Temporal & spatial dynamics in the fish community of marsh-mangrove ecotonal habitats

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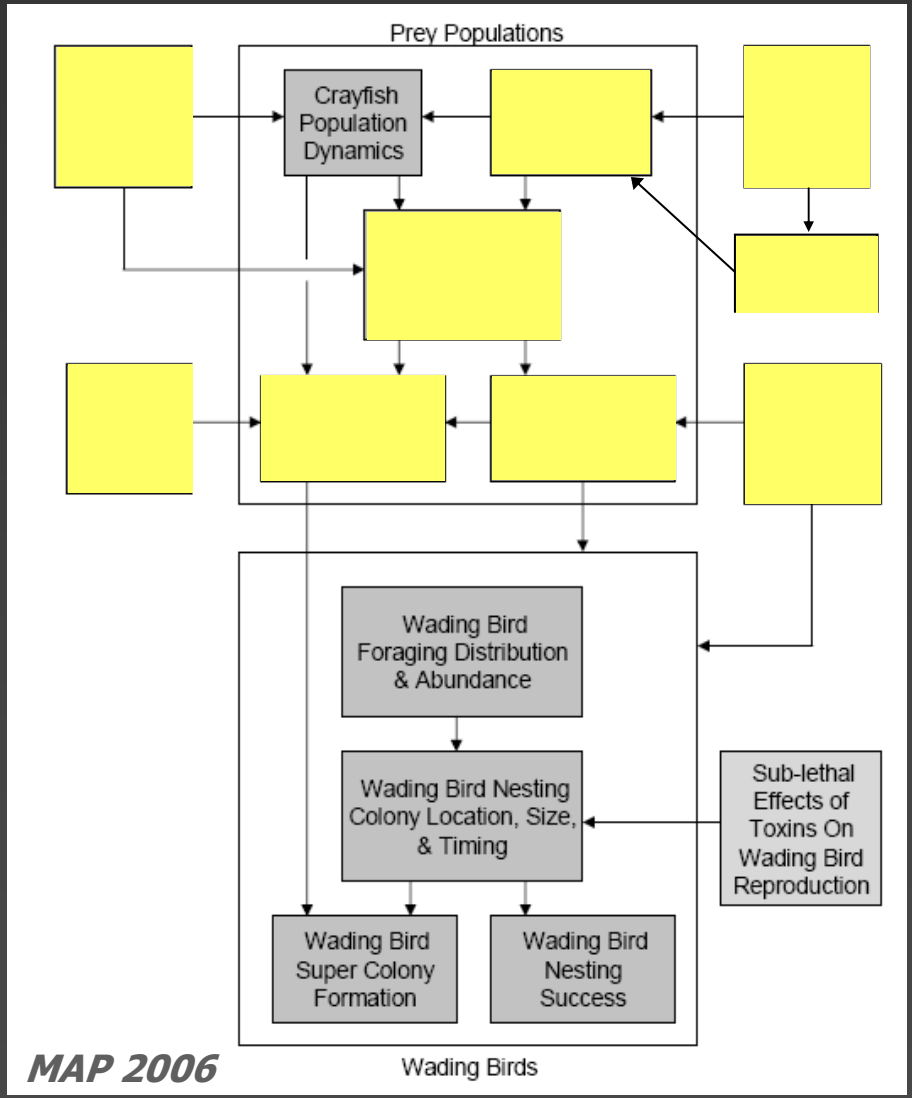
Trophic Hypotheses for Everglades Restoration

- Wading bird foraging & breeding success is strongly affected by:
  - Prey population sizes
    - Wet season water levels
    - Time since last dry-down
    - Salinity
  - Seasonal concentrations of prey
    - Microtopography
    - Recession pattern



Gawlik 2002, Lorenz 1999, Trexler et al. 2005

In a seasonally flooded wetland…

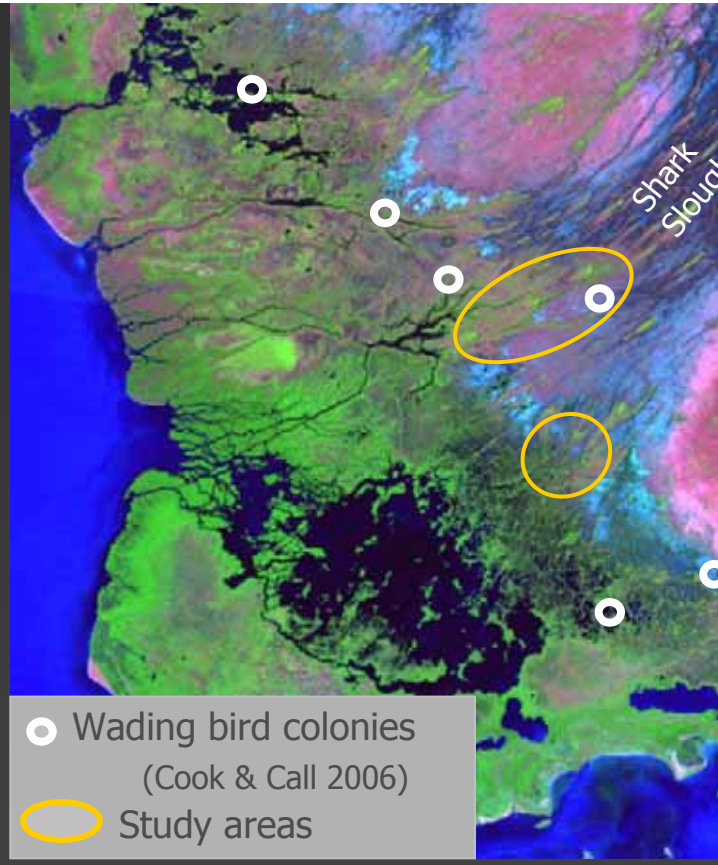
- Inundation fluctuates seasonally
  - Thus, amount & quality of fish habitat also fluctuate
- Recurrent dry-down structures fish community
  - Limits the abundance (predators)

  (Loftus & Eklund 1994, Ruetz et al. 2005, Trexler et al. 2005)
- Fish respond to dry down by dispersing into deep-water habitats

  (Nelson & Loftus 1996, Kobza et al. 2004, Rehage & Trexler 2006, Rehage & Loftus 2007)

Marsh-mangrove ecotone

- Freshwater marshes transition into an extensive region of tidal mangrove forest
- Historically, important wading bird habitat
  - Coastal nesting may be an important indicator of restoration
- Mangrove-lined creeks link marshes to coastal habitats
  - Provide deep-water habitat for an dynamic & understudied fish community
    - Estuarine residents
    - Marine transients
    - Marsh species



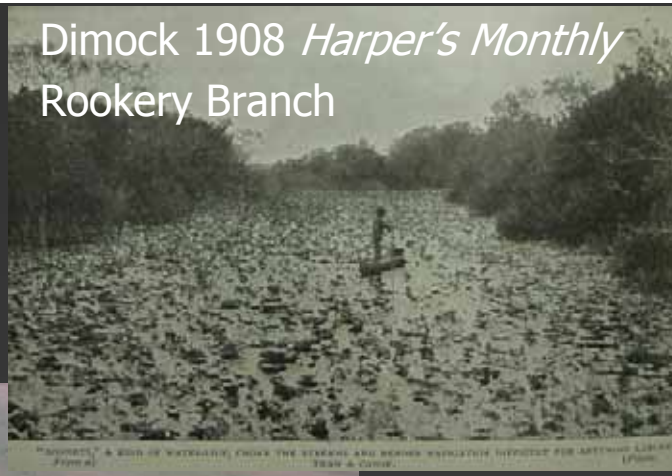
Ecotonal creeks as fish habitat

- Reductions in freshwater inflow have resulted in:
  - Higher salinity
  - Higher frequency of marsh drying
  - Changes in habitat structure

How do these factors affect the use of creeks by fishes, particularly by wetland species?

How do they affect their availability to wading birds?

How will this fish community respond to increased freshwater inflow?

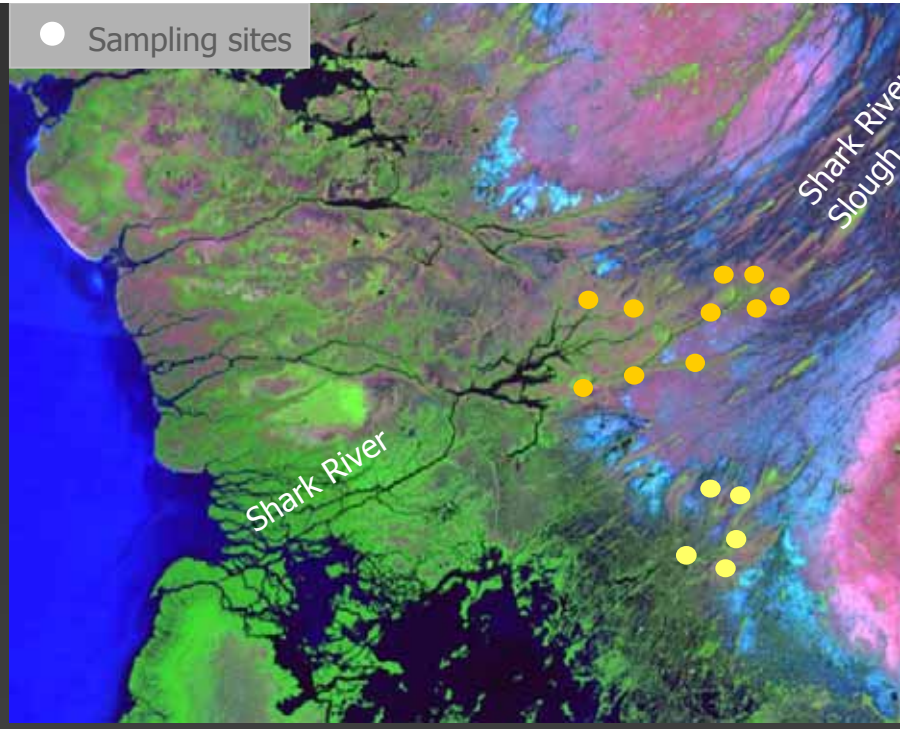

Dimock 1908 *Harper's Monthly*
Rookery Branch

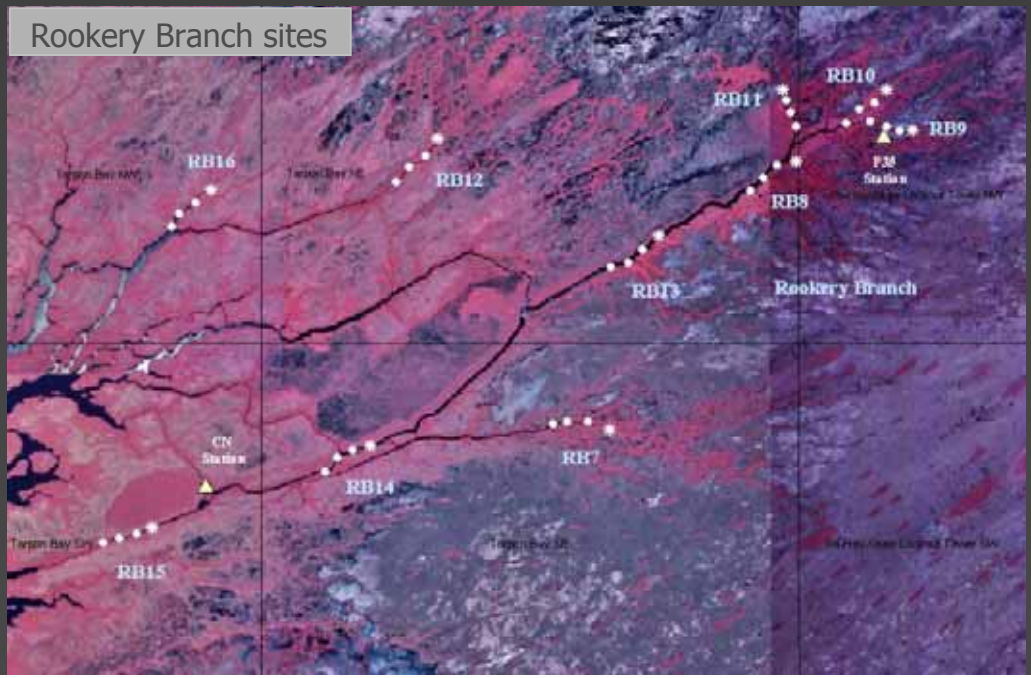

D. Green

Sampling effort

Focused on creek channels at ecotone, targeting both large fishes & prey species:

- 4 years of data
- 2 drainages, 15 sites
  - 10 in Rookery Branch
  - 5 in North & Roberts Rivers
- Sample 3 times per year
  - Nov-Dec = wet season
  - Feb-Mar = transition
  - April-May = dry season





Large-fish sampling

Boat-mounted electrofishing unit

- Gather data on game & non-native species
  - Limited understanding of what drives their distribution & abundance
- Multiple bouts per creek with standardized power
  - 37 species, 8,770 fish (n = 474 samples)

Gar 28 %

Sunfishes 12 %

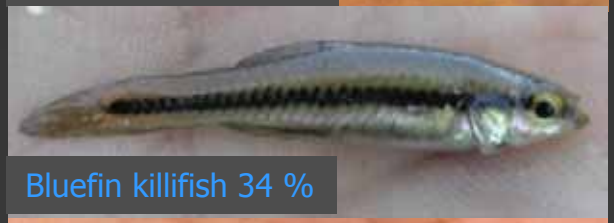
Snook 11 %

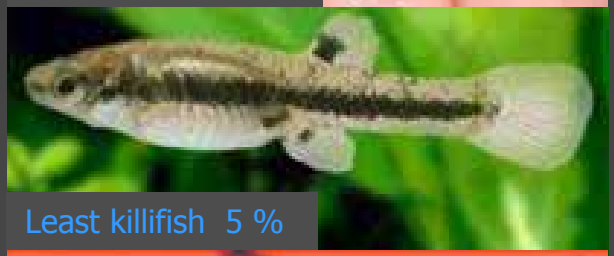
L. bass 8 %

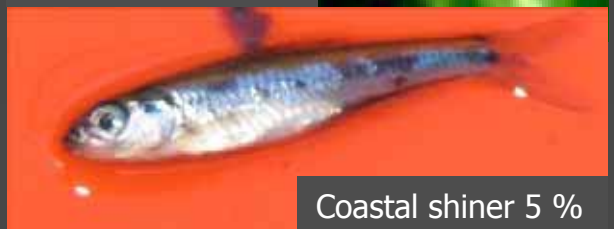
Striped mullet 5 %

Mayan cichlid 4 %

Small-fish sampling







- Deployed overnight in pairs attached to mangrove proproots (1 in. opening)
- Multiple pairs per creek (n = 740 samples)
  - 32 species, 9,246 fish

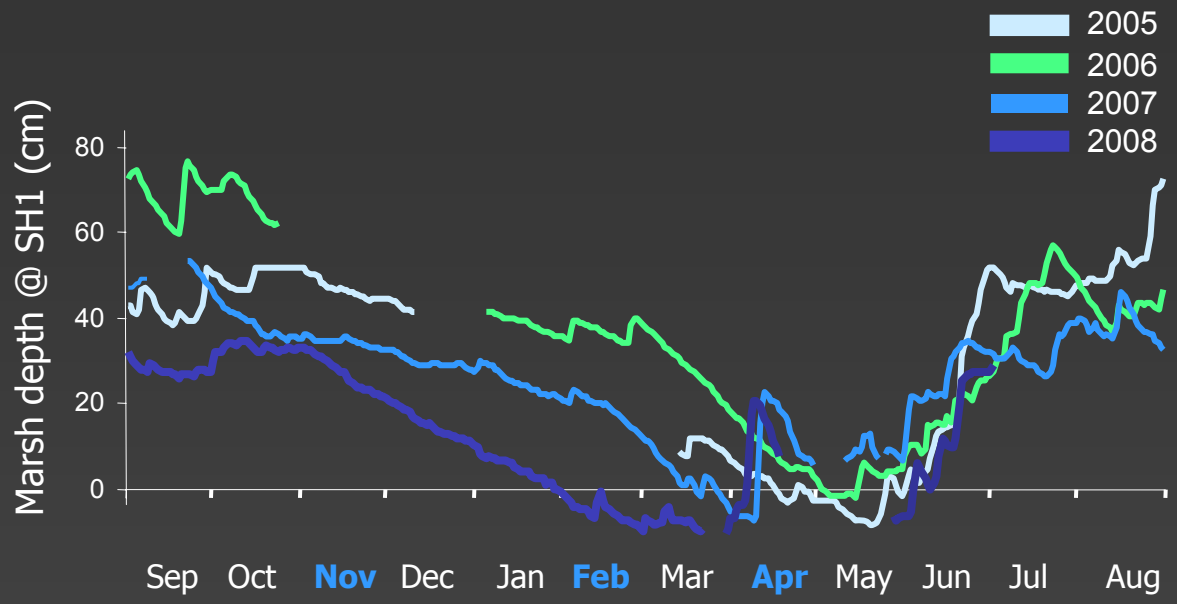
Specific questions

1. What is the pattern of seasonal variation in fish catches with relation to the timing of marsh drying?
2. How do catches vary across years with varying dry-down severity?
3. What is the contribution of the freshwater taxa?
4. How does variation in catches relate to variation in hydrological & physicochemical parameters?

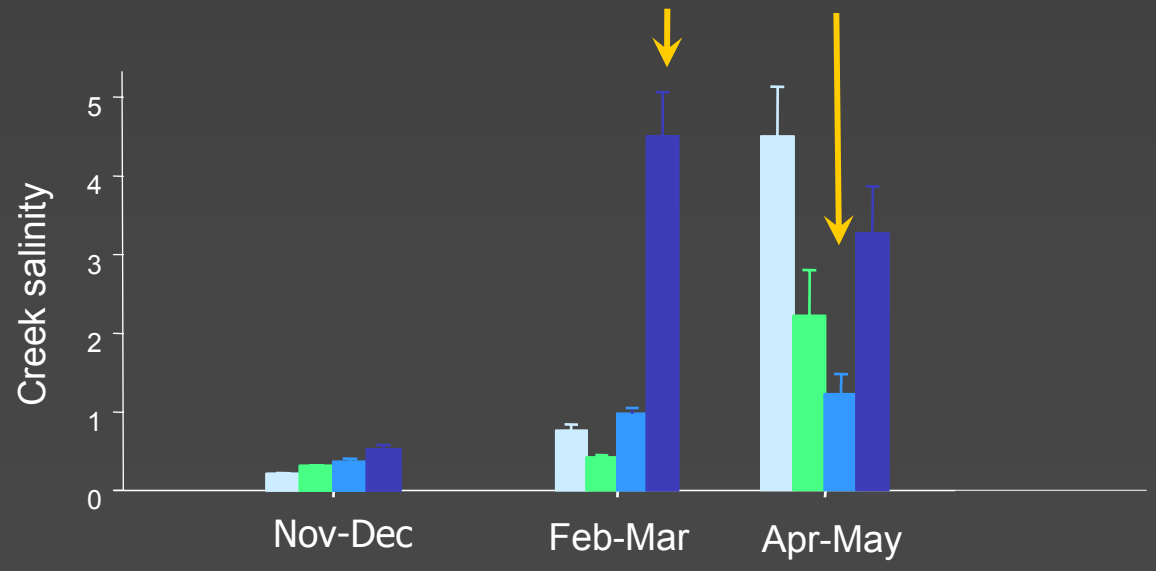
Hydrological conditions

- Marshes dry all years but there is variation

2005 - moderately dry + no reversals
2006 - wet + steady recession
2007 - dry + reversal
2008 - very dry + reversal

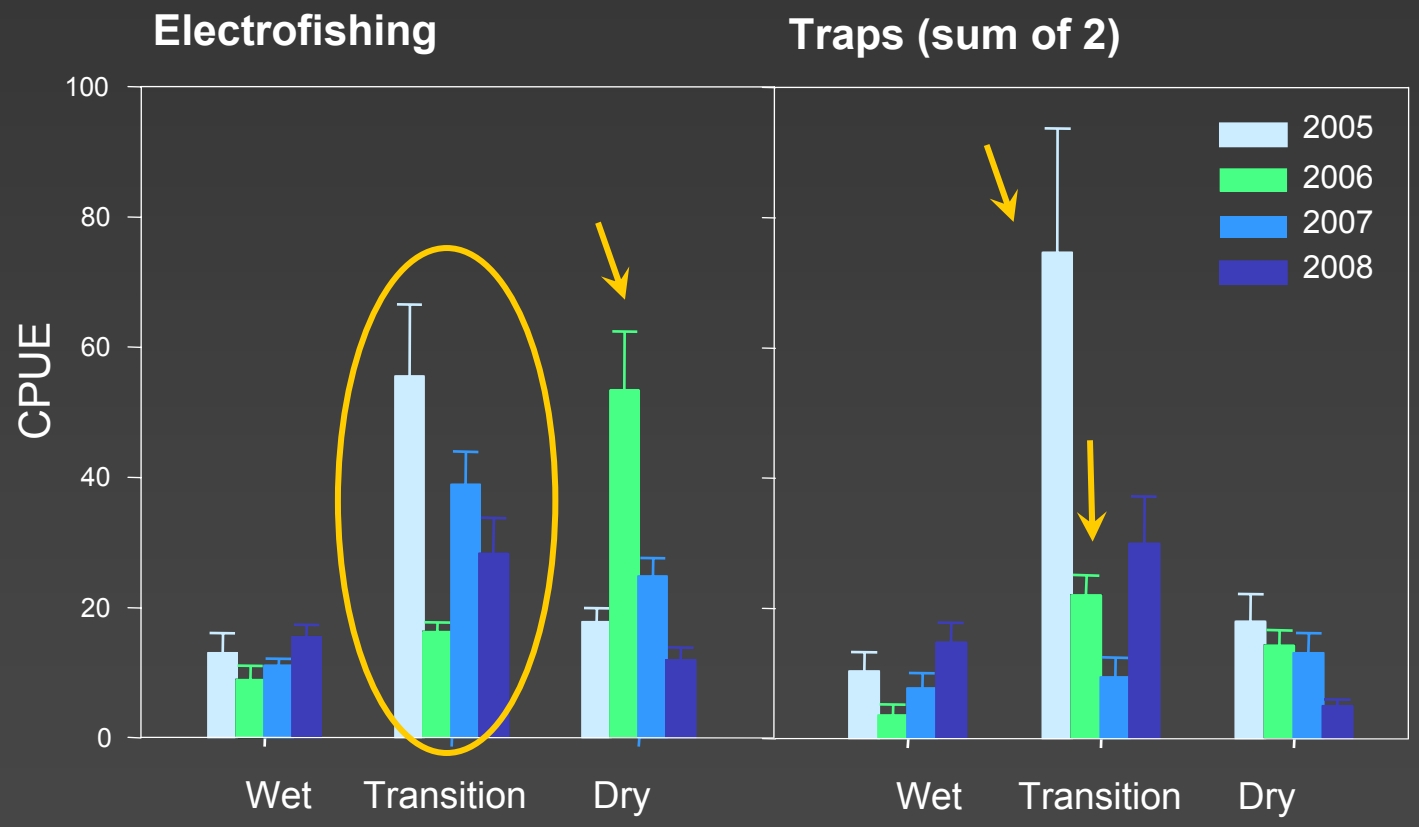


- Salinities reach 2-5 PSU by April-May
  - Increase occurs earlier in 2008
  - Low in 2007 = sampling is post-reversal



Seasonal & yearly variation in catches

Rookery Branch

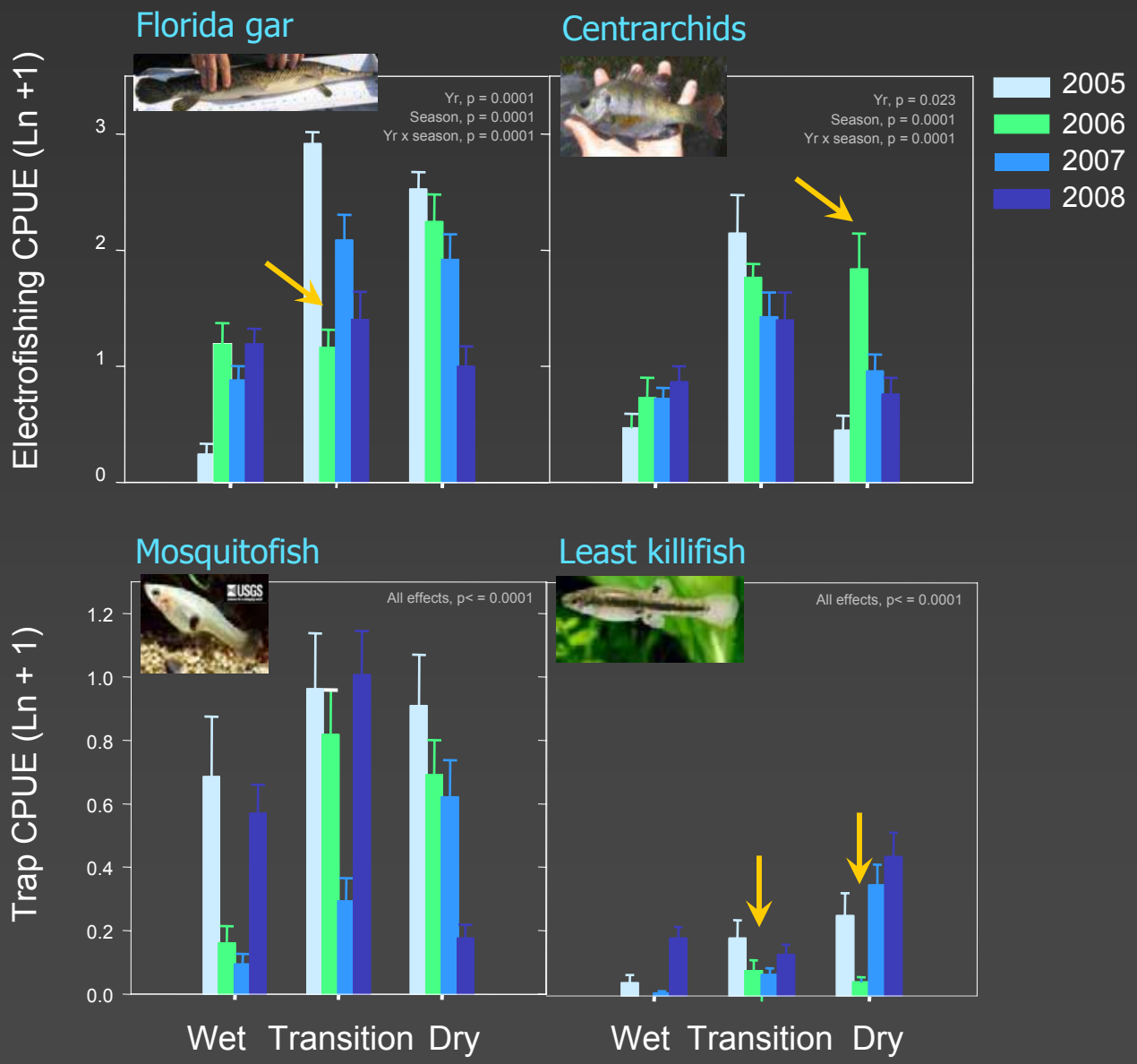


Yr, p = 0.034
Season, p = 0.0001
Yr x season, p = 0.0001

Yr, p = 0.0001
Season, p = 0.0001
Yr x season, p = 0.0001

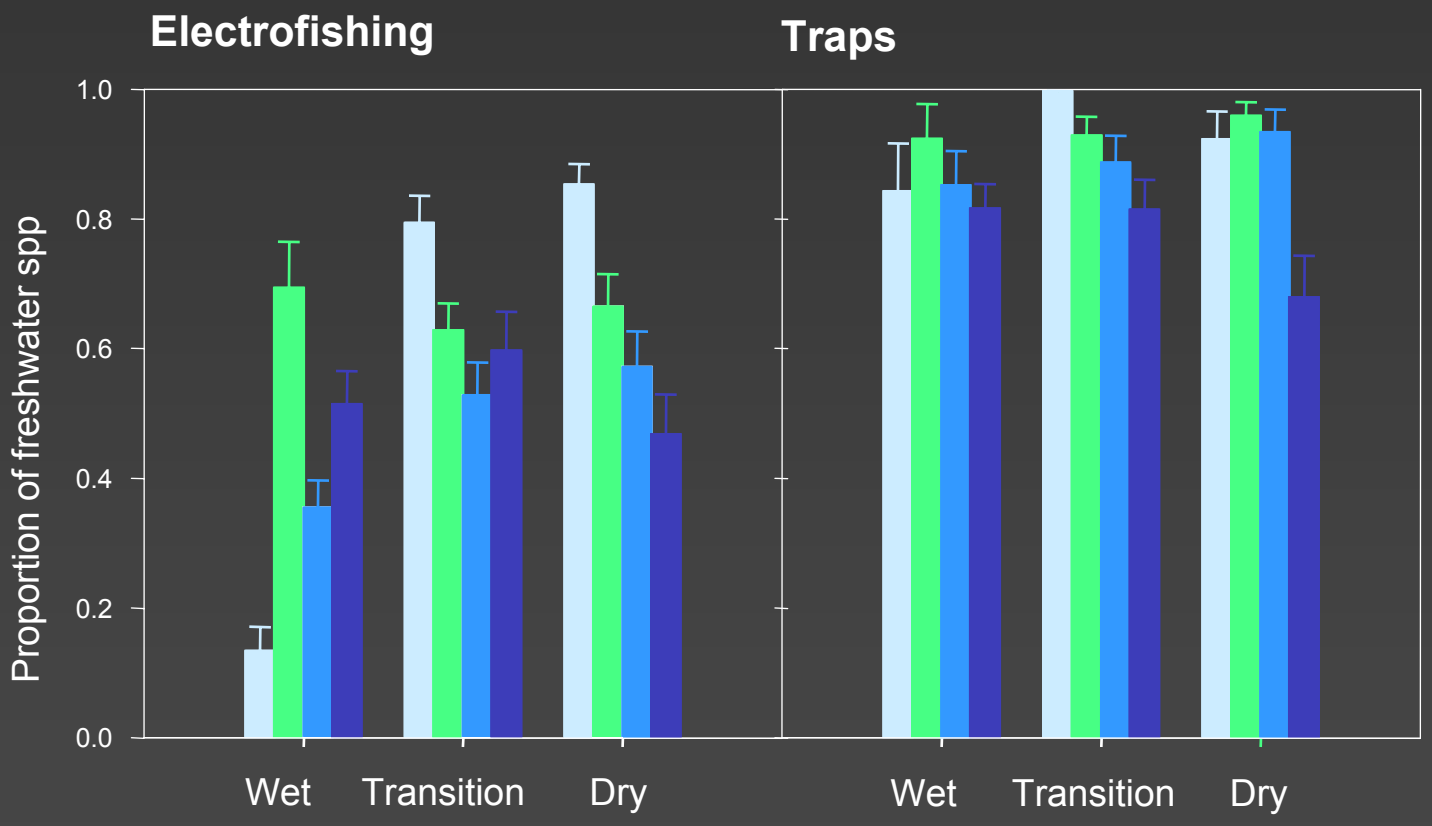
- For larger taxa, catches peak earlier in dry years
- For the prey, similar pattern in dry yrs without reversals
  - Little variation in wet year (2006)

Peaks in CPUE reflect influx of freshwater taxa



- Influx occurs early in drier years for gar
- Centrarchids peak early & drop in dry years
- Among smaller taxa, some sp may be creek residents, while others are only found in high numbers in dry years

Contribution by freshwater species is large

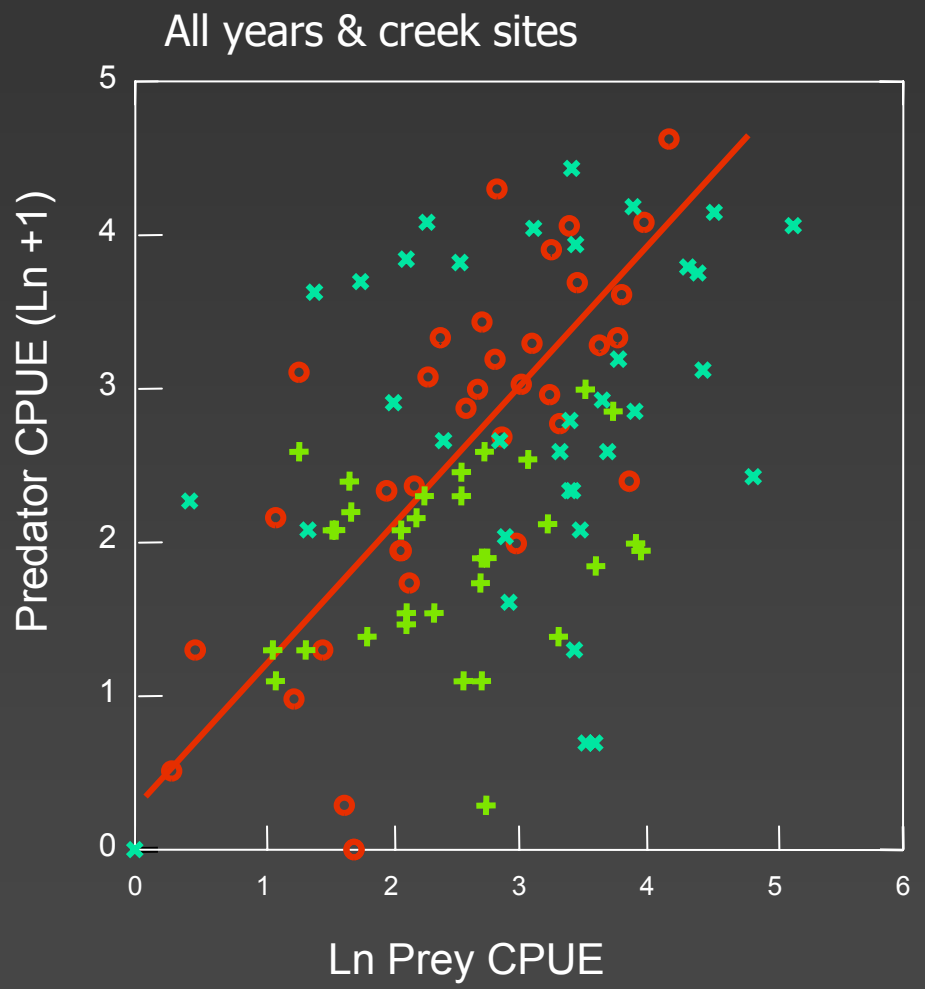


Yr, p = 0.0004
Season, p = 0.0001
Yr x season, p = 0.0001

Yr, p = 0.0001
Season, p = 0.3167
Yr x season, p = 0.0399

- For the large fishes, their relative abundance increases from 40 % to 60 % in drier months
- Small fish CPUE is dominated by freshwater spp, 88 %

Both prey & predators move into creeks



SEASON

- dry
- transition
- wet

- Prey and predator CPUE are positively related only in the dry season
- This co-occurrence in time & space could result in 'loss' of marsh prey biomass in creeks

Dry, r^2= 0.56, p = 0.0001

Transition, r^2= 0.08, p = 0.097

Wet, r^2=0.05, p = 0.24

Relating CPUE to environmental parameters

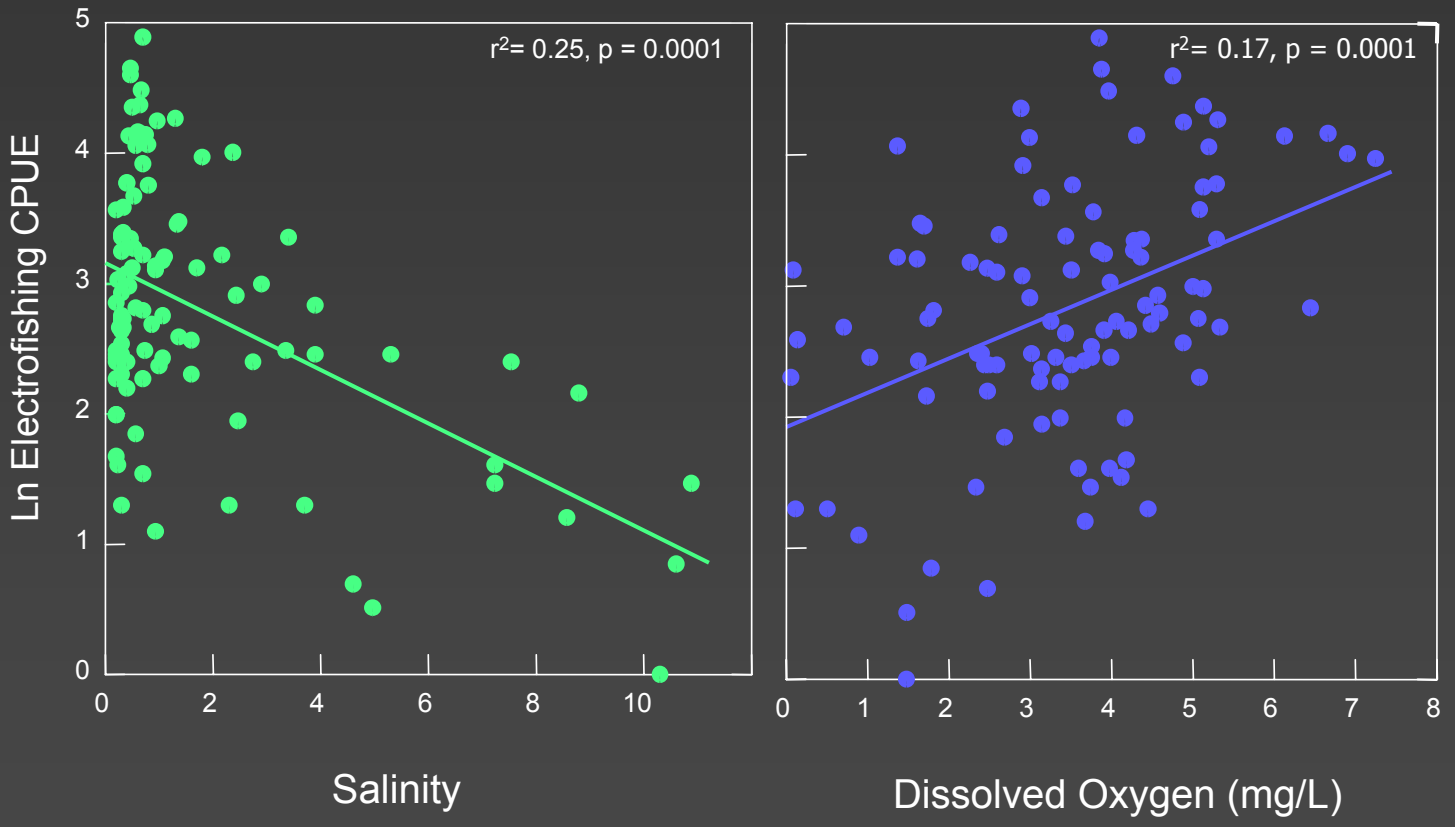
- Model selection techniques to examine explanatory power of physicochemical & hydrological variables (Burnham and Anderson 2002) :

- Model fit was improved with different variables:

ELECTROFISHING CPUE	TRAP CPUE
Salinity	Salinity
Dissolved oxygen	Creek water depth
	Marsh water depth (SH1, averaged 15 days prior to sampling)

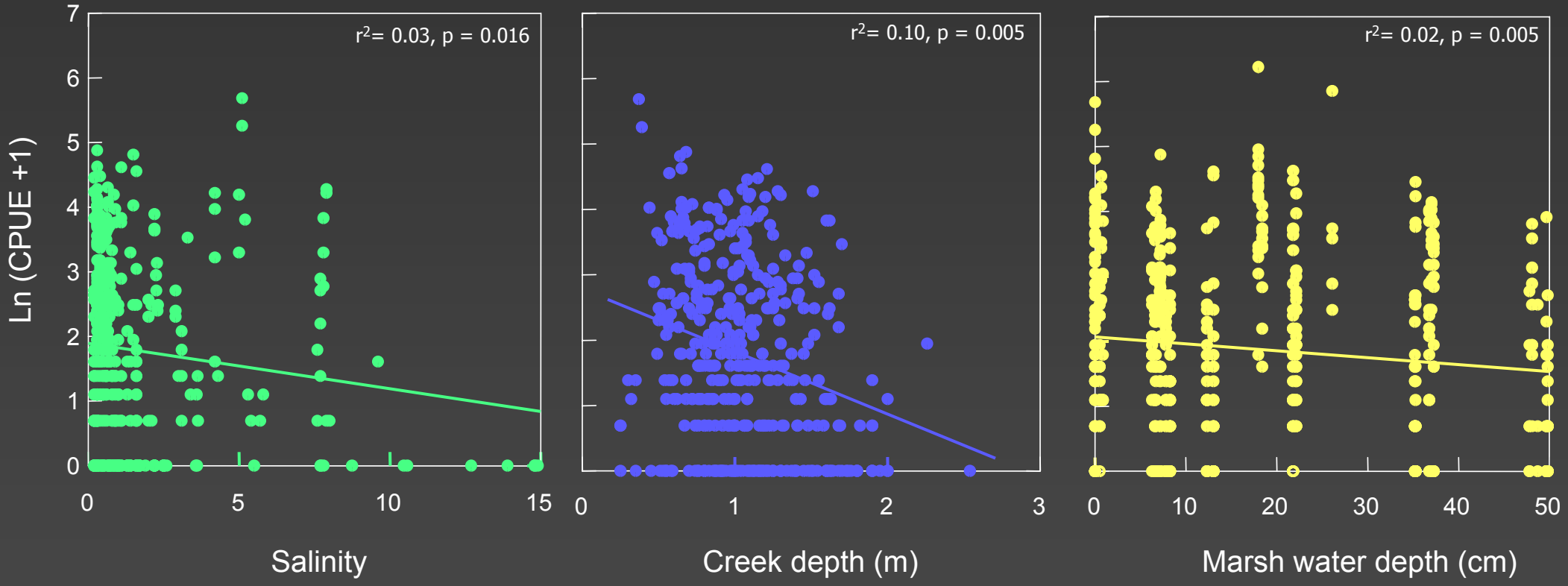
- Other variables examined included: temperature, days since last dry down (in marshes upstream)

Large fish CPUE as a function of environmental variables



- Large fish catches are negatively related to salinity
- And, positively related to DO levels

Small-fish CPUE & environmental variables



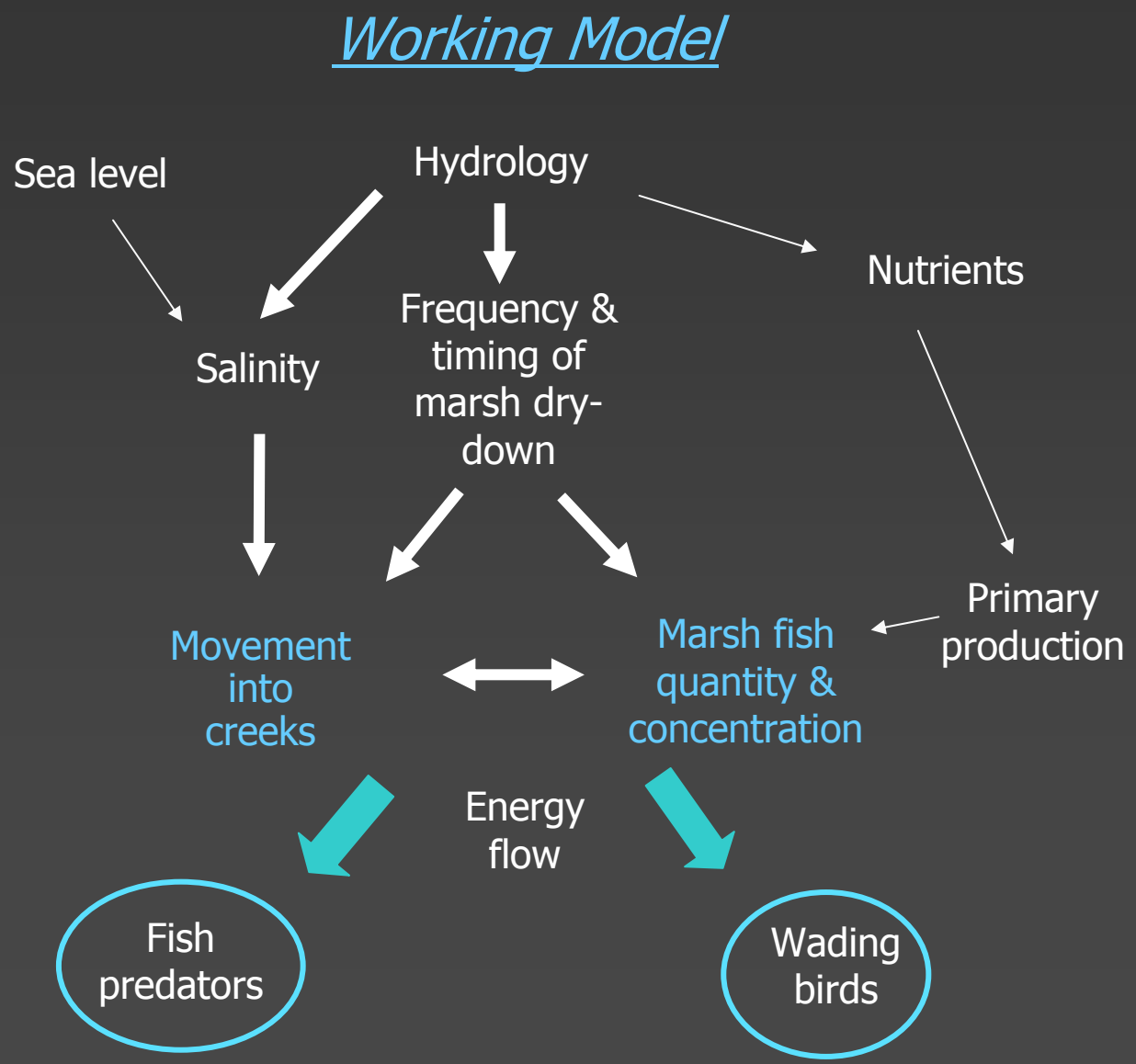
- CPUE may be inversely related to salinity, creek depth (highest catches are at shallowest sites = closest to marsh), & marsh water depth

Summary

- Freshwater taxa are an important component of the ecotonal fish community.
- Creeks appear to be functioning as dry-down habitat for certain freshwater taxa:
  - Spatial extent of this effect is not known
  - How good of a refuge?
    - Prey move into creeks with predators & encounter estuarine predators
- Salinity affects the spatial and temporal extent of the ecotone that is suitable to marsh fishes.
- Timing & severity of marsh drying affects timing of influxes of marsh fishes into creeks and thus seasonal patterns of abundance.

Implications for restoration

- Frequent dry down pushes fishes into creeks:
  - They spend longer part of the dry season in this habitat
  - Fish biomass may be consumed by piscine predators (instead of avian predators)
- With increases in freshwater inflow & prolonged pooling of water at ecotone, a shift in energy flow back to wading birds may be expected.



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