

Valuing ecosystem services of estuarine ecosystem as a coastal management tool: a case study for Galveston Bay

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Pre-Hurricane Ike,
4/8/2008



West end, Galveston, Texas
(the hurricane landfall on
9/13/2008)

Post-Hurricane Ike,
10/10/2008





- After Hurricane Ike (landfall on 9/13/2008)
- Upper left: FEMA 500 year flooding zone
- Upper right: FEMA 100 year flooding zone
- Lower left: The Seawall area
- Lower right: the Harbor side

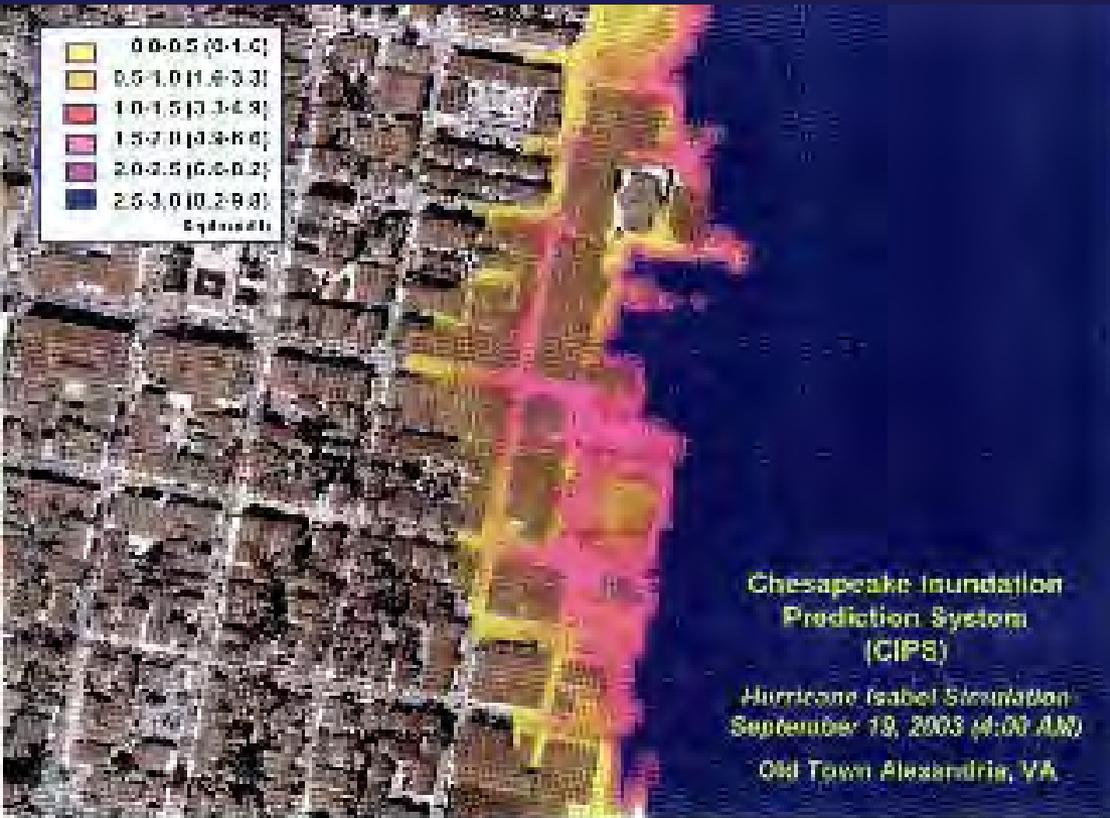




NOW. Estimating the flooding level from the sea level across the island behind the seawall with professor Jones at Texas A&M at Galveston



Goal: to illustrate the spatial peak flooding level across the Galveston island behind the seawall using 1) differential GPS information and 2) reference mark of coastal & geodetic survey



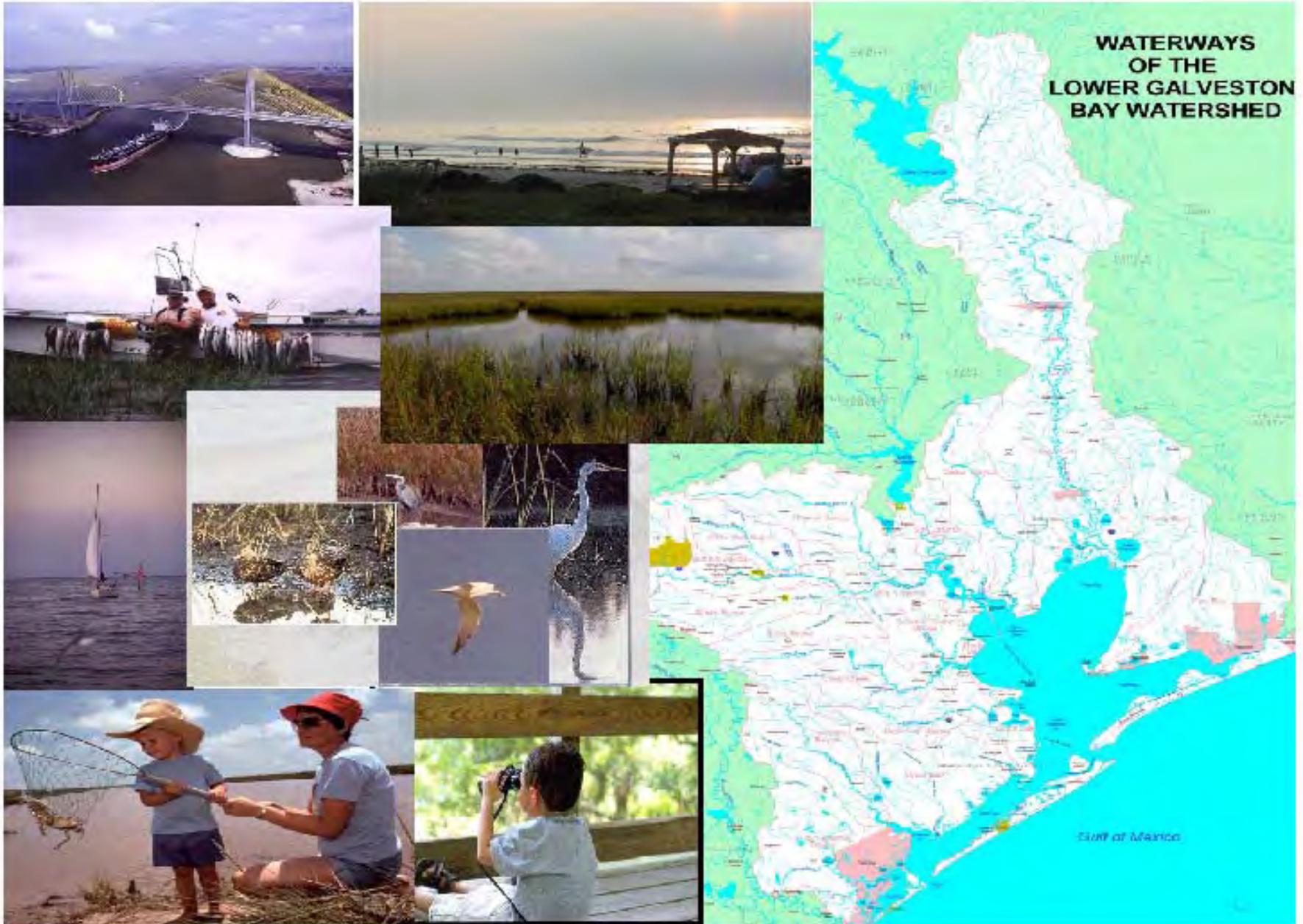
Example: Flooded Old town Alexandria, VA from Hurricane Isabel, on 9/19/03 (Stamey, B. et al., 2007; numbers are water depth in m/ft)

Research Importance

Improve environmental policy and management decisions

- Natural environments tend to be public goods
 - non-rival and non-excludable
- Emphasize the importance of ecosystem services, which may have been taken for granted
- Provide better communication of information to diverse stakeholders

Diverse forms of ecosystem services in the bay



Current conflicts over Development and Preservation in Galveston, Texas

Tall vs. sprawl

TRENDS

Galveston County the Daily News, 2/27/2007

How tall is too tall?

City wants residents' input about high-rise development

By LEIGH JONES
The Daily News

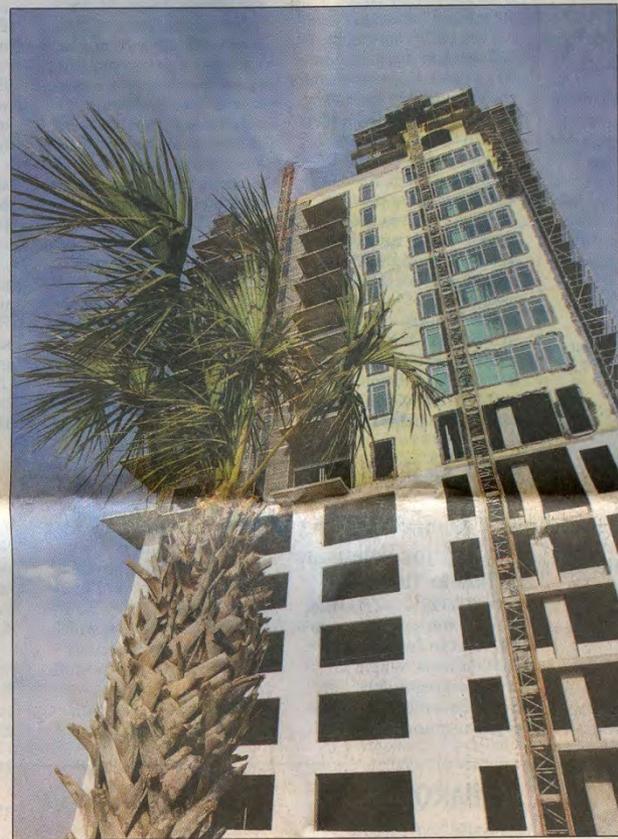
GALVESTON — Galveston's skyline won't change without residents weighing in on the debate.

Some developers, wanting to maximize the value of small, waterfront parcels, want to build upward. It's a new phenomenon for the island, and one that has some homeowners worried that Galveston might one day resemble Miami, where the beachfront is lined with high rises.

Homeowners near one West End project protested loudly enough to make the city veto planning commission approval.

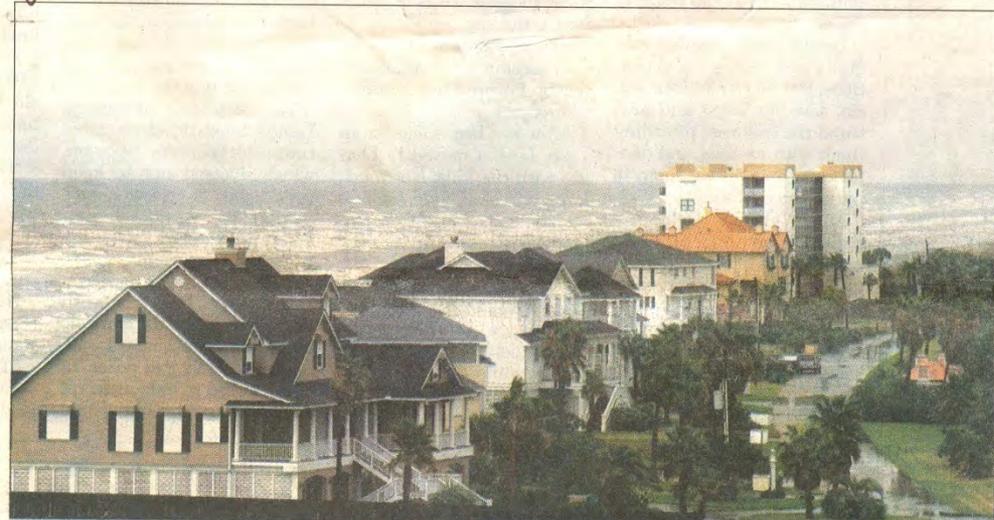
City officials now want to find out what the rest of the island's residents think about restricting the height and density of future development.

A survey delivered in March



KEVIN M. COX/The Daily News

The Emerald by the Sea condominium project at 500 Seawall Blvd. in Galveston towers over neighboring structures. The city is surveying to island residents to gather input for new building height and density regulations for future high-rise projects.



JENNIFER REYNOLDS/The Daily News

Rooftops and mid-rise condominiums can be seen along the beach in Galveston from the rooftop of Escapes on FM 3005 near 9 Mile Road.

Multi-level development booming, but is it right for the island?

Galveston County the Daily News, 8/19/2007

SHRINKING, SINKING



JENNIFER REYNOLDS/The Daily News

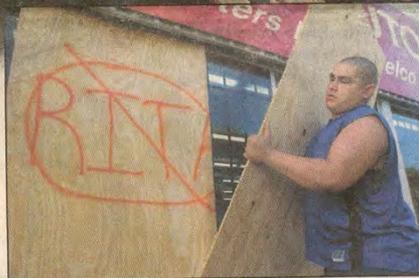
A great egret looks for dinner in the wetlands along Interstate 45 near Tiki island. A coastal geologist from Rice University recently told the Galveston City Council it's doing a poor job of managing and protecting its fast-disappearing wetlands.

Galveston County the Daily News, 8/12/2007

Galveston County the Daily News, 1/4/2007

WEATHER

Prepare for worst



FILE PHOTOS/
The Daily News

A program set to air on The Weather Channel on Sunday examines what would happen if a Category 4 hurricane, like the 1900 Storm (TOP), were to hit Texas. The show advises resi-

dents to do many things early, such as cutting plywood to fit windows (LEFT) and evacuating early. Such a storm now could cause more deaths than the 1900 Storm.

Weather Channel show plays 'What if...' with hurricane

By SARA McDONALD
The Daily News

WHAT: "It Could Happen Tomorrow"

cane, have wind speeds between 131 and 155 mph and storm surges up to 18 feet, according to

Major challenges in valuing ecosystem services

1. incomplete knowledge; some ecosystems are better understood than others
2. some type of values (e.g., nonuse value) are more difficult to estimate than others

(NRC, 2005)



Epistemological differences in valuation methods

Approach	Anthropocentric	Biocentric
Discipline	Neo-Classical Economics (demand oriented)	Classical economics (supply oriented)
Value	Utility, exchange	Embodied energy, matter
Major concepts	Willingness-to-pay	Energy quality, Energy- return-on-investment,
Principles	Substitution, market	Thermodynamics, holistic
View on technology	Positive	Neutral
View on society	Bargaining process	Web of energy, resource flow
Growth factor	Human capital, technology	Natural capital

Valuing Ecosystem service for Galveston bay

Step 1.

-Define types of ecosystem services and corresponding valuation methods for Galveston bay through stakeholder discussions

-Twenty-five diverse local stakeholders participated to a workshop at Texas A&M University at Galveston, 7/11/2006

Combined list collected from the first workshop

Ecosystem service	Valuation methods
Storm water abatement	A/RC, H
Water quality	A/RC, CV, H
Erosion control	A/RC, H
Flood & Storm protection	A/RC
Subsidence abatement	A/RC
Cultural & Historical Activities	CV, M, TC
Gas regulation	CV
Nutrient regulation	A/RC, CV

AC-avoided cost; CV-contingent valuation; H-hedonic pricing; M-market pricing; P-production approach; RC-replacement cost; TC-travel cost

Ecosystem service	Valuation methods
Open space	CV, H
Fish & wildlife habitat	P, E, CV
Spawning & nursery habitat	CV, E, P, Ranking
Commercial transportation	M
Commercial fishing	M, P, E
Recreational fishing	M, TC, E, Ranking
Recreational activities	TC, CV, Ranking
Ecotourism	TC, CV, Ranking
Scientific & Educational Activities	CV, P, M
Aesthetics	H, CV, TC, Ranking

AC-avoided cost; CV-contingent valuation; H-hedonic pricing; M-market pricing; P-production approach; RC-replacement cost; TC-travel cost

Step 2 (qualitative study)

- Prioritize the defined diverse ecosystem services, and define managerial challenges for the bay

- Twenty-eight diverse local stakeholders participated through a keypad voting, 1/24/2007

Workshop 1 Categories (18)

Storm water abatement
Subsidence abatement

Water quality

Erosion control
Flood & storm protection

Gas regulation
Nutrient regulation

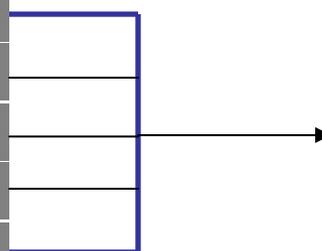
Fish & wildlife habitat
Spawning & nursery habitat

Commercial fishing

recreational fishing
Open space
Recreational activities
Ecotourism
Aesthetics

Cultural & historical activities
Scientific & educational act.

Marine transportation



Keypad Categories (9)

Storm water & subsidence
abatement

Water quality

Protection from flooding,
storm & erosion

Gas & nutrient regulation

Fish & wildlife habitats

Commercial fishing

Recreation, ecotourism,
Aesthetics, & open space

Cultural, educational,
historical & scientific activities

Marine transportation

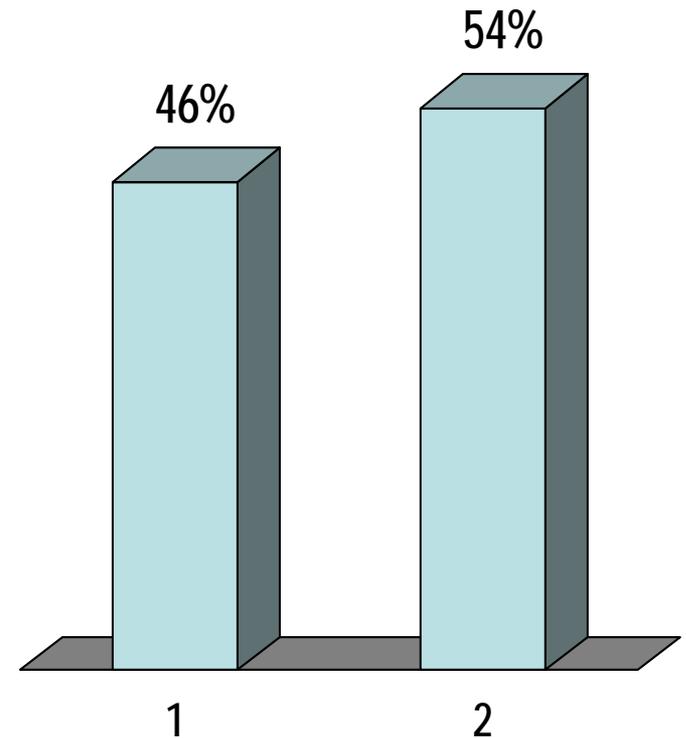
GALVESTON BAY ECOSYSTEM SERVICES

Keypad Voting (pick one and hit send)

Should marine transportation be considered an ecosystem service in Galveston Bay?

1. Yes

2. No



Summary of the second stakeholder workshop

Question	First rank	Second rank	Third rank
Most overall value	Fish and wildlife habitats	Recreation, ecotourism, aesthetics, open space	Protection from flooding, storm, erosion
Most economic value	Recreation, ecotourism, aesthetics, open space	Commercial fishing	Marine transportation
Most at risk	Fish and wildlife habitats	Water quality	Protection from flooding, storm, erosion
Priorities for future work	Fish and wildlife habitats	Protection from flooding, storm, erosion	Water quality

Step 3 (quantitative study)

- Estimate financial contributions of selected ecosystem services to the local economy

3-1) Non-market valuations

3-1-a) Flooding attenuation

- Wetlands intercept storm runoff and store storm waters, thereby changing sharp runoff peaks to slower discharges over longer periods of time, resulting in reduced danger of flooding.
- Replacement cost method is used to quantify economic benefit of the ecosystem service, compared with alternative engineering method: channelization.

Two feasibility studies for Friendswood, Texas

A. Expected peak flow reduction efficiency for a 100-year flood, Cowarts Creek.

Monitoring sites	Channelization			Detention pond		
	Existing flow (ft)	Improved flow (ft)	Reduction efficiency(%)	Existing flow	Improved flow	Reduction efficiency(%)
FM 518 bridge	22.63	18.38	18.78	13.20	12.94	1.97
Sunset bridge	25.89	22.25	14.06	20.35	20.18	0.84
Baker bridge	33.05	29.87	9.62	31.56	31.56	0.00
Mean			14.15			0.94

(Source: Coenco, 1985 for channelization; Dannenbaum 2001 for detention pond)

B. A cost comparison between channelization and detention pond for Friendswood, Texas

Channelization

Excavation	1,020,078 C.Y. @\$6.50	\$6,630,000
Pipeline lowering	16 Ea. @\$44,000	\$704,000
Concrete slope paving under bridge	1,660 S.Y. @\$66	\$110,000
Clearing & Grubbing	Lump sum	\$65,000
Miscellaneous		\$147,000
Total cost		\$7,654,000

Detention Pond

Land acquisition	40 AC @\$10,000	\$400,000
Excavation	429,147 C.Y. @\$6.50	\$2,789,456
Structure	\$100,000	\$100,000
	Sub-total	\$3,289,456
Contingencies (15%)		\$493,418
Total construction cost		\$3,782,874
Engineering & Administration (10%)		\$378,287
Total cost		\$4,161,161

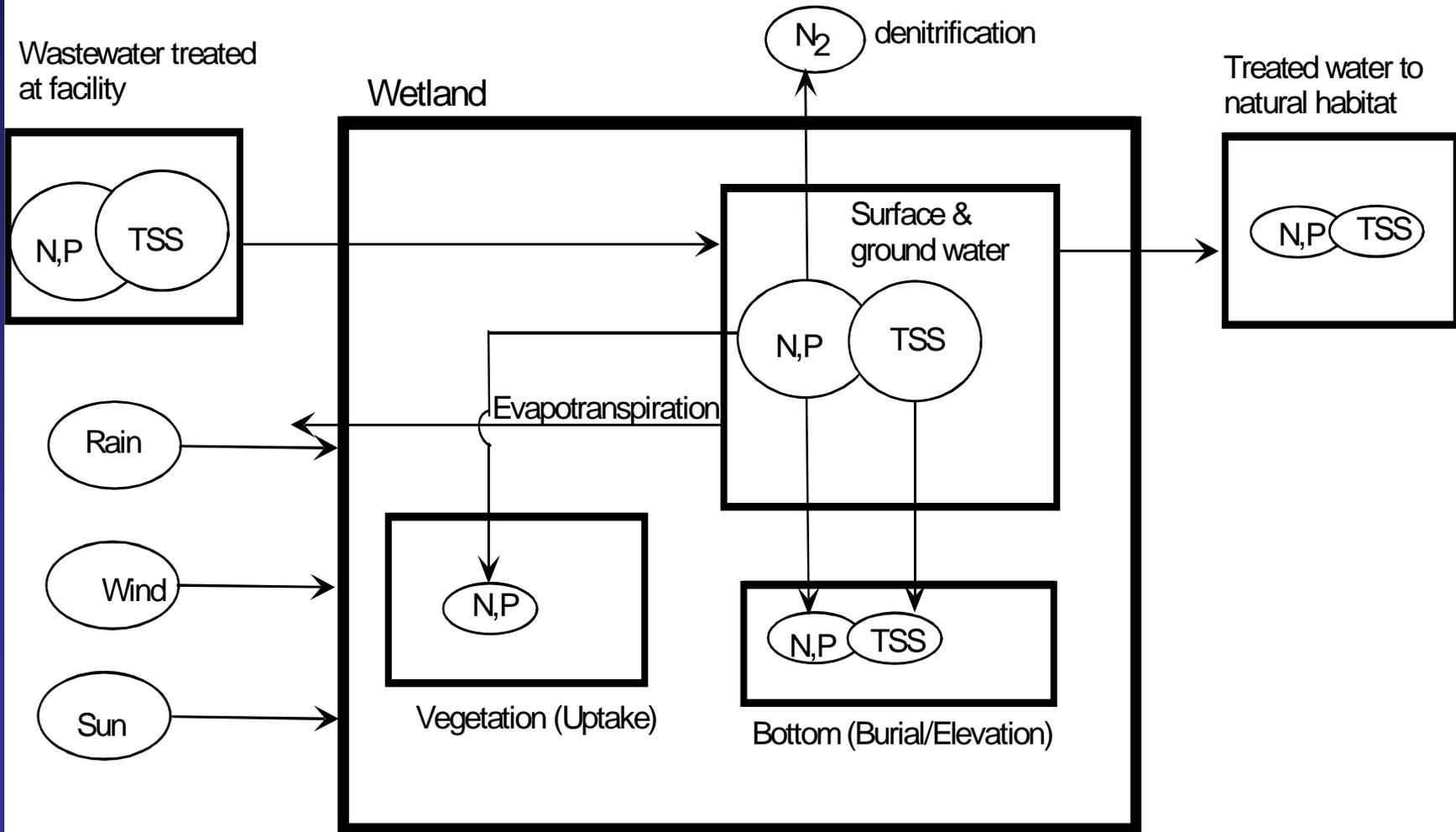
*Inflation adjusted for 2001.

- The cost savings of detention pond over channelization, \$3,494,000, is attributable to the ecosystem service of the 40 acres of wetlands to be used.
- After adjusting for the different peak flow reduction efficiency (14.15% vs. 0.94%),
- The wetlands value for flood mitigation is estimated as \$5,800 per acre.

3-1-b) Water quality improvement

- Wetlands are efficient in removing excessive nutrients and pollutants by physical settling and filtration, chemical precipitation and adsorption, and biological metabolic processes that result in burial, storage in vegetation, and denitrification.
- Replacement cost method is used to quantify economic benefit of the ecosystem service, compared with alternative engineering method: sand filtration method.

A diagram of the wetland treatment method for advanced treatment of wastewater



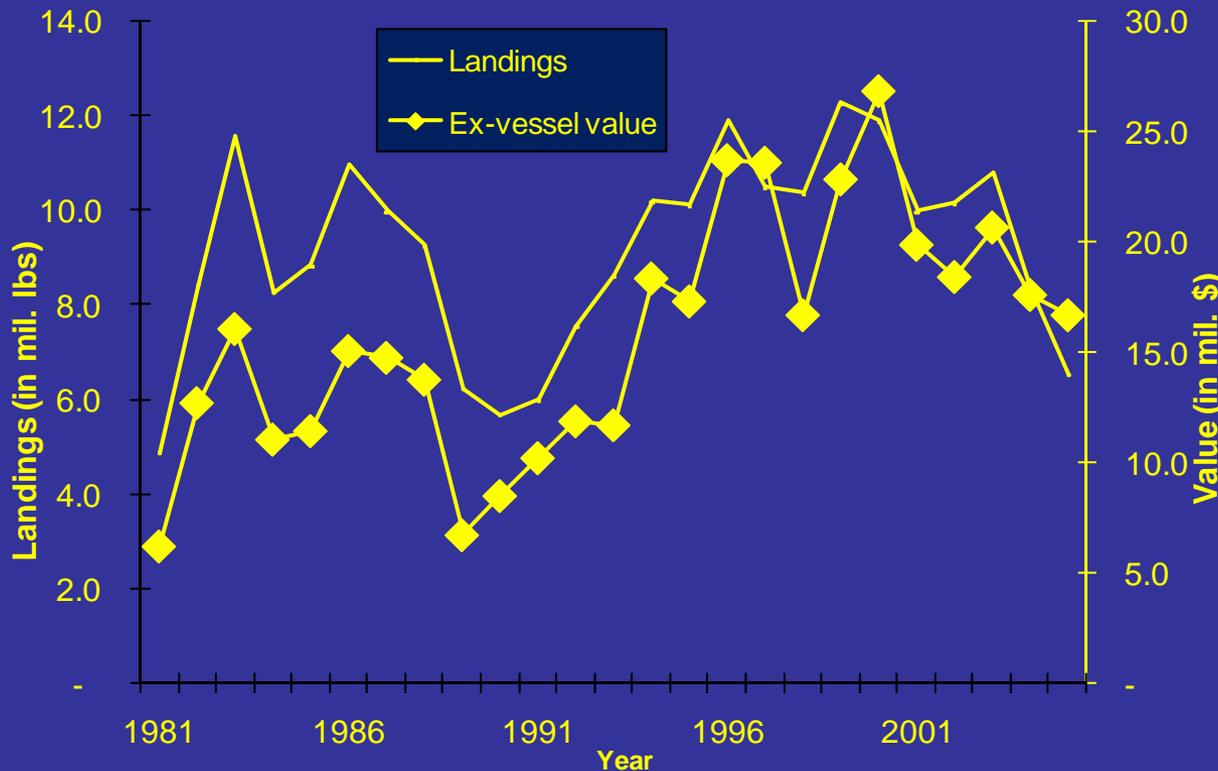
Potential wetlands value of Brazoria national wildlife refuge, Galveston Bay for water quality improvement

- The results of Breaux Bridge site in Louisiana (Ko et al., 2004) implied that
 - 1) the economic savings per 1 MGD (million-gallon-per-day) are \$1.8 million for capital cost, and \$72,000 for annual O&M cost
 - 2) Wetland method is about 7.4 times more energy efficient than sand filtration method and the accumulated energy savings over the life-span of 20 years would be 71.5 TJ, equal to 11,354 barrels of oil.
- After Applying the results to the Brazoria national wildlife refuge, Galveston Bay, assuming that nearby local town, city of Lake Jackson (capacity: 3.2 MGD), use a portion of wetlands (1,800 acres) inside the wildlife refuge,
 - Economic value of wetlands in improving water quality is estimated as \$129 per acre.

3-2. Market valuations

3-2-a) Commercial fishing

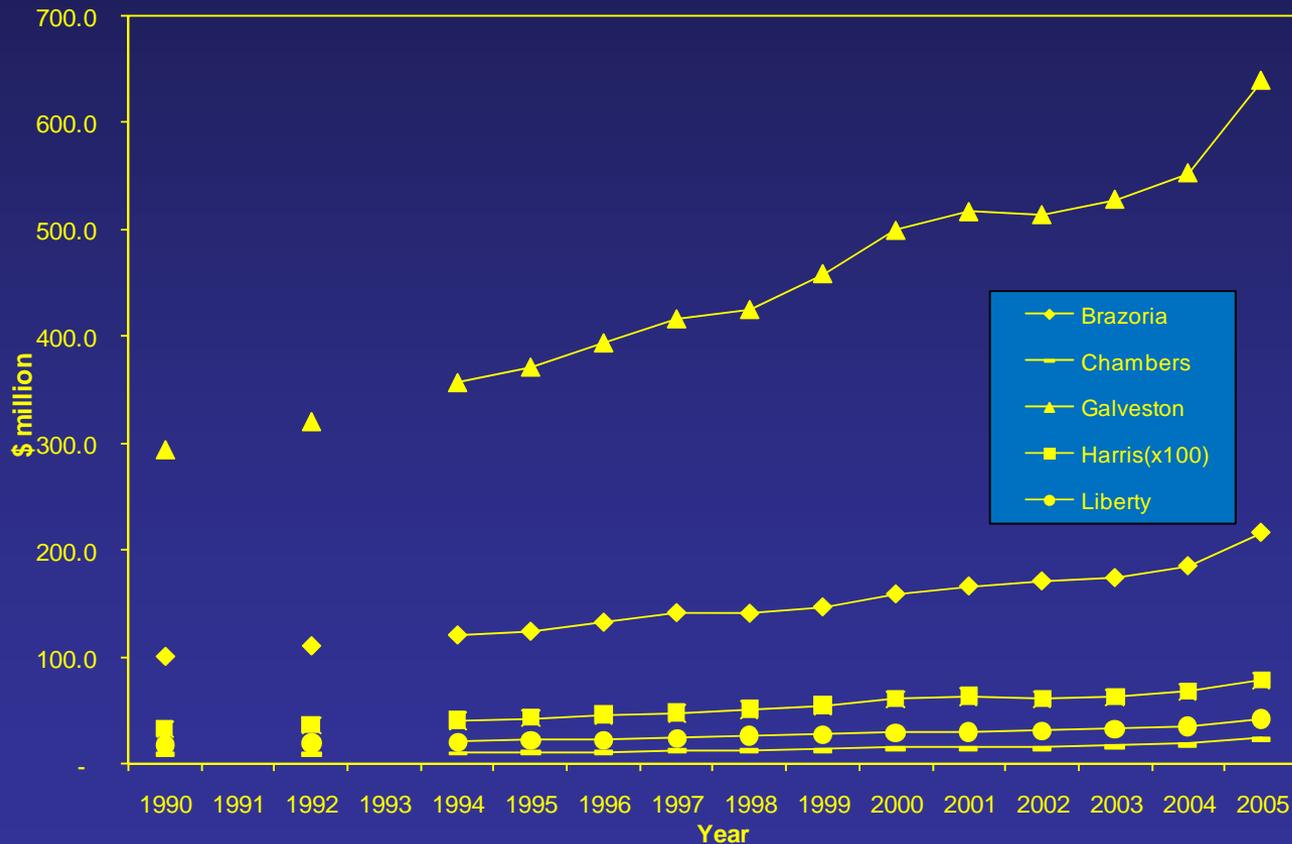
Total landings and ex-vessel value of commercial fishery from the Galveston Bay system, 1981-2005 (Source: Wagner et al. In preparation)



From the mid-1990s through 2003, combined landings were more than 10 million pounds each year and associated ex-vessel value was 21 million dollars per year in current prices.

3-2-b) Recreation-related monetary valuation

Visitor spending by County, 1990-2005



- Visitors spent more than \$600 million in Galveston county and \$216 million in Brazoria county during 2005.

- Recreation spending supported 11,700 jobs in Galveston area for 2001 (Moulton, 2003)

(Source: Dean Runyan, 2006)

Conclusion/Discussion

- Eighteen different ecosystem services are defined.
- The qualitative priority study implied significant value challenges among stakeholders.
- Selective results of ecosystem services valuation using market and non-market methods have contributed to generate more \$\$ values, which are commonly understandable to diverse stakeholders.
- Increasing demands for recreation-related services are most explicitly market valued.
- Coastal wetlands, important for fish and wildlife habitats and also, are estimated to have potentially significant economic contributions to local economy.
- As a way to improve reliability of valuation studies, the anthropocentric and biocentric methods should be conducted together.

Acknowledgement

The project, 'economic value of ecosystem services provided by the Galveston bay/estuary system' was funded by the Galveston Bay Estuary Program.