. These differences are largely congruent with the urban to rural delineation of communities.

Table 4.14 Summary of mean normalized keyword hits for the domains of human well-being index organized by coastal CCS groups. See Table 2.1 for description of community classification system groups. (Table omits the six city comprehensive planning documents).

Coastal Cluster Group	CG 1	CG 2	CG 3	CG 4	CG 5	CG 6	CG 7	CG 8
Document Count	13	3	9	2	8	1	14	2
Connection	6.57	10.10	11.50	10.36	10.19	16.00	11.12	2.49
Cultural Fulfillment	3.61	5.94	5.89	2.40	3.26	1.00	3.56	4.22
Education	12.33	11.23	8.69	9.46	6.69	13.00	7.64	15.37
Health	5.15	4.99	6.47	3.68	6.12	2.00	4.35	9.52
Leisure Time	10.05	14.37	15.43	14.94	22.32	23.00	15.40	7.79
Living Standards	30.37	19.69	21.88	35.83	21.21	22.00	26.23	29.92
Safety and Security	17.21	13.54	16.48	15.70	20.55	19.00	18.10	15.15
Social Cohesion	14.71	20.14	13.68	7.62	9.66	4.00	13.61	15.53

Of the demographic variables available for comparison across communities, Educational attainment of a community offers some interesting differences in community priorities. When the communities are grouped by percent of residents 25 and older with a high school degree or higher or by percent of residents 25 and older with a bachelor's degree or higher (Table 4.15), similar trends are observed in number of hits by domain. In each case, a higher score in *Cultural Fulfillment* is associated with a higher level of educational attainment. Similarly, counties with the lowest levels of per capita education completion had fewer keyword hits for *Social Cohesion* than counties with the two highest levels of education completion. The reverse of this is true when looking at *Education* and *Living Standards*, lower levels of education had the higher scores for these domains.

Table 4.15 Summary of mean normalized keyword hits for the domains of the human well-being index organized by proportion of adults citizens with either a high school diploma or a bachelor's degree in 2000 (U.S. Census Data**; accessed 14 September 2016).** See Chapter 2 for description of community classification system groups.

	High school degree or higher >80	High school degree or higher 70-80	High school degree or higher 70>	Bachelor's degree or higher >20	Bachelor's degree or higher 10-20	Bachelor's degree or higher 10>
Connection	8.07	9.85	9.97	9.03	8.61	11.63
Cultural Fulfillment	5.17	4.11	3.16	5.01	4.39	2.77
Education	8.64	9.22	10.49	8.07	9.99	8.93
Health	4.90	5.73	4.31	5.08	5.45	4.03
Leisure Time	14.99	14.86	15.20	15.46	13.61	18.92
Living Standards	24.12	25.76	27.51	23.06	26.17	27.72
Safety and Security	20.13	15.07	19.61	19.96	16.99	17.42
Social Cohesion	13.97	15.39	9.77	14.32	14.78	8.59

*Table omits the six city strategic planning documents.

Keyword hits also differed among communities by median income, population size, median age, and demographics, but in a pattern seen in other variables, particularly the CCS groups (Tables 4.16 and 4.17). Scores for *Social Cohesion* and *Cultural Fulfillment* were highest for a median income over $50,000 and the lowest score for median income less than $40,000. *Safety and Security* and *Living Standards* have the opposite pattern, with the highest scores associated with the lowest median income. Incomes of less than $40,000 also had the highest score for *Leisure Time*. *Education* was similar across all income levels. County population size was broken down into three categories; counties with a population greater than 150,000, between 50,000 and 150,000, and less than 50,000. Higher populations were associated with lower scores for *Leisure Time*. The most variance came from counties between 50,000 and 150,000 people, which had the lowest scores for *Connection to Nature* and *Safety and Security*, as well as the highest score for *Living Standards* and *Education*. Median age was split into two categories (> 40 and ≤ 40) and the older group scored higher for *Connection to Nature* and *Leisure Time*, while the younger group scored higher for *Education*. Ethnic diversity was measured by relative proportion of Caucasian, African-American, and Hispanic citizens. As the percentage of African-Americans increases the scores for both *Leisure Time* and *Connection to Nature* decrease. The opposite is true for *Social Cohesion*, which increases as the percentage of African-Americans in a county increases. As the proportion of Hispanics in a community increased the *Social Cohesion* decreased. *Connection to Nature* is noticeably higher when the Caucasian proportion is 70% or greater. Higher percentages of Caucasians are also associated with a lower score for *Cultural Fulfillment* and *Education* and higher scores for *Safety and Security*.

Table 4.16 Summary of mean normalized keyword hits for the domains of the human well-being index organized by median income level, median age, and population size in 2000 (U.S. Census Data**; accessed 14 September 2016).** See Chapter 2 for description of community classification system groups.

	Median Income >$50,000	Median Income $40,000-$50,000	Median Income $40,000>	Median Age >40	Median Age 40>	Population >150,000	Population 50,000-150,000	Population 50,000>
Count	14	23	21	29	29	14	16	28
Connection	9.03	9.05	9.49	11.05	7.35	9.84	6.60	10.37
Cultural Fulfillment	5.33	4.37	3.58	3.62	5.01	4.43	4.57	4.11
Education	9.87	9.06	9.08	8.07	10.46	9.19	10.32	8.70
Health	4.45	6.19	4.40	4.95	5.29	5.32	5.40	4.86
Leisure Time	14.84	12.75	17.50	16.15	13.80	12.90	13.24	17.01
Living Standards	24.21	26.42	25.35	24.50	26.50	25.72	29.75	22.96
Safety and Security	15.45	17.88	19.63	18.66	17.20	18.99	16.40	18.28
Social Cohesion	16.81	14.27	10.97	13.00	14.38	13.61	13.72	13.71

When variance in all variables, including both community characteristics and keyword-based priorities by domain, are analyzed together the individual patterns are easily observed (Table 4.17), but there are interesting pairings among variables suggesting some useful linkages for interpretation. The principal components analysis demonstrated clear negative relationships between prioritization of *Leisure Time* and *Education* with prioritization of *Safety and Security* and *Connection the Nature.* This gradient was highly associated with a high median age and a high percentage of Caucasian residents, and a high CCS group number on the *Leisure Time* end. However, most interesting from this multivariate perspective was that this gradient was nearly orthogonal with prioritization of *Living Standards*, as well as mean income level and population size. The existence of two nearly orthogonal gradients in communities has some interesting implications for interpretation. Communities in the analysis were well-balanced between these two gradients in well-being with a slightly higher weight on the former (Figure 4.9).

Table 4.17 Summary of mean normalized keyword hits for the domains of the human well-being index organized by proportion of community self-reporting in three ethnic groups in 2000 (U.S. Census Data**; accessed 14 September 2016).** See Chapter 2 for description.

	Caucasian >80	Caucasian 60-80	Caucasian 60>	African-American >30	African-American 20-30	African-American 0-10	Hispanic >20	Hispanic 5-10	Hispanic 0-5
Count	13	26	19	16	20	22	16	13	29
Connection	9.38	10.45	7.36	6.89	9.26	10.83	9.76	10.56	8.28
Cultural Fulfillment	3.06	4.04	5.55	5.72	4.57	3.06	5.90	3.18	3.96
Education	8.11	9.27	10.06	11.21	9.05	8.04	9.04	7.80	10.04
Health	4.35	6.02	4.43	4.83	5.68	4.83	5.18	4.57	5.34
Leisure Time	16.42	14.99	13.98	13.16	14.61	16.63	16.13	19.28	12.41
Living Standards	26.25	23.38	27.89	27.20	24.13	25.50	24.30	23.43	27.09
Safety and Security	18.66	20.02	14.57	13.22	20.02	19.45	17.21	18.38	18.12
Social Cohesion	13.76	11.84	16.17	17.75	12.67	11.66	12.47	12.79	14.76

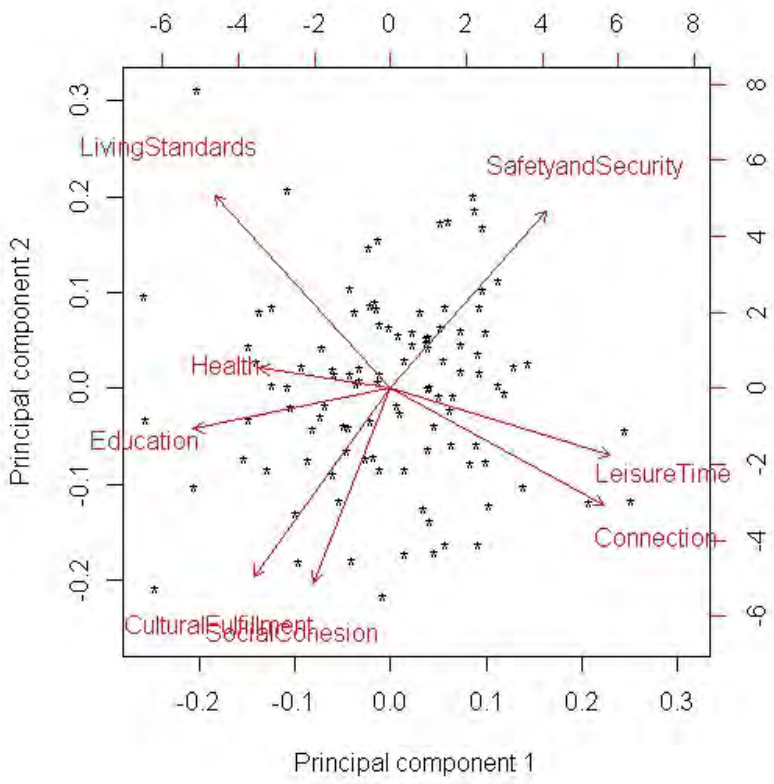

Figure 4.9 Plot summarizing results of a principal components analysis (PC) of normalized hits per domain of the human well-being index among with the full suite of independent variables considered (See Chapter 4.2.2 for details). Only Principal component 1 (x axis) and Principal component 2 (y axis) are shown. Arrows (red) indicate direction and size of loadings for independent variables on PC1 and PC2 respectively.

4.2.4 Discussion

Keyword analysis of strategic planning documents shows great promise as a contributing method for clarifying the long-term priorities of stakeholders. Validation results indicated keyword outcomes generally consistent with a manual read suggesting the approach can be used to interpret planning documents at least as well as a direct read of the same document. Clarifying community priorities from document analysis is limited by the scope of the document, as well as the level to which the document reflects community input rather than the input of elected officials or hired external experts. Yet, these issues can largely be minimized by appropriate document selection, so the process of reviewing and selecting documents for analysis should be reported for maximum value of the results. The keyword results were not biased by document length or text organization, which suggests a wide variety of documents can be potentially selected for analysis. Exact line-by-line matching of results between automated and manual reads was less consistent, but it seems the two methods get to the same interpretation even with some variability in exact phrases aligned with particular domains. The manual reads were somewhat inconsistent, which created a lot of the discrepancy and suggests an objective keyword approach should generate more consistent results than interpretation of a document by multiple individuals.

Keyword analysis is an effective technique for analysis of large documents such as the planning documents considered here, but the technique requires careful analysis. Keyword analysis has been commonly used to compare documents and *corpora* for similarity (Berber Sardinha 1996, Peirsman et al. 2010), to look at word frequency in lexicographic studies (Kilgariff 1996), and use of automated tools is a well-developed analytical technique (Ball 1994). However these approaches typically involve analysis of word clusters without pre-defined meaning (Berber Sardinha 1999). The planning document analysis approach is similar in execution, but is dependent on the use of specific words groups with pre-assigned meaning. This makes the analysis more dependent on manual vetting of word lists, such as the validation procedure described earlier (Ball 1994). Therefore, keyword analysis can be very useful, but its limits must be carefully considered in drawing conclusions.

A key consistency among communities in this analysis was the importance of quality of life metrics to stakeholder priorities. Across communities and community types the consistently dominant domains, in terms of total number of keyword hits, were *Living Standards* followed by *Safety and Security* followed closely by *Social Cohesion* and *Leisure Time*. An interest in quality of life seems to be a common community attribute, which is not surprising. The consistent low scores for either *Connection to Nature* and *Health* were surprising, but suggest these are not community-level priorities (i.e., not highlighted in comprehensive plans) but may be important at a different scale (e.g., personal/family). For instance, even in cases where an action may directly benefit human health (e.g., investment in hospitals) the community-scale priority for the action may not be directly tied to health, but rather to ancillary benefits more aligned with community-scale priorities such as job creation, reductions in burden on public services, or community reputation. These differences can be important to setting measures of success at the appropriate scale. It is also important to understand if these results differ among community types (Bagstad and Shammin 2012).

The dominant delineations for stakeholder priorities at the community level were between states and CCS groups (Chapter 2). The state comparison made here is limited to three states in the coastal Gulf of Mexico region (LA, MS, and FL), but this allows for a useful comparison of state differences to differences in other categories. For CCS, four groups could be meaningfully compared. States differed most for *Safety and Security* and *Social Cohesion*, while CCS groups differed most in *Living Standards* and *Leisure Time*. The less commonly mentioned domains such as *Connection to Nature* were more important in specific categories such as median age and ethnic composition of the community. The broader categories, such as CCS, are not independent from these specific categories (e.g., demographics) as these data were also used as a part of the CCS score calculation (Chapter 2). However a lack of pattern at the CCS level suggests these issues are more individualistic in nature and may not drive community decision making other than to crystalize individual interests.

The value of understanding these differences among groups is to identify the domains of human well-being for which the CCS or geographic delineations are the most informative. These most informative differences lie on a gradient from an emphasis on *Safety and Security* and *Living Standards* on one end to an emphasis on *Leisure Time* and *Social Cohesion* on the other end. This generalization is supported by both the categorical results, as well as the multivariate analysis of all domains together. This gradient is also consistent with an urban to rural gradient in that it is directly related to population size, and demographics as 'ruralness' tends to be related to an increased emphasis on social connectivity (Bagstad and Shammin 2012, Smith and Clay 2010). As communities become more urban, more diverse, or less dependent on local natural resources, they also tend to have a higher median income and a higher overall education level, which is consistent with, but not dependent on increasing urbanization. They also seem to prioritize *Safety and Security*, *Living Standards*, and *Connection to Nature*; and reduce priorities for *Social Cohesion* and *Education*. The inverse relationship between educational attainment in a

community and their interest in *Education* was surprising but fairly consistent, which suggests it is a real trend among groups.

In absolute terms the most informative delineation of keyword data at the community scale is for CCS groups followed by state differences, but other delineations become more important at smaller scales within the community. Domains such as *Connection to Nature* and *Education* do not parse out very well at the community scale, as indicated by the lack of difference among communities for these domains, and the lack of information about them contained in categories such as CCS and geography. Nonetheless, they can be quite important in driving individual priorities and so have a collective influence at the community level not well captured by review of community planning documents. As such, it is not advised that any conclusions can be drawn about community priorities for these domains with a keyword-based method. Better data may be obtained if more specific documents were used for the analysis and this is a topic for future study. These findings strongly suggest that keyword analysis combined with a CCS based comparison can be very informative regarding differences in the relative importance of community-scale priorities such as *Social Cohesion*, *Living Standards*, *Leisure Time*, and *Safety and Security*. Beyond the specifics, it is evident that communities differ in how they rank and prioritize the domains of human well-being and these differences are predictable based on community type. This indicates the value of community delineations for informing the decision process. However, it also indicates that measures of success can only be partially generalized and the very definition of human well-being may differ among community types as has been pointed out in the past (Bagstad and Shammin 2012, Moller et al. 2015). Such differences must be kept in mind when comparing the objective well-being across communities, particularly along the urban to rural gradient. Therefore, use of this technique in the future should focus on improving the understanding of how community type may inform differences in the importance of the domains of human well-being that can be used to both develop and assess decision options at the community level.

4.3 Engagement conclusions

In this section, two methods for obtaining stakeholder input on community level priorities were explored. The human well-being index (HWBI) was used as a framework for engagement in each case, but the source of information was very different. In Chapter 4.1, a workshop approach is described based on structured decision making (Structured Decision Making; accessed 16 September 2016), while in Chapter 4.2 an automated analysis of strategic planning documents is described based on keyword counting method. Both methods have advantages and disadvantages for identifying stakeholder priorities, but more importantly they may be highly complementary methods that should be considered for paired application.

Key differences were observed in the outcomes of these two methods when they were applied to the same communities across community type (Figure 4.10). The workshop method generated more diverse findings that nonetheless consistently reported high importance in the domains of *Education* and *Social Cohesion*. In contrast, the keyword method was always dominated by the *Living Standards* domain, which is the primary economic domain of the HWBI. In terms of meaning, the keyword results are based on strategic planning, which is predictably action-focused and heavily weighted to economic aspects of a community's well-being. In contrast, workshop results show a broader influence and this is likely the result of facilitation and the separation of community priorities from a particular action (Chapter 4.1). However, if one removes the *Living Standards* domain from the keyword results, the relative importance of the remaining domains is highly congruent with workshop results (Figure 4.10). Therefore, the findings of the keyword analysis can be thought of as hierarchical with the secondary outcomes being more similar to workshop outcomes. There is, thus, strong support for the complementarity of the two methods.

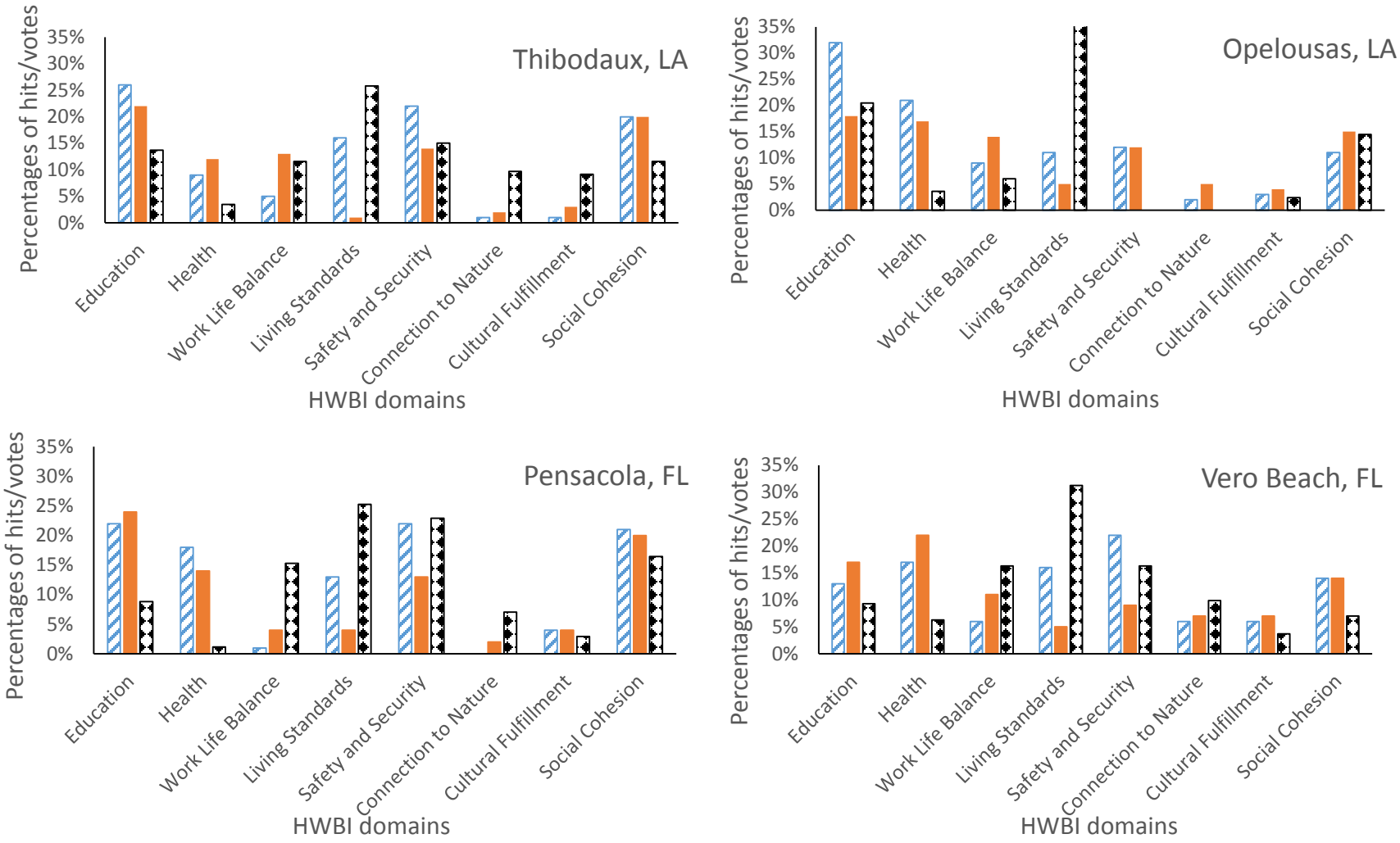

Figure 4.10. Summary comparison of combined results from workshops (Chapter 4.1) and keyword analysis (Chapter 4.2) in four focal communities. Community name is given in each panel. Three bars are results from an individual ranking exercise during the workshop (hashed; WS rank), results from a group voting exercise during the workshop (solid; WS dot vote), and results of the relative proportion of hits from the keyword analysis (diamond; Keyword). Details of these data can be found in the respective chapters.

This complementarity is also highlighted in the advantages and disadvantages of each engagement method. The keyword method is based on existing and vetted information obtained from extensive discussion and feedback of community stakeholders. Often the values reported in these planning documents are the results of months of stakeholder engagement occurring in multiple forms (e.g., workshop, mail survey, interviews). However, the information is usually obtained in a very constrained way based on particular issues of current importance to a community. The information is also filtered through community leaders and sometimes outside experts, and may be packaged to meet pre-conceived objectives. Further, the findings are dependent on the keyword list which must be vetted and tested prior to use. In contrast, the workshop method is well planned and facilitated to obtain a broad representative outcome reflecting community priorities independent of any particularly issue. The information is therefore more comprehensive than what may be found in planning documents. However, the group of people contributing to a workshop is far smaller than for the keyword analysis and may not represent the entire community. In balance, a consistent result across the two approaches provides good support for the complementary nature of the data and the value of applying both methods simultaneously to identify community priorities.

The priorities were more consistent across communities than across community types. For both analytical methods, community type was most informative about the relative importance of low scoring domains of the HWBI such as *Connection to Nature* and *Cultural Fulfillment*. This is important information for scoring the HWBI and will be used to explore relative weighting within the HWBI, but the dominance of *Living Standards*, *Safety and Security*, *Education*, and *Social Cohesion* was consistent in both community type examined and so seems robust to categorization. Community-specific deviations were more evident, such as the dominance of the *Health* domain in Vero Beach, FL, and the *Living Standards* domain in Opelousas, LA. However, these community-level differences are to be expected and the overarching consistency of multiple domains across communities suggests important common themes that should be explored for their value in informing and measuring the success of community level decision support.

Photo courtesy of USEPA

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5 Ecosystem goods and services

5.1 Introduction

A critical element of community decision making is the actual and perceived value of goods and services being collected from the surrounding ecosystem. Available ecosystem goods and services (EGS) differ greatly in form and visibility to community stakeholders (Millennium 2005). For instance, a community may be highly aware of an extractive resource such as a fishery, as it may be an economic driver for the community. Yet, less visible services such as healthy swimmable waterways, or viewscapes and their contribution to community identity, may be just as important in driving community priorities. All ecosystem goods and services contribute in some way to community well-being, but those EGS most common across coastal communities that can be most useful for comparing communities and looking for common themes are of greatest interest. Therefore, this chapter focuses on a comparison of four focal communities (see Chapter 4) with respect to the availability of four critical EGS: flood protection, usable air, usable water, and stable climate. These four critical EGS are highly valuable to all coastal communities (Russell et al. 2013), but also highly dependent on local conditions with respect to land cover and quality (Barbier et al. 2011). First, the value and distribution of these core EGS in each community is characterized. Then, a across community comparison was conducted to look for patterns among community types.

5.2 Methods

Estimates of service delivery and value were collected in the four service categories for four selected counties in the coastal Gulf of Mexico region. The service categories were: flood protection, usable air, usable water, and stable climate. The four counties were used in the comparison and described in Chapter 1. Production rate and value of selected EGS were estimated based on the composition of land use, soils, impervious surfaces and canopy cover within each county and value based on decreased health care costs, social coast of carbon and replacement values (Russell et al. 2013). Land use was based on National Land Cover Dataset (NLCD, Homer et al. 2015) maps for each county. Rates and values for individual EGS were either obtained from the literature or calculated for each land use type based on secondary data. The land use maps were downloaded directly from the NLCD website and imported into ArcGIS (ESRI Version 10.1) as rasters. Data on impervious surface cover, canopy cover, and soil classification were also obtained as secondary data to NLCD (Table 5.1). In order to generate EGS values, each of the NLCD classes were selected by attribute and then exported as an individual map layer. This was necessary because the files from the NLCD websites are rasters, which prohibits them from being spatially joined. To match all data layers, canopy cover, soil type, and impervious surface map grids were extracted using NLCD land use masks created for each county.

Table 5.1 Summary of external data used in calculation of ecosystem goods and service delivery. Data were all downloaded separately for the four focal counties. See text for details**.**

Data	Source	URL
NLCD Land Use	NLCD 2011 Land Cover	National Land Cover Database 2011; accessed 15 September 2016
Denitrification Rates	See Table 5.5	N/A
Carbon Burial	See Table 5.6	N/A
Impervious Land Cover	NLCD 2011 Percent Developed Imperviousness	National Land Cover Database 2011; accessed 15 September 2016
Canopy Cover	NLCD 2011 USFS Tree Canopy Cartographic	National Land Cover Database 2011; accessed 15 September 2016
Soil Classification	Soil Survey Geographic Database	USDA Web Soil Survey Database; accessed 15 September 2016
Curve Number	Zhang et al. 2011	N/A

5.2.1 Usable water and stable climate

The services usable water and stable climate were based on the effective sequestration or removal of excess nitrogen and carbon respectively as a function of land use category (Russell et al. 2013). The denitrification and carbon burial rates were average values for each NLCD category derived from a comprehensive literature review (Appendix F). Denitrification and carbon burial values selected for each of the NLCD categories (Appendix G) came from peer-reviewed literature sources, predominantly work located in the southeastern United States / Gulf of Mexico region. The rate values included in each average were individually selected based on relevance to the county, making the table county-specific wherever possible. The selected rates within all NLCD categories, except developed land, were then averaged as the overall rate. Coverage of NLCD categories for each county are given in Appendix G. Denitrification and carbon burial rates for the developed land classes required further calculations to account for the extent of impervious surface within each land use category. Denitrification and carbon burial rates for the developed land use categories were based on the literature-based average for open land (e.g., non-impervious) adjusted for the amount of impervious surface estimated to be present in a particular developed land-use category in a particular county. The impervious cover maps were downloaded directly from the NLCD website (Xian et al. 2011). To assign an impervious cover percentage to each pixel, the pixels were extracted by a mask for each of the NLCD classes created above. The impervious cover percentages for that set of pixels were averaged and recorded for each NLCD class per county and compiled into a master table. The denitrification and carbon burial rates for developed open space were first calculated as described above based on literature values. This average was then adjusted according to the following equation:

(1 - % Impervious) * (Mean denitrification or carbon burial rate for open space)

Which results in either a denitrification or carbon burial rate value per square meter. Since the percent impervious surface varies between each of the developed land classes, the rates are NLCD class and county specific. The usable water value is based on the NLCD category specific denitrification rates and was calculated using the following equation:

0.018 ($ / g N) * Denitrification Rate * (10,000 m^2 / ha)

The denitrification value term based on abatement costs of reducing nitrogen from point sources estimated at $8.16 / lb, which equals $18 / kg (Birch et al. 2011). The stable climate value is a parameterization of the mean carbon burial rate and was calculated using the following equation:

$1.3542 * 10^{-4}$ ($ / g C)* Carbon Burial Rate * (10,000 m^2 / ha)

The carbon burial value term was generated from the value of carbon removal: $37 / ton of carbon dioxide (Boscolo et al. 1998). Since the molecular mass of carbon dioxide (44.0095 g / mol) is 3.66 times as massive as carbon (12.0107 g / mol), the cost per ton of carbon is $37 * 3.66 = $135.42 / ton C.

5.2.2 Usable air

The usable air value is the representation of the decrease in health care costs resulting from removal of five common pollutants: carbon monoxide (CO), ozone (O_3), particulate matter (PM10), sulfur dioxide (SO_2), and nitrogen dioxide (NO_2) (Murray et al. 1994). The usable air service is based on the removal value per average canopy cover within a NLCD land use class. The canopy cover percentages were determined by extracting a mask of each of the NLCD land use classes from the NLCD canopy cover map downloaded from the NLCD website (Homer et al. 2015). The canopy cover percentages for each set of pixels were averaged and recorded for each NLCD class per county and compiled into a master table.

For each pixel, the removal rate for the particular pollutant was multiplied by the percent canopy cover, the area, and the estimated value of removal. These values were added together and consolidated in one equation as seen above to estimate usable air.

CO: (0.5 g / m^2 / yr) * (% Canopy Cover) * (1 ton / 1,000,000 g) * (Area in m^2) * (959 $ / ton) = $/yr

O_3: (5.8 g / m^2 / yr) * (% Canopy Cover) * (1 ton / 1,000,000 g) * (Area in m^2) * (6,752 $ / ton) = $/yr

SO_2: (2.4 g / m^2 / yr) * (% Canopy Cover) * (1 ton / 1,000,000 g) * (Area in m^2) * (1,653 $ / ton) = $/yr

PM10: (4.5 g / m^2 / yr) * (% Canopy Cover) * (1 ton / 1,000,000 g) * (Area in m^2) * (4,508 $ / ton) = $/yr

NO_2: (1.1 g / m^2 / yr) * (% Canopy Cover) * (1 ton / 1,000,000 g) * (Area in m^2) * (6,752 $ / ton) = $/yr

Which combine into the following overall formula:

Total: [(0.000713215 $ / m^2 / yr) * (% Canopy Cover) * (Area in m^2)] * (10,000 m^2 / 1 ha)

5.2.3 Flood protection

The flood protection service is the value of the grey infrastructure needed to be built to handle the amount of water from the average two year period storm event if the natural system were not present (Wang et al. 2013). This is based on the curve number, a function of soil type, for each of the NLCD land classes.

The soil type maps were based on the soil survey area (soil survey geographic database = SSURGO) data downloaded from the USDA website (U.S. Department of Agriculture 2015). Soils are classified into different hydrological groups, distinguished by letters A through D, based on soil texture. In Microsoft Access, the file was opened and the tables were imported into the soil's tabular folder. The component table was exported as a text file with a .csv extension. Once the component table was added to a GIS platform along with the original soil shapefile, the two were joined based on their map unit key (MUKEY) fields. All fields except the hydro groups and map unit keys were deleted. A new field, Max_Type_N, was added to the attribute table. Then, selecting by attribute from the hydro group field, all attributes with A or A/D type soil were assigned a value of 1 in Max_Type_N. The same applied for the other hydro groups: B or B/D, C or C/D, and D were assigned a value of 2, 3, or 4, respectively. The map was then exported as a new shapefile and the symbology was changed based on Max_Type_N value.

Curve number (CN) is an index that represents an area's ability to hold water. That is, after a rain event has begun and just before runoff starts to occur, how much water has entered the system. The lower a CN is, the lower its runoff potential. For example, a land use type with a CN of 30 has a very high water retention rate and a low runoff potential, whereas a land use type with a CN of 100 has a very low water retention rate and a high runoff potential. The curve number maps were based on the Max_Type_N values from the above Soil Type attribute tables and the NLCD class. According to Zhang et al. (2011) there are four potential curve numbers for each NLCD class based on the four different Max_Type_N values. To align these, a new field was added to the new Soil Type shapefile created above. It was populated by the following equation:

(100* Max_Type_N) + 2 digit NLCD code

This merges the two fields together to create a three digit code. The Zhang et al. (2011) table was reorganized in an identical fashion and the two tables were joined by code, assigning a curve number to each pixel which were then totaled for each county (Appendix I).

The Flood Protection Value was calculated using the curve number as described above and the following equation:

$[(0.05 * [(25{,}400/CN) – 254)] / (1{,}000 \text{ mm}/ 1 \text{ m})] * 70.629265 (\$/\text{mm}/\text{m}^2) / (30 \text{ yr}) * (10{,}000 \text{ m}^2/ 1 \text{ ha})$

This was generated from multiplying the depth of the water retained in the area that was affected and the value of water retention per cubic meter. This was achieved by converting the water retention value from $\$2/\text{ft}^3$ (Wang et al. 2013) to $\$ / \text{m}^3$ by multiplying by 35.3147, totaling $\$70.629265 / \text{m}^3$. The depth of the water retained in mm for each feature is (0.05 * (25,400 mm / Curve Number) – 254 mm). 30 year is based on the design lifespan of the grey infrastructure (Wang et al. 2013).

5.3 Results

The four counties examined differed in both the amount and distribution of NLCD land cover types (Figure 5.1). The three largest land cover types in Escambia County, FL (Pensacola), are Evergreen Forest (22.06%), Woody Wetlands (18.55%), and Shrub / Scrub (13.93%). Of the remaining twelve land cover types, seven of them are under 3% of the total land coverage individually. In Indian River County, FL (Vero Beach), the two most prevalent land cover types are Cultivated Crops (28.52%) and Woody Wetlands (27.02%). Similar to Escambia County, Indian River County has eight land cover types each under 3% of total area. Lafourche Parish, LA (Thibodaux), is even less diverse. The top three areal land cover types are Emergent Herbaceous Wetlands (42.57%), Woody Wetlands (22.29%), and Open Water (15.98%). There are nine land cover types that are each under 1% of the total land coverage. The three most dominate land cover types for St. Landry Parish, LA (Opelousas), are Cultivated Crops (39.49%), Woody Wetlands (32.07%) and Pasture / Hay (14.72%) (Table 5.2). Of the remaining land cover types, ten account for less than 1% individually of the total land area. It is important to note that the percentages are proportional values based on each county's total area. Escambia County and Indian River County are roughly half the area of Lafourche Parish and St. Landry Parish, respectively. For example, although woody wetlands was the second most dominate land cover type in both Escambia County and Lafourche Parish and differed by less than 4%, the areal coverage in Lafourche Parish was twice as much as in Escambia County. Furthermore, as a generality, all four counties are dominated by undeveloped or cultivated land with a consistently low percentage of development. This is important when considering the EGS on a per capita basis. There are also differences in the percentage of impervious land cover and areal canopy cover between the four counties. This is based on the amount of coverage of each for the pixels classified in each NLCD category. For example, impervious land cover percentage for Open Space of Escambia County is 8%, while it is 13% for Lafourche Parish (Table 5.3). Further highlighting differences, the percentage of areal canopy cover for woody wetlands in Indian River County is 57% and 90% in St. Landry Parish (Table 5.4). These differences have an effect on the values of usable water and air for each of the counties.

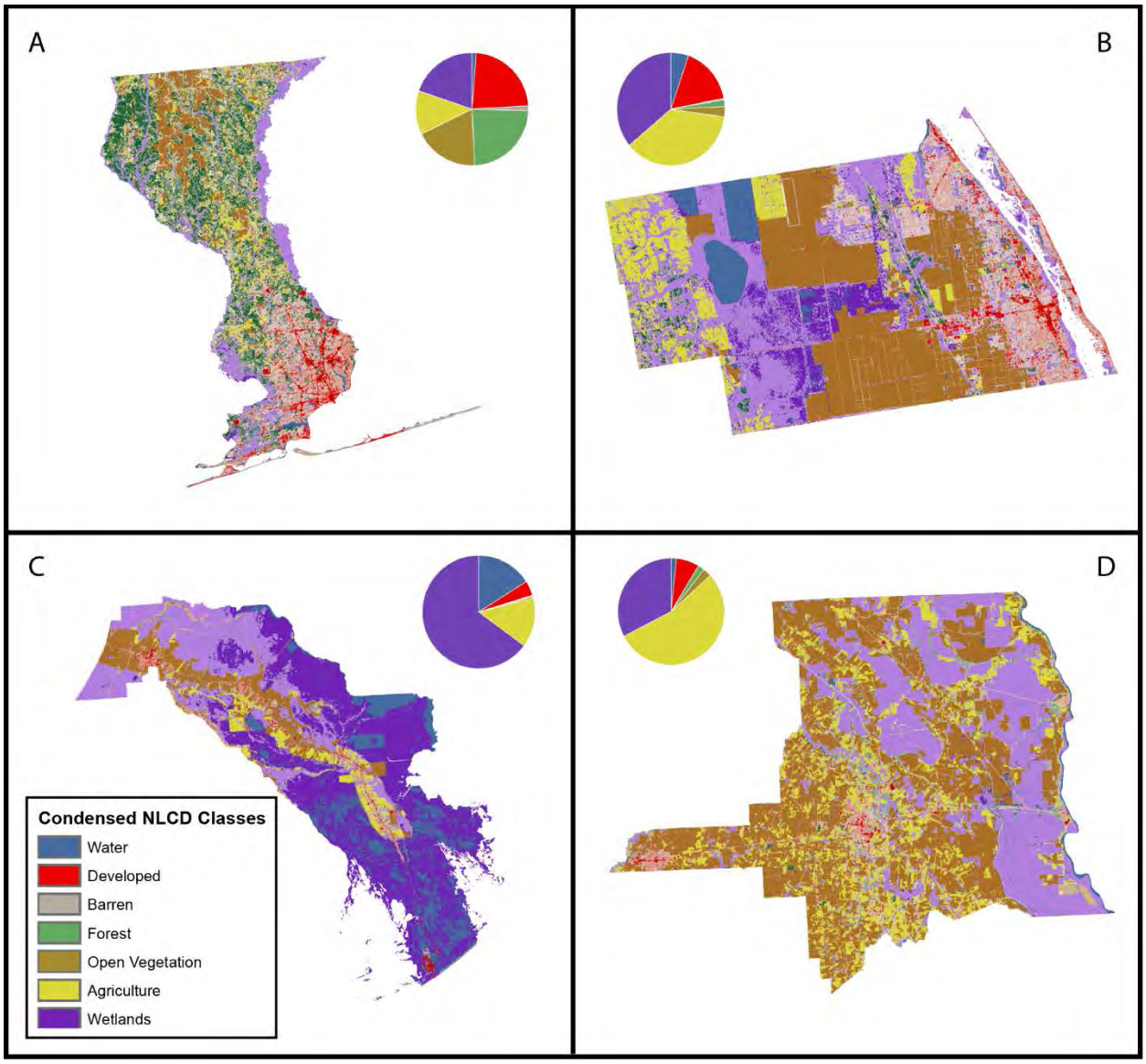

Figure 5.1 Maps showing National Land Cover Dataset (NLCD) coverage (See Table 5.2) for: (A) Escambia County, FL; (B) Indian River County, FL; (C) Lafourche Parish, LA; and (D) St. Landry Parish, LA. The NLCD classes were condensed for clarity to a single color for the legend and pie charts, but not for the maps. Water is Open Water; Developed is Open Space, Low, Medium, and High Intensity Developments; Barren is Barren Land; Forest is Deciduous, Evergreen, and Mixed Forests; Open Vegetation is Shrub / Scrub and Herbaceous; Agriculture is Hay / Pasture and Cultivated Crops; Wetlands is Woody and Emergent Herbaceous Wetlands.

Table 5.2 Total area and percentage of areal coverage of NLCD land cover categories for four counties. Water is Open Water; Op Spc is Open Space; L Dev is Low Intensity Development; M Dev is Medium Intensity Development; H Dev is High Intensity Development; Barrn is Barren; De For is Deciduous Forest; Ev For is Evergreen Forest; Mi For is Mixed Forest; Shrub is Shrub/Scrub; Grass is Grassland/Herbaceous; Pastur is Pasture/Hay; Crops is Cultivated Crops; W Wet is Woody Wetlands; E Wet is Emergent Herbaceous Wetlands.

NLCD	Escambia Area (ha)	Escambia Percentage (%)	Indian River Area (ha)	Indian River Percentage (%)	Lafourche Area (ha)	Lafourche Percentage (%)	St. Landry Area (ha)	St. Landry Percentage (%)
Water	2,122.74	1.23	7,112.79	5.32	48,129.84	15.98	3,926.97	1.61
Op Spc	20,562.48	11.88	11,869.47	8.88	2,047.05	0.68	6,698.16	2.75
L Dev	11,987.10	6.93	7,359.39	5.51	8,693.01	2.89	9,338.13	3.84
M Dev	4,974.93	2.87	2,460.51	1.84	1,179.99	0.39	527.58	0.22
H Dev	1,997.01	1.15	487.44	0.36	846.72	0.28	365.04	0.15
Barrn	2,452.05	1.42	536.94	0.40	784.44	0.26	38.25	0.02
De For	591.21	0.34	20.52	0.02	159.57	0.05	2,805.03	1.15
Ev For	3,8175.39	22.06	2,474.73	1.85	34.92	0.01	550.71	0.23
Mi For	2,471.85	1.43	137.88	0.10	124.65	0.04	1,460.61	0.60
Shrub	24,111.99	13.93	2,892.51	2.16	856.62	0.28	4,578.39	1.88
Grass	7,740.27	4.47	10,52.55	0.79	454.95	0.15	1,677.96	0.69
Pastur	6,766.29	3.91	10,948.14	8.19	13,532.67	4.49	35,805.60	14.72
Crops	14,955.12	8.64	38,175.93	28.56	28,982.79	9.62	96,048.36	39.49
W Wet	32,105.52	18.55	36,109.98	27.02	67,128.03	22.29	77,996.16	32.07
E Wet	2,071.26	1.20	12,016.71	8.99	12,8211.12	42.57	1,396.17	0.57
Total	**173,085.2**	**100**	**133,655.49**	**100**	**301,166.4**	**100**	**243,213.1**	**100**

Table 5.3 Percentage of impervious land cover in each of four counties. Data are based on published values from NLCD 2011 Percent Developed Imperviousness data for each developed land cover category. This is used in the calculation of denitrification and carbon burial rates for developed land classes.

NLCD	Escambia, FL Percentage (%)	Indian River, FL Percentage (%)	Lafourche, LA Percentage (%)	St. Landry, LA Percentage (%)
Open Space	8	8	13	12
Low Intensity Development	33	32	33	30
Med Intensity Development	61	59	61	62
High Intensity Development	87	86	85	85

Table 5.4 Percentage of areal canopy cover by land cover category for four counties. Data are calculations based on published values from NLCD 2011 USFS Tree Canopy cartographic data for each developed land cover category. This is a metric for the valuation of air quality.

NLCD	Escambia, FL Percentage (%)	Indian River, FL Percentage (%)	Lafourche, LA Percentage (%)	St. Landry, LA Percentage (%)
Open Water	0	0	0	0
Open Space	38	24	10	26
Low Intensity Development	16	14	7	12
Med Intensity Development	4	5	1	2
High Intensity Development	1	1	0	1
Barren	6	5	1	13
Deciduous Forest	86	75	56	84
Evergreen Forest	82	55	35	81
Mixed Forest	82	34	64	82
Shrub/Scrub	60	26	23	58
Grassland/Herbaceous	25	11	11	19
Pasture/Hay	14	5	8	11
Cultivated Crops	5	9	4	7
Woody Wetlands	83	57	77	90
Emergent Herbaceous Wetlands	30	14	4	46

Table 5.5 Denitrification rates (g N/m2/yr) by NLCD category for each county. Calculations are based on published rates for each land cover category. This is a metric for the valuation of water quality.

NLCD	Escambia, FL	Indian River, FL	Lafourche, LA	St. Landry, LA
Open Water	8.29	8.29	8.29	8.29
Open Space	0.71	0.71	0.67	0.67
Low Intensity Development	0.51	0.52	0.52	0.54
Med Intensity Development	0.3	0.31	0.3	0.29
High Intensity Development	0.1	0.12	0.12	0.12
Barren	1.05	1.05	1.05	1.05
Deciduous Forest	0.22	0.22	0.22	0.22
Evergreen Forest	0.09	0.09	0.09	0.09
Mixed Forest	0.14	0.14	0.14	0.14
Shrub/Scrub	0.92	0.92	0.92	0.92
Grassland/Herbaceous	0.19	0.19	0.19	0.19
Pasture/Hay	4.31	4.31	4.31	4.31
Cultivated Crops	10.23	10.23	10.23	10.23
Woody Wetlands	17.21	17.21	17.21	17.21
Emergent Herbaceous Wetlands	12.92	12.92	12.92	12.92

Table 5.6 Carbon burial rates (g C/m2/yr) for each NLCD category in four counties. Data are based on published rates for each land cover category. This is a metric for the valuation of a stable climate.

NLCD	Escambia, FL	Indian River, FL	Lafourche, LA	St. Landry, LA
Open Water	103.25	103.25	210	210
Open Space	91.75	91.62	86.93	87.2
Low Intensity Development	66.55	67.75	66.96	69.8
Med Intensity Development	39.15	40.7	38.52	38.08
High Intensity Development	12.67	14.96	14.94	15.04
Barren	0	0	0	0
Deciduous Forest	7.97	7.97	7.97	7.97
Evergreen Forest	47.14	47.14	47.14	47.14
Mixed Forest	27.56	27.56	27.56	27.56
Shrub/Scrub	0	0	0	0
Grassland/Herbaceous	30.11	30.11	30.11	30.11
Pasture/Hay	48.65	48.65	48.65	48.65

NLCD	Escambia, FL	Indian River, FL	Lafourche, LA	St. Landry, LA
Cultivated Crops	43.48	43.48	43.48	43.48
Woody Wetlands	171.53	171.53	171.53	171.53
Emergent Herbaceous Wetlands	187.14	187.14	187.14	187.14

Spatial distribution of land cover classes varied between counties particularly in the placement and concentration of developed classes (Figure 5.1). Escambia County, FL, is densely populated in the southeastern portion of the county with scattered agriculture and pasture in the north. Indian River County, FL's developed areas are isolated on its eastern coast. The vertical middle of the county is predominantly cropland and the western part of the state is a mixture of open water, pastureland, and wetlands. Lafourche Parish, LA, has a narrow band of development adjacent to open water and surrounded by agriculture and pastureland running along the center of the county. Surrounding this is wetlands and open water. St. Landry Parish, LA, has large portions of wetlands in its northern and eastern sections. Its central and western landscape is mostly agriculture and pastureland. There is a small pocket of development in its westernmost section and another in its center.

Separating the values of ecosystem goods and services further by NLCD type, the only differences in the value of maintaining water quality are in the development classes (Figure 5.6; Table 5.7). This is because the calculation considered differences in canopy cover and impervious surfaces among counties in estimating denitrification rates (Figures 5.2 and 5.3; Tables 5.3 and 5.4). The largest per hectare values for usable air in NLCD were for the forest classes, shrub / scrub, and woody wetlands (Figure 5.7; Table 5.8). Similar to the usable water values, the values for maintaining stable climate only varied in open water and the development classes (Figure 5.8; Table 5.9). The variation in open water values was the result of separation of carbon burial rates based on ecosystem location. For example, the two coastal communities factored in open ocean carbon burial rates to the average, while the two inland communities included lake rates. For the development classes, as with maintaining water quality values, the variation is a reflection in differences in canopy cover and impervious surfaces. Across the counties, flood protection was highest in the forest classes. Open space, shrub / scrub, grassland, and pasture NLCD classes provided mid-level flood protection. Open water, woody wetlands, and emergent herbaceous wetlands provided no flood protection (Figure 5.9; Table 5.10). This is because those ecosystems are already flooded and cannot absorb any more water. This is opposite of the aforementioned land cover types that usually are not flooded and can therefore retain a larger volume of rain water, thus preventing runoff.

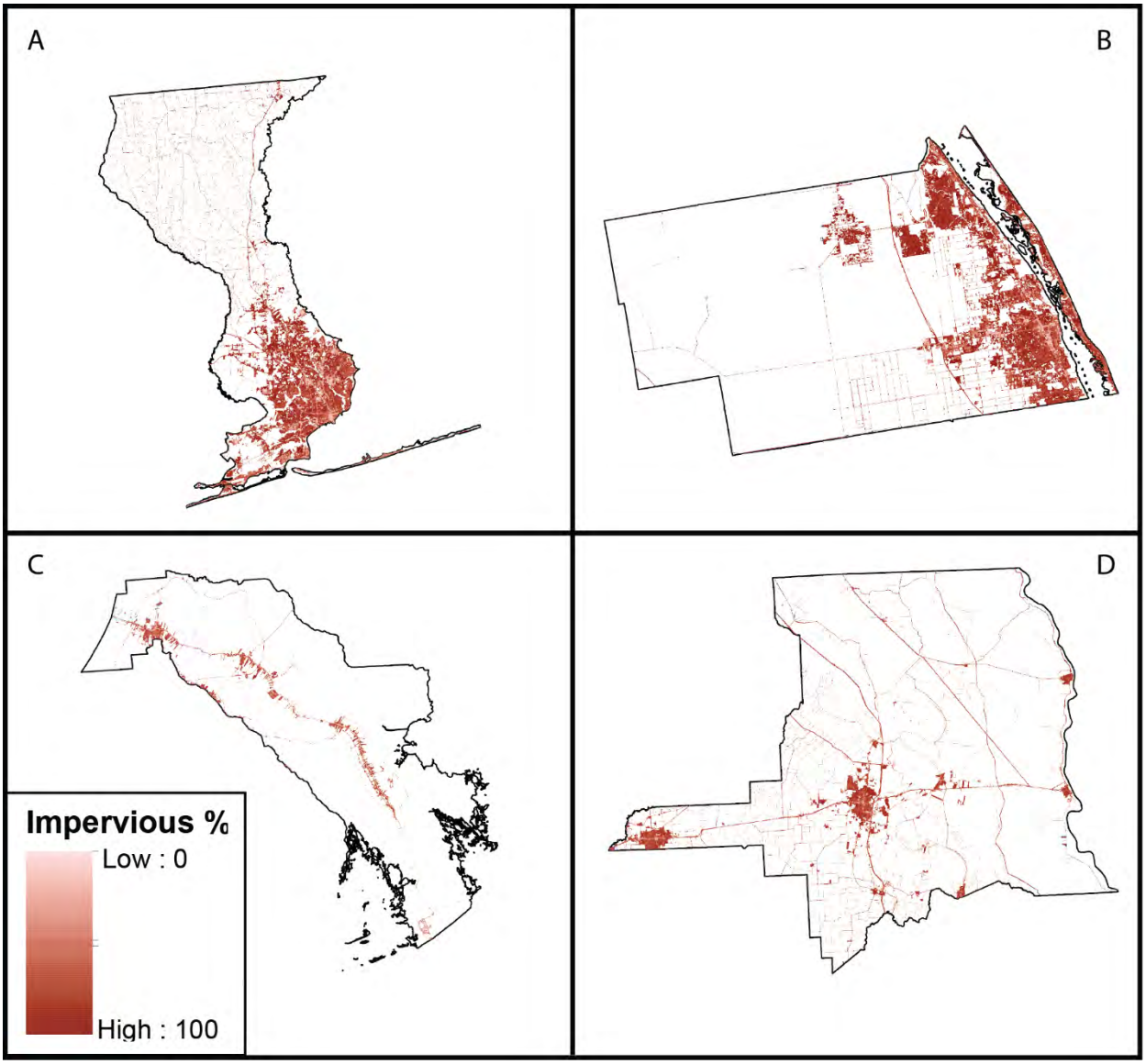

Figure 5.2 Impervious land cover as reported by the NLCD 2011 Percent Developed Imperviousness data (See Table 5.3) for: (A) Escambia County, FL; (B) Indian River County, FL; (C) Lafourche Parish, LA; and (D) St. Landry Parish, LA. This is used in the calculation of denitrification and carbon burial rates for developed land classes.

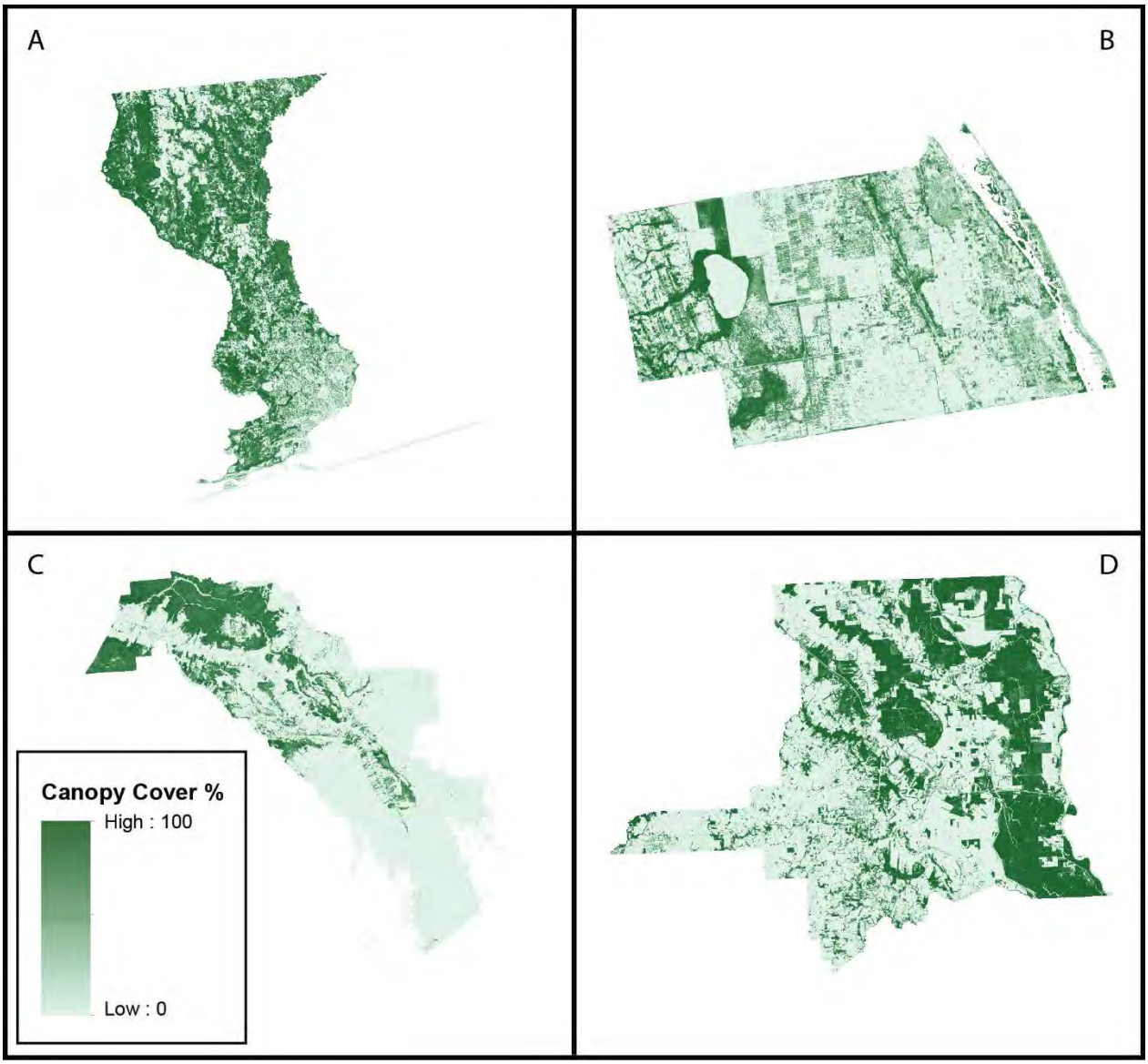

Figure 5.3 Canopy cover as reported by the NLCD 2011 USGS Tree Canopy cartographic data (See Table 5.4) for: (A) Escambia County, FL; (B) Indian River County, FL; (C) Lafourche Parish, LA; and (D) St. Landry Parish, LA. This is a metric for the valuation of air quality.

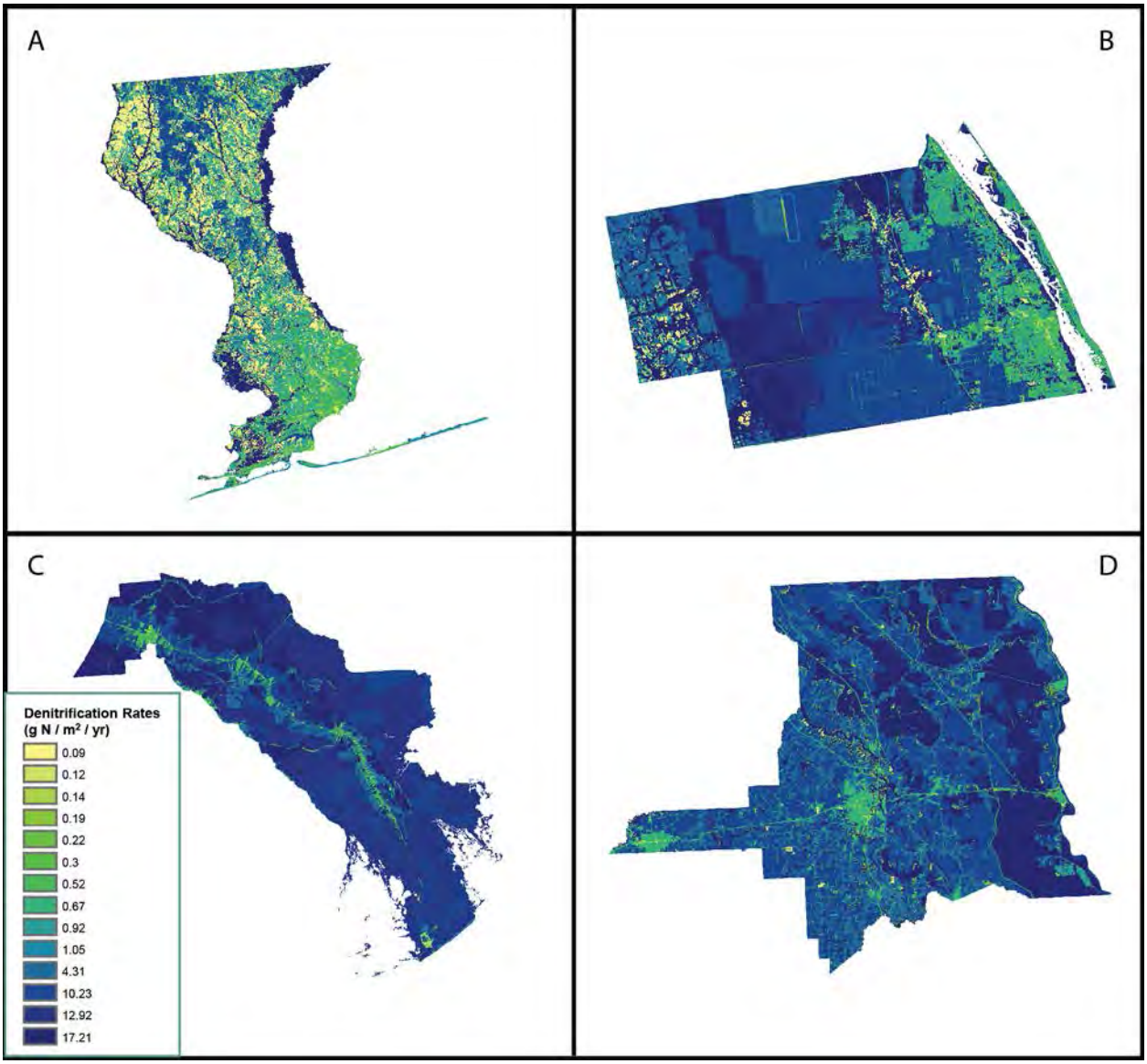

Figure 5.4 Denitrification rates averaged from literature review (See Table 5.5) for each NLCD category for: (A) Escambia County, FL; (B) Indian River County, FL; (C) Lafourche Parish, LA; and (D) St. Landry Parish, LA. This is a metric for the valuation of water quality.

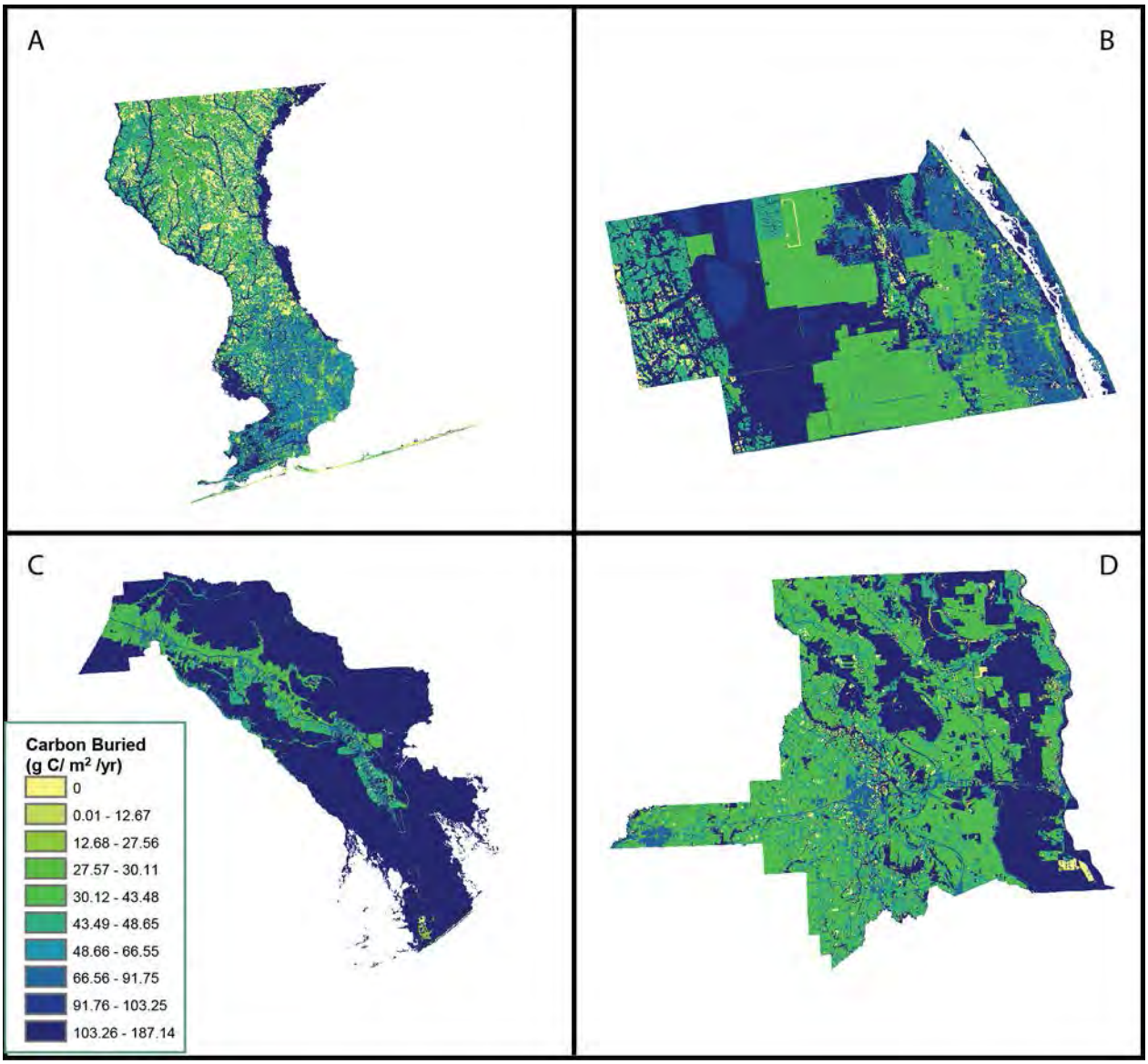

Figure 5.5 Carbon burial rate averaged from literature review (See Table 5.6) for each NLCD category for: (A) Escambia County, FL; (B) Indian River County, FL; (C) Lafourche Parish, LA; and (D) St. Landry Parish, LA. This is a metric for the valuation of a stable climate.

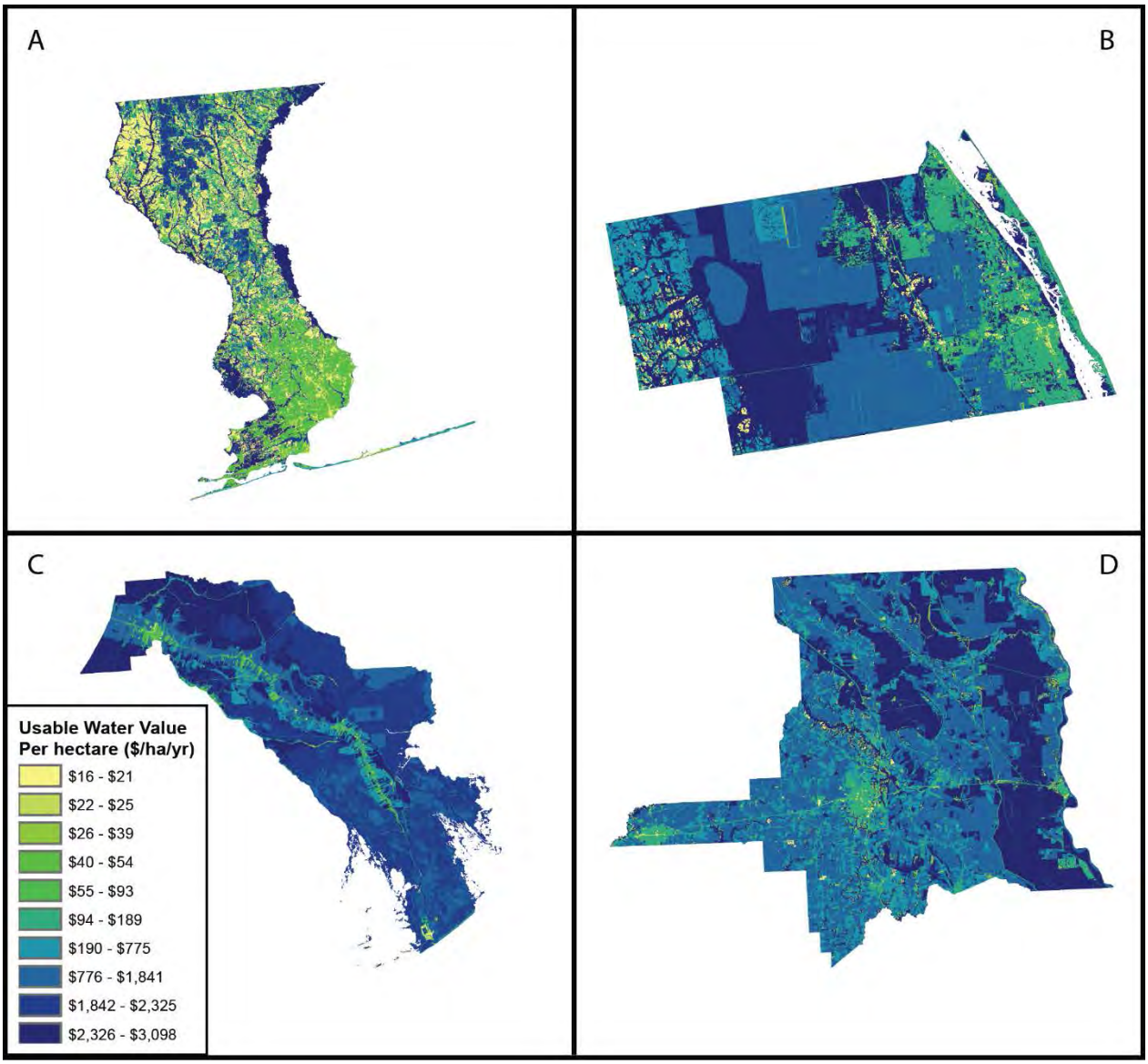

Figure 5.6 Usable water value as calculated using average denitrification rates for each NLCD category (See Table 5.7) for: (A) Escambia County, FL; (B) Indian River County, FL; (C) Lafourche Parish, LA; and (D) St. Landry Parish, LA.

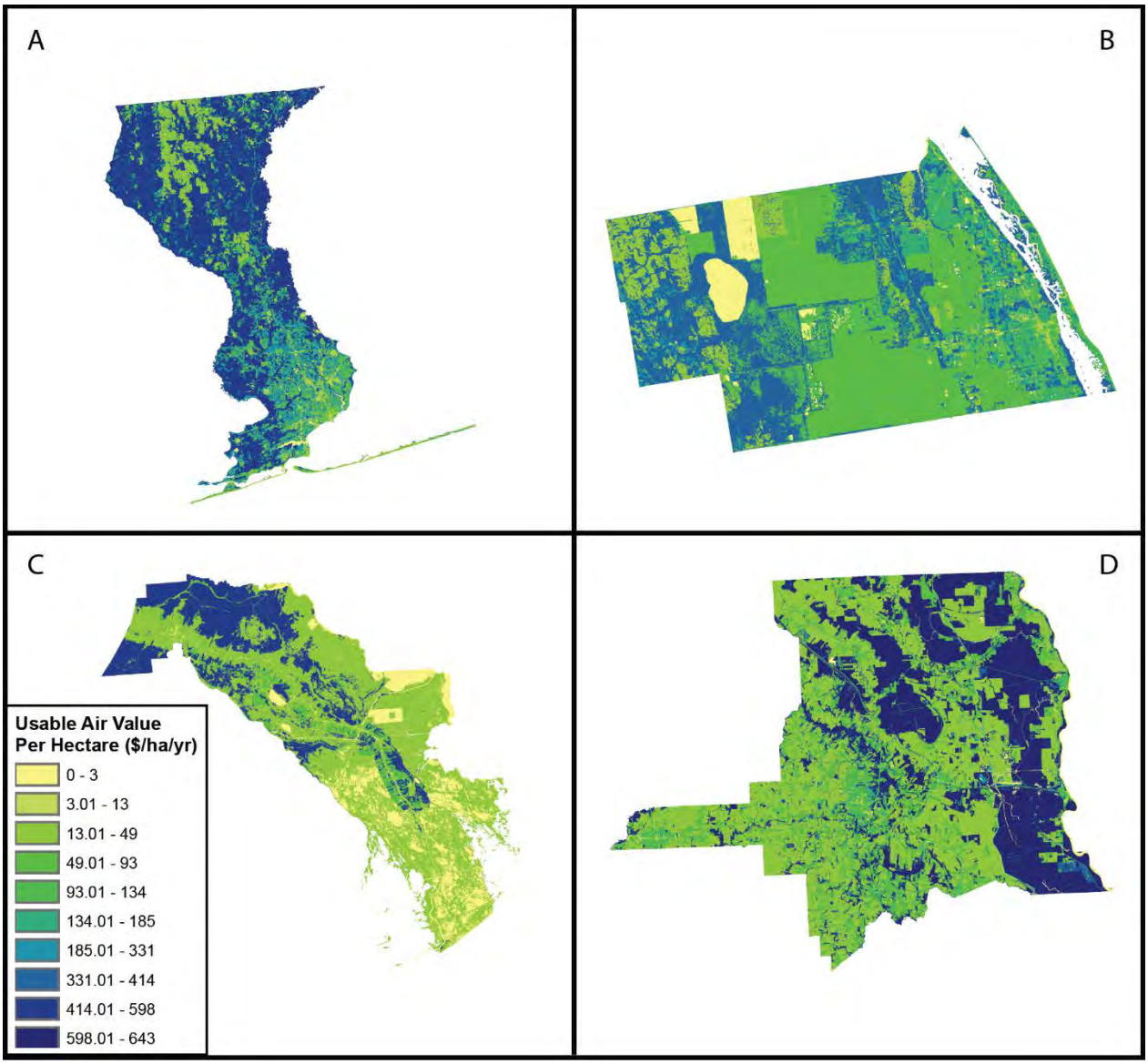

Figure 5.7 Usable air value as calculated using the average canopy cover percentage for each NLCD category (See Table 5.8) for: (A) Escambia County, FL; (B) Indian River County, FL; (C) Lafourche Parish, LA; and (D) St. Landry Parish, LA.

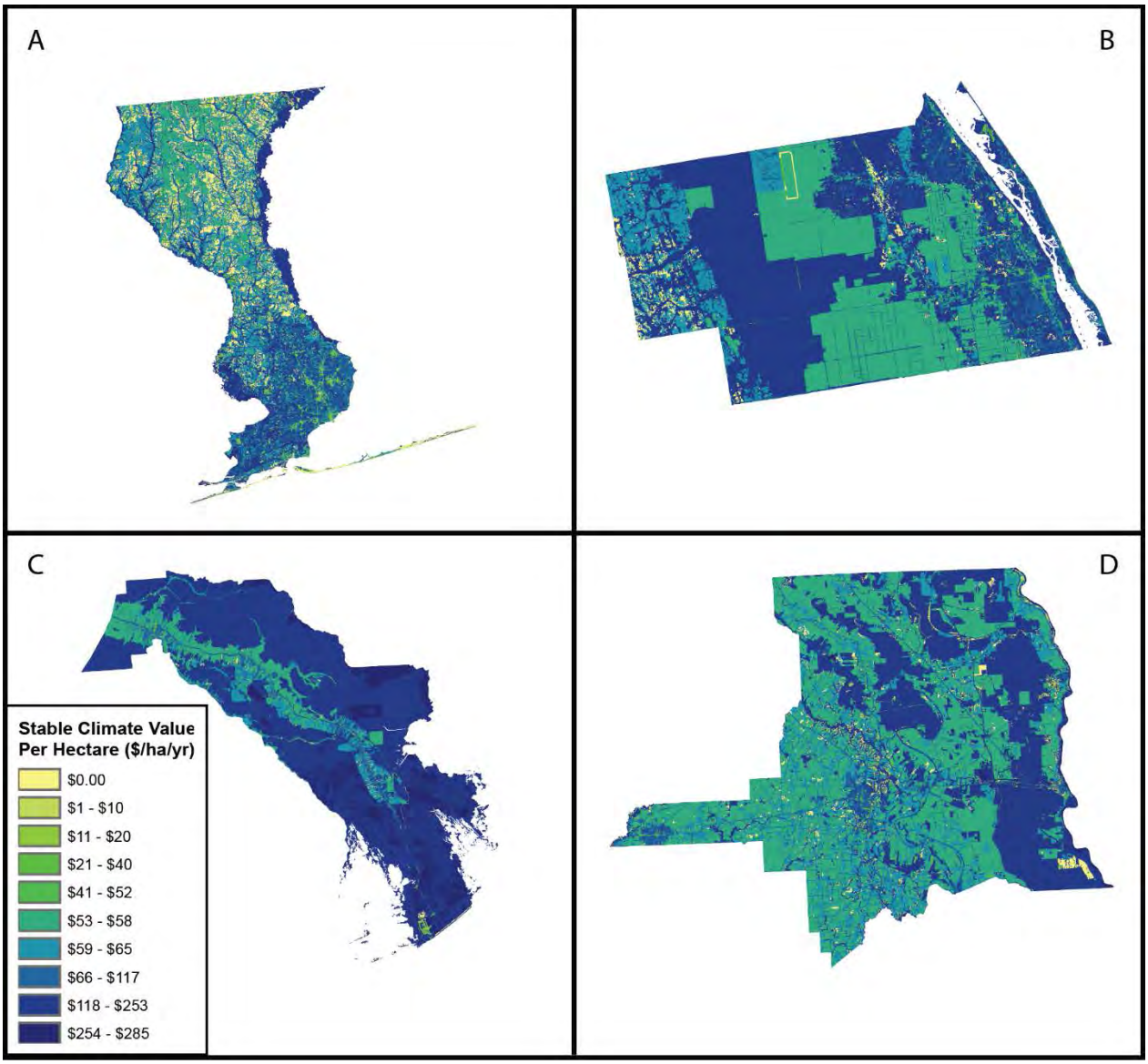

Figure 5.8 Stable climate value as calculated using average carbon burial rates for each NLCD category (See Table 5.9) for: (A) Escambia County, FL; (B) Indian River County, FL; (C) Lafourche Parish, LA; and (D) St. Landry Parish, LA.

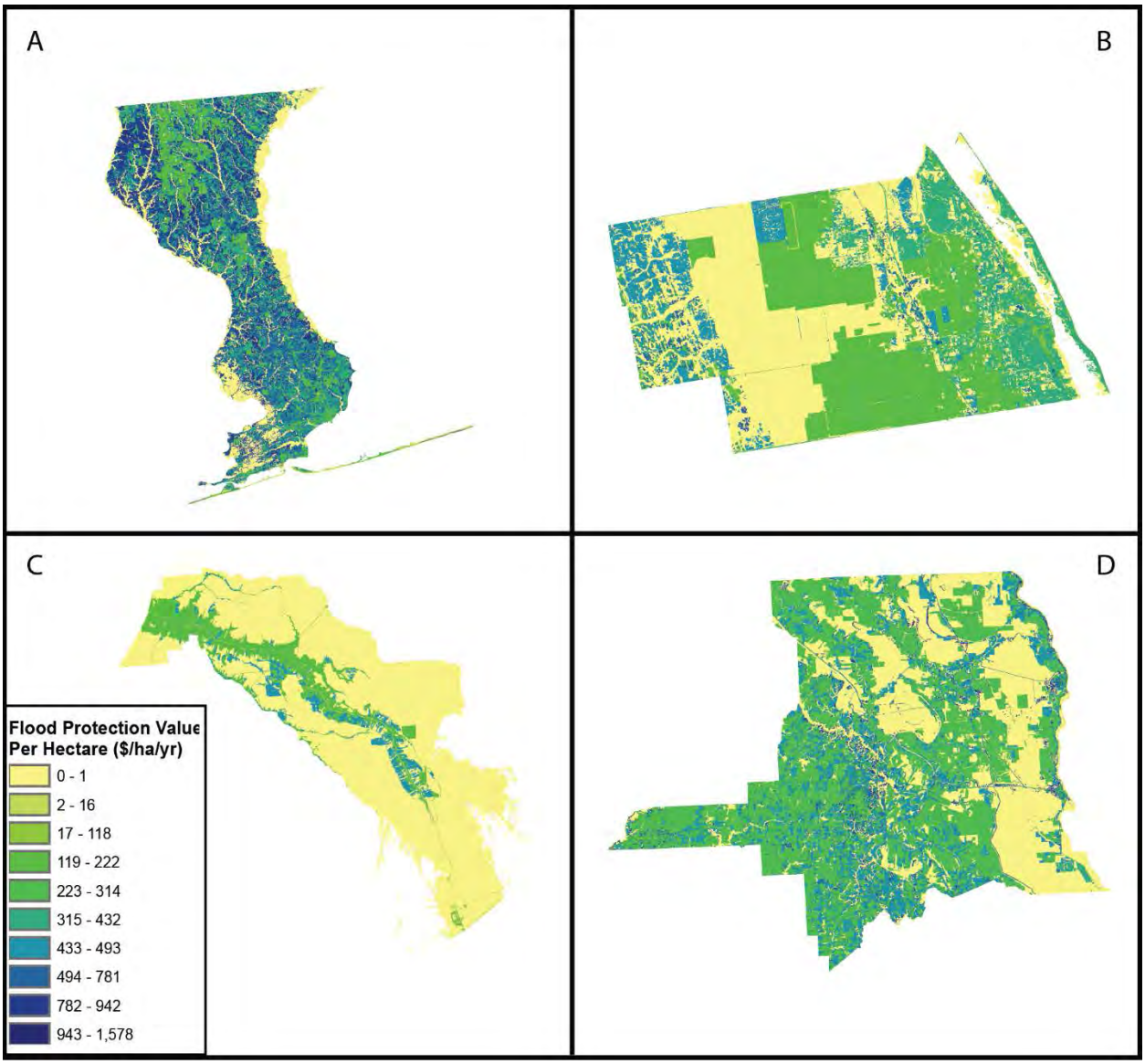

Figure 5.9 Flood protection value as calculated using averaged curve numbers for each NLCD category (See Table 5.10) for: (A) Escambia County, FL; (B) Indian River County, FL; (C) Lafourche Parish, LA; and (D) St. Landry Parish, LA.

Differences in land cover among the four counties translates into differences in availability of final ecosystem goods and services directly beneficial to humans. Mean usable water per hectare was highest in Lafourche Parish, LA ($2,136/ha/yr), and lowest in Escambia County, FL ($865/ha/yr) (Figure 5.6; Table 5.7). Mean values for Indian River County and St. Landry Parish were similar to one another and closer to Lafourche Parish than to Escambia County (Table 5.7). Mean usable air per hectare was highest in Escambia County, FL ($369/ha/yr), and lowest in Lafourche Parish, LA ($141/ha/yr) (Figure 5.7; Table 5.8). The increase in mean value for usable air increased monotonically as a function of differences in canopy cover between the four counties (Figure 5.3; Table 5.4). Lafourche Parish, LA, had the highest mean stable climate value ($218/ha/yr), while Escambia County, FL, had the lowest ($95/ha/yr) (Figure 5.8; Table 5.9). For flood protection, Escambia County, FL, had the highest mean value ($412/ha/yr) and

Lafourche Parish, LA, had the lowest ($52/ha/yr) (Figure 5.9; Table 5.10). The average per hectare value of all of the ecosystem services – usable water, usable air, stable climate, and flood protection – was highest for Lafourche Parish, LA ($637/ha/yr), and lowest for Escambia County, FL ($435/ha/yr) (Table 5.11).

Table 5.7 Value ($/ha/yr) of maintaining water quality via natural denitrification by land cover categories for four counties. Value is based on a literature review summarized in Appendix F: Table 5. See text for details.

NLCD	Escambia, FL	Indian River, FL	Lafourche, LA	St. Landry, LA
Open Water	1,492.20	1,492.20	1,492.20	1,492.20
Open Space	127.80	127.80	120.60	120.60
Low Intensity Development	91.80	93.60	93.60	97.20
Med Intensity Development	54.00	55.80	54.00	52.20
High Intensity Development	18.00	21.60	21.60	21.60
Barren	189.00	189.00	189.00	189.00
Deciduous Forest	39.60	39.60	39.60	39.60
Evergreen Forest	16.20	16.20	16.20	16.20
Mixed Forest	25.20	25.20	25.20	25.20
Shrub/Scrub	165.60	165.60	165.60	165.6
Grassland/Herbaceous	34.20	34.20	34.20	34.20
Pasture/Hay	775.80	775.80	775.80	775.80
Cultivated Crops	1,841.40	1,841.40	1,841.40	1,841.40
Woody Wetlands	3,097.80	3,097.80	3,097.80	3,097.80
Emergent Herbaceous Wetlands	2,325.60	2,325.60	2,325.60	2,325.60
Total Average	**864.82**	**1,737.50**	**2,135.90**	**1,883.51**

Table 5.8 Value ($/ha/yr) of maintaining air quality via natural carbon processing in the canopy cover. Values are given by land cover categories for four counties and are based on NLCD 2011 USFS Tree Canopy cartographic data. See text for details.

NLCD	Escambia, FL	Indian River, FL	Lafourche, LA	St. Landry, LA
Open Water	0.08	0.09	0.00	0.04
Open Space	268.51	173.51	70.33	184.43
Low Intensity Development	113.79	97.34	47.43	84.98
Med Intensity Development	30.44	34.36	5.10	12.37
High Intensity	4.53	9.40	1.97	7.29

NLCD	Escambia, FL	Indian River, FL	Lafourche, LA	St. Landry, LA
Development				
Barren	40.68	33.92	9.94	92.68
Deciduous Forest	612.62	536.10	399.38	597.24
Evergreen Forest	587.17	391.96	248.56	578.35
Mixed Forest	587.82	240.69	456.02	584.12
Shrub/Scrub	431.46	187.48	160.54	413.95
Grassland/Herbaceous	175.97	80.88	77.71	133.90
Pasture/Hay	101.64	32.43	54.76	81.74
Cultivated Crops	35.12	65.36	28.88	48.48
Woody Wetlands	594.17	406.90	548.40	642.92
Emergent Herbaceous Wetlands	215.99	98.42	25.79	330.45
Total Average	**369.06**	**173.97**	**141.35**	**268.07**

Table 5.9 Value ($/ha/yr) of maintaining stable climate via natural carbon burial. Values are given by land cover categories for four counties and are based on a literature review summarized in Appendix F: Table F.2. Citations: a is 2, 3, 4, 5, 6, 7; b is 1, 2.

NLCD	Escambia, FL	Indian River, FL	Lafourche, LA	St. Landry, LA
Open Water	139.82[a]	139.82 [a]	284.38[b]	284.38 [b]
Open Space	124.25	124.07	117.72	118.09
Low Intensity Development	90.12	91.75	90.68	94.52
Med Intensity Development	53.02	55.12	52.16	51.57
High Intensity Development	17.16	20.26	20.23	20.37
Barren	0.00	0.00	0.00	0.00
Deciduous Forest	10.79	10.79	10.79	10.79
Evergreen Forest	63.84	63.84	63.84	63.84
Mixed Forest	37.32	37.32	37.32	37.32
Shrub/Scrub	0.00	0.00	0.00	0.00
Grassland/Herbaceous	40.77	40.77	40.77	40.77
Pasture/Hay	65.88	65.88	65.88	65.88
Cultivated Crops	58.88	58.88	58.88	58.88
Woody Wetlands	232.29	232.29	232.29	232.29
Emergent Herbaceous Wetlands	253.42	253.42	253.42	253.42
Total Average	**94.69**	**133.90**	**217.51**	**121.29**

Table 5.10 Value ($/ha/yr) of maintaining flood protection based on soil characteristics by land cover categories for four counties. Value is based on Curve Number table in Zhang et al. 2011 and soil survey data by SSURGO. The rate was based on a 30 year construction life cycle. See text for details.

NLCD	Escambia, FL	Indian River, FL	Lafourche, LA	St. Landry, LA
Open Water	0.00	0.00	0.00	0.00
Open Space	532.75	417.38	334.98	494.19
Low Intensity Development	396.88	327.09	207.88	308.48
Med Intensity Development	195.66	161.06	129.73	141.99
High Intensity Development	118.36	104.98	87.24	94.12
Barren	15.74	15.74	15.74	15.74
Deciduous Forest	877.13	1,578.48	219.79	941.76
Evergreen Forest	825.32	604.71	306.99	780.52
Mixed Forest	963.05	586.32	224.19	918.85
Shrub/Scrub	421.55	313.72	377.80	432.27
Grassland/Herbaceous	493.15	441.71	309.12	511.51
Pasture/Hay	417.56	460.05	477.70	477.77
Cultivated Crops	207.21	221.67	209.49	278.91
Woody Wetlands	0.00	0.00	0.00	0.00
Emergent Herbaceous Wetlands	0.00	0.00	0.00	0.00
Total Average	**411.77**	**181.80**	**52.48**	**236.20**

The differences in the four counties populations influence the per capita supply of each of the ecosystem goods and services. The total values of ecosystem goods and services per capita were calculated based on total area of each county by population (U.S. Census Bureau 2010). The total usable water per capita value was highest in Lafourche Parish, LA ($6,679/person/yr) (Table 5.7), and lowest in Escambia County, FL ($503/person/yr). The total usable air per capita value was highest in St. Landry Parish, LA ($782/person/yr) (Table 5.8), and lowest in Indian River County, FL ($168/person/yr). For total stable climate per capita value, Lafourche Parish, LA, had the highest ($680/person/yr) (Table 5.9) and Escambia County, FL, had the lowest ($55/person/yr). St. Landry Parish, LA, had the highest total flood protection per capita value ($689/person/yr) (Table 5.10) and Lafourche Parish, LA, had the lowest ($164/person/yr). The average total per capita value of all of the ecosystem services – usable water, usable air, stable climate, and flood protection – was highest for Lafourche Parish, LA ($7,965/person/yr) (Table 5.12), and lowest for Escambia County, FL ($1,012/person/yr).

Table 5.11 Summary table of total value per hectare for select ecosystem goods and services for four counties. Data are based on calculations by land cover category in previous tables. Mean total value is also presented by community classification system group and by state. Group 1 includes Escambia and St. Landry and Group 3 includes Indian River and Lafourche.

	Escambia, FL	Indian River, FL	Lafourche, LA	St. Landry, LA	Type 1	Type 3	Florida	Louisiana
Usable Water ($/ha/yr)	864.82	1,737.50	2,135.90	1,883.51	1,374.16	1,936.70	1,301.16	2,009.71
Usable Air ($/ha/yr)	369.06	173.97	141.35	268.07	318.56	157.66	271.51	204.71
Stable Climate ($/ha/yr)	94.69	133.90	217.51	121.29	107.99	175.70	114.30	169.40
Flood Protection ($/ha/yr)	411.77	181.80	52.48	236.20	323.99	117.14	296.79	144.34
Total Average ($/ha/yr)	435.08	556.79	636.81	627.27	531.18	596.80	495.94	632.04

Table 5.12 Summary table of total value per capita per year for select ecosystem goods and services for four counties. Data are based on calculations by land cover category in previous tables. Mean total value is also presented by community classification system group and by state. Group 1 includes Escambia and St. Landry and Group 3 includes Indian River and Lafourche. (U.S. Census, 2010).

	Escambia, FL	Indian River, FL	Lafourche, LA	St. Landry, LA	Type 1	Type 3	Florida	Louisiana
Population (capita)	297,619	138,028	96,318	83,384	381,003	234,346	435,647	179,702
Usable Water ($/person/yr)	503	1,682	6,679	5,494	1,595	3,736	877	6,129
Usable Air ($/person/yr)	215	168	442	782	339	281	200	600
Stable Climate ($/person/yr)	55	130	680	354	120	356	79	529
Flood Protection ($/person/yr)	239	176	164	689	338	171	219	408
Total ($/person/yr)	1,012	2,157	7,965	7,318	2,392	4,544	1,375	7,665

The ecosystem goods and services largely vary by NLCD class, so the value distribution is similar to the aforementioned spatial description for land cover. The usable water value is lower for development and pastureland and higher in wetlands and open water. As a result, Escambia County has lower values spread throughout the county; Indian River County has lower values along the eastern coastline, but increased values in the middle and western portion of the county; Lafourche Parish has decreased values along the narrow band of development, but higher values in the remaining area; St. Landry has less usable water value in the developed pockets, but higher values in the surrounding areas (Figure 5.6; Table 5.7).

Usable air is highest in areas of high canopy cover such as forest, and lowest in agriculture, wetlands, and open vegetation. For Escambia County, the usable air values are low around its southeastern development and northern agriculture, but are higher in its flanking woody wetlands and scattered forests; Indian River's usable air values are low in its western open water and central agriculture, but higher on its coastal woody wetlands; Lafourche Parish has high usable air values in its northern woody wetlands and pastureland, but lower values in its surrounding open water and emergent herbaceous wetlands; St. Landry has high values in its eastern and northern woody wetlands and lower values in its agriculture and developed values found in the central and western portion (Figure 5.7; Table 5.8). Stable climate is highest in wetlands and open water, and lowest in agriculture and open vegetation. For stable climate value, in Escambia County, the southern and far eastern portions of the county have high values, which lower values are scattered north; for Indian River, higher values are found vertically along the eastern and western sections, with lower values in the agriculture in the middle; Lafourche Parish has lower values along its development spine, surrounded by higher values in its wetlands; St. Landry has high values in the eastern and northern parts of the Parish, with lower rates in the central and western portion (Figure 5.8; Table 5.9).

Flood protection is focused in forested areas and lowest in wetlands. Flood protection value in Escambia County is scattered throughout in its forests; Indian River has medium values in the agriculture and development along the eastern half of the county, but has no protection value on the western side in the wetlands and open water; Lafourche Parish has mid-level values along its central development string with no flood protection in its surrounding water and wetlands; St. Landry has no protection value on the western and northern sections and average values in the rest of it (Figure 5.9; Table 5.10).

The data were also organized by CCS (Chapter 2), geography, and state (Tables 5.11 and 5.12). For CCS, Escambia County and St. Landry Parish are Type 1 communities, and Indian River County and Lafourche Parish are Type 3 communities (See Chapter 2 for details). For geography, the two coastal communities are Escambia and Indian River Counties (both in Florida) and the two inland communities are Lafourche and St. Landry Parishes (both in Louisiana). The usable water value per hectare for Type 1 was less than for Type 3 and was less in the coastal communities than the inland ones. Type 1 had higher usable air value per hectare than Type 3 as did the coastal communities to the inland ones. The stable climate value per hectare was higher for Type 3 and inland communities than for Type 1 and coastal communities. The flood protection value per hectare is over twice has high in both Type 1 and coastal communities than in Type 3 and inland communities. Overall, the total average value of ecosystem goods per hectare was higher in Type 3 and inland communities than in Type 1 and coastal communities.

5.4 Discussion

Differences among communities in the production and availability of ecosystem services is a key factor in defining community priorities to support decision making (Smith et al. 2013). Ecosystem goods and services represent a community's ties to the local environment and as such contribute to economic

stability, sense of place, and community identity (Smith et al. 2013). All EGS are potentially important, but the four services considered here are expedient and relevant for coastal counties interested in environmental sustainability and reducing the effects of coastal hazards and climate change (Barbier et al. 2011). For that reason they are also useful for exploration of a central question, which is how well do various delineations of communities inform about community priorities and therefore aid efforts to inform the local decision process.

This study directly compared two delineations of community EGS value: U.S. state and coastal CCS (See Chapter 2). The largest difference in EGS value between groups was for CCS with the exception of useable water which differed more by U.S. state. Type 1 communities in both LA and FL had higher specific value for usable air and flood protection, which is to be expected with an increase in canopy and grass/shrub land associated with low and medium intensity development. Type 3 communities were consistently lower in total area of both developed land and forest, and highest in wetlands, the latter which provide higher denitrification but the former provide more carbon burial and water retention during flood events (Pouyat et al. 2002, Ullah and Faulkner 2006).

These differences suggest tradeoffs exist between EGS categories in terms of benefits to humans. In the abstract it seems plausible that flood protection, high denitrification, and high carbon burial could co-exist at the spatial scale of this analysis (10-100 km), but in practice different land cover types contributed to each and that land cover types were both distributed differently and affected differently by human development linked to changes in impervious surface and canopy cover. Carbon burial, which contributes to a more stable climate, and flood protection are clearly affected by development and differences between CCS Groups 1 and 3 reflect this as these two groups differ principally in the level of urbanization, which is higher in Type 1 communities. Denitrification, which contributes to clean water, differed more by state than CCS group indicating a lower impact from development but a stronger regional influence. These realized tradeoffs are important in that they can help clarify differences in the impacts of development likely to affect decision outcomes. These trade-offs also support the conclusion that local priorities for sustainability may differ based on the existing high value services they need to sustain and/or improve and thus CCS groups can help inform the prioritization process. This is tied to the notion that spatial demand for ecosystem services is the reciprocal of spatial supply (Burkhard et al. 2012).

The communities chosen for this study were selected to allow for a preliminary scoping comparison between CCS and state level differences, which are useful for examining the utility of the CCS, but limit drawing generalizations. This comparison was limited to four counties in two states, so conclusions regarding CCS groups or states not considered here cannot be made. Nonetheless, differences in EGS value by community type were observed and suggest a meaningful delineation can be made of EGS services to communities. As with the human well-being index (Chapter 3) and stakeholder priorities (Chapter 4), EGS resource availability and their inherent value to stake holders can be identified with particular CCS groups and alongside these other characteristics, differences in EGS resources is an important factor in decision support. The challenge moving forward will be to broaden the analysis to more CCS groups and regions and examine the overall utility of this approach to classifying communities.

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6 Synthesis

In this report communities have been compared based on four distinct metrics (community classification, human well-being, stakeholder priorities, and availability of ecosystem goods and services) with the purpose of seeking common ground for defining and measuring sustainability at the local scale. Each metric can be interpreted independently as has been done in the respective chapters of this report. However, the comparison of these metrics and more specifically the identification of commonalities across metrics and between communities is the main goal of this report. This information can be separated into two broad categories of useful information: how communities define sustainability, and how that definition is tied to resources. Overlying this comparison is the final question of the usefulness of the community type delineation for generalizing the findings to new communities.

Sustainability can be defined either subjectively by the community or objectively based on externally derived metrics. In practice, the two can be tightly interrelated. The HWBI is a good example of an objective measure of community quality, but it is not a measure of sustainability unless it measures what community stakeholders wish to sustain. In the comparison of communities based on the HWBI, more rural communities with a high degree of economic dependence on local natural resources had a lower level of well-being (Chapter 3). This outcome was based on an unweighted objective measure (Smith et al. 2013) and is highly consistent with similar outcomes from other studies (Cumming et al. 2014). Yet, when stakeholder input was solicited on the subject of well-being, the domains were not found to be consistently important in every community (Chapter 4). In fact, relative importance of the eight domains of the HWBI, varied greatly in importance overall and varied among community types (Chapter 4). This outcome suggests that well-being is not a constant feature that can be objectively measured the same way in all communities, but must be weighted differently based on community characteristics. This outcome is significant and limiting if the objective is a national comparison of well-being, but may still be of value for community-level decision support. An alternative approach of understanding common ground across communities will allow for a more targeted use of the HWBI at the local level.

Two major delineations of community type are considered here. First is geographic, or simply asking if place (i.e., county, state) defines how communities measure well-being. The second was a community CCS (Chapter 2) based on community demographics and economic dependencies. A comparison of commonalities between communities was attempted in the final three chapters of this report involving the HWBI, stakeholder weights on the HWBI, and available EGS resources. All three differed in important ways but there was variance in the relative importance of geography versus community type. The unweighted, objective HWBI varied more among community types than geographically. Similarly, relative weightings of the eight domains of the HWBI differed by community type but some domains were more strongly affected by geography so the outcome for weightings was domain dependent. Finally, EGS resources were more strongly tied to geography with a smaller amount of variability attributed to community type. The mixed result for the relative weightings and the dependence on geography of EGS resources are related in that the domains of the HWBI vary in their association with EGS resources and this may drive the relative importance of place in local weightings of the HWBI domains (Chapter 5). Combined, these results suggest both geography and community type are important for adapting a metric like the HWBI into a measure of local sustainability that is tied directly to human benefits. They also suggest that a link between EGS resources and the HWBI is important and should be quantified as a part of local decision support.

An additional critical question addressed in this report is the relative value of objective and subjective information for measuring sustainability at the local scale. Many studies have compared human well-

being or similar metrics across communities (Vemuri and Costanza 2006) or have developed purely objective measures of sustainability such as ecological footprint (Mancini et al. 2016) or density of green infrastructure (Van Mechelen et al. 2015). Yet, these objective studies come under criticism for generalizing measures of benefit that are economically biased and therefore pre-determine well-being to be something you have to purchase. This study examines the validity of this approach by asking stakeholders in multiple communities what they value and prioritize (Chapter 4). The findings suggest a moving target for measuring human benefit that is tied to tradeoffs in access to natural resources (Chapter 5) and most importantly changes across the rural to urban gradient (Chapter 4). Therefore, a balance between subjective and objective criteria in measuring sustainability at the local level may be best achieved through use of the weighted HWBI.

A final important question for this report is how to make use of a community CCS in local decision support. Community decision support is a national scale issue in that the collective impacts of multiple local decisions can have large and pervasive results particularly in coastal areas. A good example is watershed land use management where local decision making can impact water quality synergistically and far down stream of the communities making the decisions. Central to the question of national- or regional-scale community decision support is the balance between treating all communities the same or focusing on the unique issues of each individual community. Treating all communities the same is not recommended because it allows for avoidable variability in community characteristics to bias the outcome and it may be viewed as 'externally driven', which limits the acceptability of the support by stakeholders. In contrast, treating each community as totally unique is inefficient and ignores potentially valuable commonalities. A key focus of this work has been to consider how this balance should be struck in practice, and the outcome is that a community CCS can be a valuable way to approach the issue. The community CCS examined in this report shows promise as a generalizing tool for decision support and more importantly linking it to the HWBI allows for local input in a structured way, so that the approach is transferable and adaptable as needed. Exploration of methods for effectively applying the HWBI/CCS at the community level is therefore an important future research question.

The collective outcomes of this report strongly support exploration of a balanced approach for local decision support that begins with identification of community type and the calculation of the weighted HWBI. Questions remain about the optimal structure of the CCS and how well it can be applied in new communities. This work will support new research and a coordinated case study that allows for examination of this approach to measuring sustainability in multiple communities, and at the national scale. Community-level decision support is a national scale issue and should be approached from that point of view. Doing so will maximize the impact of EPA-led efforts and can result in a more effective and accepted measure of community sustainability.

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Appendix A

Vero Beach Community Workshop:
"Be the Spark – Help Shape the Growth and Character of Vero's Downtown"

Date *Tuesday, February 24, 2014*
Location *United Way*
[Insert Address]
9:00 AM – 3:00 PM (Check in at 8:30 AM)

Purpose

- ✓ Take a "fresh look" at our vision for the downtown by identifying what makes Vero Beach a great place to live and visit and by identifying core community values to help guide current initiatives and our long-term investments in the downtown
- ✓ Contribute to a U.S. Environmental Protection Agency research project identifying values that are important to different communities

8:30 AM **Sign In and Getting Settled**

9:00 AM **Welcome and Introduction**

- Welcoming Remarks (Community Leader and EPA Representative)
- Participant Introductions
- Agenda Review

9:30 AM **Building the Foundation: Vero Beach Community-Wide Values**

Warm Up **How Would You Describe Your Community?**

Working Session **What Do You Value in a Community?**

Part 1 Breakout Group Discussion: When you think about your community, what do you care about most?
Part 2 Breakout Group Exercise: What values are important to this community?
Part 3 Prioritization Exercise: Which of these community-wide goals do you view as most important to Vero Beach?

12:00 PM **Exploring the Central Issue**

Break and Working Lunch

Working Session **"Be the Spark – Help Shape the Growth and Character of Vero's Downtown"**

Context: Presentation by local leader

Part 1 Breakout Group Exercise: When you think about an ideal vision for downtown, what would that look like? What should we avoid?

Part 2 Breakout Group Exercise: What do we recommend?
What are the most important actions for the community to pursue to meet our vision of Vero Beach's downtown in the near term? Over the longer term?

2:30 PM **Final Thoughts (Next Steps, Wrap Up)**

3:00 PM **Adjourn**

Appendix B

Table B.1 List of goals.

Goal	Code	Category
Basic educational knowledge and skills	ED1	Education
Positive social and emotional development	ED2	
More advanced knowledge and skills	ED3	
Reasonable life expectancy	HL1	Health
Physical and mental well-being	HL2	
Emotional well-being	HL3	
Good quality healthcare	HL4	
Healthy lifestyle and behavior	HL5	
Enough time devoted to leisure activities	LT1	Leisure Time
Enough time devoted to physical activity and vacation	LT2	
Reasonable time spent working and caring for others	LT3	
Ability to afford basic necessities	EC1	Living Standards (Economics)
Reasonable income	EC2	
Reasonable wealth	EC3	
Job stability and satisfaction	EC4	
Being safe	SF1	Safety and Security
Feeling (and being) safe	SF2	
Resilience to hazards	SF3	
Connectedness to nature	NT1	Connection to Nature
Cultural fulfillment	CF1	Cultural Fulfillment
Healthy family bonding	SC1	Social Cohesion
Supportive network of friends and family	SC2	
Regular participation in community activities	SC3	
Responsible engagement in our democracy	SC4	
Satisfaction with others and the community	SC5	

Table B.2 Detailed explanation of goals.

Goal	What does it mean?	What can the community can do? (examples)
Education		
ED1 Basic educational knowledge and skills	We all need basic knowledge and skills to be able to take care of our basic needs and give us a good start on the path toward our future	Provide a good quality grade school education by investing in our schools, our teachers, and our children's participation in school
ED2 Positive social and emotional development	Being able to participate in society requires more than just formal education; it means learning how to have healthy social and emotional interactions with others	Provide social support services to help young parents and foster safe and healthy home; provide safe and healthy schools and after-school youth programs
ED3 More advanced knowledge and skills	A basic education can get us started, but sometimes we need more to fully develop our potential and participate in society as parents, neighbors, workers, community volunteers, etc.	Provide a good quality high school education that meets the needs of all students; help high school graduates start their career path; and support adult education and job training
Health		
HL1 Reasonable life expectancy	We all hope to live long, productive lives, and we hope that our lives and the lives of those who we care about won't be cut short by a terminal illness	Provide safe and affordable places to live; support community clinics; provide public transit between residences, hospitals, and other medical facilities
HL2 Physical and mental well-being	To get the most out of life, we need good health and freedom from debilitating physical and mental illnesses like heart disease, cancer, diabetes, asthma, obesity, and depression	Provide walkable, bike-friendly neighborhoods and streets, parks for exercise and play, and affordable recreation and exercise programs; provide public transit between residences, clinics, and medical offices
HL3 Emotional well-being	Good health is more than just physical and mental well-being; it means that we feel good about ourselves and are satisfied with our lives	Provide safe, affordable places to live; provide safe streets and parks; foster diverse public and private cultural opportunities (e.g., fairs, music, restaurants)
HL4 Good quality healthcare	Access to a family doctor and to good hospitals and other healthcare facilities and providers helps us stay healthy	Support community clinics; help recruit and retain private family medical practices; and provide public transit between residences, clinics, and medical offices
HL5 Healthy lifestyle and behavior	Our health starts with us and our ability to make and help others make healthy choices, like eating well and avoiding behaviors like smoking and excessive drinking	Provide educational programs and social services for at risk residents; provide safe and healthy schools and after-school youth programs
Leisure Time		
LT1 Enough time devoted to leisure activities	Leisure time—socializing with friends and family, enjoying group sports and recreation, and just relaxing—helps us refresh and get more out of life	Provide safe neighborhoods and parks for people to exercise and play; provide affordable recreation and exercise programs; ensure reasonable access to good quality, affordable healthcare
LT2 Enough time devoted to physical activity and vacation	Physical activity, such as running, walking, and gardening, and getting away on vacation and to visit family and friends helps us recover from stress and maintain a positive emotional outlook	Provide safe neighborhoods and parks; affordable recreation and exercise programs for all ages; provide good access to nearby travel destinations, interstate highways, and airports
LT3 Reasonable time spent working and caring for others	Our days can be filled with work—work that we get paid for and work as caregivers, e.g., for older family members—but, if we over-commit, we become drained, less productive, and less able to provide care	Support affordable transportation and housing (to lessen demand on income); provide social services to assist care-givers; provide affordable access to day care and elderly care facilities
Living Standards (Economics)		
EC1 Ability to afford basic necessities	Well-being starts with having enough resources to meet our basic needs, including shelter, food, and clothing	Support economic development and job opportunities; support affordable transportation and housing; support adult education and job training
EC2 Reasonable income	Life is more than survival; we need enough income (from work, social security, etc.) to afford healthcare, get to work, improve our prospects, give a gift, take a vacation, etc.	Support economic development and job opportunities; provide safe streets (for pedestrians, bikes, and cars) and public transit between housing and job centers; support post-secondary education and job training
EC3 Reasonable wealth	Our "wealth" is the sum of our assets; for many, this is our home equity (value minus mortgage); wealth gives us options, e.g., when someone gets sick, and allows us to leave something for future generations	Provide social services to assist residents in addressing credit issues and accessing down payment and mortgage assistance programs
EC4 Job stability and satisfaction	Job stability and satisfaction give us confidence in the future and allow us to make smart decisions about how we spend and save so we can afford the things we need, now and in the future	Support diverse economic development and job opportunities; work with local businesses and provide education and job training to meet current and future needs

Safety and Security		
SF1 Being safe	A safe environment is critical for living long, healthy, productive lives; if we are not safe from crime, accidents, and other hazards, it not only threatens to shorten our lives, it can affect our ability to learn, work, and enjoy life	Invest in strong police, fire, and emergency medical services; enforce safe building codes; provide safe streets for pedestrians, bikes, and cars; implement community-wide emergency preparedness and response plans
SF2 Feeling (and being) safe	If our surroundings don't feel safe—regardless of whether they are or not—it has very real effects on our lives and our ability to get out and go places, visit neighbors, and enjoy our surroundings	Provide clear evidence of safety measures to ensure safe neighborhoods and streets (e.g., police patrols, street lights); provide community with crime statistics; support community watch programs
SF3 Resilience to hazards	Security means being able to cope with hazards (e.g., natural disasters) when they occur; it means being able to sustain yourself and your family and quickly get back to normal to limit the impact of the event	Support community-wide natural disaster planning, preparedness, and response; provide educational resources for preparedness
Connection to Nature		
NT1 Connectedness to nature	We have an innate emotional connection with other living organisms; experiencing this connection improves our sense of emotional and spiritual well-being	Provide safe and accessible public parks; offer affordable nature programs; and support businesses that provide opportunities for people to experience nature
Cultural Fulfillment		
CL1 Cultural fulfillment	Our connections with the "culture" of our ancestors and our existing community—including our shared language, religion, cuisine, social habits, music, arts, etc.—help us define "who we are"	Support community organizations, and community events that celebrate different cultures; create mixed use zones that support small shops and restaurants with different cultural affiliations

Social Cohesion		
SC1 Healthy family bonding	The strength of our community fabric starts with a strong family environment where we learn the importance of spending time together and interacting with others in a healthy, open-minded, and respectful way	Provide social support services to help young parents; support economic development and job opportunities close to home; support affordable transportation and housing
SC2 Supportive network of friends and family	Our extended family and friends support us through tough times; they also help us grow by allowing us to confide our thoughts and feelings in others and by helping us develop the character to be a trustworthy friend to others	Provide walkable, bike-friendly neighborhoods and parks for people to meet and enjoy; provide safe streets and transit among neighborhoods; support businesses that provide gathering places (e.g., music venues, restaurants)
SC3 Regular participation in community activities	When we participate in community activities, we meet people with different experiences, racial and ethnic backgrounds, and economic situations; we learn that we all gain work together toward common goals despite these differences	Provide public events (e.g., fairs, art exhibitions, music); parks; affordable community programs arts, seniors, and recreation programs to connect people with similar interests; support businesses that provide gathering places (e.g., music venues, restaurants)
SC4 Responsible engagement in our democracy	Our government works for us, but only if we vote and participating in public meetings; when we get involved, we learn how different community needs are considered, how decisions are made, and why our voice matters	Conduct active outreach to encourage participation in elections, referenda, and public meetings; provide opportunities for citizens to participate on boards and commissions; regularly communicate with citizens regarding government activities and results
SC5 Satisfaction with others and the community	When feel a sense of belonging, when we feel that others care about our views and our needs, and when we are motivated to help others feel the same, we know that our efforts to build a strong community are working	Support educational curriculum and cultural activities that highlight the value of diversity and encourage inclusiveness of all community members; encourage participation of all segments of the community in government decision-making

Appendix C

Counties included in keyword search.

County	State
Brevard	FL
Broward	FL
Calcasieu	LA
Clay	FL
Dixie	FL
East Feliciana	LA
Escambia	FL
Fairhope	AL
Franklin	FL
Gadsden	FL
Gilchrist	FL
Glades	FL
Gulf	FL
Hancock	MS
Hardee	FL
Hendry	FL
Holmes	FL
Indian River	FL
Jackson	FL
Jackson	MS
Jefferson	FL
Lafourche	LA
Lake	FL
Levy	FL
Live Oak	TX
Martin	FL
Mobile	AL
Monroe	FL
Moss Point	MS
Ocala	FL

County	State
Okaloosa	FL
Okeechobee	FL
Osceola	FL
Pascagoula	MS
Pearl River	MS
Pensacola	FL
Putnam	FL
Santa Rosa	FL
St. Johns	FL
Stone	MS
Sumter	FL
Suwannee	FL
Thomas	GA
Volusia	FL
Wakulla	FL
Walton	FL
Galveston	TX
Jefferson	LA
Manatee	FL
Nassau	FL
St. Charles	LA
St. James	LA
St. Landry	LA
Tangipahoa	LA
Taylor	FL
Vermilion	LA
West Baton Rouge	LA
West Feliciana	LA

Appendix D

The keyword list used to create the automated read of the community planning documents in Chapter 4.2 is located in the tables below. The list is broken down by domain and indicator, each with their own set of “include”, “near”, and “exclude” words. The include column contains the primary set of words used to describe each domain and indicator. Phrases were extracted if they contained one of the include words. Near words were used to further specify the include words, generally verbs to identify phrases that involved future actions and policy planning. With the inclusion of near words, phrases were extracted only if they contained a word in the “include” and “near” columns. Phrases containing an exclude word were ignored by the automated read.

A few notes on the formatting of the words in the tables below. The "|" symbol denotes "or", for example, Natur|environment in the include column searched for phrases containing natur OR environment. Some words were not the full spelling of the word, such as having “natur” instead of “nature”, this was to allow for variations of the word. “Natur” allowed for a more complete list, including both natural and nature, whereas using “nature” excluded natural. “Hunt” pulled phrases that included hunt, hunting, hunters, or hunts. If you just wanted “hunt” without any variations, a blank space would be placed after the word, “hunt”. Spaces placed before a word removed any prefix or other variations. This was particularly useful for words like “art” and “create” to remove instances which they are in larger words, “department” or “recreate”.

Table D.1 Keyword list for connection to nature.

Connection To Nature		
Biophilia		
include	near	exclude
nature| environment| natural beauty	protect |support|enhanc| improv|preserve| preserving| protected| protecting|protects	resource|business|work|econom|hous|agriculture| landuse|home|recreat|resident|histor|pedestrian| landscap|transportation|infrastructure| hazardous|waste|safe|urban|department of|environmental impact study|protection|living environment
trail|hike| camp|canoe |kayak| fish|hunt| outdoor	support|enhance| build|improv|provi| establish|promot| creat|encourag| expand|maintain| attract	trailer|heritage|facilit|campaign|campus|outdoor seating|encampment|life support|potable water
spiritual	environment|wild| beaut|green|natur	sustainab
biodiversity	enhanc|improv| increas|decreas|reduc| creat|maintain	
wildlife	expand|build| enhanc|maintain| creat|preserv| protect	facilit|natural resource
zoo|aquarium	visit|recreat|attract| provid|promot	

Table D.2 Keyword list for cultural fulfillment.

Cultural Fulfillment		
Activity Participation		
include	near	exclude
national park	support|enhance|build |improv|provid|establish|promot| creat|encourag|expand|maintain|visit|develop	acre
heritage| cultur	expand|build|enhanc|maintain| creat|preserve|protect|promot|support|attract |preserving	corridor|trail| art | arts| work|indust| promotion
entertainment| fair |fairs |festival| art | arts|concert| fair|fairs	support|promot|creat|provid|increas|enhanc|encourag| incorporat|integrat|recogniz|advocat|attract |attacts	state of the art|arts degree|unfair|fair housing|fair share|fairhope| fairly
museum	preserv|operat|establish|promot|advertis|enhanc|explor| ensur|visit	
religio	assist|provid|promot|encourag	discrimination| homeless
church|faith| spiritual	social|participat|attend|develop|provid|support|built| promot|offer|ensur	churchill|church street|residential| development code|good faith|development| developed
cultural center	promot|preserv|support|establish|expand| creat|maintain	

Table D.3 Keyword list for education, basic knowledge.

Education		
Basic Educational Knowledge and Skills of Youth		
include	near	exclude
educat	provid|promot|enhanc|improv|encourag|support|expand|maintain|creat|establish|upgrad	history|department of education|higher|property|audobon|home|government|financial|homeowner|property|landlord|land use|training|drainage|air quality|energy|business|water|job|work|waste
librar	maintain|promot|offer|establish|coordinat|encourag|expand|explor|fund|support|develop |upgrad|provide educ|provides educ|provide servi|provides serv	public art|performing arts
math| science| reading	educat|teach|assist|learn|provid|promot|encourag|expand|enhanc	aftermath|mathew|neuroscience|marine science|spread
skill	teach|develop|provid|assist|creat|support|attract|promot|enhanc|expand|educate|educating|retain	
training	assist|facilitat|promot|support|offer|provid|teach|encourag|enhance|improv	job|employ|medical|hospital|staff|up to date|business|financial|workforce
public education| educated public| community education| educated community	promote|program|provide	
educate the public| educate the community		

Table D.4 Keyword list for education, participation.

Education		
Participation and Attainment		
include	near	exclude
school	participat|attend|promot|support|obtain|attain	school board|roadway|transportation|economic|construct|siting|zoning|parking|bike|bicycle|sidewalk|school size|residential development|job|work
literacy	promot|provid|encourag|enhanc|offer|support|train|prepar|improv|fund|eradicat|reduc|decreas	lunch
degree|graduat	increas|complet|trend|improv|decreas	development|transportation|varying
college|university	offer|course|program|educat|provide|enhance|access|enroll|opportunit	
adult literacy|adult education	promot|provid|encourag|enhanc|offer|support|train|prepar|improv|fund|eradicat|reduc|decreas	
curriculum	educat|access|add|creat|design|implement|establish|encourag|support|promot|provid|enhanc	

Table D.5. Keyword list for education, development.

Education		
Social, Emotional, and Developmental Aspects		
include	near	exclude
social development|physical development|emotional development|social support|emotional support|social help|emotional help|counsel|physical support	youth|young|child|adult|student|teach|promot|educat|support	city|county|counties|master plan|forest|agricultur|homebuyer|home owner
cognitive skill|mental development	youth|young|child|adult|student|teach|promot|educat|support	fundamental
emotional well|emotional health	youth|young|child|adult|student|teach|promot|educat|support	
bully	youth|young|child|adult|student|prevent|school|reduc|decreas|improv|counsel	

Table D.6 Keyword list for health, healthcare.

Health		
Healthcare		
include	near	exclude
healthcare| health care	provid|improv|access|enhanc|facilit|support|upgrad| promot	
hospital	provid|build|increas|upgrad|improv|enhanc|support| encourag|promot|help|offer	hospitality|government| agriculture
doctor	employ|attract|enhanc|improv|attend|increas|provid| deliver	bill
nurse	employ|attract|enhanc|improv|attend|increas|provid| deliver	nursery|county|city| parish|nurseries
medical facilit| medical service| medical assist| emergency| clinic	provid|build|increas|upgrad|improv|enhanc|support| encourag|promot|help|offer	waste|shelter|fire| emergency management agency

Table D.7 Keyword list for health, personal well-being.

Health		
Personal Well-being		
include	near	exclude
well-being|well being	improv|increas| rais|promot|support|enhanc|encourag|support|protect|provid	environment
life satisfaction	improv|increas| rais|promot|support|enhanc|encourag|support|protect|provid	
happiness	improv|increas| rais|promot|support|enhanc|encourag|support|protect|provid	

Table D.8 Keyword list for health, physical and mental health conditions.

Health		
Physical and Mental Health Conditions		
include	near	exclude
physical health	reduc|increas|decreas|prevent|provid|trend|higher|lower|promot|encourag|enhance|support	economic|city
mental health	support|provid|promot|assist|access|offer|help|enhanc|treat	environmental
diabetes	reduc|increas|decreas|health|prevent|provid|trend|higher| lower|treat|support|promot|enhanc|encourag	
cancer	reduc|increas|decreas|health|prevent|provid|trend|higher| lower|treat|support|promot|enhanc|encourag	
depression	reduc|increas|decreas|health|prevent|provid|trend|higher| lower|treat|support|promot|enhanc|encourag	national|economic|business|natur|storm|weather
heart	reduc|increas|decreas|health|prevent|provid|trend|higher| lower|treat|support|promot|enhanc|encourag	heart of|heartbreak
stroke	reduc|increas|decreas|health|prevent|provid|trend|higher| lower|treat|support|promot|enhanc|encourag	
asthma	reduc|increas|decreas|health|prevent|provid|trend|higher| lower|treat|support|promot|enhanc|encourag	
disease	reduc|increas|decreas|health|prevent|provid|trend|higher| lower|treat|support|promot|enhanc|encourag	
wastewater treatment	ensure|expand|monitor|maintain|upgrad|build|construct|fund|establish|install	buildings

Table D.9 Keyword list for health, life expectancy.

Health		
Life Expectancy and Mortality		
include	near	exclude
mortality	reduc|increas|decreas|health|prevent|provid|trend|higher|lower|treat|support|promot|enhanc|encourag	
suicide	reduc|increas|decreas|health|prevent|provid|trend|higher|lower|treat|support|promot|enhanc|encourag	
life expectanc	reduc|increas|decreas|health|prevent|provid|trend|higher|lower|treat|support|promot|enhanc|encourag	water treatment
death|fatal	fewer|reduction|reduce|decrease|lower|growth|increas|prevent|support|promot	manatee

Table D.10 Keyword list for health, lifestyle.

Health		
Lifestyle and Behavior		
include	near	exclude
lifestyle	health|improv|enhanc|encourag|promot|support|provid|retain|protect|preserv	
behavior	health|safe|promot|enhanc|encourag|prevent	behavioral health
exercis|fitness	support|enhance|build|improv|provid|establish|promot|creat|encourag|expand|maintain|increas|develop |developing	ranking|SWOT|S.W.O|rights|zoning|voting|authority
smoking	prevent|encourag|educat|promot|reduc|increas|decreas|enhanc|support	
pregnancy	prevent|encourag|educat|promot|reduc|increas|decreas|enhanc|support	
alcohol	addict|prevent|health|behavior|risk|program|rehab|service|support|enhanc|encourag|offer	
public health	improv|enhanc|increas|promot|protect|ensure	

Table D.11 Keyword list for leisure time, activity participation.

Leisure Time		
Activity Participation		
include	near	exclude
leisure	support|enhanc|build|improv|provid| establish|promot|creat|encourag|expand| maintain|increas|activit	
vacation	promot|encourag|enhanc|provid|access| draw|attract|visit	public right
physical activit	encourag|exercis|increase|decreas| reduc|bike|bicycl|walk|jog|run|health| lifestyle|promot|provid|access|enhanc	construction
play|basketball|football| soccer|tennis|volleyball| golf|baseball| sport| -sport|physical activit|softball	establish|build|install|enhanc|improv| invest|construct|upgrad|sponsor|promot| encourag|provid|participat	display|played|role|government |hotel|econom|playhouse
jog| run|water-sport|winter-sport|water sport|winter sport	promot|exercis|establish|install|program| develop|activit|event	campaign|agricultur| encampment|campus|runoff| run-off
youth|child|kid| teen	activ|camp|league| sport|service|program|recreat	educat|librar|income|housing| child care|senior care|crim|active adult|active-adult|homebuyer|agricultur| family services|child support|wastewater|health service|public health|homeless|child abuse
recreation|park	build |provide | fund | funding| funded| creat|encourag|enhanc|maintain| support|promot|establish	housing|car|highway|road| vehicle|parking|park and ride|park-and ride|business|office|agricultur| mobile home|sewer|wastewater| aquacultur|industrial|trailer park

Table D.12 Keyword list for leisure time, retired seniors.

Leisure Time		
Retired Seniors		
include	near	exclude
retire|retiring| elderly|senior	attract|encourag|support|promot|establish| recreat|protect|activit|maintain	hous|apartment| transportation |high school|habitat| development right

Table D.13 Keyword list for leisure time, time spent.

Leisure Time		
Time Spent [amount of time]		
include	near	exclude
leisure time	increas|decreas|reduc|provid|offer|promot|encourag|ensur| rais|maintain|improv|enhanc|establish|creat	
socialize|relax	promot|provid| creat|encourag|increas|improv|decreas|limit	

Table D.14. Keyword list for leisure time, working age adults.

Leisure Time		
Working Age Adults		
include	near	exclude
work week	increas|decreas|reduc|provid|offer|promot|encourag| ensur| rais|maintain|improv|enhanc|establish| creat	
long hours	increas|decreas|reduc|provid|offer|promot|encourage |ensur| rais|maintain|improv|enhanc|establish| creat	
working day|work day	increas|decreas|reduc|provid|offer|promot|encourag| ensur| rais|maintain|improv|enhanc|establish| creat	
work balance|life balace|work-life|work life		

Table D.15 Keyword list for living standards, basic necessities.

Living Standards		
Basic Necessities		
include	near	exclude
afford|cheap| low-cost	health| work |food|water|energy| electricity	housing|house|rent|home| apartment|unit| stormwater|storm water
affordable hous|housing afford|diverse hous|housing divers|cheap hous|cost hous|affordable rent|diverse home|workforce hous|housing work|affordable apart|apartment afford|diverse apart|apartment divers	encourag|provid|offer| enhanc|increas|decreas| establish|fund| creat|prepar|preserv| develop |educat|promot|support	census data|department of housing
drinking water|potable water	develop|provid|ensur|protect	
food	access|expand|provid|basic| expens|cheap|assist| local|security|healthy	%
basic necessit		
living standard| standard of living	rais|improv|decreas| maintain|preserv|enhanc	
hous|home| apartment	access	accessory|afford|sewer|water| street|pedestrian|internet| transportation|wildlife|habitat| playhouse|accessories| homelesss|transit|guard house|sidewalk|manufactur| automobil
homeless	encourag|offer|enhanc|establish|fund |funding|creat|prepar|preserv| develop |educat|promot|support| prevent	
shelter	encourag|offer|enhanc|establish|fund |funding|creat|prepar|preserv| develop |educat|promot|support| prevent|provid	
retirement community| retirement housing|assisted living|nursing home|retirement home	provid|build|encourag|enhanc| offer|creat|fund|develop |promot|support|establish	
park and ride|carpool|ride share|ride share|ride-share	promot|encourag|provid|offer| fund|establish|support|expand |implement|incentiv|coordinat	
public transportation|public transit	promot|encourag|provid|offer|fund| establish|support|expand |implement|incentiv|coordinat| improv|develop |maintain	

Table D.16 Keyword list for living standards, income.

Living Standards		
Income		
include	near	exclude
income	increas|decreas|rais| lower|trend|high|reduc	%|percent|housing|median

Table D.17 Keyword list for living standards, wealth.

Living Standards		
Wealth		
include	near	exclude
mortgage	program|service|counsel|assist	
debt	management|assist|counsel|cut|raise|increas|decreas|reduc	
wealth	increas| rais|improv| creat|enhanc|improv|promot|decreas|reduc	commonwealth

Table D.18 Keyword list for living standards, work.

Living Standards		
Work		
include	near	exclude
Employment |job	increas|enhanc|recruit| creat|train|improv|retain|support|promot|encourag|attract	address|%|untrain| network
econom	diversity|retain|expand|enhanc|employ|promot|improv	economic development| socioeconomic
economic development	diversity|retain|expand|enhanc|employ|promot|improv|job | creat	

Table D.19 Keyword list for safety and security, actual safety.

Safety and Security		
Actual Safety		
include	near	exclude
safe	provid|improv|ensur|promot|safe access|support|encourag|enhanc	transportation| safeguard|sidewalk| traffic
transportation|traffic	safe	
hazard	protect|reduc|mitigat|safe	
toxic	safe|minimiz|spill|reduc	
sidewalk|crosswalk	repair|construct|upgrad|improv|provid|enhanc| establish|safe|build |develop	
crime|murder|robbery| rape|assault| violence	prevent|protect|reduc|increas|lower|stop|decreas |improv|stop|enhanc|encourag	
financial assistance|financial security|economic security	assist |support|coordinat|promot|provid|offer|increas| decreas|improv|enhanc	
emergenc|disaster| hurricane|storm| flood|snow|blizzard| drought|fire|explosion	prepar|prevent |mitigate|coordinate	

Table D.20 Keyword list for safety and security, perceived safety.

Safety and Security		
Perceived Safety		
include	near	exclude
perceived safety		
community safety		
feel safe		
neighborhood watch|crime prevent|crime stop		

Table D.21 Keyword list for social cohesion, attitude towards community.

Social Cohesion		
Attitude Towards Others and the Community		
include	near	exclude
small town|charm| lifestyle|character	preserv|protect| enhance|maintain| embrac|retain	protection
satisfaction| belonging|pride| value|beautification	develop|enhanc| promot|improv| increas|decreas| encourag|preserv	groundwater|housing|development| investment|money|monetary|median| customer|township| census|stream|recreation|home|house| manufactur|property|land value|agricultur
quality of living|quality of life| community value|value of the community	enhanc|improv|maintain| attract|promot|creat|preserv	
cohesive community| community cohesion| family cohesion	enhanc|improv|more| increas|decreas	
historic	expand|build|enhanc| maintain| creat|preserve|protect| promot| support|attract |encourag|preserving	ship|indust|soil|lake|stream|wetland| archaeological|hydrology|habitat| resource|storm water|record|building|traffic
sense of place	creat|identity|establish| provid|maintain| preserv|improv|enhance| develop|conserv|support| unify|strengthen|encourag	

Table D.22 Keyword list for social cohesion, democratic engagement.

Social Cohesion		
Democratic Engagement		
include	near	exclude
voting| vote|election	increas|turnout|participat|more|decreas| reduc|encourag	
politic	outreach|volunteer|involv|support|assist| encourag|promot	
democracy|democractic engagement	practic|support|promot|improv|increas| enhanc|encourag	
public participation|public planning|engagement| workshop|participation|public engagement|civic|public hearing|community organiz	promot|enhance|encourage|improv|increas| decreas|involve |involved	employ|literacy| business|park| school|recreat| art

Table D.23 Keyword list for social cohesion, family bonding.

Social Cohesion		
Family Bonding		
include	near	exclude
family	entertainment|recreation|camp|park|play|bond|event|museum|festival|friendly|social|communit	multi-family|single family|single-family|home|households|dwelling|hous
social cohesion	maintain|enhanc|creat|support|encourag|increas|improv|promot	
community cohesion	increas|decreas|more|less|reduc|improv|enhanc|encourag|promot|support	

Table D.24 Keyword list for social cohesion, social engagement.

Social Cohesion		
Social Engagement		
include	near	exclude
volunteer	assist|participat|coordinat|creat|encourag|provid|promot|enhanc|support	respond
community gathering|gathering place|gathering point|public gathering|gathering space	improv|provid|creat|enhanc|encourag|establish|expand|allow|support|promot	data|hunting
group activit|family activit|community activit	promot|support|fund|provid|creat|coordinat|encourag|enhanc|develop|improv|establish|expand|offer	undevelop
social engagement	promot|support|fund|provid|creat|coordinat|encourag|enhanc|develop|improv|establish|expand	undevelop
extracurricular	promot|support|fund|provid|creat|coordinat|encourag|enhanc|develop|improv|establish|expand|offer	undevelop
welcome center|visitor center	develop|provid|inform|support|fund|creat|enhanc|expand|offer|improv|establish	

Table D.25 Keyword list for social cohesion, social support.

Social Cohesion		
Social Support		
include	near	exclude
social support	promot|support|fund|provid|creat|coordinat|encourag|enhanc|develop|improv|establish|expand|offer	undevelop
friend|neighbor	support|assist|help|promot|enhanc|encourag	neighborhood|environmental|pedestrian-friendly|neighboring|friendship house|pedestrian friendly|regulation|user-friendly|business|ecofriendly|eco-friendly

Appendix E

R code for keyword analysis annotated.

The following is formatted R script for conducting a keyword analysis of a pdf or word formatted document. Both the document and the keyword list are input files for the analysis. The output for this analysis is organized according to the eight domains of the Human well-being index (HWBI) (Smith et al. 2013). See Table 3.1 or Appendix B for details.

```
####This can change to your own folder names, as long as all needed files in
a single folder
####directory <- "M:\\Gmeccs\\Workshops\\Inferring\\"
directory <- "L:\\Priv\\Sustainable_Community_Projects\\CoorCaseStudy
Task\\IanKraussFiles\\Keyword Planning\\RScript\\WorkingFolder\\"


###This is the table of keyword synonyms
###First column is HWBI category, 2nd is name of domain(or service), 3rd
column is indicators, all additional columns are synonyms
x <- read.table( file = paste(
directory,"TestSynonyms.csv",sep=""),sep=",",header=TRUE,as.is=TRUE)

###First convert the pdfs file to a text file, using Save As in Adobe, they
need to be in the same directory as this code & synonyms list####
filenames<-list.files(path = directory, pattern = "txt", all.files =
FALSE,full.names = FALSE, recursive = FALSE)

####This will overwrite the existing file, so rename if it matters to you
write.table(cbind("Planning Doc","HWBI category","Domain or
Service","Indicators","Synonym","Near","Exclude","Line Number","Matched
Words","Text from Planning
Doc"),file=paste(directory,"HWBI_ALL_Synonym_Hits.csv",sep=""), sep = ",",
row.names=FALSE,col.names=FALSE,append=FALSE)
write.table(cbind("Planning Doc","HWBI category","Domain or
Service","Indicators","Line Number","Text from Planning
Doc"),file=paste(directory,"HWBI_Doc_Hits.csv",sep=""), sep = ",",
row.names=FALSE,col.names=FALSE,append=FALSE)


for(k in 1:NROW(filenames)){   ##cycle through all the planning docs
     y_by_lines <- readLines(paste(directory,filenames[k],sep=""))
     y_whole<-paste(y_by_lines,collapse=' ')
     y<-unlist(strsplit(y_whole,"[\f]|[.]\\s|[;]|[:]|[•]|[\t]|[?]|[!]"))


     for(j in 1:NROW(x)){    ####cycle over each HWBI indicator
          ind_hits<-integer(0)
          if(x[j,4]=="include"){
               for(i in 5:NCOL(x)){   ###cycle over each synonym (skipping
first four cols)
                    if(!(is.na(x[j,i])==TRUE | x[j,i]==""")){  ## if
synonym is not blank or NA then proceed
                         hits_split<-NA
```

```
                              near_word=""; excl_word="";

                              hits<-grep(x[j,i],y,ignore.case=TRUE)



     if(x[min(j+1,NROW(x)),4]=="near"){if(x[j,3]==x[min(j+1,NROW(x)),3]){if
(x[min(j+1,NROW(x)),i]!=""){
                                   hits<-
intersect(hits,grep(x[j+1,i],y,ignore.case=TRUE))
                                   near_word=x[j+1,i];
                              }}}

     if(x[min(j+2,NROW(x)),4]=="near"){if(x[j,3]==x[min(j+2,NROW(x)),3]){if
(x[min(j+2,NROW(x)),i]!=""){
                                   hits<-
intersect(hits,grep(x[j+2,i],y,ignore.case=TRUE))
                                   near_word=x[j+2,i];
                              }}}


     if(x[min(j+1,NROW(x)),4]=="exclude"){if(x[j,3]==x[min(j+1,NROW(x)),3])
{if(x[min(j+1,NROW(x)),i]!=""){
                                   hits<-
setdiff(hits,intersect(hits,grep(x[j+1,i],y,ignore.case=TRUE)))
                                   excl_word=x[j+1,i];
                              }}}

     if(x[min(j+2,NROW(x)),4]=="exclude"){if(x[j,3]==x[min(j+2,NROW(x)),3])
{if(x[min(j+2,NROW(x)),i]!=""){
                                   hits<-
setdiff(hits,intersect(hits,grep(x[j+2,i],y,ignore.case=TRUE)))
                                   excl_word=x[j+2,i];
                              }}}

                              ###find which words were hits
                              if(NROW(hits)>0){
                                   hits_split<-rep(0,NROW(hits))
                                   y_split<-strsplit(y[hits]," ")
                                   for(w in 1:NROW(hits)){
                                        if(!(near_word=="")){hits_split[w]<-
paste(y_split[[w]][grep(gsub(" ","|",gsub(" $","",gsub("^ ","",gsub("
\\|","|",gsub("\\|
","|",paste(x[j,i],"|",near_word,sep=""))))))),y_split[[w]],ignore.case=TRUE)
],sep="",collapse=", ")}
                                        if(near_word==""){hits_split[w]<-
paste(y_split[[w]][grep(gsub(" ","|",gsub(" $","",gsub("^ ","",gsub("
\\|","|",gsub("\\|
","|",x[j,i])))))),y_split[[w]],ignore.case=TRUE)],sep="",collapse=", ")}
                                   }
                              }
```

```
                              ### this writes ALL matches for ALL synonynms,
comment out using ### if not needed

     write.table(cbind(filenames[k],x[j,1],x[j,2],x[j,3],x[j,i],near_word,e
xcl_word,hits,hits_split,y[hits]),file=paste(directory,"HWBI_ALL_Synonym_Hit
s.csv",sep=""), sep = ",",
row.names=FALSE,col.names=FALSE,append=TRUE,qmethod="double")

                              ###remove duplicates for the indicator i
                              if(i==5){ind_hits<-hits}
                              if(i>5){ind_hits<-union(ind_hits,hits)}
                         }
                    }
                    ###this writes the lines associated with an indicator
(ignores which synonym they came from)

     write.table(cbind(filenames[k],x[j,1],x[j,2],x[j,3],ind_hits,y[ind_hit
s]),file=paste(directory,"HWBI_Doc_Hits.csv",sep=""), sep = ",",
row.names=FALSE,col.names=FALSE,append=TRUE,qmethod="double")
          }
     }
}



####Read back in the file you just created
WordMatches <- read.table( file = paste(
directory,"HWBI_Doc_Hits.csv",sep=""),sep=",",header=TRUE,as.is=TRUE,fill=TR
UE)
names(WordMatches)
######Change to a 1 or a 0 if there was a text match to a keyword
Hits<-rep(0,NROW(WordMatches))
Hits[!(WordMatches$Text.from.Planning.Doc=="")]=1

###Count the number of hits for Domains/Services
index<-
aggregate(x=1:NROW(Hits),by=list(WordMatches$Planning.Doc,WordMatches$HWBI.c
ategory,WordMatches$Domain.or.Service),FUN="min")
Hit_Counts<-
aggregate(Hits,by=list(WordMatches$Planning.Doc,WordMatches$HWBI.category,Wo
rdMatches$Domain.or.Service),FUN="sum")
Hit_YesNo<-Hit_Counts$x
Hit_YesNo[Hit_Counts$x>0]=1
output<-cbind(Hit_Counts,Hit_YesNo)
output<-output[order(index$x),]  ### this is to get back the original order
write.table(cbind("Planning_Doc","HWBI_Category","Domain/Service","Number_of
_Hits","Hit_YesNo"),file=paste(directory,"HWBI_Domain_Service_Hits.csv",sep=
""), sep = ",", row.names=FALSE,col.names=FALSE,append=FALSE)
write.table(output,file=paste(directory,"HWBI_Domain_Service_Hits.csv",sep="
"), sep = ",", row.names=FALSE,col.names=FALSE,append=TRUE)

###Count the number of hits for Indicators
```

```
index<-
aggregate(x=1:NROW(Hits),by=list(WordMatches$Planning.Doc,WordMatches$HWBI.c
ategory,WordMatches$Domain.or.Service,WordMatches$Indicator),FUN="min")
Hit_Counts<-
aggregate(Hits,by=list(WordMatches$Planning.Doc,WordMatches$HWBI.category,Wo
rdMatches$Domain.or.Service,WordMatches$Indicator),FUN="sum")
Hit_YesNo<-Hit_Counts$x
Hit_YesNo[Hit_Counts$x>0]=1
output<-cbind(Hit_Counts,Hit_YesNo)
output<-output[order(index$x),]  ### this is to get back the original order
write.table(cbind("Planning_Doc","HWBI_Category","Domain/Service","Indicator
","Number_of_Hits","Hit_YesNo"),file=paste(directory,"HWBI_Indicator_Hits.cs
v",sep=""), sep = ",", row.names=FALSE,col.names=FALSE,append=FALSE)
write.table(output,file=paste(directory,"HWBI_Indicator_Hits.csv",sep=""),
sep = ",", row.names=FALSE,col.names=FALSE,append=TRUE)


###############
###Count the number of hits for Domains/Services, but remove duplicates
(each line counted only once for each domain)
noDups<-
aggregate(x=1:NROW(Hits),by=list(WordMatches$Planning.Doc,WordMatches$HWBI.c
ategory,WordMatches$Domain.or.Service,WordMatches$Line.Number),FUN="min")
Hits<-rep(0,NROW(WordMatches))
Hits[noDups$x]=1

index<-
aggregate(x=1:NROW(Hits),by=list(WordMatches$Planning.Doc,WordMatches$HWBI.c
ategory,WordMatches$Domain.or.Service),FUN="min")
Hit_Counts<-
aggregate(Hits,by=list(WordMatches$Planning.Doc,WordMatches$HWBI.category,Wo
rdMatches$Domain.or.Service),FUN="sum")
Hit_YesNo<-Hit_Counts$x
Hit_YesNo[Hit_Counts$x>0]=1
output<-cbind(Hit_Counts,Hit_YesNo)
output<-output[order(index$x),]  ### this is to get back the original order
write.table(cbind("Planning_Doc","HWBI_Category","Domain/Service","Number_of
_Hits","Hit_YesNo"),file=paste(directory,"HWBI_Domain_Service_Hits_NoDups.cs
v",sep=""), sep = ",", row.names=FALSE,col.names=FALSE,append=FALSE)
write.table(output,file=paste(directory,"HWBI_Domain_Service_Hits_NoDups.csv
",sep=""), sep = ",", row.names=FALSE,col.names=FALSE,append=TRUE)

###Count the number of hits for Indicators, but remove duplicates (each line
counted only once for each domain)
noDups<-
aggregate(x=1:NROW(Hits),by=list(WordMatches$Planning.Doc,WordMatches$HWBI.c
ategory,WordMatches$Domain.or.Service,WordMatches$Indicator,WordMatches$Line
.Number),FUN="min")
Hits<-rep(0,NROW(WordMatches))
Hits[noDups$x]=1

index<-
aggregate(x=1:NROW(Hits),by=list(WordMatches$Planning.Doc,WordMatches$HWBI.c
ategory,WordMatches$Domain.or.Service,WordMatches$Indicator),FUN="min")
```

```
Hit_Counts<-
aggregate(Hits,by=list(WordMatches$Planning.Doc,WordMatches$HWBI.category,Wo
rdMatches$Domain.or.Service,WordMatches$Indicator),FUN="sum")
Hit_YesNo<-Hit_Counts$x
Hit_YesNo[Hit_Counts$x>0]=1
output<-cbind(Hit_Counts,Hit_YesNo)
output<-output[order(index$x),]  ### this is to get back the original order
write.table(cbind("Planning_Doc","HWBI_Category","Domain/Service","Indicator
","Number_of_Hits","Hit_YesNo"),file=paste(directory,"HWBI_Indicator_Hits_No
Dups.csv",sep=""), sep = ",", row.names=FALSE,col.names=FALSE,append=FALSE)
write.table(output,file=paste(directory,"HWBI_Indicator_Hits_NoDups.csv",sep
=""), sep = ",", row.names=FALSE,col.names=FALSE,append=TRUE)
```

Appendix F

Table F.1 References for denitrification rates.

NLCD Class	Citations
Open Water	An and Gardner 2002[1], An et al. 2001[2], Bianchi et al. 1999[3], Brenner et al. 2001[4], DeLaune et al. 2005[5], Fennell et al. 2009[6], Gardner et al. 2006[7], Gihring et al. 2010[8], Heffernan et al. 2010[9], James et al. 2011[10], Joye and Anderson 2008[11], Messer and Brezonik 1983[12], Mortazavi et al. 2000[13], Pina-Ochoa and Alvarez-Cobelas 2007[14], Seitzinger 1988[15], Seitzinger et al. 2006[16], Smith et al. 1985[17]
Open Space	Barton et al. 1999[18], Raciti et al. 2011[19], Robertson et al. 1987[20], Tsai 1989[21]
Low Intensity Development	Barton et al. 1999[18], Raciti et al. 2011[19], Robertson et al. 1987[20], Tsai 1989[21]
Med Intensity Development	Barton et al. 1999[18], Raciti et al. 2011[19], Robertson et al. 1987[20], Tsai 1989[21]
High Intensity Development	Barton et al. 1999[18], Raciti et al. 2011[19], Robertson et al. 1987[20], Tsai 1989[21]
Barren	Walker et al. 1992[22]
Deciduous Forest	Barton et al. 1999[18], Chestnut et al. 1999[23] Henrich and Haselwandter 1997[24], Robertson et al. 1987[25]
Evergreen Forest	Barton et al. 1999[18], Henrich and Haselwandter 1997[24], Robertson et al. 1987[25]
Mixed Forest	Barton et al. 1999[18], Dutch and Ineson 1990[26], Goodread and Keeney 1984[27]
Shrub/Scrub	Walker et al. 1992[22]
Grassland/Herbaceous	Robertson et al. 1987[25], Tsai 1989[28]
Pasture/Hay	Barton et al. 1999[18], Espinoza 1997[29], Hofstra and Bouwman 2005[30], Seitzinger et al. 2006[16], Tsai 1989[28]
Cultivated Crops	Pina-Ochoa and Alvarez-Cobelas 2007[14]
Woody Wetlands	Bowden 1987[31], DeLaune et al. 1998[32], Gale et al. 1993[33], Lindau et al. 2008[34], Seitzinger 1994[35], Walbridge and Lockaby 1994[36]
Emergent Herbaceous Wetlands	Craft et al. 2009[37], DeLaune et al. 1989[38], Dodla et al. 2008[39], Gale et al. 1993[33], Morris 1991[40], Nixon and Lee 1986[41], Reddy et al. 1989[42], Seitzinger 1987[43], Wigand et al. 2004[44]

Table F.2 References for carbon burial rates.

NLCD Class	Citations
Open Water	Brennar et al. 2001[1], Craft and Richardson 1993[2], Downing et al. 2008[3], Duarte et al. 2005[4], Duarte et al. 2007[5], Gacia et al. 2002[6], McCleod et al. 2011[7]
Open Space	Pouyat et al. 2009[8], Pouyat et al. 2010[9], Pouyat et al. 2011[10], Qian and Follett 2002[11], Raciti et al. 2011[12]
Low Intensity Development	Pouyat et al. 2009[8], Pouyat et al. 2010[9], Pouyat et al. 2011[10], Qian and Follett 2002[11], Raciti et al. 2011[12]
Med Intensity Development	Pouyat et al. 2009[8], Pouyat et al. 2010[9], Pouyat et al. 2011[10], Qian and Follett 2002[11], Raciti et al. 2011[12]
High Intensity Development	Pouyat et al. 2009[8], Pouyat et al. 2010[9], Pouyat et al. 2011[10], Qian and Follett 2002[11], Raciti et al. 2011[12]
Barren	N/A
Deciduous Forest	Downing et al. 2008[13], Johnston et al. 1996[14], Laffoley and Grimsditch 2009[15], McCleod et al. 2011[7]
Evergreen Forest	Garten Jr. 2002[16], Hooker and Comptoon 2003[17], Hooker and Comptoon 2004[18], Huntington 1995[19], Richter et al. 1999[20], Schiffman and Johnson 1989[21]
Mixed Forest	Downing et al. 2008[13], Garten Jr. 2002[16], Hooker and Comptoon 2003[17], Hooker and Comptoon 2004[18], Huntington 1995[19], Johnston et al. 1996[14], Laffoley and Grimsditch 2009[15], McCleod et al. 2011[7], Richter et al. 1999[20], Schiffman and Johnson 1989[21]
Shrub/Scrub	N/A
Grassland/Herbaceous	Burke et al. 1995[22], Downing et al. 2008[13], Gebhart et al. 1994[23], Knops and Tilman 2000[24], Laffoley and Grimsditch 2009[15], Post and Kwon 1999[25]
Pasture/Hay	Downing et al. 200[13]
Cultivated Crops	Heath and Pacala 2001[26], Houghton et al. 1999[27]
Woody Wetlands	Briethaupt et al. 2012[28]
Emergent Herbaceous Wetlands	Brennar et al. 2001[29], Chmura et al. 2002[30], Day et al. 2004[31], DeLaune et al. 1981[32], Downing et al. 2008[13], Duarte et al. 2005[33], Laffoley and Grimsditch 2009[15]

Appendix G

Table G.1 NLCD category descriptions (Homer 2015).

NLCD Code	NLCD Description
11	Open Water
21	Open Space
22	Low Intensity Development
23	Med Intensity Development
24	High Intensity Development
31	Barren
41	Deciduous Forest
42	Evergreen Forest
43	Mixed Forest
52	Shrub/Scrub
71	Grassland/Herbaceous
81	Pasture/Hay
82	Cultivated Crops
90	Woody Wetlands
95	Emergent Herbaceous Wetlands

Appendix H

Table H.1 Percentage of each soil type by NLCD land cover categories for the four counties. This is used to calculate a weighted Curve Number value that is a metric for Flood Protection.

NLCD	Escambia, FL (%)				Indian River, FL (%)				Lafourche, LA (%)				St. Landry, LA (%)			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
11	88.23	7.36	4.41	0.00	95.92	0.00	3.91	0.18	97.07	0.00	0.28	2.65	93.36	0.21	0.91	5.52
21	71.80	15.97	12.23	0.00	64.46	2.09	26.58	6.87	54.50	0.00	0.47	45.03	71.61	7.34	13.97	7.08
22	86.86	5.29	7.86	0.00	71.82	3.71	16.53	7.94	44.00	0.00	0.74	55.26	65.78	5.53	20.32	8.38
23	86.62	4.05	9.33	0.00	66.58	3.66	22.22	7.54	52.83	0.00	1.30	45.88	52.49	7.51	27.50	12.50
24	87.62	1.83	10.55	0.00	71.34	3.60	18.98	6.07	56.38	0.00	0.07	43.55	58.12	3.26	26.74	11.89
31	92.57	3.81	3.61	0.00	60.81	0.27	36.31	2.61	88.88	0.00	2.40	8.72	81.84	0.94	13.21	4.01
41	75.08	14.65	10.27	0.00	69.74	0.00	25.88	4.39	8.01	0.00	0.00	91.99	80.47	11.28	7.79	0.46
42	69.06	20.90	10.04	0.00	65.32	0.42	4.85	29.41	26.29	0.00	7.73	65.98	70.05	11.33	17.34	1.28
43	80.40	14.08	5.51	0.00	64.30	0.59	1.17	33.94	9.17	0.00	0.00	90.83	78.26	13.39	7.93	0.43
52	65.49	23.80	10.71	0.00	58.52	0.75	10.18	30.55	72.99	0.00	1.09	25.92	76.11	6.72	10.59	6.58
71	62.93	23.98	13.09	0.00	66.17	0.87	24.78	8.18	49.39	0.00	0.97	49.64	76.49	3.85	8.84	10.83
81	46.12	34.72	19.16	0.00	70.31	1.75	14.00	13.95	75.54	0.00	3.60	20.86	70.03	6.17	14.98	8.81
82	13.91	44.59	41.50	0.00	40.82	0.05	59.08	0.05	44.70	0.00	0.60	54.71	70.30	1.45	12.48	15.77
90	69.07	25.41	5.53	0.00	62.33	4.76	27.73	5.18	30.01	0.00	4.99	65.00	66.69	0.69	3.04	29.58
95	78.75	17.33	3.92	0.00	75.50	1.89	21.74	0.87	65.65	0.00	8.66	25.69	61.89	0.36	2.50	35.26

Appendix I

Table I.1 Curve numbers by land cover category and soil type. Curve Number (CN) is an index that represents a land cover category's ability to hold water after a rain event has begun and just before runoff starts to occur. The lower a CN value, the lower the runoff potential. For example, a land use type with a CN of 30 has a very high water retention rate and a low runoff potential, whereas a land use type with a CN of 100 has a very low water retention rate and a high runoff potential. A, B, C, and D are different soil types and textures distinguished by varying combinations of sand, loam, silt, and clay. (Zhang et al. 2011).

NLCD	A	B	C	D
Open Water	100	100	100	100
Open Space	29	48	61	69
Low Intensity Development	40	56	67	74
Med Intensity Development	58	70	79	83
High Intensity Development	70	79	84	87
Barren	95	95	95	95
Deciduous Forest	19	39	53	61
Evergreen Forest	19	39	53	61
Mixed Forest	19	39	53	61
Shrub/Scrub	34	52	64	72
Grassland/Herbaceous	29	48	61	69
Pasture/Hay	29	48	61	69
Cultivated Crops	45	57	66	70
Woody Wetlands	100	100	100	100
Emergent Herbaceous Wetlands	100	100	100	100

Table I.2 Weighted curve number by land cover category for four counties assigned based on the soil hydrogroup of each NLCD class. Curve Number (CN) is an index that represents a land cover category's ability to hold water after a rain event has begun and just before runoff starts to occur. The higher the curve number, the less able the soil is to absorb runoff. For example, in Escambia, FL, Deciduous Forest can hold almost four times as much water as woody wetlands. (Zhang et al. 2011).

NLCD	Escambia, FL	Indian River, FL	Lafourche, LA	St. Landry, LA
Open Water	100.00	100.00	100.00	100.00
Open Space	35.95	41.74	47.16	37.70
Low Intensity Development	42.97	47.76	58.99	49.22
Med Intensity Development	60.44	64.99	69.74	67.80
High Intensity Development	71.64	74.01	77.41	76.06
Barren	95.00	95.00	95.00	95.00
Deciduous Forest	25.42	15.93	57.63	24.10
Evergreen Forest	26.59	33.09	49.34	27.70
Mixed Forest	23.69	33.77	57.15	24.55
Shrub/Scrub	41.50	48.80	44.18	40.89
Grassland/Herbaceous	37.75	40.37	49.17	36.89
Pasture/Hay	41.73	39.39	38.50	38.49
Cultivated Crops	59.07	57.43	58.80	51.74
Woody Wetlands	100.00	100.00	100.00	100.00
Emergent Herbaceous Wetlands	100.00	100.00	100.00	100.00

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