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Introduction

The Geotechnology Research Institute (GTRI) / Houston Advanced Research Center (HARC) was contracted by the Galveston Bay Estuary Program (GBEP) of the Texas Commission on Environmental Quality (TCEQ) in 2008-2011 to compile data and information describing natural resources and the uses of those resources in the Lower Galveston Bay watershed.

Information was gathered via the Galveston Bay Status and Trends Project and presented in the project deliverable entitled The State of the Bay: A Characterization of the Galveston Bay Ecosystem, 3rd Edition. Additional project deliverables included a Quality Assurance Project Plan (QAPP) and the Galveston Bay Watershed Ecosystem Services Planning Workshop held September 27-28, 2011 in The Woodlands, Texas. Completion of all major tasks and project outcomes are described in this final report.

Galveston Bay Status and Trends Project

As discussed in State of the Bay Chapter 3 (Gallaway, 2011), map surveys and qualitative descriptions of Galveston Bay date back to 1800’s. However, the collection of standardized monitoring data by federal, state and local agencies and other organizations date back to the late 1960s. Monitoring databases describing the bay’s water and sediment quality, habitat acreage, fish and wildlife populations, and seafood safety are just a few of the many that exist. The intention of the Galveston Bay Status and Trends Project is to apply these data to the management issues raised in The Plan regarding the health of the bay, develop a set of indicators to summarize the data, and communicate the information to bay stakeholders, resource managers, and the public.

The goal of the Galveston Bay Status and Trends Project is to compile, manage, analyze, and disseminate environmental monitoring data collected by organizations with quality assurance procedures and long-term records of or a commitment to monitoring and managing Galveston Bay resources. The goal is achieved through the following objectives:

(1) Data are obtained, quality assured, and processed into standardized formats and stored in secure databases;

(2) Data are analyzed to update established indicators of bay health according to priorities set by the GBEP, the Galveston Bay Council (GBC), and the GBC subcommittees; and

(3) Results of Status and Trends Project data analyses are made available to the public in summary form through the development of the State of the Bay report, other outreach materials (e.g. materials developed for GBEP initiatives including news media outreach), presentations to community groups and at the State of the Bay Symposium, and the Status and Trends Project website (www.galvbaydata.org).
State of the Bay, 3rd Edition

An identified vehicle for communicating the status and trends of Galveston Bay natural resources has been the State of the Bay publications, first published in 1994 (Shipley & Kiesling, 1994) with a second edition printed in 2002 (Lester & Gonzalez, 2002). The report describes the nature and history of the Galveston Bay system, the findings of peer-reviewed research on Galveston Bay and its watershed, important trends in environmental data, and management actions based on those findings. Scientific and technical information germane to Galveston Bay is contextually placed with historical resource use and modern social and economic features of the Galveston Bay watershed. In addition, the State of the Bay publications summarize the efforts of resource managers to implement The Plan and progress made toward restoring and sustaining the vitality of Galveston Bay.

It had been nearly ten years since the information was originally compiled for the State of the Bay, Second Edition – a sufficient amount of time for the material to become dated and for new scientific analyses and environmental data to become available. Under the 2008-2011 contract, GTRI/HARC collected data and information needed to update and revise the State of the Bay and produce a Third Edition. Collected information included newly published peer-reviewed and agency research, changes in environmental conditions, and redirection of management efforts resulting from new knowledge regarding the state of the Galveston Bay system, changes in policy, and emerging stressors that reflect the challenges of balancing multiple and often competing human uses of natural resources.

The State of the Bay, 3rd Edition was organized into 10 chapters titled as follows:

1. Assessing the State of the Bay,
2. Galveston Bay: An Overview of the System,
3. The Human Role: Past,
4. The Human Role: Present,
5. Physical Form and Processes,
6. Water and Sediment Quality,
7. Key Habitats of the Galveston Bay Watershed,
8. The Bay’s Living Resources,
9. Impact on Public Health, and

Chapters 1-9 were included in the first and second editions of the State of the Bay report. Chapter 10 represented a new chapter added to the Third Edition to continue the discussions describing past and present human uses of Galveston Bay natural resources in chapters 3 and 4.
Galveston Bay Ecosystem Services Workshop

The Galveston Bay watershed is rich in forest, grassland, wetland and bayou habitats, which provide an abundance of ecological services that are enjoyed by many people. These habitats provide a significant contribution to the local and state economy.

Ecosystem services are the benefits that people and businesses receive from a functioning ecosystem. Examples of ecosystem services include adequate supplies of clean water for municipal, agricultural, and industrial uses; habitats for fish and wildlife that provide the basis for ecotourism, fishing, and hunting industries; and the capacity of wetlands and other habitats to regulate stormwater quality and mitigate flooding.

The Houston-Galveston Region is expected to experience continued population growth through 2035 (HGAC, 2006). Economic development and land-use conversion in the Houston-Galveston region is expected to put significant pressure on local ecosystems. Decision-makers need to factor in values and preferences for ecosystem services so existing services can be maximized and the full impact of altering ecosystem functions can be evaluated and mitigated. While much data and information exist on the ecosystem services of the Houston-Galveston region, no process, comprehensive tool, or set of tools currently exist to systematically examine and analyze the full range of ecological services.

HARC was tasked to organize and convene a workshop to bring together local, regional and national experts to formulate a strategic plan for building regional capacity in the measurement, valuation and use of ecosystem services for public and private decision-making in the Houston-Galveston region. Workshop results included:

• An annotated bibliography (see attached Appendix D) categorizing literature according to ecosystem service and valuation technique, with a specific focus on those ecosystem services relevant to the Lower Galveston Bay Watershed; a network of technical experts and stakeholders committed to participate in this capacity-building effort;

• A white paper (see attached Appendix E) that forms the foundation and a path forward for building technical capacity in the use of ecosystem services information in decision-making for the Houston-Galveston region and the Galveston Bay watershed; and a

• Network of stakeholders and experts knowledgeable in ecosystem services valuation methodologies and data applications and willing to work in the future to develop and implement an ecosystem services framework for Galveston Bay.
Project Methodology for Contracted Tasks

1. Environmental Data and Peer Reviewed Article Collection

The GBEP originally compiled the relevant data related to the environmental management of Galveston Bay in the early 1990’s. These data sets were interpreted, but not maintained for future management decisions. A decision was made in 2000 to repeat the compilation process and to maintain the data in a clearinghouse. Since the 2000 Status and Trends Project, the GBEP and the GBC have recognized the value in maintaining the Status and Trends Project.

As in the past, data are analyzed to make judgments on the status and trends of natural resources and resource use in Galveston Bay and the Lower Galveston Bay Watershed. Records produced by this project consist of databases in several stages of quality beginning with the raw data acquired from the agencies and progressing through stages of data compilation, quality assurance, and analysis. The raw data consist of all historical and current data made available by federal, state, and local agencies and collected from the spatial domain of Galveston Bay and its watershed as described in the Galveston Bay Segmentation Scheme (Jones & Neuse, 1992) (Figure 1). Progress reports on data acquisition, processing, quality assurance and analysis have been submitted to the GBEP quarterly.

The Galveston Bay Status and Trends Project does not conduct any sampling. All of the data employed by this project are non-direct in that they are obtained from the agencies that collected the direct measurements. Sampling process design is the responsibility of the agencies collecting the monitoring data.

During the term of the contract (July 2008 – January 2012) GTRI/HARC acquired and updated 38 federal, state, and local databases. The databases were updated annually or as data were released by the agency. For example, TCEQ Surface Water Quality Monitoring data and TPWD Coastal Fisheries data are acquired annually from the source agencies. However, NOAA Coastal Change and Analysis Program land use and land cover data are released by the source agency every five years. A list of the databases is included in Appendix A.

Figure 1. Galveston Bay Segmentation Scheme (Jones & Neuse, 1992) identifies the spatial domain for Galveston Bay Status and Trends Project data.
A literature review was conducted to find and acquire peer-reviewed journal articles, white papers and agency reports. Literature search parameters revolved around ecosystem research and resource management studies conducted in or relevant to Galveston Bay. Additionally, GTRI/HARC contacted university researchers and agency staff who conducted research on the Galveston Bay system and acquired relevant project reports. In all, 1,163 bibliographic citations were acquired. Of those, 481 citations were included in the *State of the Bay, Third Edition*. A bibliographic list of all literature acquired is included in Appendix B.

2. **Database Maintenance**

This project is built upon the use of computing and electronic communication resources for the transfer, processing and maintenance of the data. Three data servers (one for GIS data and applications, one for project data files, and one for website products and associated backend databases) on the GTRI/HARC computing network are used this project. GTRI/HARC employs software and security protocols to protect data from virus infection and tampering by unauthorized users. The GTRI/HARC network and the Status and Trends servers administer user rights using password protection to limit access to the data files. The data servers are equipped with a tape backup and an archival system to provide additional security. The servers also have emergency power supplies.

The project uses Microsoft (MS) software packages for processing and maintaining the data: MS SQL Server, MS Access and Excel. ESRI ArcGIS is used to produce maps and spatial analysis products. S-Plus, SPSS and *Analyse-It* are used to perform statistical analyses. MS Access and SQL Server are used as the database maintenance software packages. Web products are created using .HTML, .ASP, and .NET.

All data accepted from agency sources undergo a validation process prior to data analyses and placement on Status and Trends website (see Figure 2). Raw agency data and processed data are stored in separate locations on the server.

Volunteer monitoring data are acquired, stored, and analyzed separately from agency monitoring data. The volunteer monitoring data are held on the same server, but in a database separate from agency monitoring data. The two types of data are not combined.
| 1. Data Acquisition          | • Acquire data  
|                             | • Import into database  
|                             | • Ensure complete transfer and integrity of data  
|                             | • If import errors are found, correct errors  |
| 2. Data Processing          | • Determine and document relationships between fields and tables  
|                             | • Check for and remove duplicate records  
|                             | • Assign GBEP segmentation to spatially filter and aggregate data  
|                             | • Exclude data collected outside the GBEP study area  
|                             | • Document database changes  |
| 3. Data Analysis            | • Query database by parameter, time period, and geographic area (subbay or tributary)  
|                             | • Create statistical and graphical analysis products (e.g. trend graphs and indicators)  
|                             | • Document database queries; track database versions  |
| 4. Information Dissemination | • Update www.galvbatdata.org website with statistical and graphical analysis products  
|                             | • Update .ASP web applications with new data  
|                             | • Ensure interactive .NET charting is displaying correct information  
|                             | • Forward statistical and graphical analysis products to GBEP as needed for outreach materials  
|                             | • Incorporate statistical and graphical analysis products into GBEP reports and presentations  |

Figure 2. Data acquisition and processing methodology for data acquired by the Galveston Bay Status and Trends Project.
3. Data Queries and Analysis

Data analyses conducted by the Status and Trends project are of three general types: analysis of monitoring gaps, status and trends analyses (including indicators), and spatial analyses. The results of the analyses conducted under this contract are described in detail in the *State of the Bay, Third Edition*. In the State of the Bay report, many data products (graphs and maps) are linked to MS Excel data files that include metadata, quality assured data, and pivot charts as well as to interactive Adobe geoPDF files that allows users to turn on and off GIS layers in an Adobe PDF format. Additionally, results of data analyses are available on the [www.galvbaydata.org](http://www.galvbaydata.org) project website.

4. Quality Assurance

All data acquired by the Status and Trends Project in FY 2008-2011 were managed under a QAPP updated and approved annually by the TCEQ. The last update of the project QAPP was approved by the TCEQ on April 8, 2011. The QAPP designates the data processing methodologies, data storage and backup requirements, data quality objectives, and data validation and verification requirements.

All data are accepted from agency sources, but are subject to a validation process. The intention is to apply historical data to the management issues raised in *The Plan* regarding the health and integrity of the bay. If data are validated and agency quality assurance procedures are noted, the only limitations on use of the data are set by the sampling requirements of the various statistical tests and procedures.

Upon receipt of data from the source agency, the Status and Trends Project reviews data for duplicate records, missing data and metadata, incorrect spatial coordinates, and outlier values. These data quality steps are integral in ensuring the validity of the data, the analyses and the information products that they support. All databases updated in FY 2008-2011 have been reviewed for the data errors mentioned above.

Numerous data comparisons are made throughout the data management and analysis process. After the initial conversion to a database format used by the Status and Trends Project, the newly processed data are compared to the raw data from the source agency to ensure that no processing errors occurred. If errors are found, then the initial processing step is repeated. The source agency is contacted if the error is found to be in the raw data. In those instances a new version of the data is requested from the source agency. Additional comparisons are made between the new dataset and previous versions from prior Status and Trends Project years. If large changes in sample sizes or analytical results are seen, then the data are reviewed to ensure that no errors were introduced. All databases updated in FY 2008-2011 have been reviewed for data processing errors.
Duplicate and Missing Records

Records that are identified as duplicates are removed from analyses as are records with incomplete metadata (e.g. date and location). In some instances it may be determined that a large number of records are missing from a dataset (such as an entire geographic area). The missing data are requested from the source agency. If they are not available, then the dataset is not analyzed.

Incorrect Geospatial Coordinates

All geospatial coordinates are reviewed. Those that are incorrect (latitude/longitude does not match the physical location description of the sampling site) are corrected when possible. If the coordinates cannot be corrected, then the data records are removed from all analyses.

Outliers

In some databases, such as those describing water and sediment quality, data records are identified by the source agency as being below or above an acceptable range of values. The Status and Trends Project typically identifies a value as an outlier if it is greater than two orders of magnitude above or below the maximum or minimum acceptable value. This is modified in some locales and for some parameters such as bacteria in surface waters where extremely high concentrations are commonly observed. Identified outliers are removed from analyses and the source agency is notified.

The introduction of errors and loss of data are managed through procedures for record keeping and auditing. Documentation (using MS InfoPath) describes changes made by project personnel and the time at which the changes were made. Each time a file is changed it is saved in a new version and the old version is archived. New file names and locations are recorded in the database documentation. Files are archived when data updates are received from the source agency and the data processing cycle starts over. Periodic comparisons between recent and early versions are made to detect problems.

During the FY2008-2011 project period, the Status and Trends Project underwent an annual quality assurance audit by the TCEQ GBEP project representative (See Appendix F). At each quality assurance annual review, all quality assurance documentation was reviewed and QAPP practices were reviewed and verified by project staff.
Project Results


The *State of the Bay, Third Edition* is about the nature and history of the Galveston Bay system, the findings of studies on Galveston Bay and its watershed, and the management actions based on those findings. As in the first and second editions, the scientific information is placed in the context of historical resource use and modern social and economic features of the Galveston Bay watershed.

As evidenced by the FY2008-2011 progress reports submitted under this project, completion of the *State of the Bay, Third Edition* was delayed due to an extended review process. See Appendix C for a timeline of *State of the Bay* development.

Tasks related to the State of the Bay included data and peer-reviewed article collection as described in this report. Text for ten chapters was written based on the text of the first and second editions of the State of the Bay report. The ten chapters are:

1. Assessing the State of the Bay (written by Lisa Gonzalez)
2. Galveston Bay: An Overview of the System (written by Jim Lester)
3. The Human Role: Past (written by Alecya Gallaway)
4. The Human Role: Present (written by Lisa Gonzalez)
5. Physical Form and Processes (written by John Anderson)
6. Water and Sediment Quality (written by Lisa Gonzalez)
7. Key Habitats of the Galveston Bay Watershed (written by Jim Lester)
8. The Bay’s Living Resources (written by Lisa Gonzalez)
9. Impact on Public Health (written by Jim Lester)
10. The Future of Galveston Bay (written by Jim Lester)

Text was also drafted for a set of bay success and issue stories included as insets in chapters 1-9:

1. Galveston Bay Council: Success Founded in Partnership (written by Jim Lester)
2. Future of Freshwater Inflows to Galveston Bay (written by Priscilla Weeks)
3. The Changing Shoreline (written by Lisa Gonzalez)
4. Decline of the Fishing Village (written by Priscilla Weeks)
5. Hurricane Ike - Ecological Impacts (written by Jim Lester)
6. Bacteria in the Bayous (written by Lisa Gonzalez)
7. North Deer Island Restoration Project (written by Lisa Gonzalez)
8. Invasive Species Issues in Galveston Bay (written by Lisa Gonzalez)
9. Seafood Safety Consumption Program (written by Jim Lester)
10. No success or issue story was included
All text was submitted to GBEP stakeholders including members of the Galveston Bay Council and subcommittees. In all, 31 stakeholders submitted 63 sets of comments and edits for the 10 chapters. All comments and edits were considered and most were incorporated. Chapters were then submitted to TCEQ GBEP staff, TCEQ Agency Communications and TCEQ management for review. In the event that there was disagreement with the agency, edits were negotiated until a final agreement was reached. Otherwise, all agency edits and comments were incorporated.

The State of the Bay, Third Edition is available in two electronic formats. All chapters are available in PDF format from the State of the Bay web page on the Status and Trends project website:
http://www.galvbaydata.org/StateoftheBay/tabid/1846/Default.aspx

Additionally, 1,000 CD and executive summary booklets were printed and sent to TCEQ GBEP for distribution. The CD contains an Adobe PDF portfolio. All chapters can be opened and read using free Adobe Acrobat software.

State of the Bay data products include MS Excel pivot charts and Adobe geoPDF files. Graphs and maps in the State of the Bay chapters are linked to these files, providing an interactive user experience.

2. Ecosystem Services Valuation

Dr. Eric Biltonen of GTRI/HARC was contracted to develop materials to assist GBEP staff, stakeholders and partners by summarizing peer review and case study literature regarding the concept, theory and methods for understanding and conducting economic valuation of ecosystem services. The results of this work included an annotated bibliography, a white paper, a workshop, and a website.

Under this task a literature review was conducted. The literature review focused on ecosystem services with a specific focus on those ecosystem services that are relevant to the Lower Galveston Bay Watershed (Brazoria, Chambers, Galveston, Harris and Liberty Counties). The literature review included case studies where ecosystem services valuation has been used to influence policy and/or operations for municipalities, state and federal government, industries, and foundations. This task resulted in the creation of an annotated bibliography of 134 references (see attached Appendix D).

Next, an ecosystem services valuation workshop was held on September 27-28, 2011 at Lone Star College System Office-Training & Development Center in The Woodlands, Texas. The workshop brought together 32 local, regional and national experts to formulate a strategy for coordinating and developing regional capacity for the measurement, valuation and use of ecosystem services to better support public and private environmental management decision making for the Houston-Galveston region. The workshop resulted in a network of technical experts and stakeholders interested in developing an ecosystem services program in the Lower Galveston Bay Watershed. A website for the workshop was created at http://gbess.harc.edu. The website hosts the participant list, Adobe PDF files
of all speaker presentations, as well as the annotated bibliography and white paper deliverables of the ecosystem services valuation task.

Lastly, the ecosystem services task required that a white paper be written, covering, at an introductory level, ecosystem services valuations techniques and, in more detail, case studies. The case studies outline what ecosystem services were valued, why the study was conducted, where the study was conducted, and how the results led to the development of new policies, incentives or markets pertaining to the management of ecosystem services. The target audience is a multidisciplinary group of stakeholders interested in the environment of the Lower Galveston Bay Watershed. A subset of the 10 workshop participants, which included local experts as well as ecosystem service valuation experts from around the U.S., reviewed and contributed to the white paper. The white paper is included as attached Appendix E of this final report.

3. Project Website

Staff of the Galveston Bay Status and Trends Project maintain the project website: http://www.galvbaydata.org. The website hosts data products including: maps, past project reports, selected presentations, the water quality data portal, the coastal fisheries data portal, and summary information and select data describing living resources, key habitats, and seafood safety. The website also hosts the State of the Bay, Third Edition and links to the Galveston Bay Ecosystem Services project deliverables described above.

Traffic to the project website is tracked using free Site Meter software. Traffic has been reported in quarterly progress reports since the website was launched in November 2004. During this project period (July 2008 – December 2011; January 2012 is not included as the web traffic data are incomplete), the project website received 23,460 visits (see Figure 3). The total number of visits for the life of the website (November 2004-December 2011) is 36,525 visits.

The majority of visitors to the project website (81 percent) are from North America and the majority of those visitors reside in the central U.S. time zone. However, the website does reach people in other parts of the world. Of the 36,525 visits to the website, 7 percent of users are from Europe, Asia, Africa, or Australia and 12 percent of users are from unknown locations (see Figure 4).
4. Community Outreach

As required by the contract, Status and Trends project staff attend and present at external meetings for project planning purposes, attend quality assurance audits, and provide community outreach presentations. Appendix F details the meetings attended and presentations given by project staff.
Conclusions and Lessons Learned

GTRI/HARC has been contracted by the TCEQ Galveston Bay Estuary Program since 2002 to conduct the annual Status and Trend data updates, write and edit the *State of the Bay* reports, and communicate the state of Galveston Bay natural resources and resource use to GBEP stakeholders and the public via presentations and the project website. This 4-year contract included numerous tasks including database updates, creation of the *State of the Bay, Third Edition*, and the planning and hosting of the Galveston Bay Ecosystem Services Workshop and associated website.

Much progress was made in FY 2008-2011 under all tasks outlined in the contract. All project databases were updated annually or as data were released by the source agencies. The QAPP was updated and approved annually. Quality assurance/quality control documentation was updated and maintained as required by the QAPP. Project servers and firewalls were maintained without loss or corruption of project data. Numerous major analyses were completed and are included in the *State of the Bay, Third Edition* and on the project website ([www.galvbaydata.org](http://www.galvbaydata.org)). A number of meetings were attended and presentations made by project staff. The number of visits to the project website continues to increase. Demand for the information on the interactive web site is growing. The agencies contributing data to the program have made no changes in data management or analyses that conflict with or duplicate the Status and Trends effort. When consulted about the analytical results, the source agencies are cooperative and usually confirm and support Status and Trends project findings.

One lesson learned over the course of the project is the essential aspect of quality assurance. Large agency data sets received by Status and Trends project staff often have incomplete or inaccurate metadata and sometimes erroneous data values. However, it appears that data quality is receiving more attention from agencies, e.g. the addition of new quality assurance codes in the TCEQ surface water quality monitoring database.

Challenges included the extended timeline for completion of *State of the Bay* chapter review. Eventually, all chapter review issues were resolved resulting in a completed, high quality *State of the Bay* report. Should the *State of the Bay* report be updated for a Fourth Edition at a point in the future, the review process and agency review entities should be clarified and established in writing long with a timeline that is agreed upon by the agency and the report editors at the beginning of the project.

Another challenge was the resignation of Dr. Eric Biltonen from HARC in September 2011. Dr. Biltonen was the original Principal Investigator on the Ecosystem Services portion of the project. Upon Dr. Biltonen’s resignation, Dr. Jim Lester, Lisa Gonzalez, and Kali Frost completed tasks associated with that portion of the contract with assistance from Mr. Greg Biddinger, Co-Chair of the Galveston Bay Council.

The Status and Trends process of compilation and analyses of data relevant to the Galveston Bay Plan is an important and unique effort. GTRI/HARC is proud of the work completed to date and hopes to continue the important work of the Galveston Bay Status and Trends Project in the future.
### Appendix A. List of Status and Trends Databases

<table>
<thead>
<tr>
<th>Database Agency &amp; Name</th>
<th>Update Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. NOAA/BEG Environmental Sensitivity Index</td>
<td>When released by agency</td>
</tr>
<tr>
<td>2. DSHS Bacteriological data</td>
<td>Annually</td>
</tr>
<tr>
<td>3. DSHS Seafood Consumption Advisories</td>
<td>Annually</td>
</tr>
<tr>
<td>4. DSHS Shellfish Harvest Areas</td>
<td>Annually</td>
</tr>
<tr>
<td>5. DSHS Tissue Contaminant/Health Assessment data</td>
<td>When released by agency</td>
</tr>
<tr>
<td>6. GLO Oil Spill Reporting Data</td>
<td>Annually</td>
</tr>
<tr>
<td>7. H-GAC 2002 Land Use data</td>
<td>When released by agency</td>
</tr>
<tr>
<td>8. H-GAC Clean Rivers Program data</td>
<td>Annually</td>
</tr>
<tr>
<td>9. H-GAC Parks data</td>
<td>When released by agency</td>
</tr>
<tr>
<td>10. H-GAC/Texas Watch volunteer monitoring data</td>
<td>Annually</td>
</tr>
<tr>
<td>11. NMFS Commercial Shrimp Harvest data</td>
<td>Annually</td>
</tr>
<tr>
<td>12. NOAA Coastal Change Analysis Program (C-CAP) data</td>
<td>When released by agency</td>
</tr>
<tr>
<td>13. NOAA Mussel Watch data</td>
<td>Annually</td>
</tr>
<tr>
<td>14. NOAA National Benthic Inventory Data for Galveston Bay</td>
<td>When released by agency</td>
</tr>
<tr>
<td>15. Port Statistics (Houston, Galveston and Texas City)</td>
<td>Annually</td>
</tr>
<tr>
<td>16. TCEQ 303d Lists</td>
<td>When released by agency</td>
</tr>
<tr>
<td>17. TCEQ Surface Water Quality Monitoring data</td>
<td>Annually</td>
</tr>
<tr>
<td>18. Texas Office of the Governor, Economic Development &amp; Tourism data</td>
<td>Annually</td>
</tr>
<tr>
<td>19. Texas Sea Grant Marina Pumpout Stations</td>
<td>Annually</td>
</tr>
<tr>
<td>20. TPWD Land Classification data</td>
<td>When released by agency</td>
</tr>
<tr>
<td>21. TPWD Coastal Fisheries Commercial Harvest data</td>
<td>Annually</td>
</tr>
<tr>
<td>22. TPWD Coastal Fisheries Independent Monitoring data</td>
<td>Annually</td>
</tr>
<tr>
<td>23. TPWD Coastal Fisheries Recreational Harvest data</td>
<td>Annually</td>
</tr>
<tr>
<td>24. TPWD Commercial Boat License data</td>
<td>Annually</td>
</tr>
<tr>
<td>25. TPWD Kills and Spills data</td>
<td>Annually</td>
</tr>
<tr>
<td>26. TPWD Mottled Duck data</td>
<td>When released by agency</td>
</tr>
<tr>
<td>27. TPWD Pleasure Boat License data</td>
<td>Annually</td>
</tr>
<tr>
<td>28. TPWD Recreational Hunting and Fishing License data</td>
<td>Annually</td>
</tr>
<tr>
<td>29. TWDB Freshwater Inflow data</td>
<td>When released by agency</td>
</tr>
<tr>
<td>30. US Census Bureau data</td>
<td>When released by agency</td>
</tr>
<tr>
<td>31. US Coast Guard Vessel Traffic and Incident data</td>
<td>Annually</td>
</tr>
<tr>
<td>32. USACE Bay Circulation Flow Maps (PDF/vector data only)</td>
<td>When released by agency</td>
</tr>
<tr>
<td>33. USACE Maintenance Dredging Water and Sediment Quality data</td>
<td>When released by agency</td>
</tr>
<tr>
<td>34. USACE Section 10/404 permits</td>
<td>When released by agency</td>
</tr>
<tr>
<td>35. USEPA EMAP/REMAP data</td>
<td>When released by agency</td>
</tr>
<tr>
<td>36. USEPA National Coastal Assessment Texas data</td>
<td>When released by agency</td>
</tr>
<tr>
<td>37. TPWD Colonial Nesting Bird data</td>
<td>Annually</td>
</tr>
<tr>
<td>38. USGS Stream Mean Monthly Stream Gage data</td>
<td>Annually</td>
</tr>
</tbody>
</table>
Appendix B. Galveston Bay Status and Trends Project 2008-2011 Literature Review Bibliography


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TDH. 2000. Health consultation for East Galveston Bay, Galveston County, Texas. Austin, Texas: Texas Department of Health, Seafood Safety Division and Environmental Epidemiology and Toxicology Division.

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TDH. 2001. Health consultation for Upper Galveston Bay, Galveston, Galveston County, Texas. Austin, Texas: Texas Department of Health, Seafood Safety Division and Environmental Epidemiology and Toxicology Division.

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### Appendix C. The State of the Bay, Third Edition Review Timeline

<table>
<thead>
<tr>
<th>Project Period</th>
<th>Quarter</th>
<th>Tasks Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>7/1/09-9/30/09</td>
<td>5th Quarter</td>
<td>All text, success stories, and photos for the State of the Bay publication were sent out to GBEP network for review. Comments received and editing begun. TCEQ review will occur in the 6th quarter of the project. Layout and design on all chapters has been completed. Potential vendors for DVD printing were contacted.</td>
</tr>
<tr>
<td>10/1/09-12/31/09</td>
<td>6th Quarter</td>
<td>All text, success stories, and photos for the State of the Bay publication were sent out to GBEP network for review. Comments received and editing is nearing completion. All edits were tracked and submitted to TCEQ along with edited chapters. Chapters 1-8 were completed and sent to TCEQ for final review. Chapters 9 and 10 will be sent in the coming days. Final TCEQ review will occur in the 7th quarter of the project.</td>
</tr>
<tr>
<td>1/1/10-3/31/10</td>
<td>7th Quarter</td>
<td>In total for all ten chapters, 31 stakeholders submitted 63 sets of chapter comments. GTRI/HARC submitted electronic versions (in .pdf and .doc formats) of reviewed and edited chapters 9 and 10 to TCEQ for final review (text included photos, figures and success stories/challenge issues; chapters 1-8 were submitted in 6th quarter). Awaiting results of final TCEQ review in the 8th quarter of the project. Presented the demo of the PDF portfolio layout (for DVD) to GBEP staff. Demonstrated links from chapters to data and interactive maps.</td>
</tr>
<tr>
<td>4/1/10-6/30/10</td>
<td>8th Quarter</td>
<td>Final TCEQ review of Chapter 1-9 received and edits made. Awaiting final review comments of Chapter 10 from TCEQ.</td>
</tr>
<tr>
<td>7/01/10-9/30/10</td>
<td>9th Quarter</td>
<td>Reviewed all State of the Bay chapters for formatting consistency and grammar. Awaiting final review of Chapter 10 from TCEQ.</td>
</tr>
<tr>
<td>10/1/10-12/31/10</td>
<td>10th Quarter</td>
<td>Completed all supplementary documents for State of the Bay report, including glossary, acronym list, chapter bibliographies, acknowledgements, and foreword. Chapter 10 edits received from TCEQ/GBEP. Final approval from external authors received for Chapters 3 and 5. All State of the Bay chapters, data tables, and geoPDF's finalized for final review by TCEQ Agency Communications Department. Submitted Executive Summary booklet to GBEP, received edits, and incorporated GBEP edits. PDF portfolio updated with all new files; linked chapter text to related geoPDF's and data tables for fully functional PDF portfolio. Submitted electronic PDF portfolio demo and Executive Summary booklet to GBEP and TCEQ Communications for final review. Media relations for State of the Bay coordinated with TCEQ GBEP. Water and Sediment Quality and Fisheries data portals on Status and Trends website (<a href="http://www.galvbaydata.org">www.galvbaydata.org</a>) updated through 2009.</td>
</tr>
<tr>
<td>1/11-3/31/11</td>
<td>11th Quarter</td>
<td>Submitted State of the Bay chapters and interactive CD to TCEQ Agency Communications and GBEP’s TCEQ Division Director for required approvals. PI revised chapters to incorporate TCEQ Agency Communication edits. GTRI/HARC is awaiting edits from review by Division Director as well as comments from TCEQ on interactive CD.</td>
</tr>
<tr>
<td>4/1/11-6/30/11</td>
<td>12th Quarter</td>
<td>GTRI/HARC awaited edits from review by Division Director as well as comments from TCEQ on interactive CD.</td>
</tr>
<tr>
<td>7/1/11-9/30/11</td>
<td>13th Quarter</td>
<td>Edits from review by Division Director received on 8/5/11. Issues with Chapter 5 emerged.</td>
</tr>
<tr>
<td>10/1/2011-12/31/2011</td>
<td>14th Quarter</td>
<td>Chapter 5 negotiations commenced and continued through October and November. Negotiations concluded in December 2011 with final completion of the report.</td>
</tr>
</tbody>
</table>
Appendix D. Ecosystem Services Valuation Annotated Bibliography

Note: This appendix is included as a separate attachment.
Appendix E. Ecosystem Services Valuation White Paper

Note: This appendix is included as a separate attachment.
# Appendix F. Project Meetings & Community Outreach Presentations

<table>
<thead>
<tr>
<th>Date</th>
<th>Personnel</th>
<th>Location &amp; Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>14th Quarter</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9/13/2011</td>
<td>Gonzalez</td>
<td>State of the Bay guest lecture to graduate students at Texas Southern University in Houston, Texas</td>
</tr>
<tr>
<td>9/24/2011</td>
<td>Gonzalez</td>
<td>State of the Bay presentation to students at Summer Creek High School in Houston, Texas</td>
</tr>
<tr>
<td>10/26/2011</td>
<td>Gonzalez</td>
<td>Attended Galveston bay Council Meeting at Armand Bayou Nature Center where State of the Bay was discussed.</td>
</tr>
<tr>
<td>11/28/2011</td>
<td>Gonzalez, Lester</td>
<td>Meeting to discuss State of the Bay, Chapter 5 held at TCEQ Headquarters in Austin, Texas</td>
</tr>
<tr>
<td><strong>13th Quarter</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7/5/2011</td>
<td>Lester, Biltonen</td>
<td>Ecosystem Services Workshop planning meeting at HARC.</td>
</tr>
<tr>
<td>7/21/2011</td>
<td>Lester, Biltonen</td>
<td>Ecosystem Services Workshop planning meeting at HARC.</td>
</tr>
<tr>
<td>7/28/2011</td>
<td>Lester, Biltonen</td>
<td>Ecosystem Services Workshop planning call at HARC.</td>
</tr>
<tr>
<td>8/15/2011</td>
<td>Gonzalez, Lester</td>
<td>Meeting to discuss State of the Bay, Chapter 5 held at TCEQ Headquarters in Austin, Texas</td>
</tr>
<tr>
<td>9/27/2011-</td>
<td>Gonzalez, Lester,</td>
<td>Convened Ecosystem Services Workshop</td>
</tr>
<tr>
<td>9/28/2011</td>
<td>Frost</td>
<td></td>
</tr>
<tr>
<td><strong>12th Quarter</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4/1/2011</td>
<td>Gonzalez, Bender</td>
<td>State of the Bay Video Shoot w/ Jamie Schubert of TPWD and John Huffman of USFWS at Galveston Island State Park, Galveston, Texas</td>
</tr>
<tr>
<td>Date</td>
<td>Name(s)</td>
<td>Event Description</td>
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<tr>
<td>------------</td>
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<tr>
<td>5/20/2011</td>
<td>Gonzalez, Bender</td>
<td>State of the Bay Video Shoot w/ Lori Traweek of GCWDA and Lalise Mason of Scenic Galveston at the GCWDA 40 Acre Facility &amp; Scenic Galveston Virginia Point Property in Texas City, Texas</td>
</tr>
<tr>
<td>6/3/2011</td>
<td>Lester, Biltonen</td>
<td>Houston-Galveston Ecosystem Services Workshop conference call with Greg Biddinger</td>
</tr>
<tr>
<td>6/16/2011</td>
<td>Gonzalez</td>
<td>Data quality audit with TCEQ/GBEP contract manager</td>
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**11th Quarter**

<table>
<thead>
<tr>
<th>Date</th>
<th>Name(s)</th>
<th>Event Description</th>
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<tr>
<td>1/2/2011</td>
<td>Gonzalez</td>
<td>GBEP Stakeholder Meeting w/John Hankinson, Gulf Coast Ecosystem Restoration Task Force, Harris Galveston Subsidence District, 1660 West Bay Area Blvd, Friendswood, TX 77546</td>
</tr>
<tr>
<td>2/3/2011</td>
<td>Gonzalez, Lester</td>
<td>Galveston Coastal Wetlands Review, EPA Online Webinar</td>
</tr>
<tr>
<td>2/15/2011</td>
<td>Lester</td>
<td>GBEP Monitoring &amp; Research Subcommittee Meeting, GBEP Offices</td>
</tr>
<tr>
<td>3/23/2011</td>
<td>Gonzalez, Lester, Bender</td>
<td>State of the Bay Video Shoot w/ Alecya Gallaway, Eagle Point Fishing Camp (San Leon)</td>
</tr>
<tr>
<td>3/24/2011</td>
<td>Gonzalez, Bender</td>
<td>State of the Bay Video Shoot w/ Breck Sacra, EcoNRG Ecocenter, 7705 West Bay Road, Baytown TX 77523</td>
</tr>
<tr>
<td>3/29/2011</td>
<td>Gonzalez, Bender</td>
<td>State of the Bay Video Shoot w/ Bob Stokes &amp; Mark Kramer, Armand Bayou Nature Center, 8500 Bay Area Boulevard, Pasadena, TX 77507</td>
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<tr>
<td>Date</td>
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<tr>
<td>12/10/2010</td>
<td>Gonzalez</td>
<td>Attended Ecosystem Modeling Workgroup Meeting sponsored by GBEP and UHCL EIH at EIH Offices.</td>
</tr>
<tr>
<td>11/15/2010</td>
<td>Gonzalez, Vernon, Frost</td>
<td>Attended Restore America’s Estuaries Conference</td>
</tr>
<tr>
<td>11/11/2010</td>
<td>Lester</td>
<td>Gave presentation on State of the Bay to North Houston Association’s Environment Committee at Lone Star College – Greenspoint, 250 North Sam Houston Parkway, Houston, TX.</td>
</tr>
<tr>
<td>10/27/2010</td>
<td>Lester</td>
<td>Attended Galveston Bay Council meeting at Armand Bayou Nature Center and provided SotB project update.</td>
</tr>
<tr>
<td>10/14/2010</td>
<td>Lester</td>
<td>Gave presentation on water quality of Lower Galveston Bay Watershed to Houston Tomorrow at 2010 Waugh Dr., Houston, Texas, 77006</td>
</tr>
<tr>
<td>10/7/2010</td>
<td>Gonzalez</td>
<td>Attended Ecosystem Modeling Workgroup Meeting sponsored by GBEP and UHCL EIH at EIH Offices.</td>
</tr>
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</table>

<table>
<thead>
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<th>Date</th>
<th>Attendees</th>
<th>Event Description</th>
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<tr>
<td>9/28/2010</td>
<td>Lester</td>
<td>GBEP M&amp;R Subcommittee meeting</td>
</tr>
<tr>
<td>7/28/2010</td>
<td>Gonzalez</td>
<td>Attended Galveston Bay Council meeting at Armand Bayou Nature Center and provided SotB project update.</td>
</tr>
<tr>
<td>7/20/2010</td>
<td>Gonzalez</td>
<td>Data quality audit with TCEQ/GBEP contract manager and TCEQ/GBEP QA manager</td>
</tr>
<tr>
<td>7/12/2010</td>
<td>Gonzalez</td>
<td>Gave presentation at GBEP PPE subcommittee meeting on the potential impacts of the oil spill on Galveston Bay.</td>
</tr>
<tr>
<td>7/7/2010</td>
<td>Gonzalez, Lester</td>
<td>Met with Ericka McCauley regarding media relations for State of the Bay (SotB).</td>
</tr>
<tr>
<td>7/6/2010</td>
<td>Gonzalez</td>
<td>Gave presentation at Galena Park ISD’s Sam Houston Elementary school on the potential impacts of the oil spill on Galveston Bay.</td>
</tr>
<tr>
<td>Date</td>
<td>Name(s)</td>
<td>Event Description</td>
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<tr>
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</tr>
<tr>
<td>6/15/2010</td>
<td>Gonzalez</td>
<td>Gave presentation at UH-Downtown on the potential impacts of the oil spill on Galveston Bay</td>
</tr>
<tr>
<td>6/7/2010-6/8/2010</td>
<td>Gonzalez</td>
<td>Attended Atlantis Modeling Workshop at NMFS Galveston Lab to determine if model can be applied to S&amp;T data.</td>
</tr>
<tr>
<td>5/18/2010</td>
<td>Lester</td>
<td>GBEP M&amp;R Subcommittee meeting</td>
</tr>
<tr>
<td>3/24/2010</td>
<td>Lester &amp; Gonzalez</td>
<td>Conference call with GBEP staff to discuss State of the Bay publicity.</td>
</tr>
<tr>
<td>2/16/2010</td>
<td>Lester &amp; Gonzalez</td>
<td>Met with GBEP staff to demo State of the Bay DVD format and discuss State of the Bay publicity.</td>
</tr>
<tr>
<td>12/8/2009</td>
<td>Lester</td>
<td>GBEP M&amp;R Subcommittee meeting</td>
</tr>
<tr>
<td>9/23/2009</td>
<td>Gonzalez</td>
<td>Data quality audit with TCEQ/GBEP contract manager</td>
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<tr>
<td>8/19/2009</td>
<td>Lester &amp; Gonzalez &amp; Sikaneta</td>
<td>Joint Meeting of GBEP Mon &amp; Res &amp; NRU Subcommittees; presented State of the Bay report update</td>
</tr>
<tr>
<td>6/23/2009</td>
<td>Lester</td>
<td>GBEP M&amp;R Subcommittee meeting</td>
</tr>
<tr>
<td>2/17/2009</td>
<td>Lester</td>
<td>GBEP M&amp;R Subcommittee meeting</td>
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</table>
| 1/12/2009-1/14/2009 | Gonzalez, Lester, Vernon | Attended State of the Bay Symposium. Gave the following presentations:  
<p>|             |                           | 1. Lester &amp; Gonzalez: The State of Galveston Bay 2009; |</p>
<table>
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<tr>
<th>Date</th>
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<tr>
<td>1/12/2009</td>
<td>Gonzalez</td>
<td>Attended Galveston Bay Council meeting and gave an update on the State of the Bay report.</td>
</tr>
<tr>
<td>11/14/2008</td>
<td>Gonzalez</td>
<td>Texas A&amp;M University College Station Seminar: The Galveston Bay Indicator Framework</td>
</tr>
<tr>
<td>10/20/2008</td>
<td>Lester, Gonzalez</td>
<td>Presentation to League of Women Voters, Houston, Texas on the Clean Water Act and Houston Regional Water Quality</td>
</tr>
<tr>
<td>8/22/2008</td>
<td>Gonzalez, Vardhan, Vernon</td>
<td>Data quality audit with TCEQ/GBEP contract manager</td>
</tr>
<tr>
<td>8/26/2008</td>
<td>Lester, Gonzalez</td>
<td>GBEP M&amp;R Subcommittee Meeting; Presentation: “Review of Historical PCB and Dioxin Contaminant Data”</td>
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Literature Cited


