PNNL-17164

Pacific Northwest
National Laboratory
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GoMRC Website 'Meta-analysis Report: Land-use and submerged aquatic vegetation change in the Gulf of Mexico'

C Judd
ES Stefansson
H Brushnahan

December 2007

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RL01830

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As found on: http://www.gomrc.org/sav/analysis-overview.html

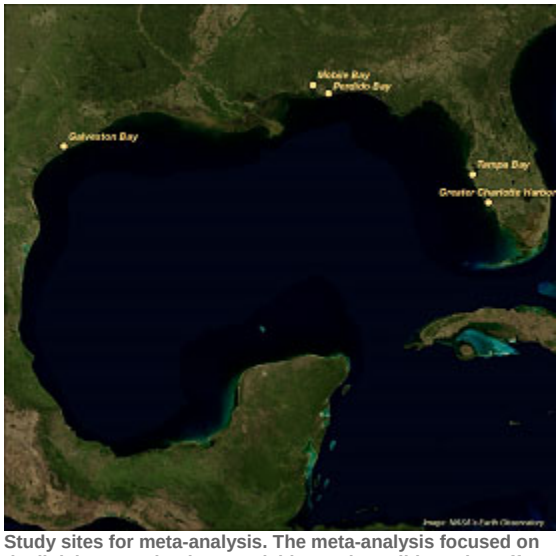
Meta-analysis

Overview | Historical Background | Approach | Findings | Additional Resources

Seagrasses and other types of submerged aquatic vegetation (SAV) play an essential role in coastal ecosystems. However, over the past century, distribution throughout the Gulf has declined drastically.

Land use activities and associated changes in runoff and water flow dynamics can have serious impacts on water quality in nearshore ecosystems. The impact of land use changes from urban development on the Mobile Bay ecosystem was studied in detail as part of the SAV restoration demonstration project.

A central objective of GoMRC is to facilitate access to common ecosystem models, tools, and methods for ecosystem assessment in the Gulf of Mexico. This "meta-analysis," or proof of concept, aimed to demonstrate how the integrated set of models applied in Mobile Bay could be applied to other geographic areas in the Gulf. The meta-analysis focused on the links between upland activities and downstream impacts on SAV habitat in five Gulf of Mexico bays. Historical and present-day trends in land use and SAV populations were examined in Mobile Bay, Perdido Bay, Tampa Bay, Charlotte Harbor, and Galveston Bay.



Study sites for meta-analysis. The meta-analysis focused on the link between land use activities and conditions that affect SAV habitat in five Gulf coast bays

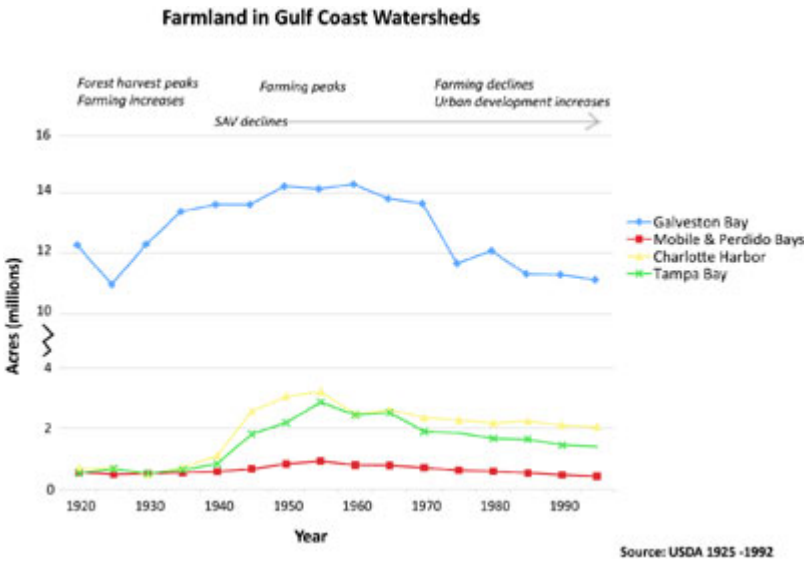
More on Meta-analysis >>

Submerged Aquatic Vegetation

Meta-analysis

Overview | **Historical Background** | Approach | Findings | Additional Resources

Increases in agriculture and urbanization are thought to be correlated with declines in SAV. As land use changes, runoff may increase, thereby increasing turbidity and temperature, and potentially decreasing salinity.



Land use trends in the Gulf of Mexico. Similar trends in land use across the Gulf of Mexico occur at the same time as declines in submerged aquatic vegetation.

In the Gulf States, forested areas declined in the late 1930s to 1960s while farmland acreages steadily increased in the early 1900s, peaked in the 1950s, and then decreased to present day. This decline in farmland was likely due to development in coastal areas, as a steep rise in population and housing units per county was observed throughout the 1900s. The most dramatic loss of SAV coverage in many of the bays and estuaries within the Gulf, based on historical estimates, occurred between 1940 and the early 1980s. This was accompanied by a loss of forest and wetlands to agriculture and urbanization. However, in Galveston Bay, much of the initial loss was not related to changes in land use, rather to storm activity.

More on Meta-analysis >>

Meta-analysis

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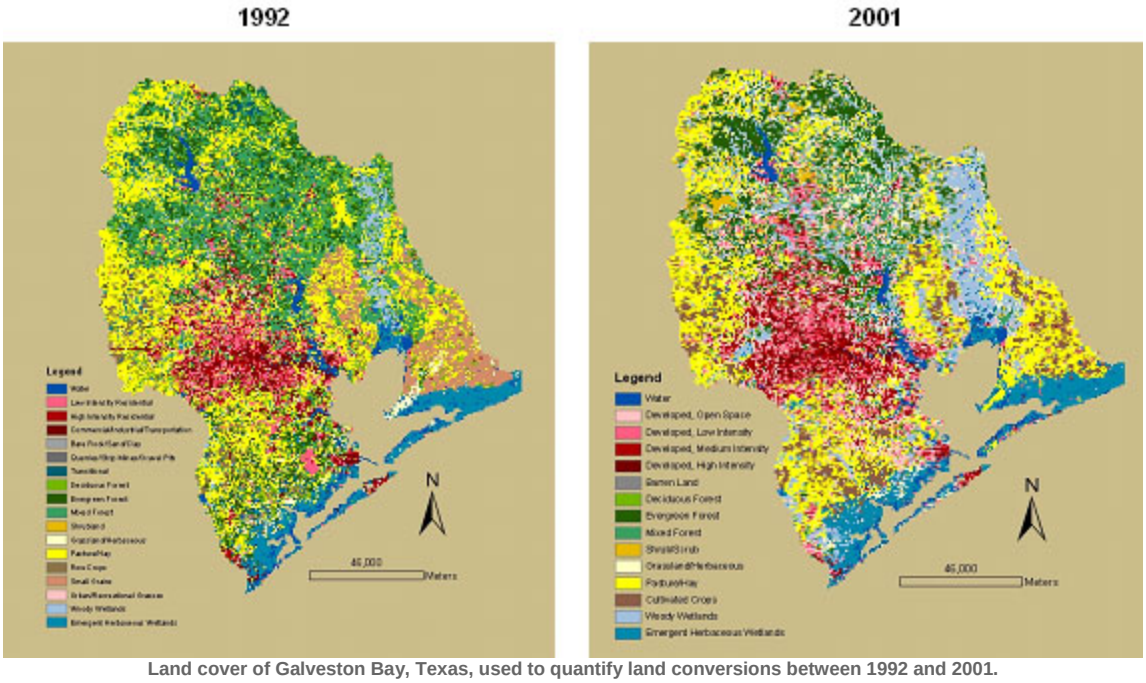
Seagrass and other SAV datasets from the National Wetlands Inventory and various local agencies were compared with L derived National Land Cover Datasets (NLCD) from 1992 and 2001. Land use change was calculated by Hydrologic Unit (HUC) boundaries to quantify area and percent change for primary land use classes, and a look-up table was used to ass use with a percent imperviousness for that class. SAV change and land cover change were correlated both on the individu HUCs and for the overall watershed. For a long-term picture, county-level data (for each watershed) were collected from t Census Bureau, U.S. Forest Service, and U.S. Department of Agriculture documenting changes in farmland, urban, and fo acreages since the early 1900s. These figures were then compared to trends in SAV coverage, taken from existing spatia prior studies, and historical navigation charts.



Land cover of Galveston Bay, Texas, used to quantify land conversions between 1992 and 2001.

More on Meta-analysis >>

Submerged Aquatic Vegetation

Meta-analysis

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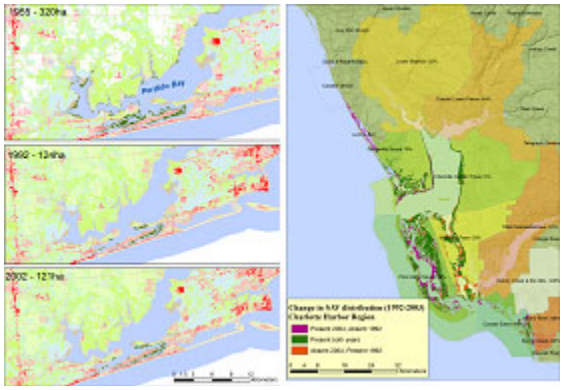
Impervious surface increased in all watersheds from 1992 to 2001, with increases ranging from .3% to 7.2% over the ten-year period. At the same time, SAVs decreased in distribution in most sub-basins, with the exception of Tampa Bay and some areas of Charlotte Harbor. Documented areas of SAV loss often occurred within tributaries to the main bay. Dataset consistency was an issue in Galveston Bay with different mapping methodologies in the two years analyzed, and it was left out of the analysis.



Perdido Bay (left) and Charlotte Harbor (right). SAV mapped from historical air photos (shown in dark green) shows a decline in SAV from 1955 to 1992 along many of the tributaries that lead into Perdido Bay. From 1992-2003, Charlotte Harbor

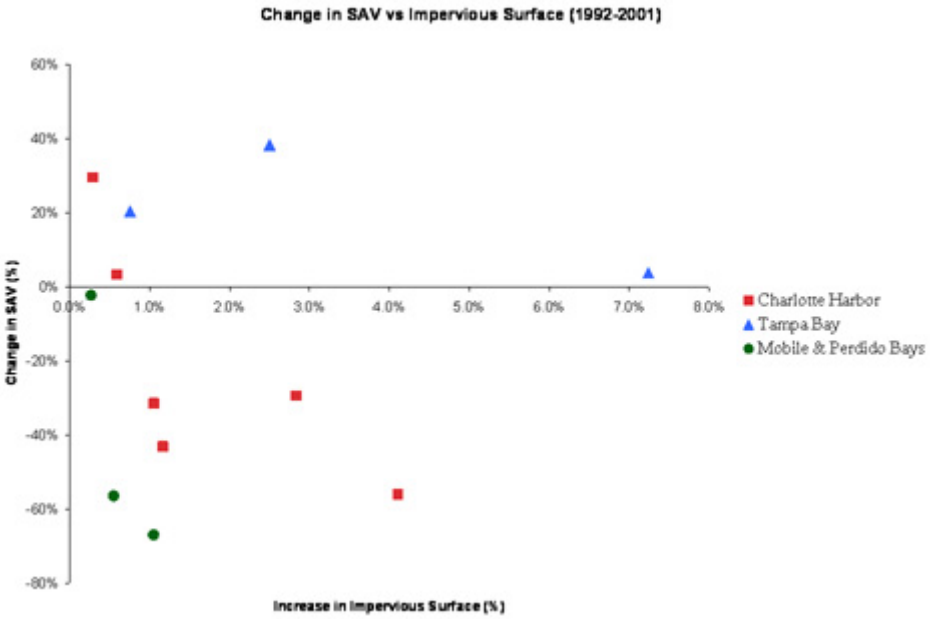
Increases in impervious surface are negatively correlated with SAVs, though the strength of relationship differs in different estuaries as does the relationship itself.

showed a similar trends in loss. Among the highest rates of loss are the Lower Myakka and Coastal Lower Peace, two tributaries that enter Charlotte Harbor. Though Hendry Creek and Six Mile show a higher percentage loss of SAV, this was originally a small population and could be due to differences in mapping methods rather than a true loss in SAV beds.

Increases in impervious surfaces are also related to other potentially damaging side effects of coastal development, which may not be terrestrial. For example, recreational boating (propeller scarring), an increase in the construction of docks and armoring, as well as the need for structures like bridges and causeways will increase as populations increase and impervious surfaces increase.

This study shows a correlation between high levels of land use change and SAV declines historically. Whether it is the immediate effects of these land conversions or the associated human activities that cause the most damage, land use changes must be managed to avoid future destruction of SAV habitats.

These potential associations between general SAV loss and impervious surface change suggest that GoMRC's method of integrating models of urban growth, hydrology and SAV stressors may be useful to identify viable sub-regions where marginal improvements to water quality may enable SAV restoration.



Increase in impervious surface and change in SAV cover. Though relationships are different in each bay or water body, there is a negative correlation between increases in impervious surfaces and SAV distribution.

More on Meta-analysis >>

Meta-analysis

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Land Use

- U.S. Census Bureau, historical data links: http://www.census.gov/population/www/censusdata/hiscendata.html
- Population by county, 1900-1990: http://www.census.gov/population/cencounts/

- Housing units by county, 1940-1990 (see table 30): http://www.census.gov/prod/cen1990/cph2/cph-2-1-1.pdf
- Historical census reports (with Census of Agriculture data for 1900-1950): http://www.census.gov/prod/www/abs/decennial/index.htm
- For Census of Agriculture data between 1950 and 1992, see City and County Data Books (available at many libraries)
- For historical forest acreages, contact the USDA Forest Service: Forest Inventory and Analysis
- Download Spatial Data: Land Use & Land Cover: http://seamless.usgs.gov/

Submerged Aquatic Vegetation Trends

- Seagrass Status and Trends in the Northern Gulf of Mexico: 1940-2002 (USGS Report): http://pubs.usgs.gov/sir/2006/5287/
- National Wetland Inventory: http://www.fws.gov/nwi/
- Gulf of Mexico Seagrass Publications : http://gulfsci.usgs.gov/gom_ims/sgpubs.html

Other

- Historical Navigation Charts: http://historicals.ncd.noaa.gov/historicals/histmap.asp