Methodology for Producing a Coastal Louisiana Report Card

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THE WATER INSTITUTE
OF THE GULF

Produced for and Funded by the Coastal Protection and Restoration Authority

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Acknowledgements

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Background

The Water Institute of the Gulf, with guidance and input from the Coastal Protection and Restoration Authority, was tasked to develop methodology for producing a report card for coastal Louisiana. The intent of this report card is to provide a holistic assessment of the environmental, social, and economic condition of coastal LA that informs the general public, managers, and public officials on the state of the coast. The need for a report card stems from the extensive changes occurring along the coast—both natural and human-induced—that may impact the resiliency and sustainably of the coastal environment and local communities. Severe land loss and habitat degradation threaten recreationally and commercially important wildlife and fish populations, while increasing flood risks continue to jeopardize critical infrastructure. It is envisioned that a coastal report card would encourage community leaders and policy makers to take action for change in their own communities and work collectively in restoring and protecting the coast.

The production of a report card requires: 1) identifying performance measures that reflect the condition of the coast, 2) assessing data availability to generate performance measures, 3) periodically collecting and analyzing data to detect change, 4) calculating grades, and 5) communicating information to the public. This report first describes the necessary steps in creating a report card, which could be applicable to multiple contexts. Secondly, it provides more specific guidance on developing a coastal Louisiana report card for communicating the status of its ecosystem and built system to a diverse audience. To inform this guidance, a report card prototype for coastal Louisiana was developed using a preliminary set of performance measures. The prototype was shared with five focus groups across Louisiana's coast that captured the perspectives of the targeted audience including: local community members, legislative representatives, business leaders, natural and social scientists, and university-level students. The focus groups also captured important geographic differences as they were held at a range of venues across the coast. The focus group attendees had the opportunity to debate the relevance of the performance measures selected and to provide feedback on layout, aesthetics, and ease of understanding and interpreting the report card grades. The discussions with the focus groups confirmed that the report card would be a useful tool to inform Louisiana's coastal residents and public officials on the condition of the ecosystem and socio-economic environment of their local communities. The focus groups also revealed that residents were interested in learning more about action they can take in their own communities to ensure their livelihoods along the coast are sustained. The challenge ahead lies in balancing the need for localized information, while reporting on a coastwide scale and ensuring report cards steer readers towards appropriate actions for change.

Introduction

Report cards are used as a communication tool to inform a large, diverse audience on the condition of the environment and to track progress toward achieving a desired goal in a succinct but informative manner. An effective report card is one that: 1) uses a select list of performance measures to evaluate the status of the system, 2) assesses long- and short-term trends in the performance measures, 3) provides transparency in the underlying methodology used to produce the grades, and 4) communicates the results in a way that is understandable to multiple audiences (Harwell et al. 1999). Performance measures should be derived from quantifiable metrics that reflect essential attributes or dynamics of the system and can be used to track changes over time and support decision making (NRC 2000). The spatial and temporal scale of the data collection efforts dictate the reporting capabilities of the performance measures and ultimately determine the ability to detect change in the metrics (Jackson et al. 2000). Producing a report card requires a systematic process reliant on a rigorous methodology to analyze scientific data and calculate the report card grades. Communicating the results using a variety of data visualization strategies (e.g., maps, graphs, conceptual diagrams, photos) and across different mediums (e.g., brochures, website, news and radio) enables the audience to interpret the data and ensures the report card reaches a broad audience (Dennison et al. 2007, Conner et al. 2010).

Report cards have been employed by numerous restoration programs (e.g., Chesapeake Bay, Everglades, Puget Sound) to communicate the effects of restoration projects on ecosystems and resources and garner support for ecosystem restoration. These efforts vary considerably in their performance measures selection, grading criteria, and communication strategies; highlighting that no one method exists for producing a report card. The Chesapeake Bay Report Card was first produced in 2006 and has been updated annually to inform citizens on the progress towards achieving a healthy ecosystem in the Chesapeake Bay[1]. The report card uses six indicators of ecosystem health and generates grades using a five point grading scheme (A through F) and color gradients (green to red). The Everglades report card was produced in 2010 using 11 performance measures and a simplified stop-light grading scheme (red, yellow, green)[2]. It has not been updated at the time this report was produced. The Puget Sound Report Card differs from the previous two examples in that it includes metrics related to not only ecosystem attributes, but human attributes as well, including shoreline protection, land development, and sewage systems[3]. Produced in 2009 and updated in 2012, the report card uses a total of 19 indicators with two additional metrics related to social aspects of the system currently under development.

The need to communicate scientific data to non-technical audiences has gained recognition by local agencies in coastal Louisiana in recent years. In 2006, the Coastal Louisiana Ecosystem Assessment and Restoration (CLEAR) program developed conceptual diagrams to describe the relationship between restoration projects and ecosystem services. The diagrams were published in two-page brochures with other visual elements—including photographs and maps—to target secondary education programs and non-governmental agencies. The underlying message that coastal communities are uniquely tied to and reliant upon the natural features of the environment is still applicable today. Additionally, a few agency-specific report cards have been produced in Louisiana including the "*Coastwide Reference Monitoring*

[1] http://ian.umces.edu/ecocheck/report-cards/chesapeake-bay
[2] http://www.sfrestore.org
[3] http://www.psp.wa.gov/sos.php

System Report Card[4]" and the "*Pontchartrain Coastal Lines of Defense Report Card*[5]". These efforts have focused on project- or region-specific goals and targets related to ecosystem restoration. Efforts to highlight the socio-economic conditions have been undertaken on a local and regional scale by the Greater New Orleans Community Data Center in their production of the "*New Orleans Index at Six*" which reports on temporal trends from twenty indicators, but does not evaluate or grade their performance[6]. Additionally, the American Society of Civil Engineers publishes the *"America's Infrastructure Report Card*" which depicts the condition and performance of Louisiana's infrastructure systems including bridges, levees, roads, and others[7]. However, there is as of yet no attempt to produce a comprehensive report card for coastal Louisiana that pulls together data on the state of both the coastal ecosystem and local communities. The natural environment plays a critical role in supporting economic activity, improving quality of life, and sustaining the built environment, but there is often a disconnect between societies and the benefits received from the ecosystem (World Health Organization 2005). Reporting on the conditions of the natural and built systems in an integrated context reinforces the connection between the resiliency of coastal communities and the sustainability of the coastal environment.

A coastal report card for Louisiana could serve several functions:

- Inform the general public on the environmental and socio-economic conditions of coastal Louisiana;
- Monitor and track changes in the coastal system as the restoration and protection program is implemented;
- Provide scientific results in a concise and understandable way to policy makers in a useful timeframe for decision making and planning;
- Encourage active discussions amongst citizens, stakeholders, and business and community leaders to prompt action and drive change in their communities;

It is envisioned that a coastal Louisiana report card would synthesize scientific data to evaluate coastwide changes as a result of ongoing climatic, economic, social and environmental change and programmatic actions. The results evaluated would be reflective of a multitude of efforts currently underway along the coast including: large-scale restoration and protection measures, individual projects and community planning efforts, and natural dynamics along the coast. This report describes the central elements of producing a report card for coastal Louisiana using practices and methodologies from other report card efforts as a guide. It also describes preliminary efforts in the identification of performance measures and the development of a mock prototype that was tested at focus groups across the coast. It is intended to serve as a technical guide under the premise that the need for a report card has previously been established and its purpose and intended audience has been identified. Instances in which the purpose and audience is uncertain, focus groups may be used to gage interest and refine these aspects (see Communications Strategy).

[4] http://lacoast.gov/crms
[5] http://www.saveourlake.org/coastal-resources.php
[6] http://www.gnocdc.org/TheNewOrleansIndexAtSix/index.html
[7] http://www.infrastructurereportcard.org/louisiana/louisiana-overview/

Fundamentals of Report Card Development

Performance Measures

Identifying Performance Measures

Assessing the overall health of a system requires the identification of performance measures that are derived from specific, measurable attributes of the environment (natural or built) that can be tracked over time. Performance measures summarize monitoring data in order to reveal important information on status and trends that can be communicated to decision makers in a simplified manner. They may serve different purposes including: assessing project or program performance, tracking progress towards meeting goals and objectives, or communicating scientific information to policy-makers, scientists, and the general public (Jackson et al. 2000, Noll 2004). Identifying relationships between specific system drivers and performance measures can improve the diagnostic capabilities of the performance measures, but separating natural sources of variation from anthropogenic impacts is inherently difficult (Niemi and McDonald 2004).

Several guidelines exist for developing and implementing environmental or ecological performance measures including approaches from the Environmental Protection Agency (Jackson et al. 2000) and the National Research Council (NRC 2000), but all center around the following themes:

- Relevant to ecologically important functions or processes;
- Sources of variability are understood and interpreted correctly;
- Effective at detecting changes at appropriate temporal and spatial scales;
- Logistics, data, and monetary requirements to implement performance measure are cost-effective;
- Useful for management decisions in that it provides responsive and reliable results regarding changes in function or processes;

Approaches for developing social performance measures follow similar concepts to those developed for ecological performance measures. Performance measures representative of social conditions can be monitored over time in order to identify problems that require action or to assesses the effectiveness of programs and policies (Noll 2004 and references therein). To aid in decision making, social performance measures should be: (1) pertinent to the problem or question at hand, (2) represent a concept that is clear, understood, and agreed upon, (3) produced using measurements that provide reliable and unbiased results, and (4) understandable in its concept and limitations (Innes 1990).

The performance measures used in the report card should be periodically reassessed by a Report Card Team (see Roles and Responsibilities for team explanation) to ensure they are meeting their intended purpose and are adequately tracking progress towards meeting a desired goal or target. The reassessment may involve identifying a need for additional data sources (e.g., increasing number of samples or sampling frequency) or supplemental performance measures to inform on the status of the system. For example, if specific changes were predicted to occur but did not, the underlying data sources should be carefully examined to determine if flaws exist in the monitoring program. Alternatively, additional sources of information about how the system works (e.g., system experts, research programs, etc.) can assist in determining if an inadequate understanding of the system dynamics or unanticipated externalities may have resulted in the selection of performance measures

that do not sufficiently track changes (EPA 2008). Abrupt changes in report card methodology or reporting schemes should be taken cautiously to maintain transparency, consistency, and credibility in the report card methodology. The introduction of new performance measures should occur gradually and be communicated clearly to the report card audience to prevent confusion (W. Dennison, personal communication). For example, the Chesapeake Bay Report Card is currently considering the inclusion of river discharge in their performance measure calculations to account for the effect of variable weather and climate on the ecosystem[8]. New performance measures or alterations to current performance measures should undergo the same rigorous testing and validation.

Assessing Data Quality

The integrity of a performance measure is highly reliant upon the accuracy and reliability of the data used to derive the measure. Standard methodologies and best practices should be employed for data collection activities. Quality assurance protocols should be implemented to assess the validity of the data (Jackson et al. 2000). A general set of attributes for assessing the quality of data used to develop social performance measures was synthesized by Maggino and Zumbo (2012):

1) Methodological Soundness
    - Internationally accepted standards, guidelines, or good practices should be employed for data collection efforts.
    - Performance measures should be based upon data sources and statistical techniques that are regularly assessed and validated to ensure accuracy and reliability of measurements. The accuracy of an estimate involves analyzing the total error associated with the estimate: sampling error and measurement error.
2) Integrity
    - The principle of objectivity in the collection, compilation, and dissemination of data, statistics, and results should be adhered to ensure professionalism in statistical policies and practices, transparency, and ethical standards.
3) Serviceability
    - Data users and their expectations should be identified in order to adequately meet their needs.
    - Data should be timely with respect to the length of time between its availability and the event it describes.
    - Data should be regularly analyzed in order to record differences and disparities between units, groups, geographical areas and so on, by employing the available information as much as possible.
4) Accessibility
    - Presentations and documentations concerning data and metadata should be clearly accessible.
    - Data should be easily findable, accessible, useable, analyzable, and interpretable in order to gain users' confidence.

Application to Coastal Louisiana

One of the challenges in developing a coastal report card for Louisiana is the inclusion of both environmental and socio-economic performance measures that are meaningful to a variety of stakeholders and relevant coastwide. To assist in the development of performance measures, two

[8] http://ian.umces.edu/blog/2013/03/20/better-ways-to-look-at-what-were-doing-to-chesapeake-bay/

workshops were held with local experts knowledgeable of the natural and built coastal system (Hijuelos and Reed 2013). The following items were taken into consideration in generating the list of performance measures:

- Natural variability should be distinguishable from the measure's response to program implementation (signal to noise ratio). This often requires long-term data collection and a clear understanding of factors that influence the measure.
- Clear expectation of the response time (rapid versus delayed) to action or no action is needed in order to accurately assess program performance.
- Response should be reliable and interpretable so that management decisions can easily be made.
- Data monitoring for the measure should be economically feasible and easy to implement.
- The measure must be relevant to the coastal program and be scientifically defensible.
- The scale of the measure should be considered and appropriately applied.

A subset of the performance measures identified in the workshops were selected for preliminary consideration in a report card and grouped into general categories of land, water, wildlife and fisheries, flood risk, economy, and culture (Table 1). This initial selection process primarily focused on the relevance of the measure to multiple stakeholders and the ease in interpreting and conveying the results. Additional research into the data sources required to produce the performance measures and into the ability to detect change in the monitoring data (see Monitoring Considerations below) is needed before implementing the performance measures for use in a report card.

Table 1. Performance measures selected for use in the coastal Louisiana report card prototype.

Ecological Performance Measures			Socio-Economic Performance Measures		
Category	Performance Measures	Definition	Category	Performance Measures	Definition
Land	Land Area	Total area of natural landscape features including barrier islands, ridges, and wetlands	Flood Risk	Flood Risk	Number of people and assets protected at 50 or 100 year flood levels
	Land Fragmentation	Indicates the amount of broken marsh or patchiness in the landscape		Flood Insurance	Number of insurers and number of policies; cost of flood insurance
	Vegetation Diversity	Variety and abundance of different vegetation types in the landscape.	Economy	Income/ Cost of Living	Ratio of income and costs associated with lifestyle expenditures such as housing, groceries, gas, and taxes.
Water	Inundation	Frequency and duration of flooding of wetlands, coastal forests, and other natural landscapes.		Employment	Total number of jobs and job growth reflect job security in a community
	Salinity	Change in mean salinity levels over time.		Commerce	Waterborne commerce, oil and gas, agriculture, and commercial fishing industries.
Wildlife and Fisheries	Fisheries Diversity	Variety and abundance of fish species.	Culture	Population Diversity	Number of individuals by age and cultural group.
	Bird Abundance	Variety and abundance of shorebirds, marsh birds, and waterfowl.		Education	The number of individuals with post-secondary education; educational opportunities in a community.
				Recreation	Hunting and fishing licenses; number of trails accessible by hikers, off-road vehicles, or bicycles.

Monitoring Considerations

Detecting Change

Performance measures synthesize monitoring data to produce a value representative of the condition of a system attribute. Implementing performance measures for use in report cards requires careful consideration of the underlying monitoring data including: (1) data collection methodology, (2) logistical requirements for collecting data, (3) management of data including processing, analysis, storage and retrieval, (4) quality assurance for accurate interpretation of results, and (5) monetary costs (Jackson et al. 2000).

Statistical analysis is an important tool in summarizing complex data sets, examining trends, detecting patterns, making predictions, and supporting key hypothesis and conclusions. Analyzing and interpreting changes in the performance measures is dependent upon the number of samples collected in a given area and the frequency of the data-collection efforts. As a result, it is important to have a well-developed experimental design that is statistically robust to assess change. Monitoring data must also have an appropriate spatial density for each of the reporting regions and ideally should be available on a time frame that allows for near-term reporting (Williams et al. 2010). The ability to detect change is a function of three factors that relate to measuring variability and the statistical design of the monitoring program (RECOVER 2006):

- Baseline variability of the performance measure;
- Strength of the response being measured;
- Power of the experimental design to detect change in the response that is significantly different from the natural variability.

The power of a statistical test, or the probability in detecting a significant difference when a difference actually exists, is related to the significance level, sample size, variance, and effect size (e.g., minimum detectable difference; Zar 2010). Although power and significance levels are arbitrary values, they are useful in providing guidance for the amount of effort needed to detect change. For instance, if a power analysis determines that an impractically large sample size is needed in order to be able to detect some desired minimum difference, it may be concluded that the time, effort, and expense to perform the monitoring is too high. Alternatively, if the sample size is already known or set through an established monitoring program, a power analysis can then be used to calculate what minimum difference is detectable given that sample size. Typically, power is greatest when sample sizes are large and variability is low, and the reader is encouraged to refer to statistical texts for additional guidance on the use of power analysis (Osenberg et al. 1994, Sit and Taylor 1998, Faul et al. 2007 and references therein).

Designing a Monitoring Program

Once an adequate sample size has been determined, the design of the monitoring program will need to be considered. Probability-based sampling designs are frequently employed as they result in unbiased and defensible parameter estimates. The spatial scale of the sampling arrangement must also be appropriate for the process or resource that is being tracked. Spatial scale is a function of two components: grain and extent. Grain is the size of the smallest unit (e.g., size of plot) while the extent is the total area encompassed by all of the sampling units in the study (Figure 1). Designs with both small

grains and extents have limited scope to allow for broad conclusions, while increasing the extent can increase the domain of inference of the results (Gotelli and Ellison 2004). Other statistical concepts including independence, replication, and confounding factors should be reviewed prior to implementing a sampling design.

The monitoring program should be inclusive of all the data necessary for calculating the performance measures. For example, the Floristic Quality Index may be used to represent the performance measure "vegetation diversity." The index requires plot-level data collection of abundance of each species, plant height, and amount of plant cover (Cretini et al. 2012). The spatial grain of these sampling efforts would be small given the nature of the data-collection activities. Assuming an adequate sample size, the spatial extent may be large in order to evaluate regional and coastwide patterns.

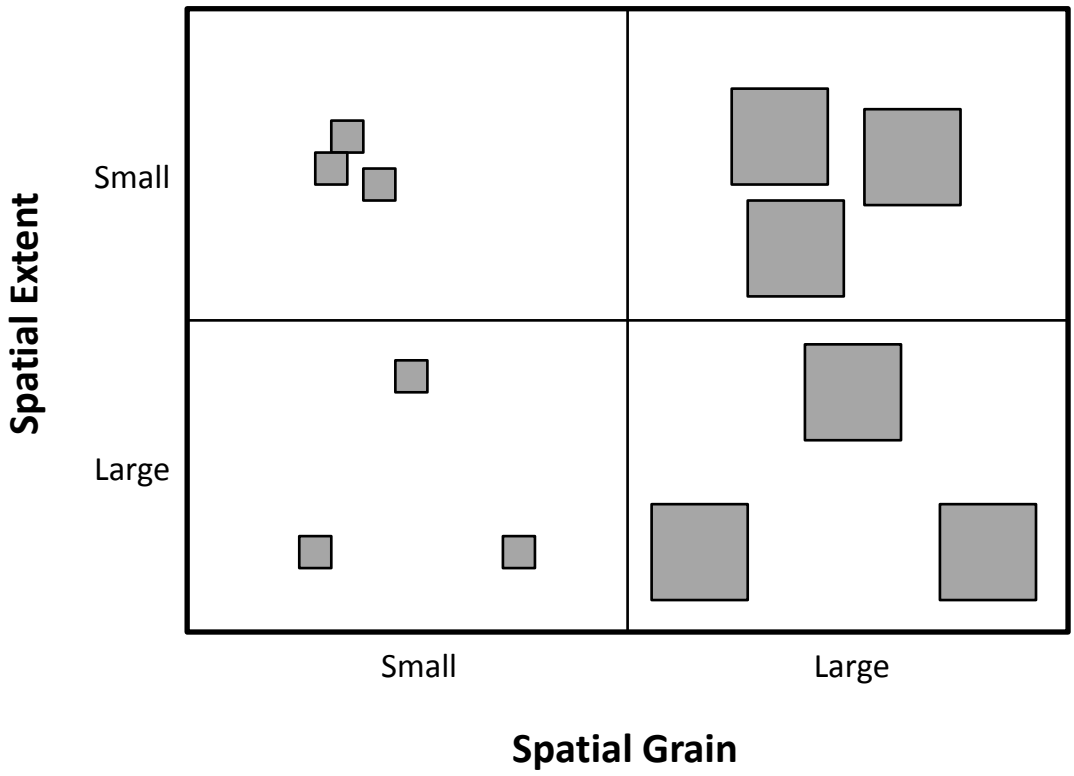

Figure 1. Spatial extent and spatial grain of a sampling scheme. Spatial grain measures the size of the sampling units (e.g., individual squares), while spatial extent measures the area encompassing all of the sampling unites (Gotelli and Ellison 2004).

Application to Coastal Louisiana

A comprehensive monitoring program is needed in coastal Louisiana to evaluate project and program performance and detect system change. Currently, monitoring of many aspects of the coastal landscape is undertaken by several state and federal agencies including the Louisiana Department of Wildlife and Fisheries, Louisiana Department of Environmental Quality, Louisiana Department of Natural Resources, U.S. Army Corps of Engineers, U.S. Geological Society and others. A collaborative framework that avoids

duplication, leverages limited funding, and supports long-term data collection has been proposed by the Coastal Protection and Restoration Agency (CPRA) through the development of a System Wide Assessment and Monitoring Program (SWAMP). A SWAMP framework is currently under development by the CPRA with assistance from The Water Institute of the Gulf that will articulate the need for a coastwide monitoring program and describe how the program would support the state's coastal protection and restoration program.

Performance Assessment

Identifying Targets

Establishing targets is a key step in assessing the performance measures and determining if the desired goals and objectives are being met. The target is defined as the overall goal or ideal state of the system. Identifying targets first requires an inherent understanding of what directionality is desired in each of the performance measures. These metrics may be based off of restoration goals, societal preference, or experts who are knowledgeable in system dynamics.

Long-term datasets from reference conditions or comparative systems can offer insight into calculating targets if data is limited in the reporting region. A quantitative benchmark calculated from model predictions can also aid in determining targets (Niemi and McDonald 2004), but can be complicated by model uncertainty, nonlinear dynamics, and by multiple drivers operating on diverse spatial and temporal scales (Groffman et al. 2006). For simplicity, the initial measurement may be used as a baseline for comparison of future measurements, however, an understanding of the system state at the baseline value must still be known. Comparison to the baseline can only be made meaningful if the desired direction of change is well understood. Setting of targets may consider the expected effects of restoration or protection projects that have been or will be implemented such that the target represents an expected post-construction system state.

Targets should be specific to the reporting region and be scientifically justified. Validation procedures to determine the robustness of the performance measures and the scoring thresholds should be employed, particularly when modeling is involved. These typically require separate validation datasets that are often unavailable (Rykiel Jr. 1996 and Williams et al. 2010).

Assigning Grades

The performance measures' grading scheme is determined during the report card development process using the targets. Assigning grades requires deliberation of what is considered reasonable/unreasonable progress even if the target is not achieved. Grading schemes should be established prior to data collection and are determined by the Report Card Team.

One method for calculating grades that has been employed for the Chesapeake Bay Report Card requires each data type used in the calculation of the Bay Health Index to have an individual threshold assigned. Thresholds were designated using methods such as the Relative Status Method and a Category and Regression Tree Analysis (CART), both which are heavily reliant on long-term monitoring data (Buchanan et al. 2005, Williams et al. 2009). Once a threshold value for each of the data types has been established, the frequency of sampling stations meeting or exceeding the threshold value is calculated. This determines the frequency of passing scores, for each data type. The occurrences of passing scores is then averaged across data types and scaled to the reporting region by averaging scores

of all stations. The resulting performance measure (the Bay Health Index) is scaled between 0 and 100 and assigned a letter grade (e.g., 80-100 is classified as an A) (Williams et al. 2009). Prior the development of thresholds, the Chesapeake Bay Report Card used a relative ranking method to assign grades. In this approach, the performance measure values in each reporting region are ranked from the best to worst result. The sum of all the performance measure ranking scores is then combined for a given region, giving an overall score for the region. The overall score is then used to rank the regions from best to worth health (Williams et al. 2010).

Statistical procedures can also be used to characterize background variability and then identify when an observed value is greater or less than what would be expected based on the background variability (see methods by Trexler and Goss 2009). This model-based assessment is specifically used for the aquatic fauna performance measure in the Everglades Report Card and is communicated using a stop-light color scheme. In brief, the deviation of the observed value from the predicted value is compared to the standard error to determine the appropriate stop-light color. The Report Card Team will need to define whether or not a three- or five-point grading scheme is employed based in part on the range of potential outcomes that may be of interest to the report card audience.

Assessing Spatial and Temporal Patterns

In addition to comparing the observed results to the targets and thresholds, supplementary analyses may be utilized to determine if changes in the system have occurred since a previous reporting year. In order for these analyses to be meaningfully interpreted, a desired direction of change should be well understood, although it is not necessary for a discrete target or threshold to be established. Trend analysis can be used to explore linear or nonlinear patterns, determine if statistically significant changes have occurred since an earlier time period, or if the direction in the trend has shifted from positive to negative, or vice versa. For data that is highly variable in space and time (e.g., dissolved oxygen), single stations or discrete sampling measurements are inappropriate for assessing the performance of an entire region or over an extended period. The spatial extent—as previously mentioned—should be large and measurement frequency should be appropriate to capture the temporal scale (e.g., daily, monthly, or seasonal) of the process or resource (Jackson et al. 2000). A large spatial extent ensures inferences can be made across a larger geographic area.

Application to Coastal Louisiana

Targets and thresholds have not yet been identified for coastal Louisiana in a way that could be used in developing a report card. The process is made increasingly difficult given the concepts of directionality, baselines, and nonlinearity described above as well as potential interaction among aspects of the coastal system reflected in the performance measures. Directionality should reflect the desirable outcome of the performance measure across the coast as a whole. In some cases, the direction of one performance measure may negatively impact other parts of the system. For example, an increase in land area may be accompanied by a decrease in marsh-edge habitat, which could result in a negative impact on nekton.

Once directionality has been determined, a decision must be made concerning the baseline value against which change in the performance measure will be compared. Nonlinearity issues also arise when making comparisons to baseline measurements. For instance, sudden changes in land area can occur because of hurricanes, drought, and other disturbances. As a result, a sufficient sampling regime is necessary to appropriately analyze temporal trends. Table 2 illustrates how some of the concepts

described in this section could be considered for an example coastal Louisiana performance measure, land area.

Table 2. Potential approach for assessing land area performance, as an example, in coastal Louisiana.

Issue	Example of Potential Approach
Targets	Predictions of change in land area can be made using models that estimate changes in land area due to background system dynamics and the effect of ongoing and expected actions. A reasonable target for land area for any reporting period may be that the expected changes have occurred. Alternatively, a target for performance on land area could be based on the direction and rate of change, e.g., land area is increasing at a rate of *X*% per year or *X* km^2 per yr, or land area is stable. Targets must be quantitative – directionality alone (e.g., land area is stable or increasing) does not provide a sound basis for measurement or reporting due to issues with detecting change and natural variability (see below).
Trends	For land area, background variability and model uncertainty are key issues to be considered. The ability to detect change in land area using remote sensing techniques depends on many measurement issues, such as controlling for water level changes (Allen et al. 2011), and has limited spatial resolution. Despite these difficulties, historic trends in land area change have been estimated (Allen et al. 2011). Statistical measures (e.g., confidence intervals) can be used to identify whether a measurement represents a real deviation from the long-term trend or should be considered natural variability.
Benchmarks	If an absolute change from a benchmark is chosen as the target for an area (e.g., an increase of *X* km^2 of land relative to 2010) then detecting change relative to that benchmark requires consideration of measurement error (e.g., water level variation). The change represented by the target must be measurable with confidence (e.g., larger than the measurement error of the technique).
Grading	For each of the grading categories, thresholds of change will need to be established. For the land area example, if the target was set as an increase in land area of *X* km^2, a 5 point stop-light scheme could be as follows (assumes historical trend was decreasing land area): • Bright Green – target increase achieved or exceeded • Light Green –increase in land area but target not achieved • Yellow – no change in land area • Orange - decrease in land area same as historical trend • Red - decrease in land area greater than historical trend In each case, the change has to be measureable considering the constraints of detection. In addition to the grading scheme, the report card could also include the actual change to demonstrate where within each of the categories the measurements fell.

Spatial/Temporal Patterns	Targets for land area can be based on basins or other subsets of the coastal system. Reporting of grades for any basin can also be accompanied by maps showing the actual patterns of change and these can also inform commentary within the report card context of the causes of change. This could be especially important if projects were not performing as anticipated or if there were unexpected events driving the changes in land area (e.g., storm damages, brown marsh events). The reporting intervals for change in land area should consider the challenge of detecting change due to natural processes at the basin scale over short time scales and the dynamics of the system (e.g., potential for recovery from storm damages).

Given the importance of understanding data variability as described above, it will be important that any targets set can be supported by timely data collection and analysis. It will also be important that the process for setting targets and grading thresholds are clearly described and made available to all report card users.

Communication Strategy

Developing an Information Pyramid

A successful communication strategy identifies the key messages to be conveyed, targeted audience, spokesperson to deliver the message, and the medium by which one disseminates the information (Conner et al. 2010). The report card process can be depicted as an information pyramid in which the raw data is processed and analyzed by technical experts and condensed into a clear message for communication to the general public and decision makers (Figure 2). The condensed messages become increasingly important in television and radio interviews in which every grade or index cannot be explained, as well as for policy makers to aid in the decision-making process. The report card itself may take several forms such as trifold brochure or a website with an interactive interface which allows users to further explore the data and access additional information that could not all be displayed in a printout. The web architecture can become the basis for learning more about the performance measures, the underlying data, and the methodology used to produce the scores. The communication strategy may also consider the naming convention of the performance measures or the manner in which they are described in the report card. In a series of focus groups Schiller et al. (2001) learned that participants preferred information on the environmental condition and the implications to changes in the environment, rather than the specifics of what was measured or how measurements were performed. Although those specific details are critical to the report card process, such focus group results highlight that audiences will likely differ in terms of their interests in and expectations of the report card.

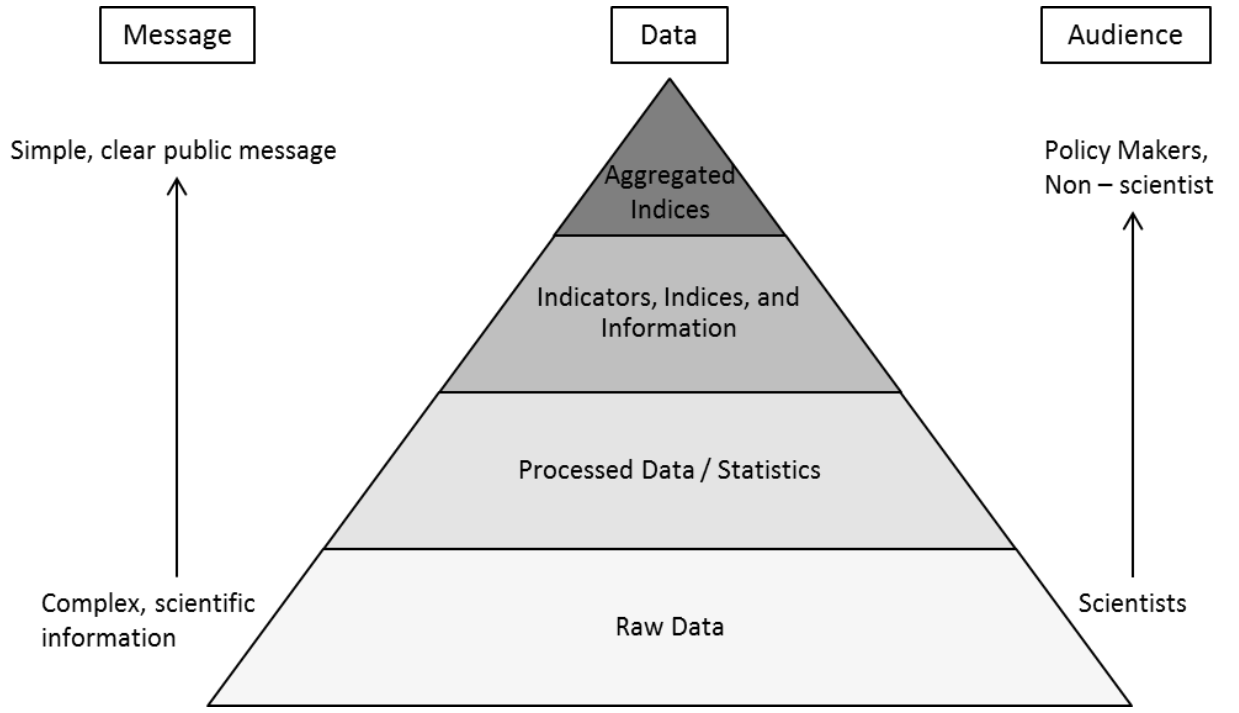

Figure 2. The information pyramid depicts the complexity of the message and level of analysis presented to different audiences. Highly aggregated indices are supported by the raw, scientific data that is assessed by experts and translated for policy and decision making needs (adapted from Fancy et al. 2009).

Displaying Results

Data visualization is a critical component of the report card communication strategy. An effective communication strategy is one that presents the data in a way that enables the audience to see and interpret the data themselves, thereby instilling confidence and de-mystifying the scientific process (Dennison et al. 2007). Existing report cards, such as those described herein, serve as excellent examples for visualizing results. Grades and familiar color schemes are frequently employed to communicate results (Figure 3) and, when combined with brief textual descriptions or overlaid on geographic boundaries, can improve understanding to a diverse audience. The grades for each of the performance measures may also be aggregated to produce one overarching score to provide a snapshot of ecosystem health and simplify complex messages (e.g., Bay Health Index in the Chesapeake Report Card; Williams et al. 2009). There are various approaches for combining performance measures scores, such as the arithmetic mean of all scores or weighting scores based on their relative importance (Table 3).

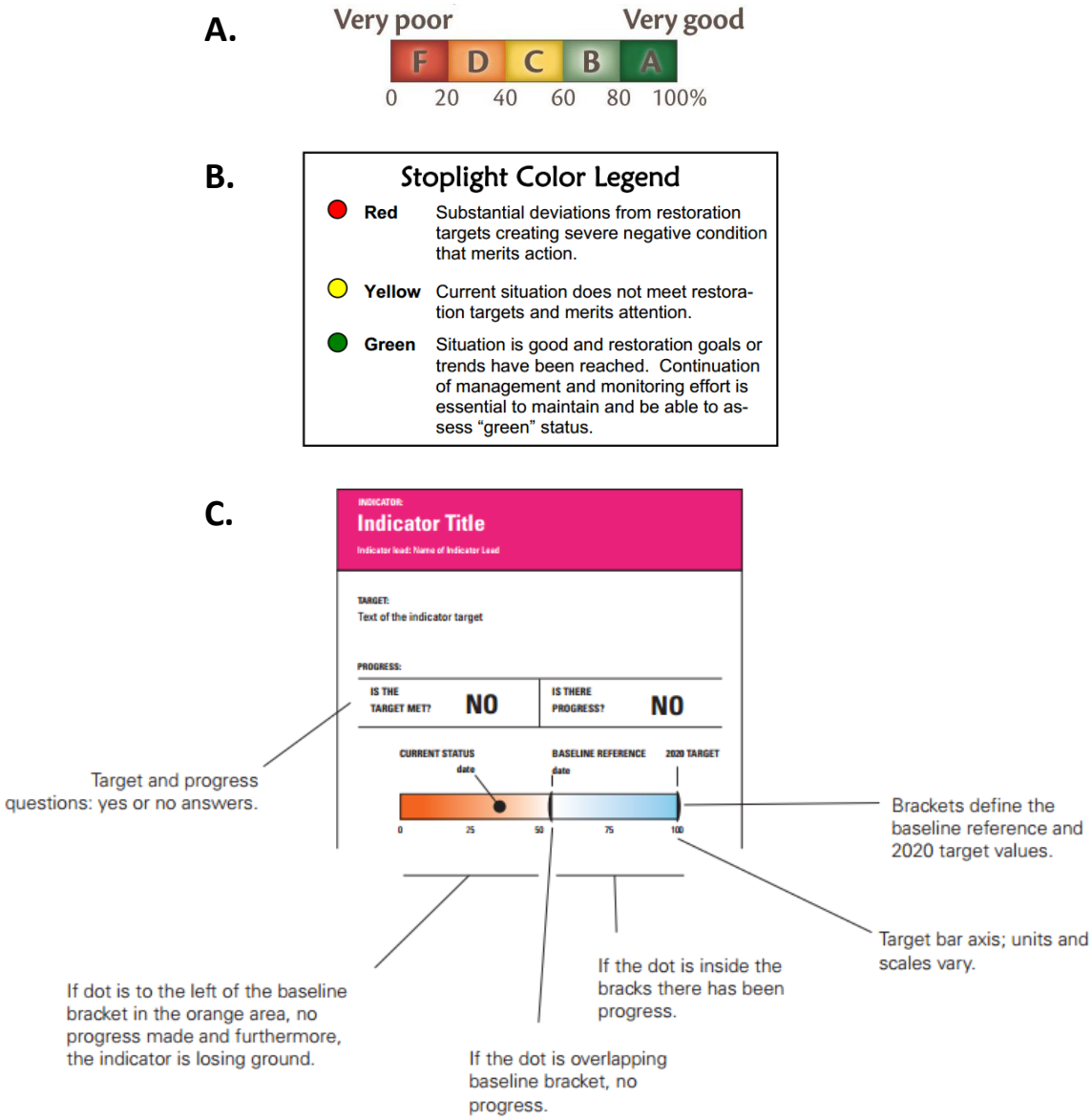

Figure 3. Examples of visuals displays used in report cards for presenting performance assessment results. A) Chesapeake Bay Report Card uses a red to green color bar along with grades. B) Everglades Report Card uses a stoplight color scheme. C) Puget Sound Report Card uses a combination of a color bar and text to describe if the target has been met and the position of the target relative to a baseline value.

Table 3. Advantages and disadvantages of different weighting methods (Williams et al. 2010).

Approach	Advantages	Disadvantages
Equal weighting (index score is average of all indicators)	Simple to understand and communicate; Do not have to justify weighting rationale	Assumes all indicators are of equal importance
Geometric Mean (weight towards lowest score)	Penalizes more imbalanced scores; The more imbalanced, the lower the score	More complicated and harder to communicate
Weight according to importance to overall health	If done correctly, provides a more accurate assessment than equal weighting	How or what decisions are used to decide weighting is dependent on who determines the weights (i.e., bias)
Weight based on uncertainty of indicator score	Less uncertainty of index scores than other methods	Varying index scores from year to year according to uncertainty rather than changes in health; No uncertainty assessment for some indicators
Only count worst score	Simple to understand and communicate	Assumes lowest score an accurate representation of ecosystem health; Loss of information if other indicators not included

Application to Coastal Louisiana

A report card prototype was designed around the theme of sustainable landscapes and resilient communities using a preliminary set of performance measures (Hijuelos and Reed 2013). The performance measures were grouped into general categories of land, water, wildlife and fisheries, flood risk, economy, and culture. This was done to simplify the themes of sustainability and resiliency into their essential components, and to communicate the metrics in a format understandable to a large audience with varying educational or technical backgrounds. The performance measures were aggregated using an equal weighting arithmetic mean to produce a single regional, parish, and coast-wide grade based off of hypothetical targets and thresholds. Grades were generated using a mock dataset for illustrative purposes and displayed using a variety of color and grading schemes.

The prototype was designed a trifold brochure (Appendix II). The inside pages of the trifold listed the performance measures and hypothetical grades assigned to each reporting region and each performance measures. On the outer page of the trifold was a brief overview as to why the report card was produced along with a description on what actions can be taken to improve the health of the coast. It is envisioned that the latter of those sections will be more fully developed to outline key steps citizens and communities can take to improve the coastal condition.

The report card was then tested with five focus groups across Louisiana's coast to determine the most effective way to present information, to collect feedback on layout, aesthetics, and ability to understand and interpret the report card grades, and to discuss the relevance of the performance measures used to grade the coast (Table 4; Appendix I). The focus group attendees were polled on a scale of 1 to 4 (poor to good) on a series of questions on how informative, clear, and understandable the report card and the two sets of performances were. Polling results showed that on average, participants scored each question a 2 or 3 indicating that there was still room for improvement. Participants also provided verbal and written feedback on the report card and some central themes emerged across all audiences (see Table 5 for audience-specific feedback). First, the intended audience of the report card was unclear to participants. This feedback appeared to stem from both the large number of performance measures and the technical descriptions of the measures, which overwhelmed readers. Although originally intended to serve as a general source of information for citizens of Louisiana, through our focus groups it became evident that multiple user-groups would be interested in learning about the coast, including scientist, managers, and policy makers. As a result, the technical language included in the report card prototype will need be to revised and additional documentation should be provided in another medium to support a more diverse audience (see Communications Strategy above). Future reporting efforts may consider using strictly the aggregated categories (e.g., land, water, risk, etc.) to simplify the message. Second, the desired direction of change for each performance measure was not always clear (e.g., does an increase in salinity improve or worsen the grade). Third, most participants were very familiar with the overarching issues that affect coastal Louisiana and, as a result, were more interested in learning more about what they could do to improve the coastal condition, rather than simply reading about the current status of the coast. Lastly, several participants expressed concern over the ramifications for assigning grades and whether poor performance would limit restoration or protection options for their region.

Table 4. Description of Focus Groups

Location	Audience	Number of People
Lake Charles, LA	Post-secondary students and faculty	18
Chauvin, LA	Coastal residents and community leaders	25
New Orleans, LA	Private sector business personnel	10
(1) Baton Rouge, LA	Legislative and congressional staff	6
(2) Baton Rouge, LA	Technical experts from governmental and non-governmental agencies	15

Table 5. Summary of audience-specific feedback received at focus groups.

Audience	Feedback
Post-secondary students and faculty	Performance measures descriptions are too long; Report card could be reduced to one page; Cover-page visuals do not pertain to coastal issues; Parish break-down is easy to follow
Coastal residents and community leaders	Report card is overwhelming and technical; Assigning grades (e.g., A,B,C,D,F) may impact funding opportunities; Interested in having a parish-specific report card; Would like to be involved in future iterations of report card development.
Private-sector business personnel	Grading scheme may deter investment opportunities.
Legislative and congressional staff	Request to include information that demonstrates how a low score can drive changes to support policy to support coastal restoration and protection efforts.
Technical experts from governmental and non-governmental agencies	Need to consider impact of Report Card on areas excluded from the Master Plan; Descriptions of performance measures should include why they are relevant; Unclear what the baseline measurement is (suggested use of Future Without Action modeling efforts).

Report Card Cycle

In order to maintain the public's interest, the report card should be periodically updated and released. Annual report cards have the benefit of maintaining interest, but require data that are highly responsive to changes in the system. Given the spatial scale of the coastal Louisiana report card and the performance measures selected for consideration, it is likely that changes in the system may only be

detectable at a frequency of five years. As a result, an annual report that publishes information on coastal events of the previous year could be useful to maintain the public's interest in the status of the coast. The report may include information on hurricanes, river floods, severe droughts as well as new projects that were built or community plans that were implemented. This coastal update would provide an opportunity to report specific events that over a five year report card period may be otherwise overlooked.

Roles and Responsibilities

The development of a report card will require the participation and coordination of a range of personnel with skills and expertise in different areas including: collection and analysis of both ecologic and socio-economic data, technical oversight, public communication, and graphic visualization. To manage these tasks four primary teams should be designated: Report Card Team, Advisory Board, Data Providers, and Communications Network Team.

Report Card Team

The responsibility of producing a report card falls under the lead of a report card team. This team will develop methodology for generating the scores for the performance measures, collect and analyze the data for the performance measures, develop and perform quality control and quality assurance protocols, form and manage the Advisory Board, and generate the report card products with assistance from the Communications Network Team. This group will likely consist of individuals from a variety of organizations and agencies that have the technical skills to analyze and produce the scores and knowledge of the system dynamics to interpret the results. Within the team, a spokesperson should be identified who has a keen understanding of the report card message and methodology, and can communicate in way that is understandable to a general audience.

Advisory Board

An advisory board should be formed by the Report Card Team to provide oversight of the report card development process and to coordinate peer review of the report card. Coordination of the peer-review process ensures an independent team is established to review the methodology underlying the report card scores. The board should consist of individuals who are experts in their respective fields and be knowledgeable in communicating science. Quarterly or semi-annual meetings with the advisory board should be held during the initial development and refinement of the report card development process. Once the report card methodology has been established, annual meetings will ensure the report card is generated in a timeline manner.

Data Providers

A multitude of data sources are likely to be required for producing a report card. Once the data sources have been identified, a representative of the data source (e.g. agency technical expert) should be identified who is knowledgeable of the data collection methods and can be held accountable for the quality control and quality assurance of the raw data. In addition to providing the raw data for analysis, the data collection methodology should also be provided to ensure transparency and rigor of the overall report card methodology.

Communications Network Team

The team is responsible for producing the web architecture, report card brochure, and setting up lines of communication with local news and radio personnel to disseminate the information upon the release of the report card. They work in hand with the Report Card Team to generate the final product and ensure the message generated by the Report Card Team is communicated in a way that is understandable to a diverse audience.

Path Forward

This report is designed to serve as a guide for implementing the performance measures and developing a report card for coastal Louisiana. The elements identified represent the key processes that should be executed, focusing on themes that are frequently overlooked or not adequately considered. Key to the success of a report card is having a scientifically-based, rigorous set of analytical procedures to analyze the raw data and produce the report card grades that are transparent in their methodology and have been peer-reviewed by appropriate experts. The data and analysis serves as the foundation for the rest of the report card and as a result, should garner the most attention and effort through the process. Improvements in the communication strategy will need to be considered in order to appropriately engage a diverse audience and include recommendations for actions local residents can take.

As the report card development process moves forward, a report card team will need to be formed to begin evaluating a preliminary set of performance measures for use in the report card. A review of the current data collection efforts will need to be conducted to assess if data is available to generate the recommended performance measures. Through this effort, the reporting regions must be clearly defined and the frequency of data collection will dictate the report card cycle. Engagement with an Advisory Board should also begin early on in the process to provide oversight throughout the report card development. With the help of the Communications Network Team, additional focus groups and engagement with local stakeholders may be held in order to continue improving the effectiveness of the report card.

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Appendix I:

Focus Group Agenda

Focus Group Agenda

I. Introduction

II. Informal Background Survey

III. Report Card "At a Glance" Feedback

1. Attendees are asked to review first report card
2. Questions for Discussion:
   - Would you pick it up? Why/why not?
   - What about it interests you and entices you to read more/what doesn't interest you and entices you to read more?
   - Is there anything about the Report Card that is unappealing to you?

IV. Written Feedback

1. Attendees answer a series of questions after reviewing the first report card
   - What does the report card tell you?
   - How informative is this report card? Please rank on a scale of 1-4 (1 being uninformative and 4 being very informative)
   - How clear is this report card? Please rank on a scale of 1-4 (1 being unclear and 4 being very clear)
   - Are the performance measures chosen for **Sustainable Landscapes** understandable? Please rank on a scale of 1-4 (1 being not understandable and 4 being very understandable)
   - Are the performance measures chosen for **Resilient Communities** understandable? Please rank on a scale of 1-4 (1 being not understandable and 4 being very understandable)
   - Overall does this report card make sense to you?
2. Attendees are handed a second report card to review and were then asked to answer the following questions
   - Compared to report card 1, what do you prefer about this report card; what do you dislike?
   - Is this report card easier to understand or harder to understand?
   - Do you prefer this grading scheme? Does it make more sense to you?
   - Is the lay out of this report card more user friendly? Why or why not?

V. Detailed Discussion

1. Participants report out on their written comments and feedback.
2. Additional questions and topics for discussion:
   - Do these performance measures accurately reflect coastal changes and dynamics?
   - Are there any performance measures missing that are important to you?
   - Feedback on the use of regions and parishes.

VI. Format Feedback and Discussion

1. Participants will rank specific parts of the reports cards on the hand out provided.
    - If you were to build a new report card, what parts would you use from the report cards presented?
    - What parts would you take away completely?
    - What parts would you change?

VII. Closeout Questions

- Is this report card something you would read?
- Do you think it would be helpful to you?
- Is this something you would share with others?
- What are the most effective ways to distribute and disseminate this information?

Appendix II:

Report Card Prototypes

Trifold Brochure – Version 1

Folded- Inside Panel

Why Do We Need a Report Card?

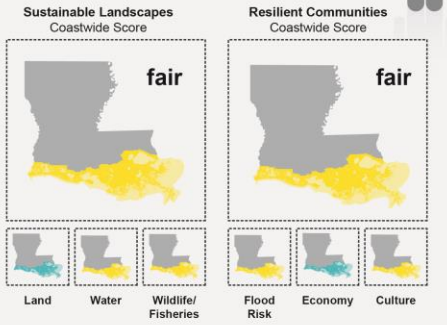
Efforts to restore the natural landscape, while also protecting local communities, require collaboration between many state agencies, local officials, communities, and engaged citizens; this report card is one step towards increasing awareness about the critical coastal issues that impact us all. Share this report card with a friend or contact your local legislators about taking action on the issues that concern you most.

What Are Performance Measures?

This report card is designed to provide an overview of coastal Louisiana's natural landscape and local communities. Performance measures were selected to provide a clear and succinct understanding of the state of the coast resulting from natural changes, protection and restoration projects, changes in built infrastructure, socio-economic trends. Taken together, these performance measures can be used to track the progress toward achieving the long-term goals of sustainable landscapes and resilient communities.

Sustainable landscapes were graded in five regions on land, water quality, and wildlife and fisheries. Resilient communities were assessed by evaluating parishes on flood risk, economy and culture.

How Is the Coast Doing?



Back Panel

How Can We Do Better?

The current trajectory of coastal Louisiana will likely worsen over the coming decades unless action is taken immediately. Achieving sustainable landscapes and resilient communities requires swift action and more integrated restoration and protection efforts. The creation of large-scale restoration projects, expansion of nonstructural projects, and implementation of adaptive community planning measures will ensure limited funding is used most efficiently and effectively. On-going monitoring of the coast will enable informed decisions that make use of the most up-to-date information.

Contact Us!

If you would like to learn more about how we scored your region or parish, please visit our website at www.website.com.

THE WATER INSTITUTE OF THE GULF

Front Cover

DRAFT (Example Data Only)

2013

Report Card for Coastal Louisiana

fair

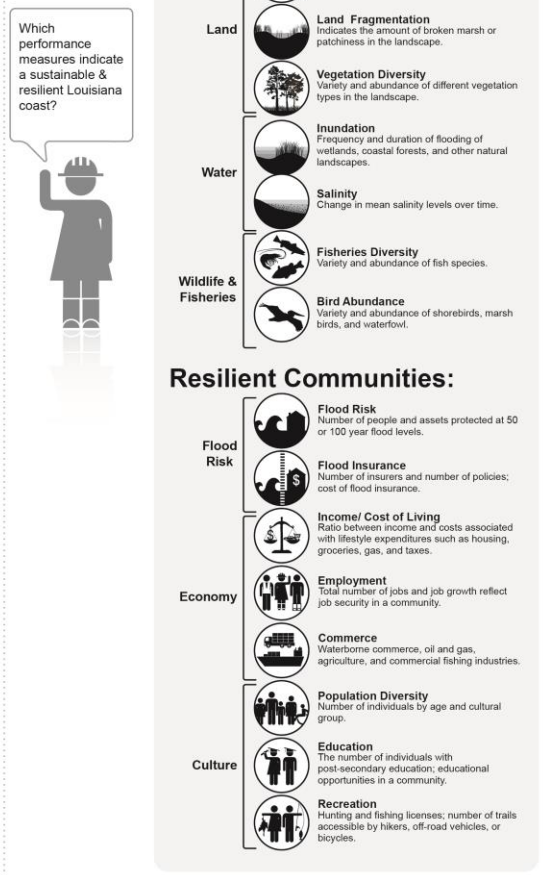
..progress towards..

SUSTAINABLE LANDSCAPES

RESILIENT COMMUNITIES

THE WATER INSTITUTE OF THE GULF

Open Inside Panel (Left)



Open Inside Panel (Center)

Sustainable Landscapes

Across the coast, landscapes were assessed a "Fair" grade for their overall sustainability, which continues the pattern from 2011. Some of the performance measures showed improvement, such as vegetation diversity, while others continue to decline. There were also distinct differences in the grades assigned to the regions.

- Barataria Region received the lowest grade, "Poor."
- The Chenier Plain and Vermillion-Atchafalaya Regions received "Good" scores.

This assessment reveals the dynamic nature of the coast and shows that not all areas will respond the same to changes in the environment. As a result, achieving sustainable landscapes will require targeted approaches to address the unique issues that face each region.

Resilient Communities

Overall, coastal communities were assigned a "Fair" score, which is a slight decrease from a "Good" grade in 2011. The performance measures reveal a wide range of scores and also show distinct differences among the various parishes.

- Employment and commerce scored highest in most parishes, indicating the economy has remained relatively robust and commerce is still very strong along the coast.
- Flood risk and cost of living received some of the lowest scores among parishes, but averaged to a "Fair" score coast-wide.
- Cultural performance measures (population diversity, education, and recreation) have decreased slightly from 2011 also resulting in a coast-wide "Fair" grade.

Progress towards achieving resilient communities has slowed slightly relative to 2011, but with both local and the combined efforts of parishes working together, Louisiana can achieve a resilient coast.

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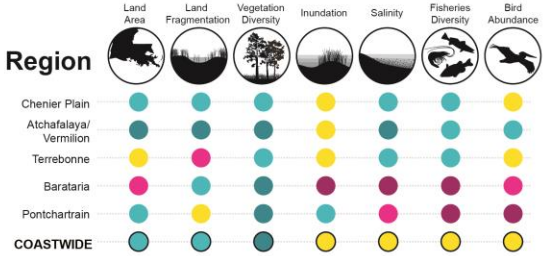

Trifold Brochure – Version 2

Folded- Inside Panel

Why Do We Need a Report Card?

Efforts to restore the natural landscape, while also protecting local communities, require collaboration between many state agencies, local officials, communities, and engaged citizens; this report card is one step towards increasing awareness about the critical coastal issues that impact us all. Share this report card with a friend or contact your local legislators about taking action on the issues that concern you most.

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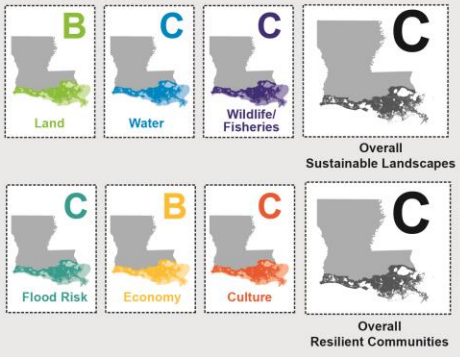
Sustainable landscapes were graded in five regions on land, water quality, and wildlife and fisheries. Resilient communities were assessed by evaluating parishes on flood risk, economy and culture.

How Are We Doing?

Coastwide Scores:



Back Panel

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THE WATER INSTITUTE OF THE GULF

Image credit: LSU Coastal Sustainability Studio

Front Cover

DRAFT (Example Data Only)

2013 Report Card for Coastal Louisiana

C

progress towards

THE WATER INSTITUTE OF THE GULF

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Open Inside Panel (Center)

Open Inside Panel (Right)

Performance Measures

We used these performance measures to indicate a sustainable & resilient Louisiana coast.

Sustainable Landscapes

Land

- **Land Area** — Total area of natural landscape features including barrier islands, ridges, and wetlands in the coastal zone.
- **Land Fragmentation** — Amount of patchiness and deterioration in wetlands.

Water

- **Vegetation Diversity** — Variety and abundance of plants.
- **Inundation** — Frequency and duration of flooding of wetlands, coastal forests, and other natural landscapes.
- **Salinity** — Change in mean salinity levels over time.

Wildlife/ Fisheries

- **Fisheries Diversity** — Variety and abundance of fish.
- **Bird Abundance** — Variety and abundance of shorebirds, marsh birds, and waterfowl.

Resilient Communities

Flood Risk

- **Flood Risk** — Number of people and assets protected at 50 or 100 year flood levels.
- **Flood Insurance** — Number of insurers and number of policies; cost of flood insurance.

Economy

- **Income/Cost of Living** — Ratio between income and costs associated with lifestyle expenditures such as housing, groceries, gas, and taxes.
- **Employment** — Total number of jobs and job growth reflect job security in a community.
- **Commerce** — Waterborne commerce, oil and gas, agriculture, and commercial fishing industries.

Culture

- **Population Diversity** — Number of individuals by age and cultural group.
- **Education** — The number of individuals with post-secondary education; educational opportunities in a community.
- **Recreation** — Hunting and fishing licenses; number of trails accessible by hikers, off-road vehicles, or bicycles.

Sustainable Landscapes

2009 D | 2011 C | 2013 C

Across the coast, landscapes were assessed a "Fair" grade for their overall sustainability, which continues the pattern from 2011. Some of the performance measures showed improvement, such as vegetation diversity, while others continue to decline. There were also distinct differences in the grades assigned to the regions.

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Resilient Communities

2009 C | 2011 B | 2013 C

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Region

	Chenier Plain	Atchafalaya/ Vermilion	Terrebonne	Barataria	Pontchartrain	COASTWIDE
Land Area	B	A	C	D	B	**B**
Land Fragmentation	B	A	D	B	C	**B**
Vegetation Diversity	B	A	B	A	A	**A**
Inundation	C	C	C	F	B	**C**
Salinity	B	A	B	F	D	**C**
Fisheries Diversity	B	B	B	F	F	**C**
Bird Abundance	C	B	C	D	F	**C**
Overall Sustainability	**B**	**B**	**C**	**D**	**C**	**C**

Parish

	Ascension	Assumption	Calcasieu	Cameron	Iberia	Jefferson	LaFourche	Livingston	Orleans	Plaquemines	St Bernard	St Charles	St James	St John the Baptist	St Martin	St Mary	St Tammany	Tangipahoa	Terrebonne	Vermilion	COASTWIDE
Flood Risk	F	C	B	D	B	F	F	C	D	C	A	C	C	B	D	D	D	D	B	A	**C**
Flood Insurance	D	A	F	B	D	A	B	D	A	D	A	A	A	A	C	C	D	F	B	B	**C**
Income/ Cost of Living	F	D	D	B	A	C	D	F	B	A	F	D	A	D	D	A	C	D	F	D	**C**
Employment	C	B	A	A	C	F	B	B	C	A	B	B	B	C	F	F	A	A	A	D	**B**
Commerce	B	A	A	A	C	A	A	B	C	A	A	A	A	A	C	C	C	B	F	B	**B**
Population Diversity	B	F	F	B	A	F	B	C	A	D	C	B	F	B	D	D	C	A	F	C	**C**
Education	C	D	A	D	F	C	A	C	B	F	A	F	D	A	A	D	F	D	A	A	**C**
Recreation	C	C	B	C	B	A	B	D	D	D	D	C	C	A	B	B	A	C	A	C	**C**
Overall Resiliency	**C**	**C**	**C**	**B**	**C**	**C**	**B**	**C**	**B**	**C**	**B**	**C**	**B**	**B**	**C**	**C**	**C**	**C**	**C**	**B**	**C**