Tampa Bay Tidal Tributary Research & Restoration Initiatives

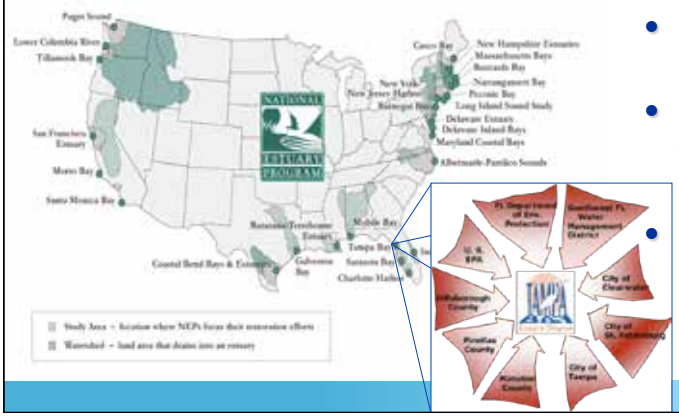
Ed Sherwood
Tampa Bay Estuary Program

Tidal Creek Summit
December 6, 2011

National Estuary Program (NEP)

28 Jewels in America's coastal necklace

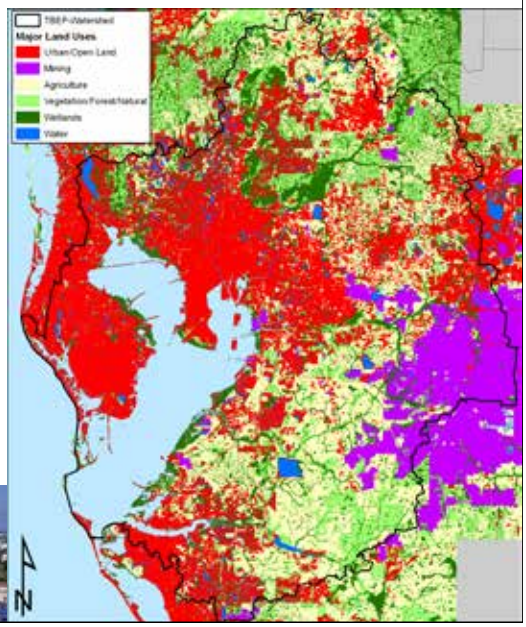
Local watershed programs making a difference



- Focus on the watershed or ecosystem
- Collaborative problem solving
- Integrate good science with sound decision making
- Public participation

Tampa Bay Watershed

- Urban Centers in Pinellas County & City of Tampa
- Agriculture / Mining Activities in Eastern Portion

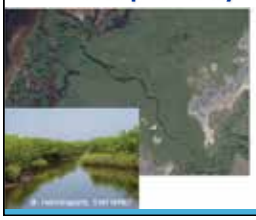


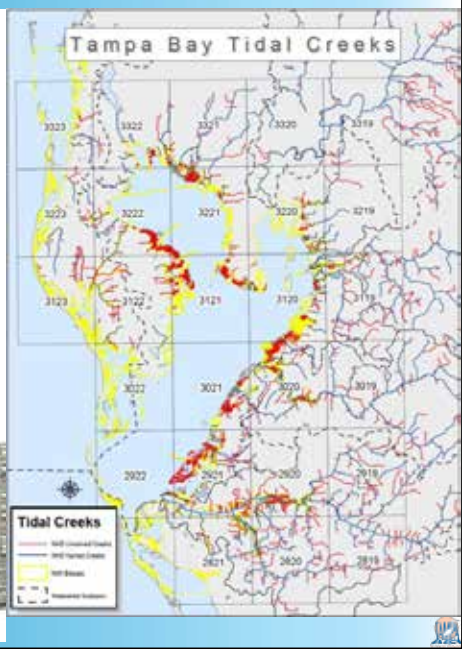
Overview

- Importance of Tidal Tributaries
- Previous & Ongoing Research Observations Related to their Abiotic & Biotic Conditions
- Factors to Consider for Restoration
- Management Actions & Initial Implementation

Focus on Tidal Tributaries

- There is extensive, long-term sampling of the bay and main stem of tidal rivers by several agencies
- Smaller, tidal tributaries were under sampled or missed entirely
- >100 Tidal Tributaries in Tampa Bay Watershed



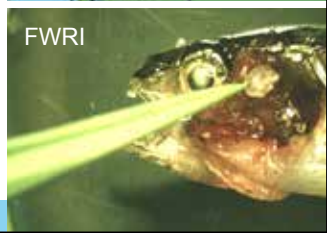


Estuarine Function of Tidal Tributaries

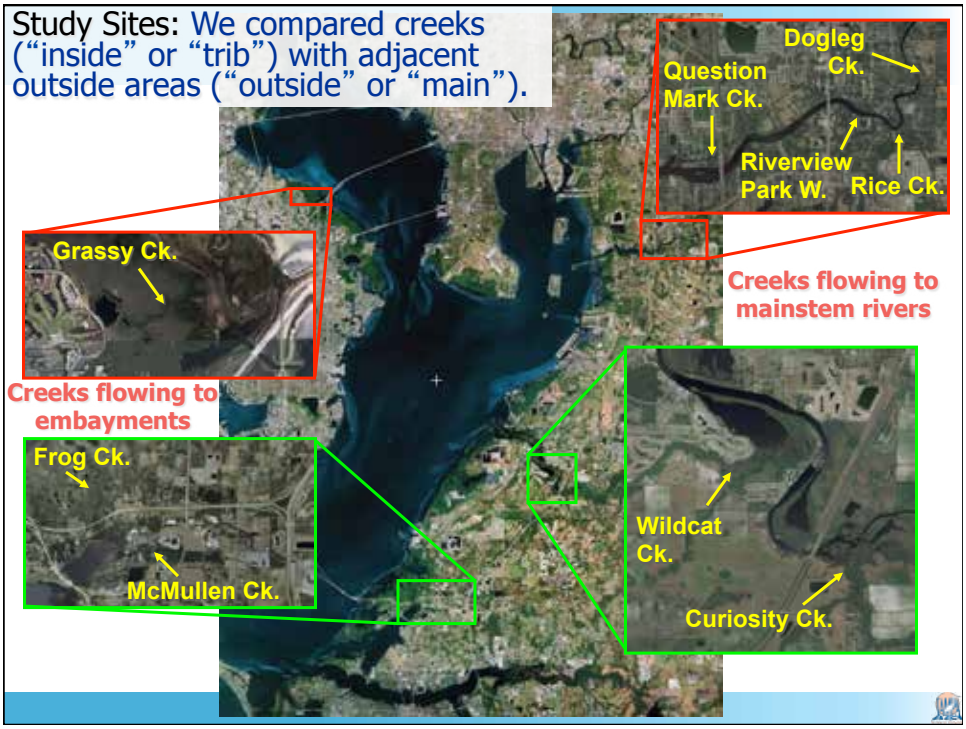
- Nutrient Processing – Unaltered tributaries may provide areas for tertiary nutrient treatment (intertidal sediments)
- Productive Nursery Areas & Refugia – Physical characteristics allow for predator avoidance (low D.O.' s, shallow depths, large salinity gradients)
- Sentinel Habitats – May be the first areas in the estuary to respond to watershed degradation

Research Initiatives in Tidal Tributaries

- 2006: TBEP & partners comprehensively evaluated 9 creeks
- 2005 – 2007: Fl. Fish & Wildlife Res. Inst. sample ~40 creeks
- 2009 – Present: USF-USGS fingerprinting fish nursery areas
- 2010 – 2012: Developing numeric nutrient criteria for tidal creeks

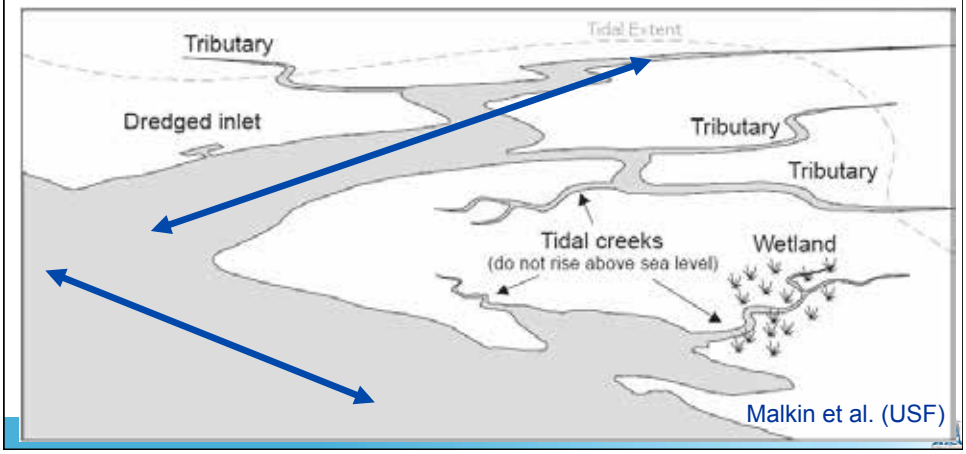


Study Sites: We compared creeks ("inside" or "trib") with adjacent outside areas ("outside" or "main").



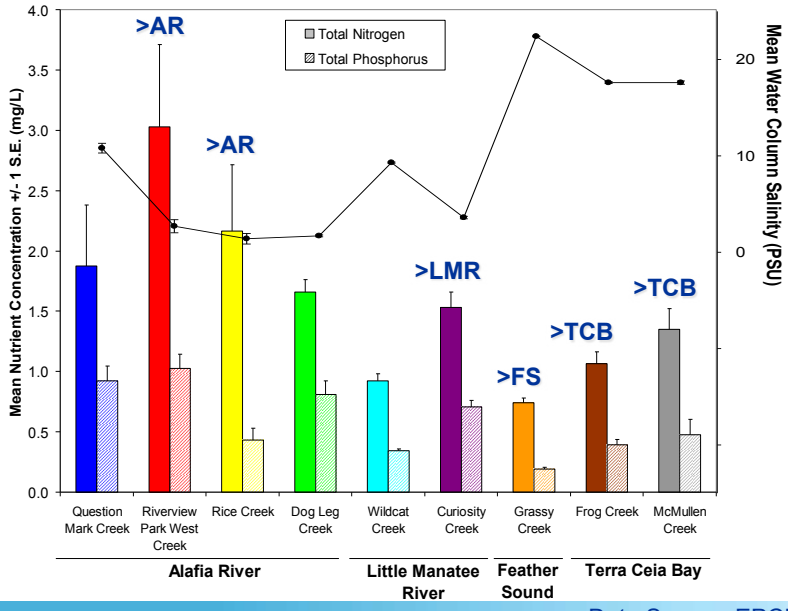
What We've Learned So Far:

- Tidal Tributary Types
  - Tributary
  - Creek
  - Dredged Inlet
- Distance from the bay's tidal extent strongly influences observed abiotic & biotic responses



Water Quality &
Primary Productivity
in Tampa Bay
Tidal Tributaries that
May Drive Higher Trophic
Level Observations

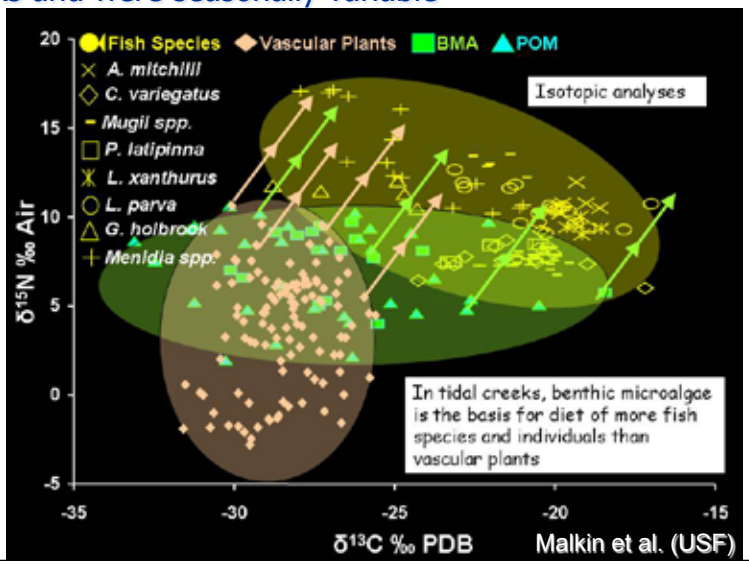
Salinity Affected Abiotic Measures



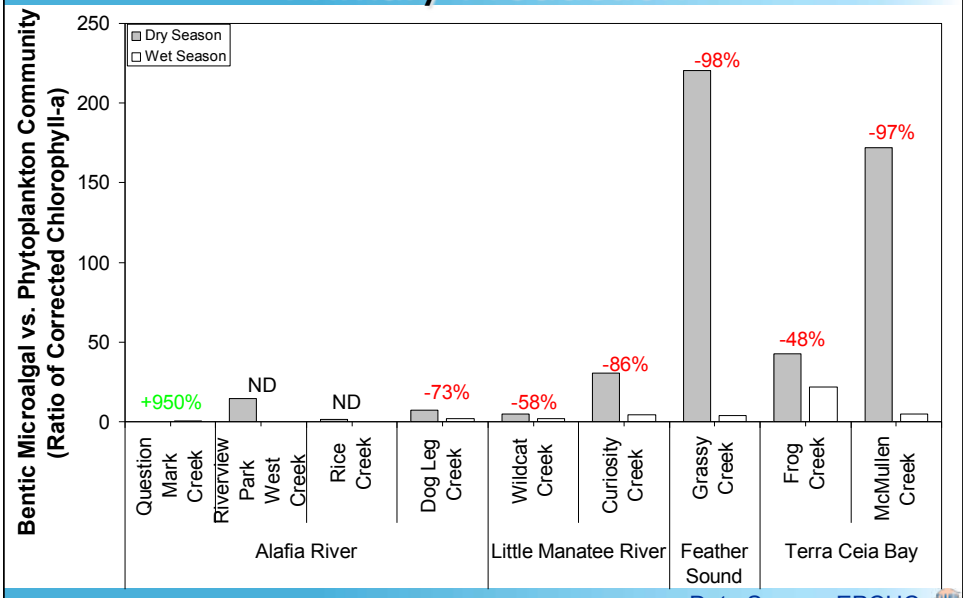
Data Source: EPCHC

Nitrogen Pathways Supporting Nekton

- Microalgae appeared to be a dominant food source in tidal creeks and were seasonally variable



Pronounced Seasonal Changes in Sources of Primary Production

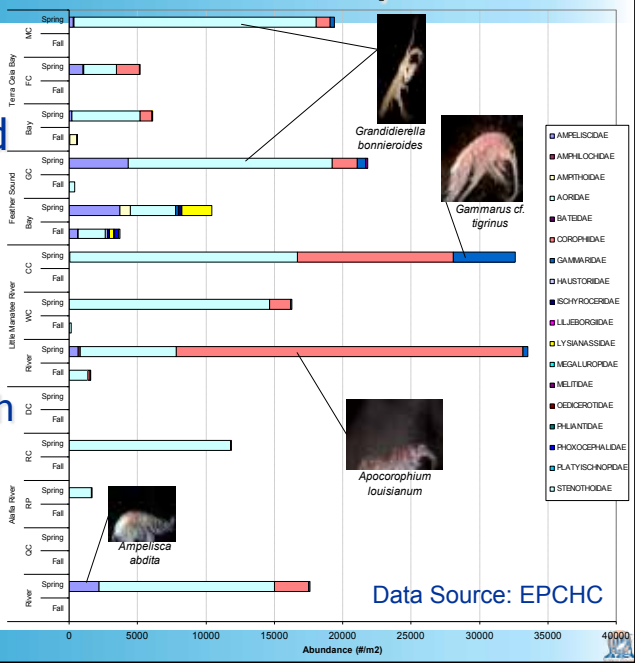


Data Source: EPCHC

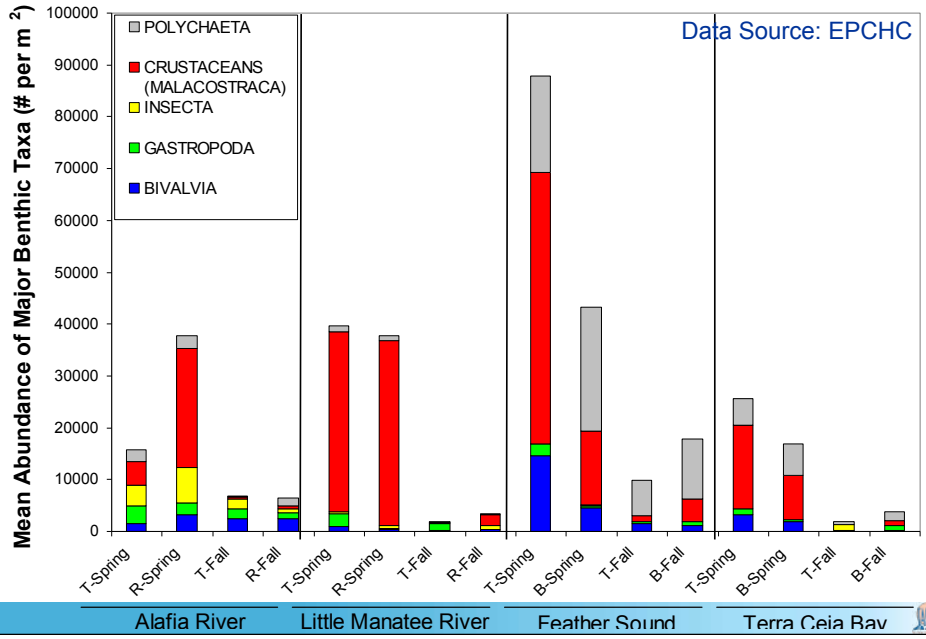
Benthic Infauna Observations in Tampa Bay Tidal Tributaries

Trophic Intermediates Seasonally Abundant

- Greater spring abundance of amphipods and mysids in all areas
  - Recruitment
  - Changes in water quality associated with inflow
  - Greater availability of benthic microalgae



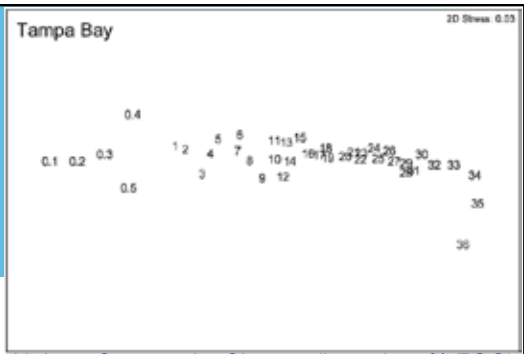
Benthos Seasonal Composition



Patterns of Nekton Utilization in Tampa Bay Tidal Tributaries

Change in Nekton Communities along Salinity Gradients in SW FL Estuaries

- Highlights estuarine continuum concept
- SW FL tidal creeks may fall anywhere along this entire gradient



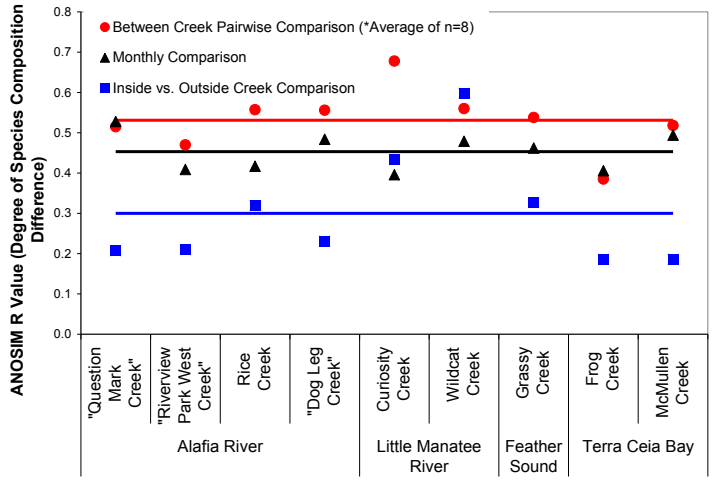
Nekton Community Change (based on % FOC)

Greenwood. 2007. Estuaries & Coast. 30(3):537-542.

Fish Communities Were Variable

- Variation in nekton community structure:

  Among Creeks > Month >> Inside vs. Outside Creek



Data Source: FWRI

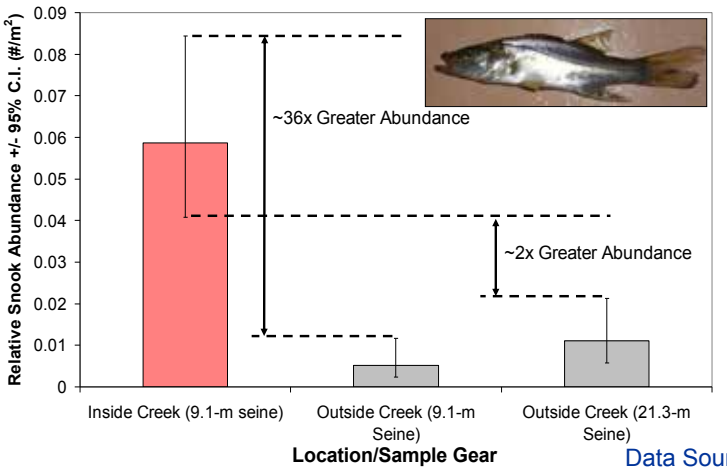
Common Nekton Species in Tidal Creeks

Taxa	Common name	Category
Palaemonetes spp.	Grass shrimp	Resident
Lucania parva	Rainwater killifish	Resident
Anchoa mitchilli	Bay anchovy	Transient
Menidia spp.	Silversides	Resident
Gambusia holbrooki	Eastern mosquitofish	Resident
Poecilia latipinna	Sailfin molly	Resident
Mugil cephalus	**Striped mullet**	**Transient**
Trinectes maculatus	Hogchoker	Transient
Cyprinodon variegatus	Sheepshead minnow	Resident
Microgobius gulosus	Clown goby	Resident
Eucinostomus spp.	Mojarras	Transient
Fundulus grandis	Gulf killifish	Resident
Gobiosoma bosc	Naked goby	Resident
Centropomus undecimalis	**Common snook**	**Transient**
Leiostomus xanthurus	**Spot**	**Transient**

MacDonald et al. 2010. BASIS 5 Proceedings. pp. 319-330.

Common Snook Use An Indicator of Health

- Juvenile common snook were much more abundant **inside creeks** than in adjacent **outside habitats**, and were rarely or never collected from some creeks. Absence of snook could indicate disturbance of a creek system.



Data Source: FWRI

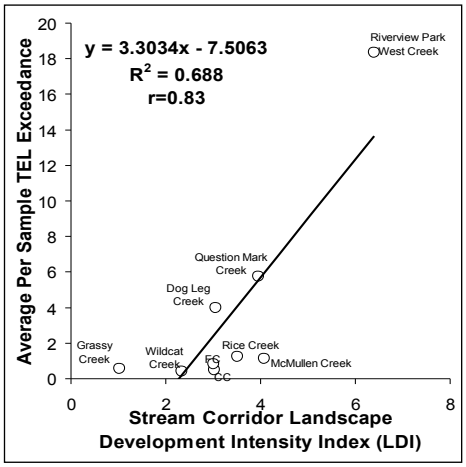
Attempts to Associate Tidal Creek Watershed/Shoreline Conditions to Abiotic & Biotic Observations

Watershed Characterization

- Two land use intensity/alteration indices were examined to determine the best overall empirical relationship with the available water and benthic quality data sources
- % Impervious Surfaces, 100-m Buffers/Sub-basin Level (Yang et al. 2003)
- Landscape Development Intensity Index, 100-m Buffers/ Sub-basin Level (Brown & Vivas 2005 [*Environ. Monit. Assess.* **101**, 289 -309])

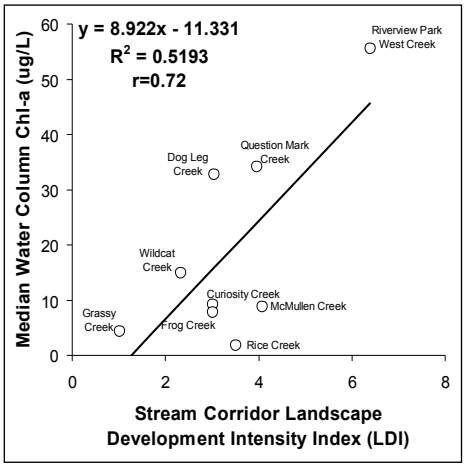
Abiotic–Landscape Associations Were Apparent

- A number of abiotic indicators of eutrophication & pollution increased with increasing landscape development intensity (LDI).



Sediment Relationships

Silt-Clay Percentage(+), Heavy Metals (+), PAHs (+), total PCBs(+), Pesticides (+)



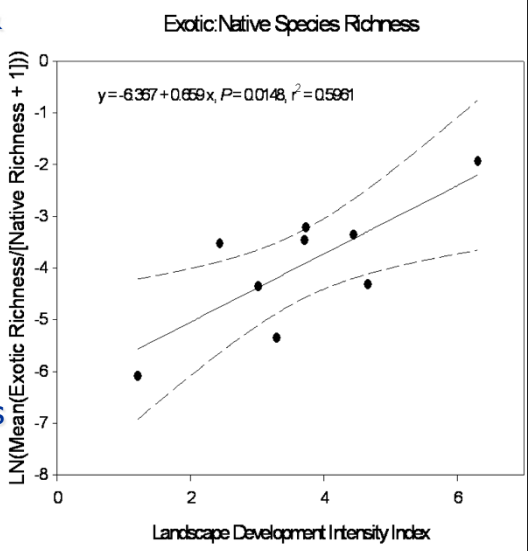
Water Quality Relationships

D.O.(+) ; Turbidity(+), Total N(+), Total P(+)

Data Source: EPCHC

Biotic–Landscape Associations Weak

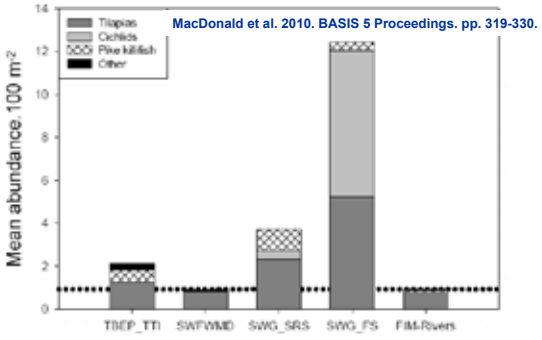
- Biotic measures (benthos & nekton species richness & abundance) did not correlate with LDI or % impervious cover.
- Exotic fishes possibly favored disturbed habitats.
- FWRI biologists proposed that inclusion of more strongly altered watersheds would have revealed stronger alteration-related responses by nekton.



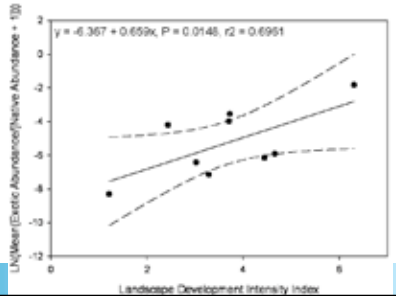
Data Source: FWRI

Exotic Nekton Species in Tidal Creeks

- More favorable habitats in tidal creeks?
- More altered creeks have greater abundance?
- Interspecific competition with juvenile snook?



MacDonald et al. 2010. BASIS 5 Proceedings. pp. 319-330.



Pike killifish

Progress from Additional Studies

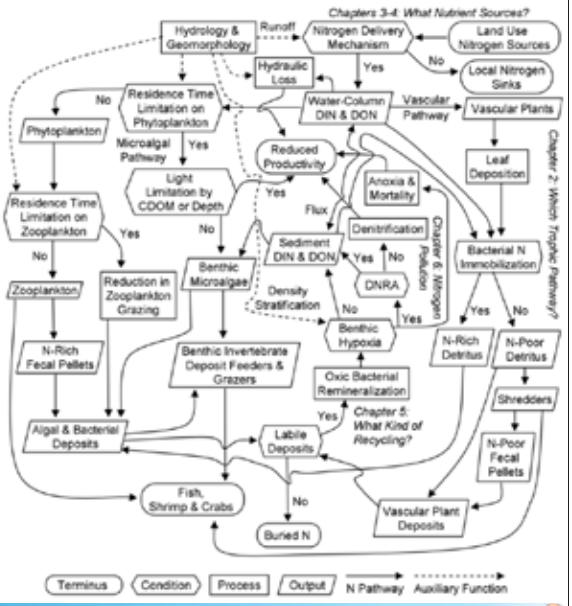
- Krebs 2011 – USF Ph.D. in progress
  - Nekton community structure different between "urbanized" & "non-urbanized" tidal creeks
    - Grass shrimp & economically important species nearly absent or in lower abundance
    - Skewed towards higher Poeciliid fish abundances
      - "Typical" tidal creek species in low abundance (*Menidia* spp., *Fundulus grandis, Adinia xenica*)
  - Nekton fitness reduced in "urbanized" tidal creeks
    - 6 of 9 common taxa had lower body mass
    - Grass shrimp fecundity reduced

Progress from Additional Studies

- Krebs 2011 – USF Ph.D. in progress
  - Characteristics of the "urbanized" creeks Explained 48% of the variation in nekton data using CCA
    - A priori selected for higher LDI
    - Greater impervious surface area
    - Less natural mangrove shoreline
    - Higher frequency of hypoxia
    - Lower, more variable salinities

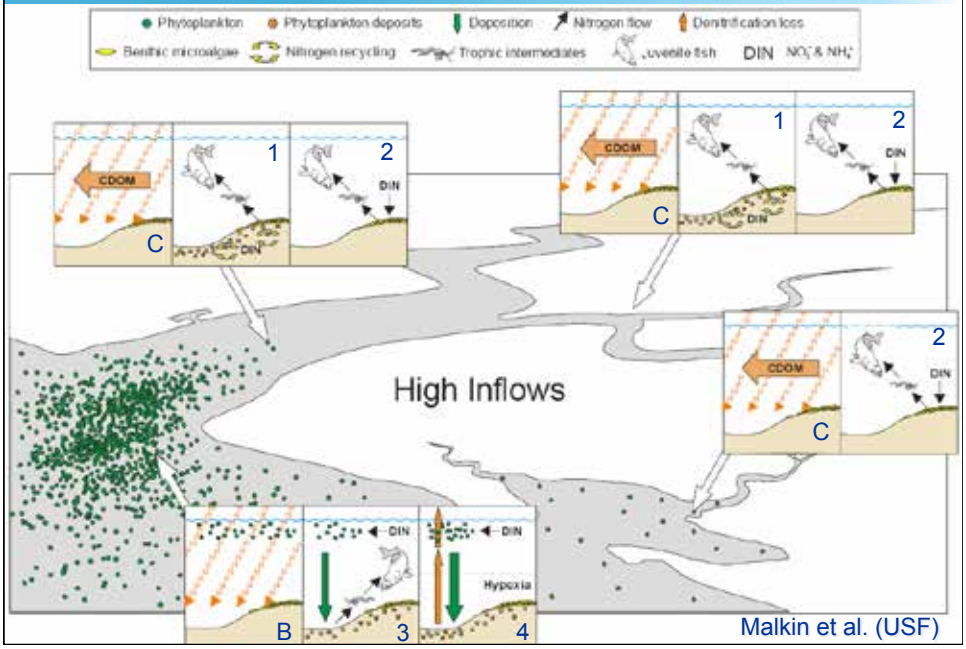
Nitrogen Pathways in Fish Nursery Habitats

- Explored "Nitrogen Delivery Mechanisms" of tidal creek watersheds and other fish nursery habitats
- Connectivity of watershed LUs to fish production / biomass – Management of Agricultural & Urbanized Watersheds



Malkin, E. 2010. USF Ph.D. Dissertation.

Estuarine Linkages Under Varying Inflows



Malkin et al. (USF)

Tidal Tributary Stressors / Biological Response

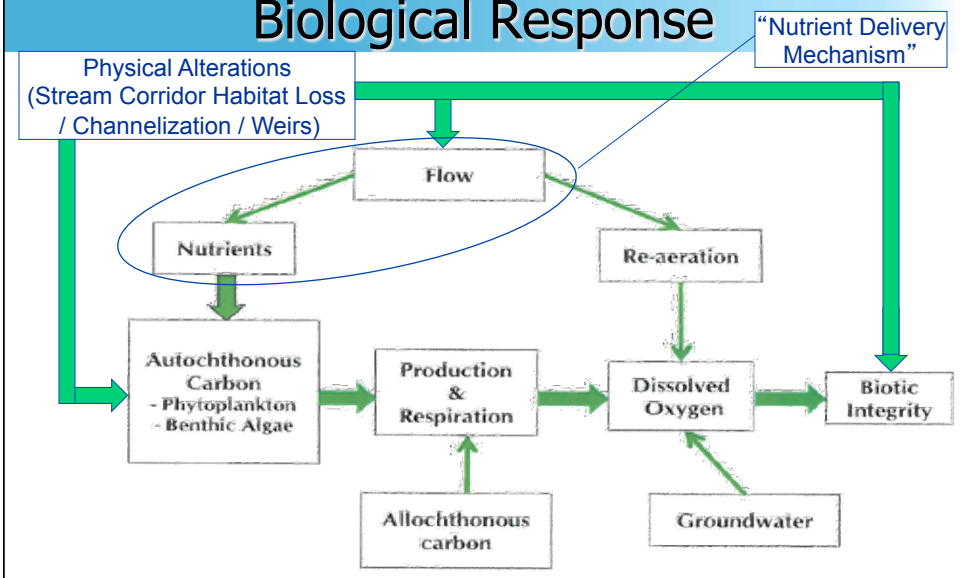


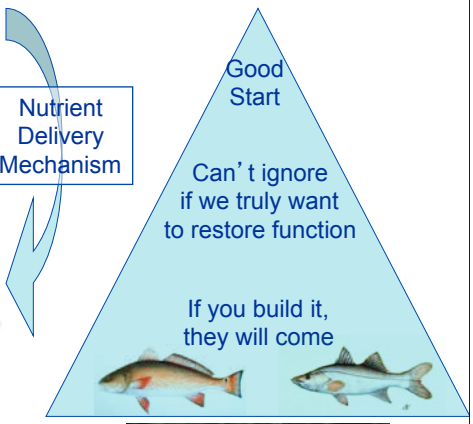
Figure 1. Conceptual diagram depicting the relationships among water-quality parameters and physical factors that influence the biotic integrity of aquatic systems. Large arrows identify the key relationships that can be used to identify strategies to completely restore tidal creek biotic function.

Factors to Consider For Restoration

- Physical alterations to a tidal creek that influence ecosystem processes
  - Shoreline cover/riparian buffers
  - Channelization/artificial deepening
  - Changes in "nutrient delivery" and cycling dynamics
  - Connectivity → truncating tidal extent / watershed inputs
- Collectively, these factors influence the "expression" of abiotic and biotic indicators in tidal creek ecosystems

Keeping the End Goal in Mind

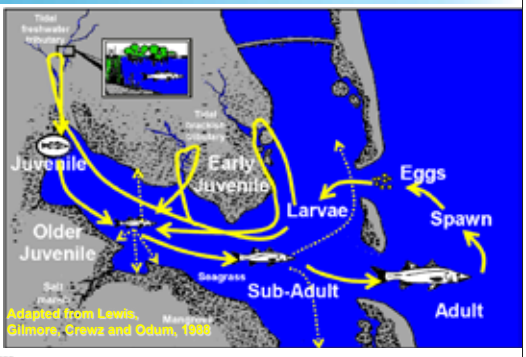
- Nutrient-criteria development
- Habitat / hydrologic restoration
- Fish and Wildlife Use / Production
- Other intangible ecosystem services

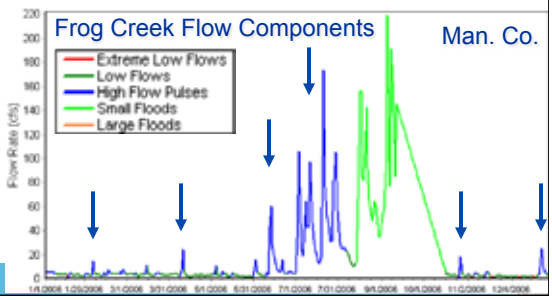


Moving Forward in Protecting and Restoring Tampa Bay Tidal Tributaries

Key Management Actions

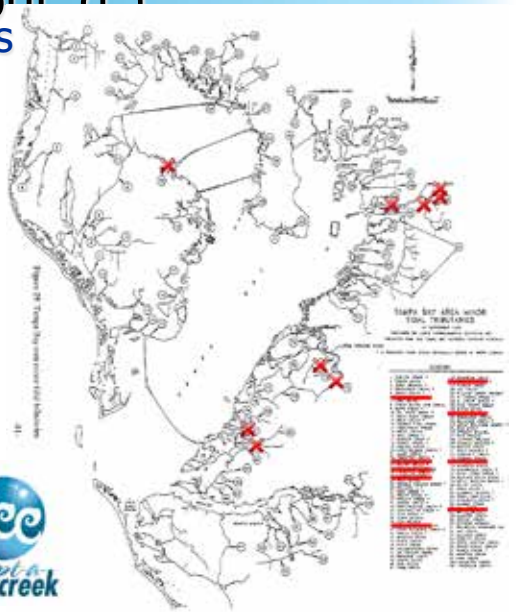
- Maintaining system connectivity to promote nutrient flux, water flow, and fish movement
- Reducing "flashiness" of water flow to tidal tributaries





Resulting Management Actions (cont'd.)

- Tracking uniqueness of Tampa Bay tidal tributaries (we've studied 9 of the 100+)
- Improving public education & stewardship of tidal tributaries

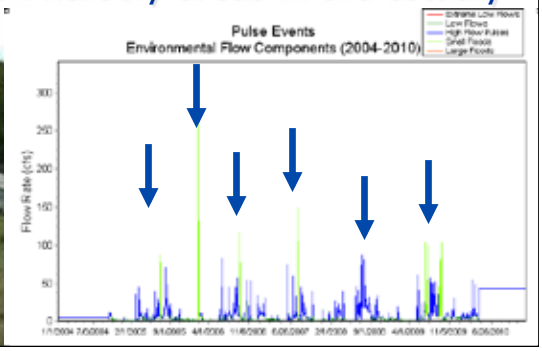


Initial Products

- Technical Summary Document
  - Individual Technical Reports
  - QA Plan
  - Associated Databases
  - Additional Analyses
- 4-Page Full Color Newsletter for General Audience
- http://www.tbeptech.org

Implementing Management Actions

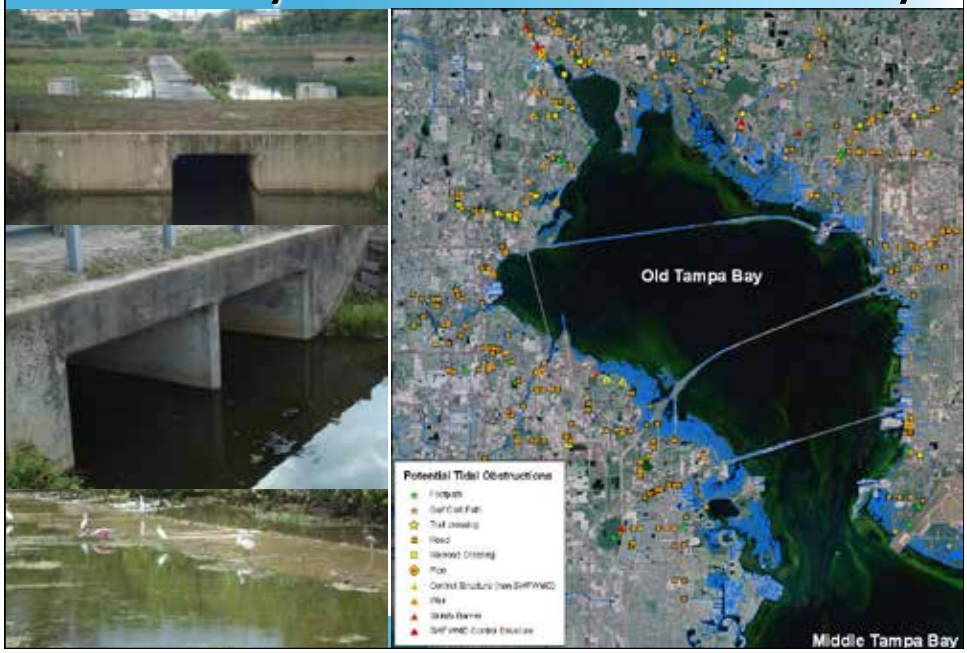
- 2010 Salinity-Barrier Removal Feasibility Project
  - Leveraging funds from USFWS, SWFWMD, NOAA
  - Restore estuarine connections in tidal tributaries
  - Improve natural hydrology of "dammed" systems
  - Restore and enhance oligohaline habitats
  - Provide additional fish nursery areas in the estuary



Pilot Tidal Tributary Restoration Project

- Survey & determine location of salinity impediments within Tampa Bay tidal tributaries
- Determine feasibility and implications of removal with respect to other habitat restoration opportunities and impacts to adjacent land uses
- Pursue pilot removal / restoration project (2012-2013)

Inventory of Structures Underway



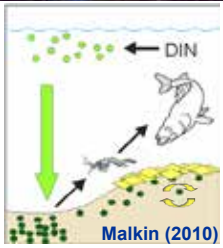
Conceptual Restoration Results

Thanks to All Partners Along the Way

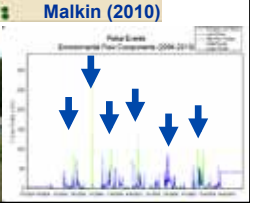
Sampling Considerations

- Accessibility / Logistics
  Considering the entire gradient

- Importance of benthic primary production processes & dynamics coupled with water-column production



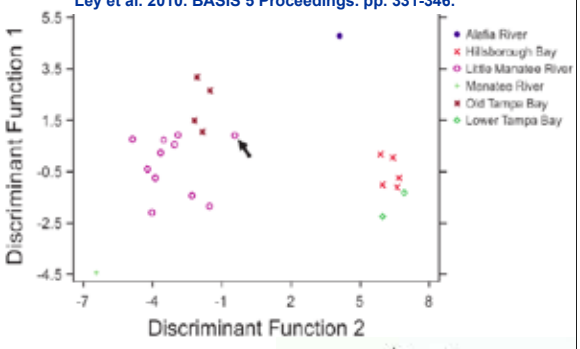
- Diurnal, seasonal & flow-dependent sampling



In Progress: Fingerprinting Key Nekton Habitats FWRI-USF-USGS Study (2009-12)

- Otolith microchemistry of 19 elements
- Refining analyses to be able to discriminate down to individual tidal creek systems
- Juvenile snook and red drum

Ley et al. 2010. BASIS 5 Proceedings. pp. 331-346.



Benthic Macrofauna Summary

- Species Richness & Abundance > in Spring vs. Fall for all areas
- Seasonal Differences in Species Composition
  - High abundance of crustaceans in spring
  - Freshwater/Low Salinity Taxa became more prevalent in Fall
    - Insect Larvae
    - Molluscs
  - Polychaetes more prevalent in creeks draining to Feather Sound & Terra Ceia Bay
- Two known exotics identified
  - Alafia River Basin
    - Asian Clams (*Corbicula fluminea*)
      - Rice Creek
    - Red-rim melania snail (*Melanoides tuberculatus*)
      - Question Mark Creek

Project Partners

TAMPA BAY WATER

Project Management
Holly Greening, Tampa Bay Estuary Program

Database Management, GIS and Quality Assurance
Greg Blanchard, Manatee County Environmental Protection Division
Kathleen O' Kiefe, FFWC Fish and Wildlife Research Institute

Water and Benthic Quality, Watershed Characterization and Assessment
Ed Sherwood, Environmental Protection Commission of Hillsborough Co. (now with the Tampa Bay Estuary Program)
Gerold Morrison, EPCHC (now with Terra Ceia Consulting, LLC)
Eric Fehrmann, Pinellas Co. Department of Environmental Management
Andy Squires, Pinellas County Department of Environmental Management
Mark Flock, Pinellas County Department of Environmental Management
Greg Blanchard, Manatee County Environmental Protection Division
Bob McConnell, Tampa Bay Water

Fish and Fish Habitat Characterization
Marin Greenwood, FFWC Fish and Wildlife Research Institute
Bob McMichael, FFWC Fish and Wildlife Research Institute
Tim MacDonald, FFWC Fish and Wildlife Research Institute
Ed Matheson, FFWC Fish and Wildlife Research Institute
Frank Courtney, FFWC Fish and Wildlife Research Institute
Justin Krebs, US Geological Survey
Carole McIvor, US Geological Survey

Fish Diet and Food Source (isotopic analyses)
Bob McMichael, FFWC Fish and Wildlife Research Institute
Ernst Peebles, Univ. of South Florida College of Marine Sciences
David Hollander, Univ. of South Florida College of Marine Sciences
Elon Malkin, Univ. of South Florida College of Marine Sciences

Interpretation and Management Strategy
Holly Greening, Tampa Bay Estuary Program
Lindsay Cross, Tampa Bay Estuary Program
Ed Sherwood, Tampa Bay Estuary Program

Project Objectives

Improve protection and management of fish populations in the Tampa Bay system by:

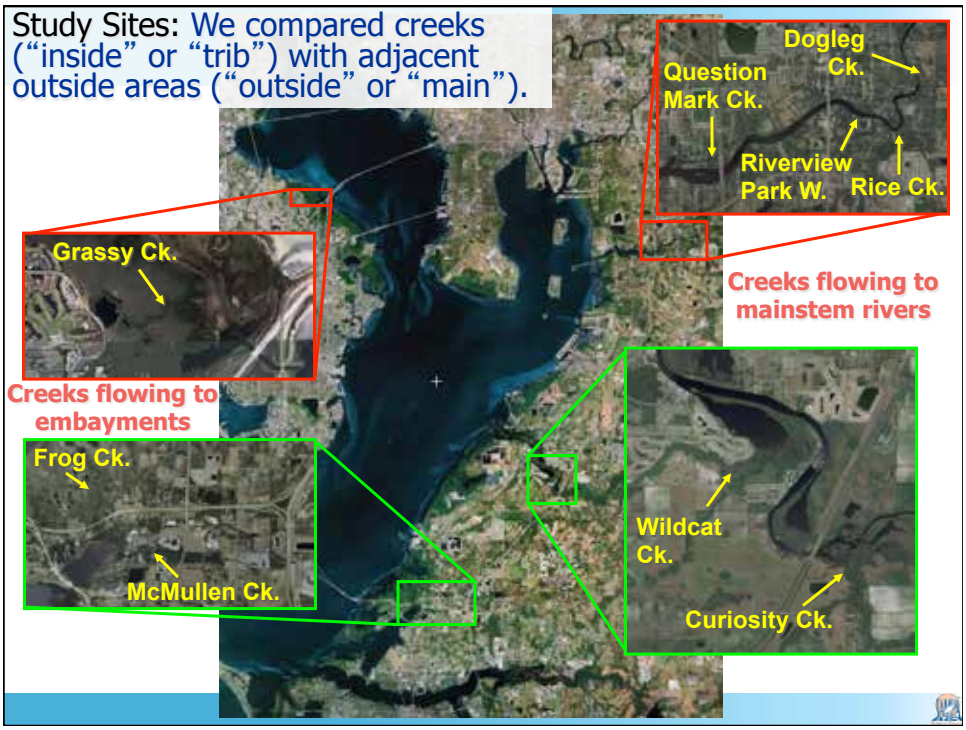
1) Determining the relative importance of tidal tributaries as fish habitat in Tampa Bay;

2) Determining effects of habitat parameters (watershed condition, water quality, structural habitat) on fish habitat use in impacted and unimpacted tidal tributaries.

Project Objectives (cont' d.)

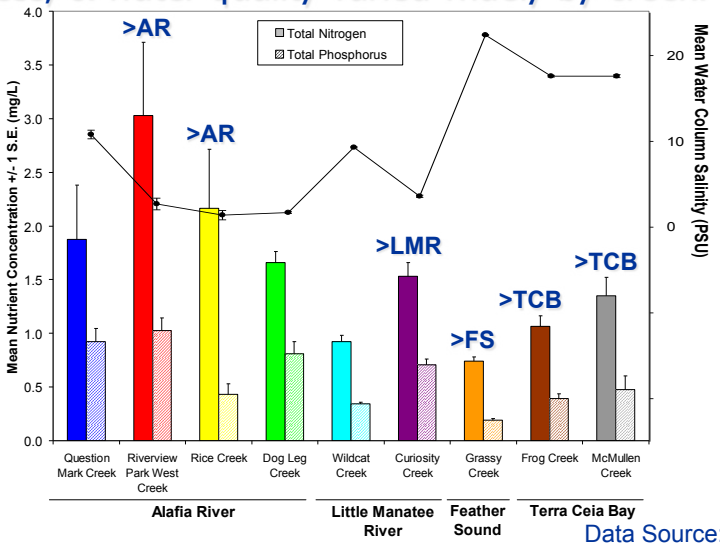
3) Developing measurable goals, management recommendations, and a pilot Tidal Tributaries Management Strategy based on study results;

4) Communicating results to managers and the public to support informed decision-making regarding preservation or restoration of tidal tributary habitats.



Variability in Biotic & Abiotic Measures

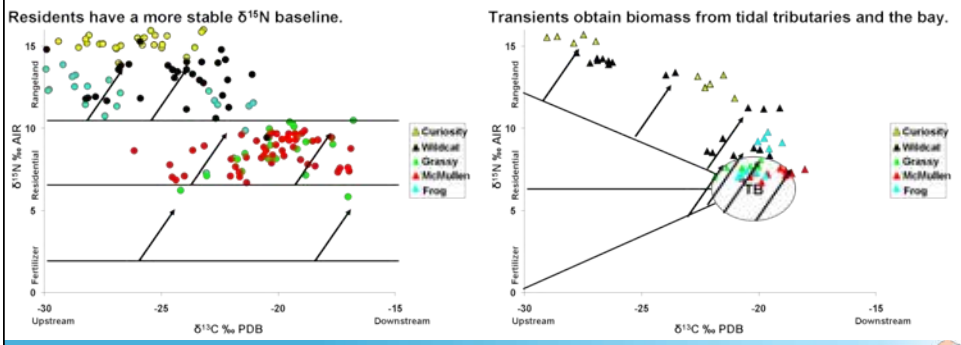
- Nekton & benthos abundance, nekton & benthos richness, & water quality varied widely by creek.



Data Source: EPCHC

Nitrogen Pathways Differed Between Resident & Transient Nekton

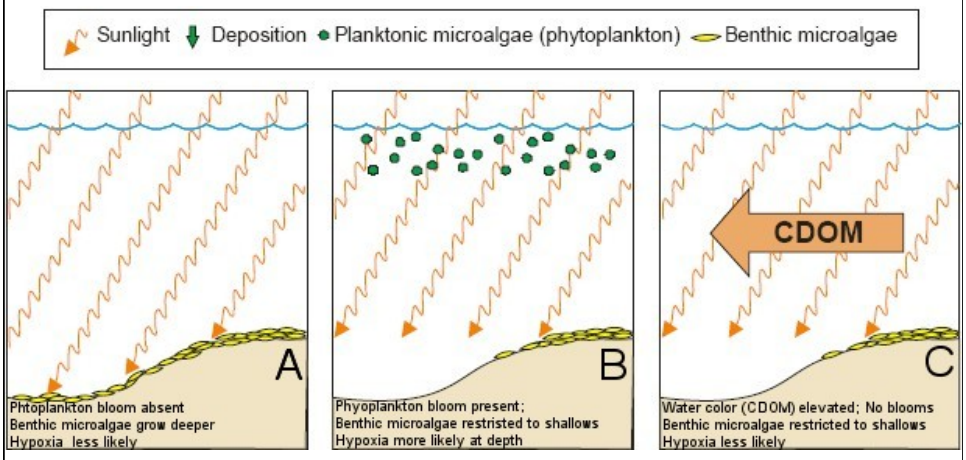
- Fish isotopes varied in a predictable manner among creeks; some species appeared to have highly localized habitat fidelity, whereas others had recently spent time outside the creeks.



Peebles et al. (USF)

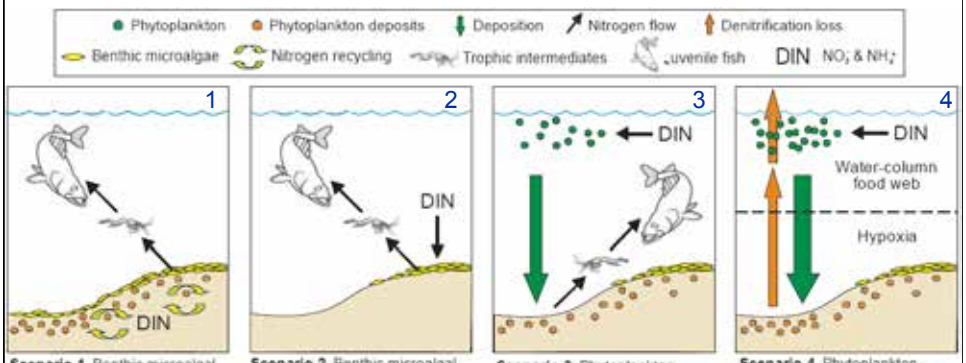
Synthesis of Tidal Tributary Processes

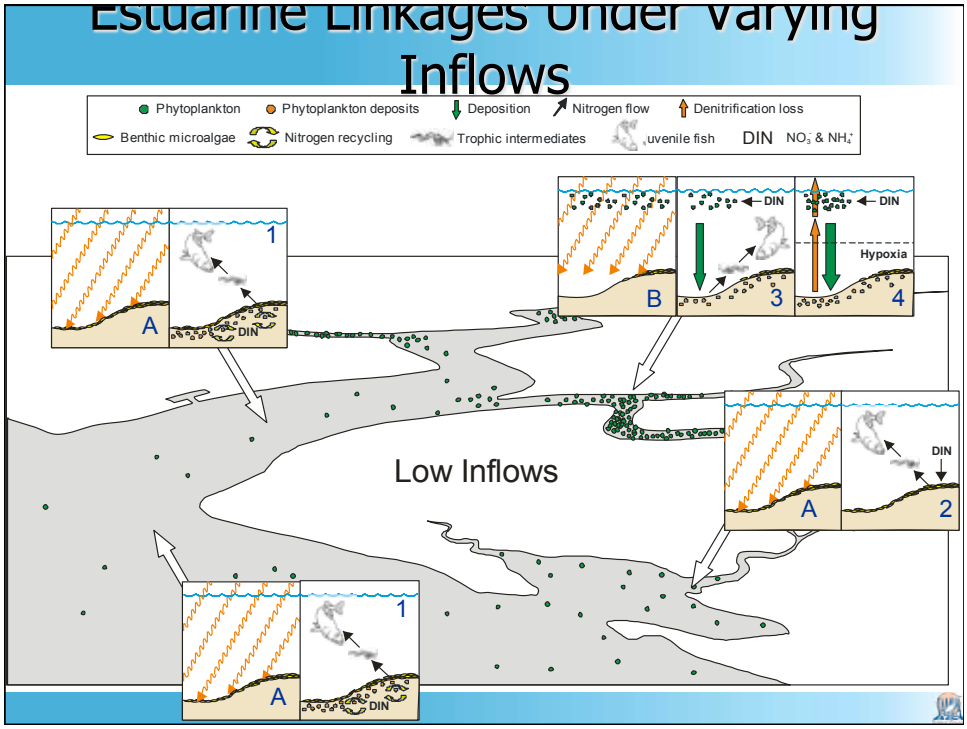
- Primary Production Pathways

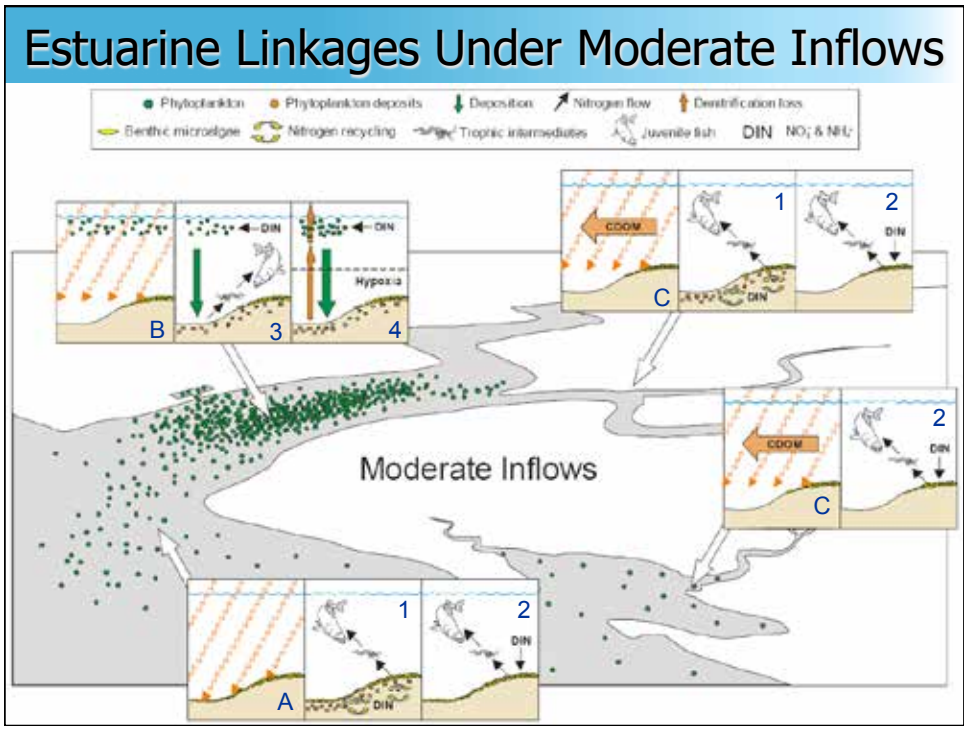


Synthesis of Tidal Tributary Processes

- Major Trophic Linkages




Estuarine Linkages Under Varying Inflows
Phytoplankton
Phytoplankton deposits
Deposition
Nitrogen flow
Denitrification loss
Benthic microalgae
Nitrogen recycling
Trophic intermediates
Juvenile fish
DIN
NO3 & NH4
A
1
DIN
B
3
4
DIN
DIN
Hypoxia
Low Inflows
A
2
DIN
A
1
DIN


Estuarine Linkages Under Moderate Inflows
Phytoplankton
Phytoplankton deposits
Deposition
Nitrogen flow
Denitrification loss
Benthic microalgae
Nitrogen recycling
Trophic intermediates
Juvenile fish
DIN
NO3 & NH4
B
3
4
DIN
DIN
Hypoxia
CDOM
C
1
2
DIN
DIN
Moderate Inflows
CDOM
C
2
DIN
A
1
2
DIN
DIN

Estuarine Linkages Under High Inflows