Science-Based Approaches to Establish Minimum Flows to Bays and Estuaries

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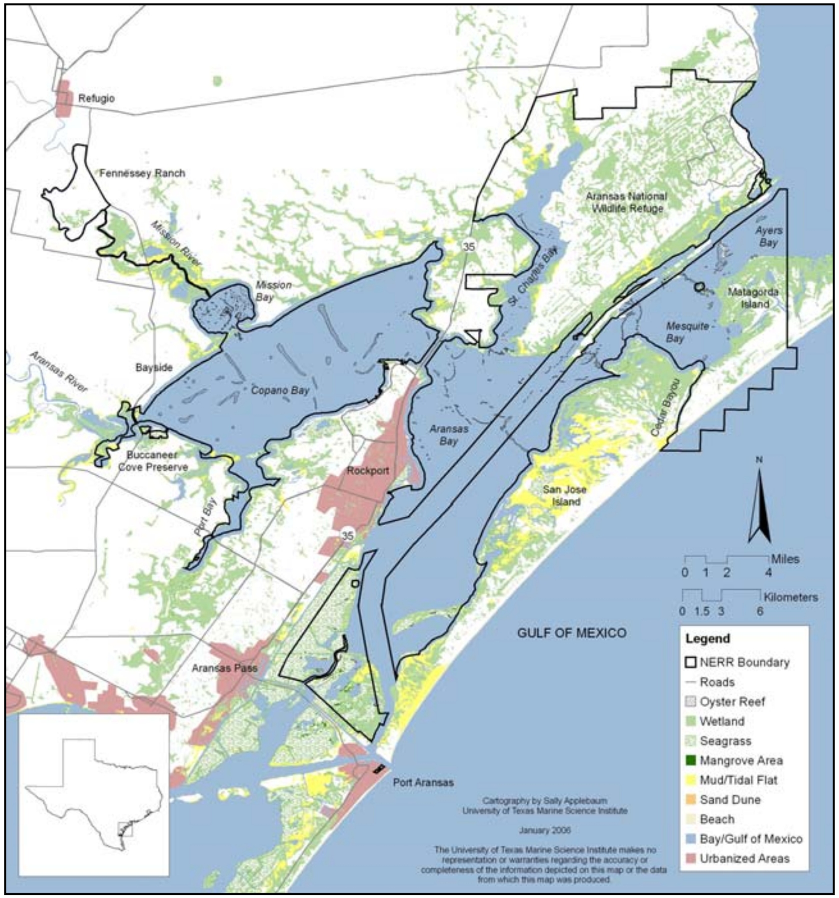
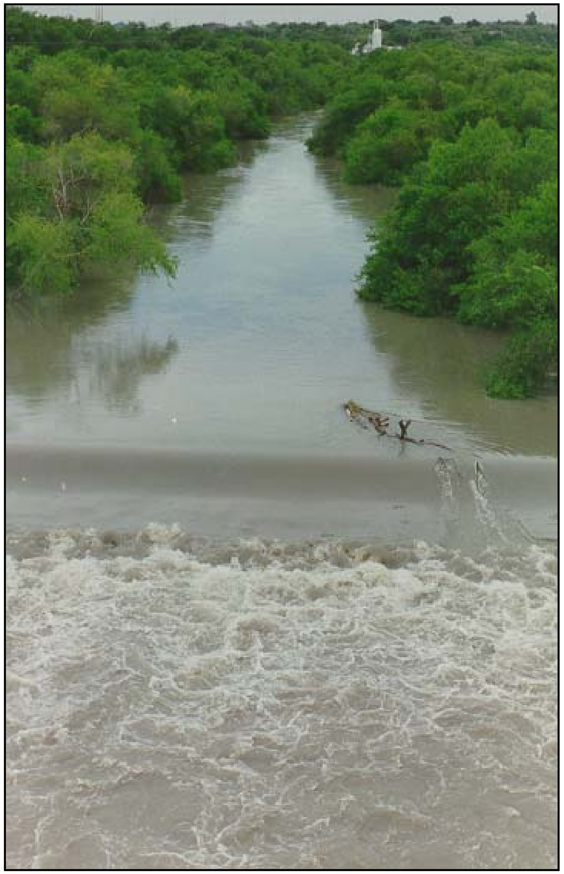
First a commercial message!

- Mission-Aransas National Estuarine Research Reserve (MANERR)
  - Designation ceremony May 6, 10 am.
  - Celebration party, 7 pm.



Presentation outline

- Case studies
- Lessons learned
- Texas Context



Case studies

- San Francisco Bay, California, USA
- Caloosahatchie Estuary, Florida, USA
- Tampa Bay watershed, Florida, USA
- Mtata Estuary, South Africa
- National Program, Australia

Florida, USA
-Water Management Districts

- Northwest Florida WMD
- St. Johns River WMD
- South Florida WMD *
- Suwannee River WMD
- Southwest Florida WMD *

Caloosahatchie, FL USA -Issues

- Modifications (channels, canals, dams), diversions and withdrawals led to:
  - Decreased sediment transport, biodiversity, and habitat.
  - Increased eutrophication and hypoxia.

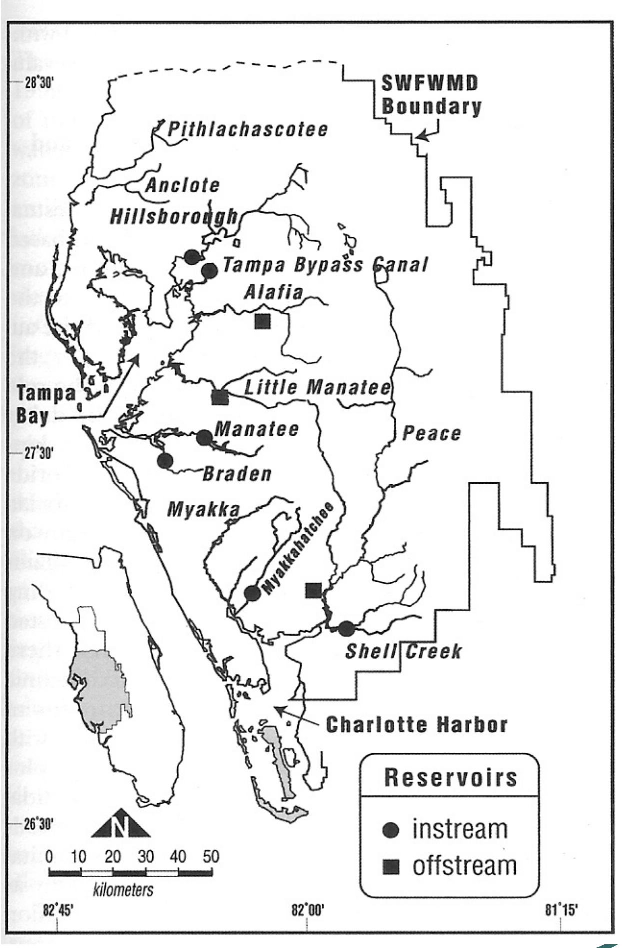
Caloosahatchie, FL USA -Approach

- Water Management agency determined a minimum flow to protect habitat would protect valued resources.
- Recommended a minimum flow level to maintain salinity levels for sensitive seagrass species.

Shell Point

Tampa Bay Area -Issues

- 6 streams and rivers feeding Tampa Bay
- 7 streams and rivers feeding Charlotte Harbor
- Enormous urbanization, channelization, loss of riparian habitat



Tampa Bay Area -Approach

- Created the “10% presumption rule” in late 1980’s.
  - Assumes water withdrawal will not cause unacceptable environmental impacts if it does not reduce the rate of daily flow by more than 10%.
  - Organisms move up as or down stream as flow rates decrease or increase so they are in synchrony with the dynamic nature of the habitats.
- Research show it is working, but needs refinement for drought periods.

San Francisco Bay, CA USA -Issues

- Decreased Sacramento-San Joaquin River system inflow led to decreased abundances of many biotic components, particularly five threatened or endangered fish species.

San Francisco Bay, CA USA -Approach

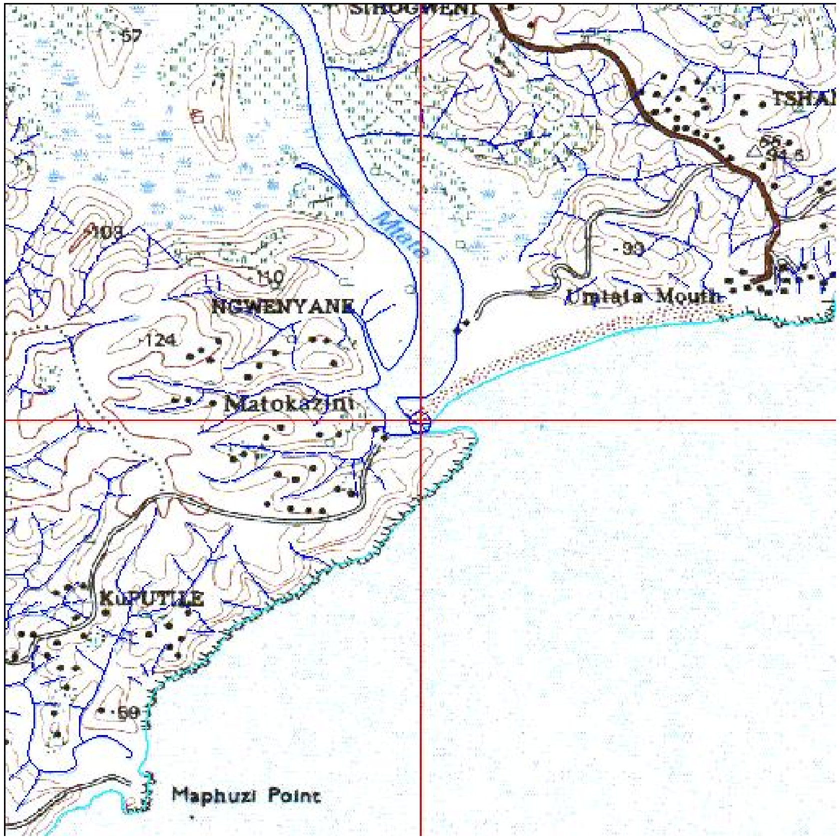
- Workshop convened in 1991:
  - Identified resource salinity ranges.
  - Relates inflow with salinity.
- Rule adopted in 1994 to ensure sufficient inflow to locate the 2 ppt isohaline downstream to enhance estuarine resources.

Mtata Estuary, South Africa -Issues

- 1998 National Water Act requires a reserve to satisfy basic human needs and to protect aquatic ecosystems.
  - Basic human needs reserve: right of every person to 25 liters of water of adequate quality per day.
  - The ecological reserve: To protect rivers, wetlands, estuaries and groundwater.

Mtata Estuary, South Africa -Issues

- Storage capacity is 50% of mean runoff and only 8% reaches the sea.



Mtata Estuary, South Africa -Approach

- Developed a 7-step process relying on value assessments (i.e., expert opinion) to set a minimum flow.
  - Geography, state, health, Reserve category, hydrology, monitoring.

Mtata Estuary, South Africa -7 Step Approach

1. Delineate geographical boundaries.
2. Ecoregional typing.
3. Assess present state and reference condition.
4. Determine present ecological status and importance using ecological health and importance indices.
5. Determine ecological management class
6. Set the quantity of the reserve and resource quality objectives.
7. Design resource monitoring program.

Mtata Estuary, South Africa -Approach

- Mtata had high scores because it was an Ecological Reserve so it has a high inflow requirement.

Australian National Program -Issues

- Laws requiring environmental flows to maintain health and biodiversity.
- Primarily state laws.
- Attempt to provide a consistent national approach.

Australian National Program -Approach

- Basis:
  - Check list of major ecological processes affected by flow to estuaries.
  - Adaptive management to assess risk associated with reduced flows.
- Two step methodology:
  - Preliminary Evaluation Phase.
  - Detailed Investigative Phase.

Australian National Program -Approach

- Preliminary Evaluation Phase:
  1. Define environmental flow issue.
  2. Assess estuary value.
  3. Assess flow changes.
  4. Assess estuary vulnerability.
- Detailed Investigative Phase:
  1. Model project impact on transport, mixing, quality, and geomorphology.
  2. Define environmental flow scenarios.
  3. Use models to assess impacts of scenarios.
  4. Assess biota risk.
  5. License and development approval.
  6. Adaptive Management.

Lessons learned

- Different approaches used everywhere:
  - Range from highly technical to highly value laden.
  - Valuing ecological services are the limiting factor, not data or technology.
- Emerging paradigms:
  - Ecosystem based management.
  - Adaptive management.

Is a generic science-based approach emerging?

- Start with management goals:
  - What is to be protected?
  - But constrained by local policies, laws, and regulations.
- Use the general resource management scenario:
  - Joint Ocean Commission recommends:
  - Ecosystem management (i.e., goals based on sustaining ecological services).
  - Adaptive management (i.e., monitor effects and reassess ecosystem services).

How are ecosystem services identified?

- Identify your estuarine typology and geomorphology, climate regime, and other physical characteristics.
- Identify your characteristic, charismatic or economically important resources at risk.
- Link resource protection to existing legal or management frameworks.

What kind of data is used?

- Physical data:
  - Long-term flow rates.
  - Size of rivers, streams, estuaries, bays.
  - Climate (rainfall and temperature) in watershed.
- Long-term health (i.e., state) of biological resources:
  - Space: Distribution of species or habitats.
  - Time: persistence over the long-term while controlling for natural variability and other stressors.

How are physical factors linked to biology?

- Can’t mechanistically relate inflow with biology.
- Identify salinity tolerances of the valued ecosystem components VEC’s.
- Define desired salinity regimes to sustain VEC’s.
- Relate salinity regimes to distribution of VEC’s.
- Identify minimum flow or elevation levels related to desired salinity regimes.

Texas policy context

- 1985, HB 2 requires: “maintain a sound ecological environment” in Texas bays and estuaries.
- 2001 HB 1629: “maintain the ecological health and productivity of the Matagorda Bay system.”
- 2003, SB 1639 requires: “provide for the freshwater inflows necessary to maintain the viability of the state's bay and estuary systems.”

So, what do these terms and phrases have in common?

- "…sound ecological environment…"
- "…ecological health…"
- "…viability of the bay and estuary systems…"
- "…productivity of a bay system…"

Are “soundness,” “health,” and “viability” really fluffy words?

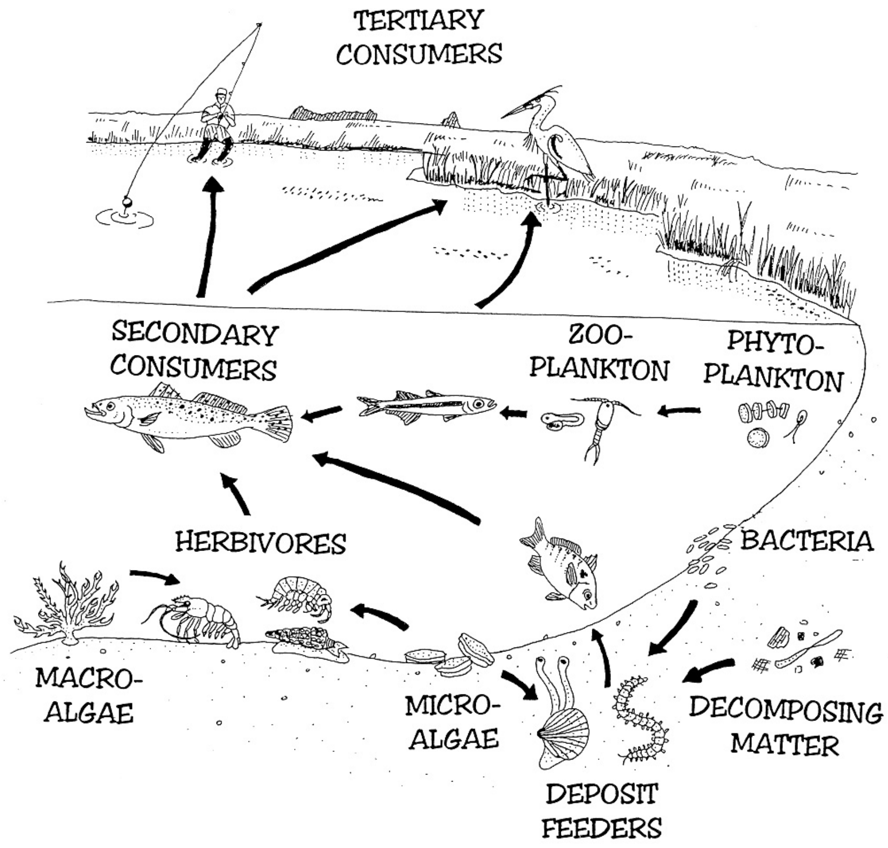
- NO!
- “Ecological Health” has been defined by scientists.
- The term is used by EPA and many others.
- Soundness and viability are the same thing as health.

Ecological health

- Ecological health is assessed by determining if **indicators** of ecological **conditions** are in an acceptable range.
- Indicators establish an acceptable range of responses across broad spatial and temporal scales.
- Condition is the status of ecological **function, integrity**, and **sustainability**.
- Function is acceptable when the ecosystem provides important ecological processes.
- Integrity is acceptable when biological diversity, species composition, structural redundancy, and functional processes are comparable to that of natural habitats in the same region.
- Sustainability is acceptable when an ecosystem maintains a desired state of ecological integrity over time.

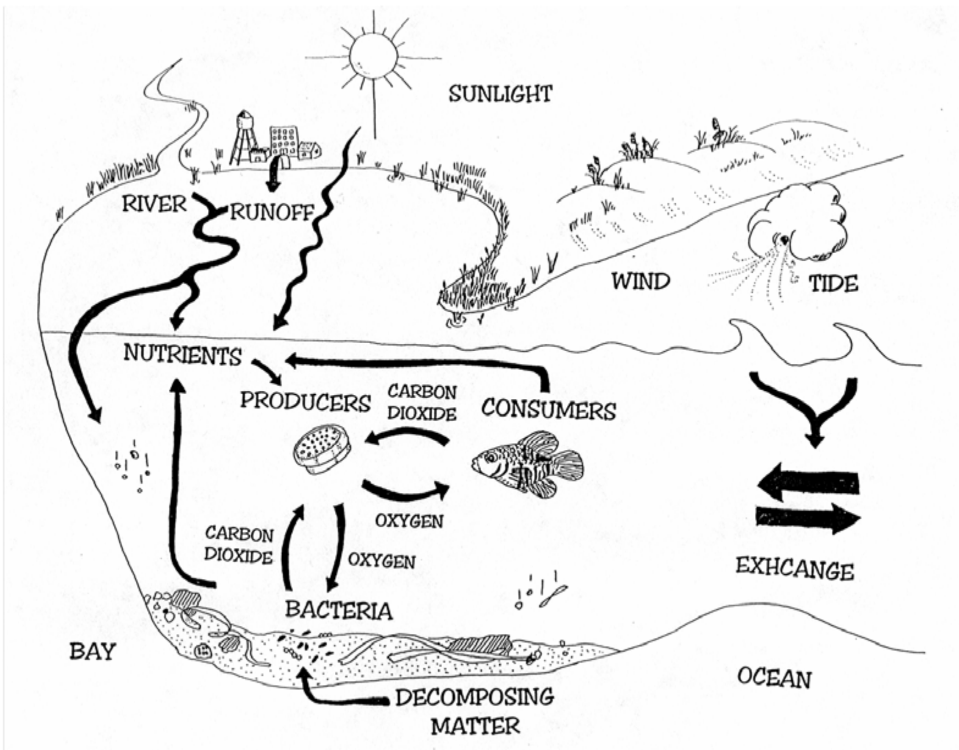
Ecological indicators that work

- Function
  - Ecological processes
    - Production, trophic links, reproduction
- Integrity
  - Community structure and biodiversity
    - Benthos, nekton, plankton
- Sustainability
  - Ecosystem services
    - Habitats, Habitats, Habitats



What is production?

- Mass per unit area (volume) per unit time
- Energy transformation
  - Follow the Sun
- Primary production by plants
  - Phytoplankton, seagrass, macroalgae, marsh
- Secondary production by animals
  - Microbes, benthos, plankton, nekton



Good (and not so good) indicators of production

- Biomass or standing stock change over time.
  - Good, but not perfect.
  - Mass per unit area (volume), so missing time.
- Harvest.
  - Not so good.
  - Effected mainly by regulation and economic conditions.

Measuring condition

- Understanding variability in space and time.
  - Long-term studies over regional scales.
- Distinguishing between natural and anthropogenic effects.
  - Comparison among systems with varying human influence.

Conclusions

- Science can inform policy.
  - Have to establish a norm or baseline.
  - Sustaining the norm (within the range of natural variability) is maintaining ecosystem health.
  - Lot's of ways to accomplish this.
  - However,
    - There is a continuum of salinity regimes and habitats.
    - There are lot's of different stressors out there.