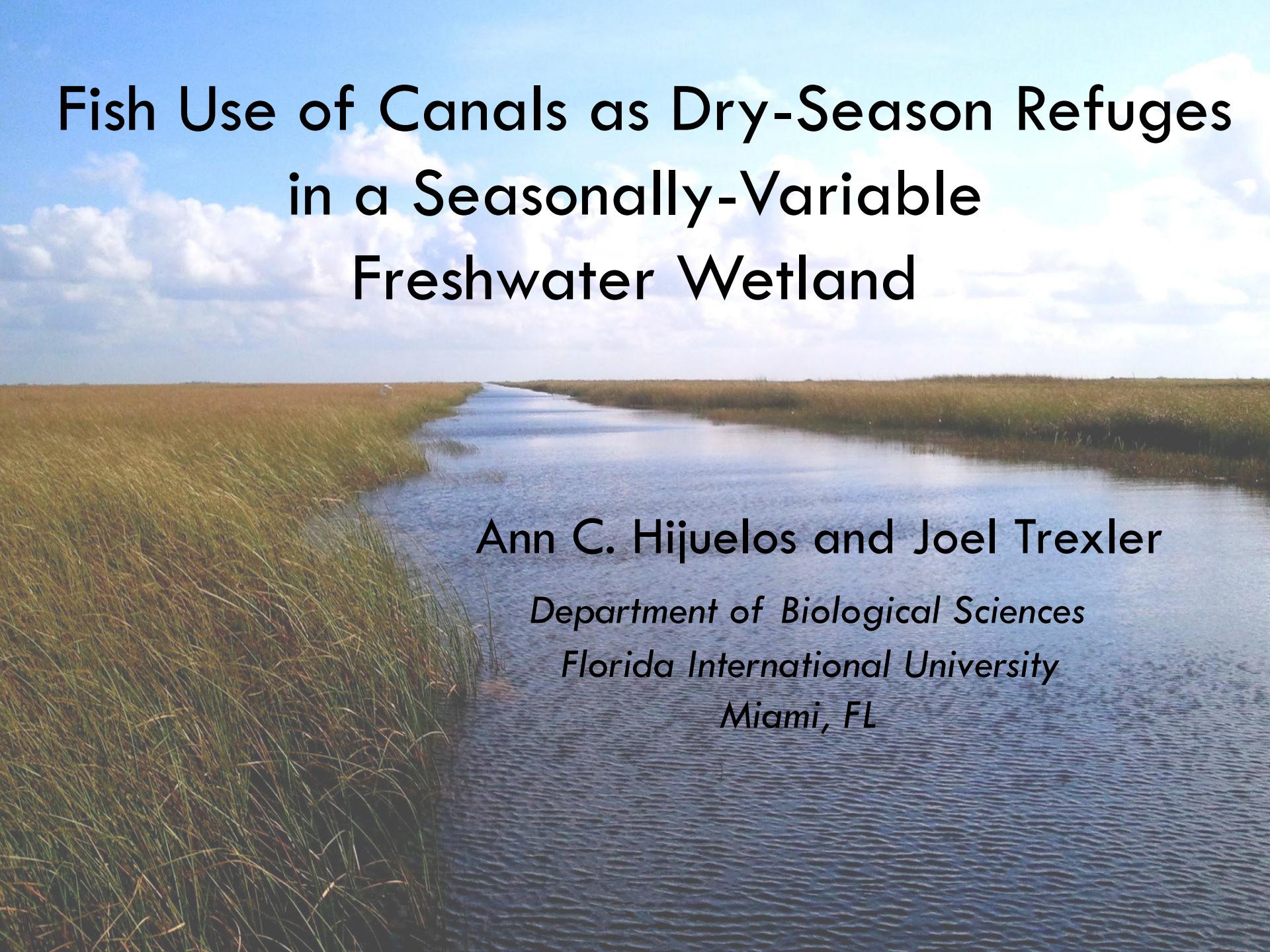
Fish Use of Canals as Dry-Season Refuges in a Seasonally-Variable Freshwater Wetland



Ann C. Hijuelos and Joel Trexler

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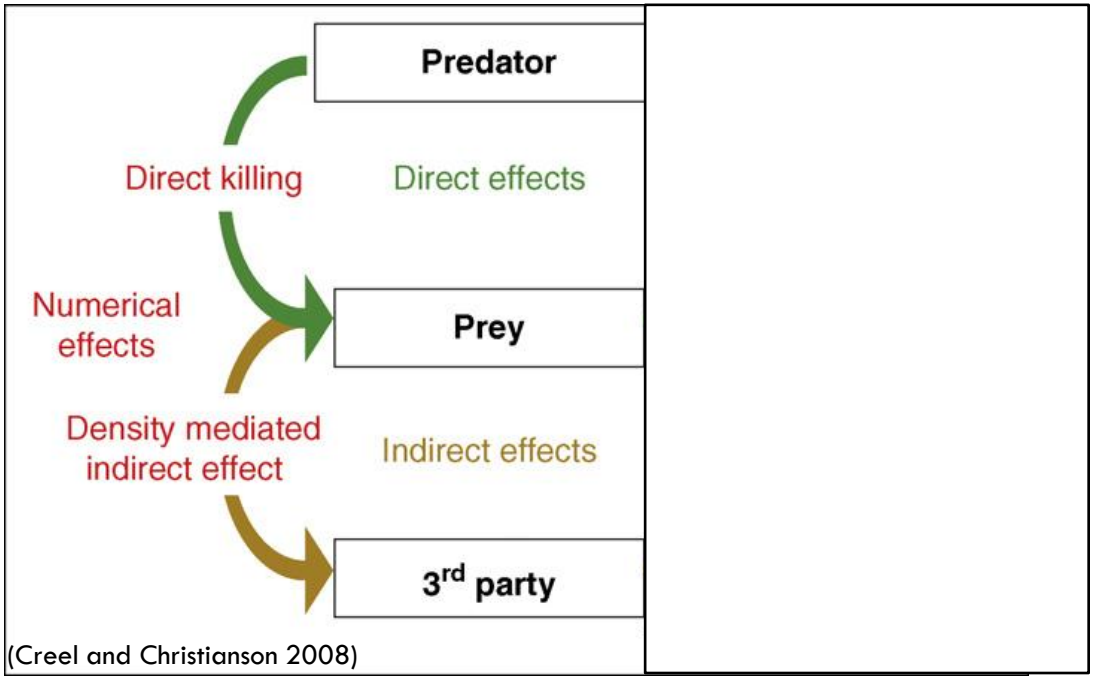
Miami, FL

How might predators impact their prey?

- Consumptive effects
  - Reducing prey density
  - Density-mediated indirect interactions
  - Increasing predator production



(Creel and Christianson 2008)

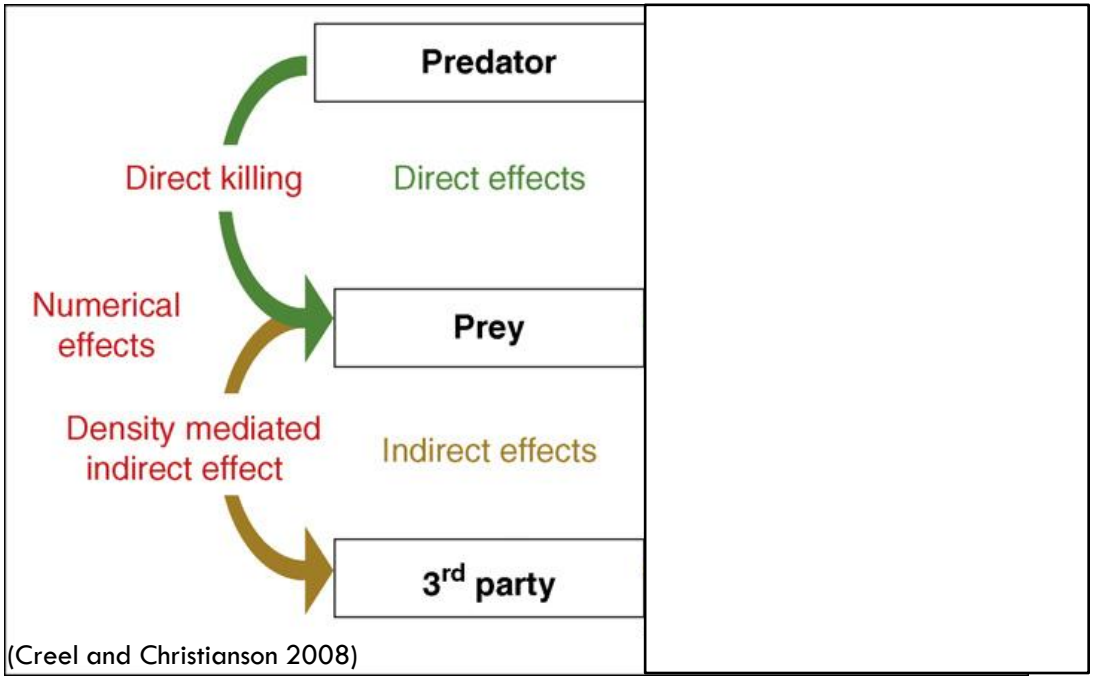
How might predators impact their prey?

Consumptive effects

- Reducing prey density
- Density-mediated indirect interactions
- Increasing predator production

Non-consumptive effects

- Decision-making process of animals
- Trait mediated indirect interactions
- Risk effects

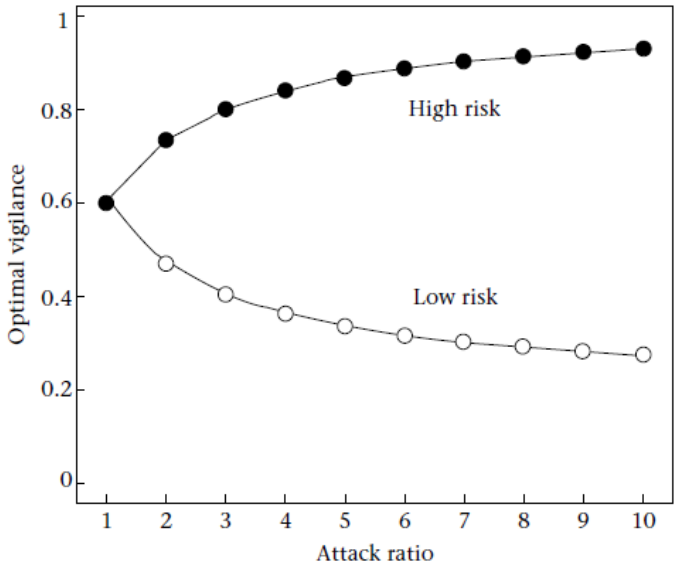


(Creel and Christianson 2008)

Risk Allocation Hypothesis

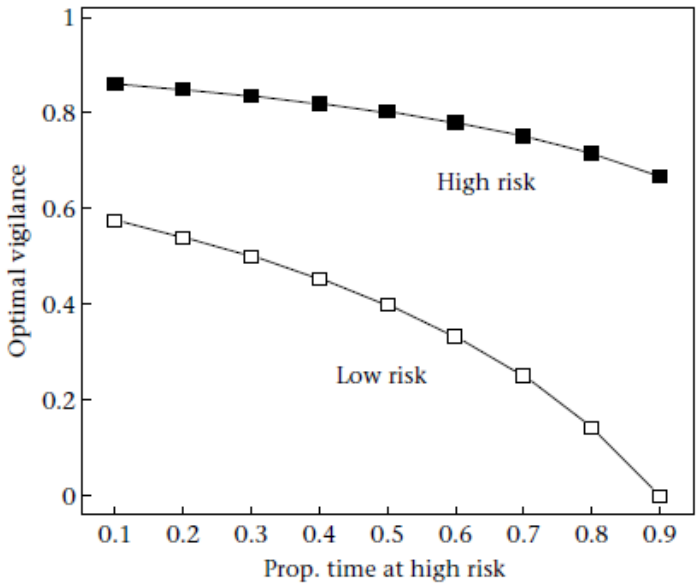
- Prey behavioral response to risk depends on:
  - Relative level of the risk (high vs. low)
  - Duration of "risky" situation (long vs. short)
- Model predicts:

With no temporal variation in risk



ratio of high to low risk

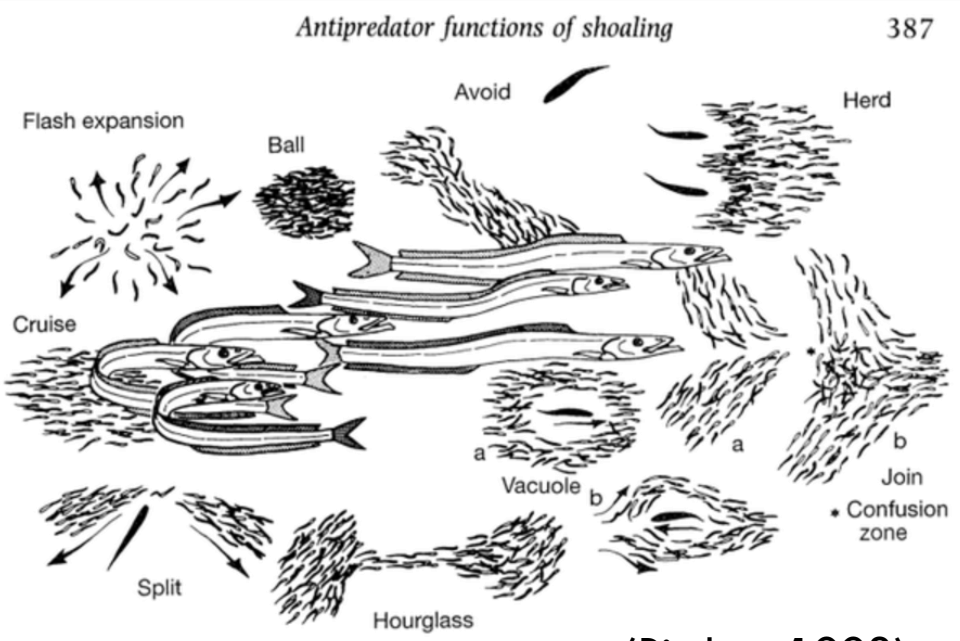
Response when exposed to a high risk



(Lima and Bednekoff 1999)

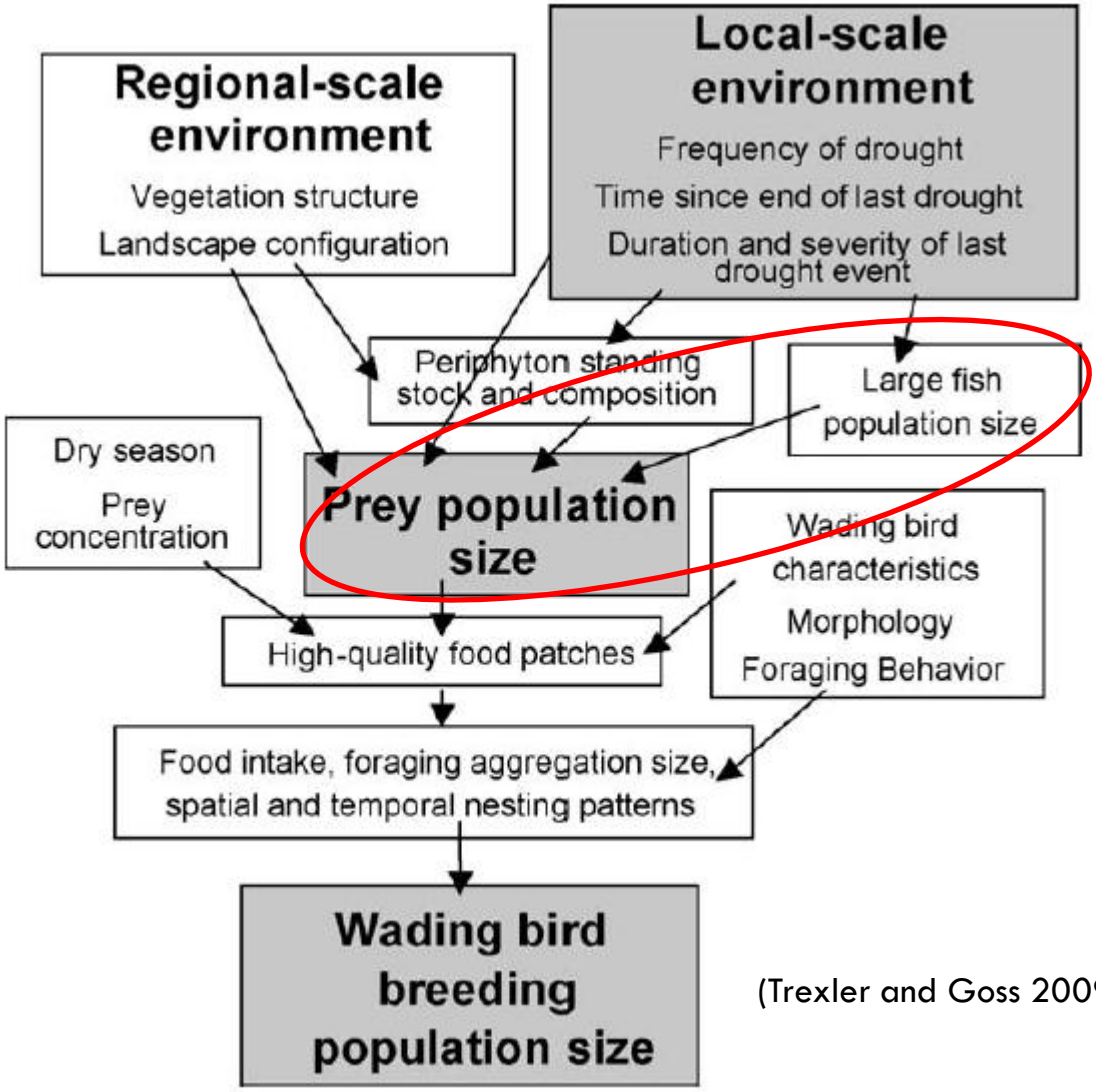
Measuring Risk

- Tethering studies
- Caged experiments
- Observational field studies:
  - SCUBA/Dive transects
  - Video cameras
  - Acoustics



(Pitcher, 1993)

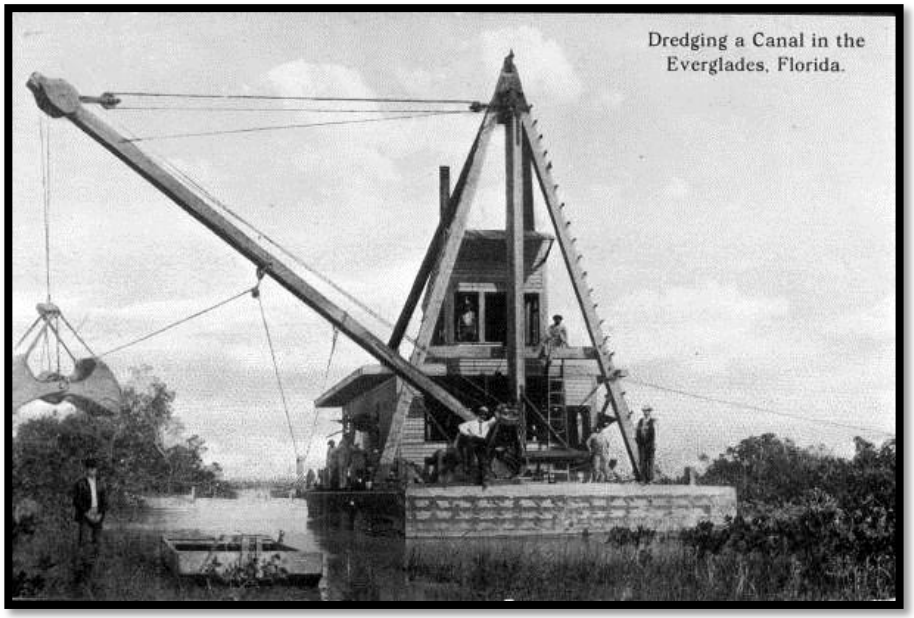
Risk in the Everglades?



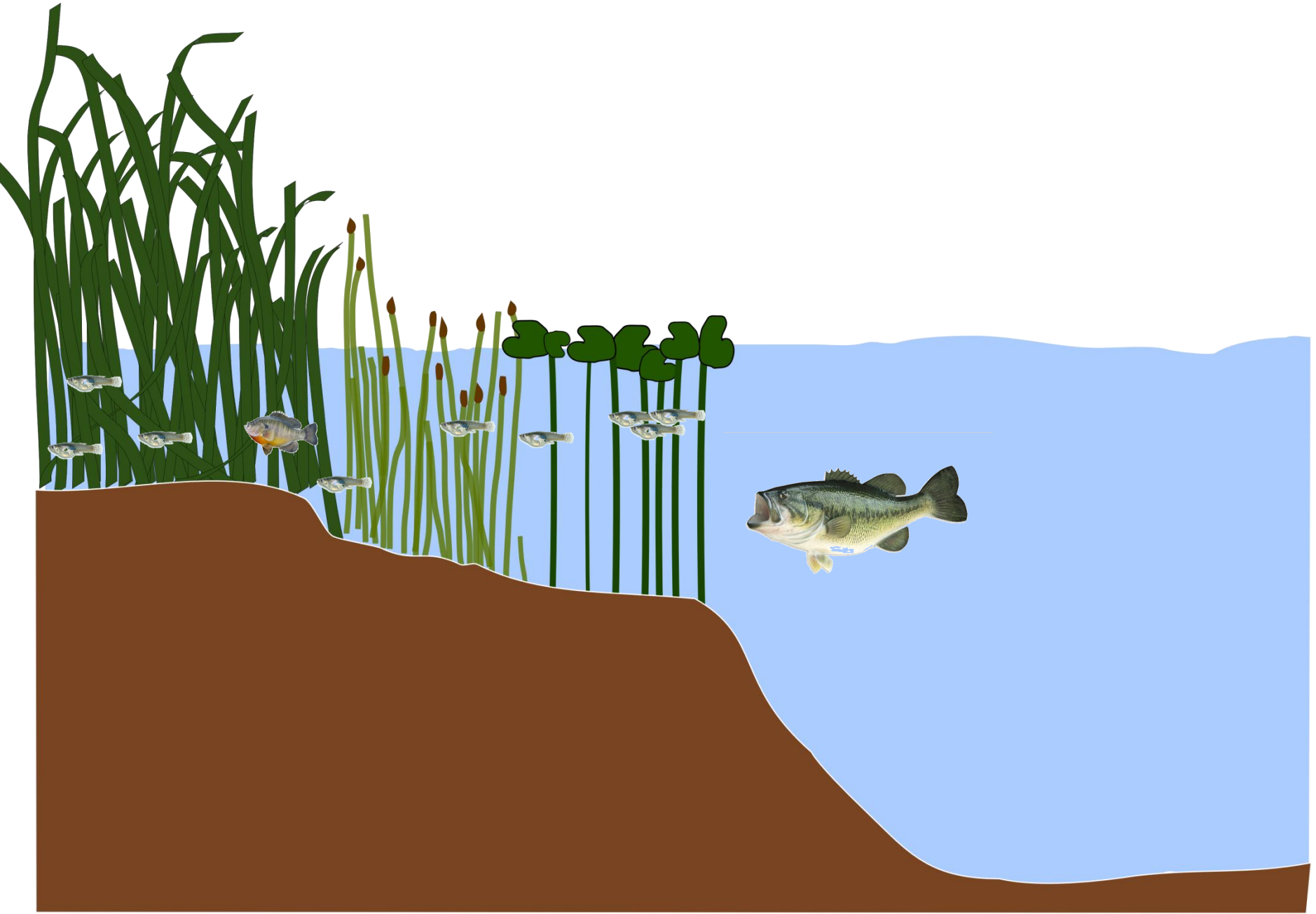
(Trexler and Goss 2009)

Construction of Canals

- 380 km of canals dredged in the early 20th century
- Additional construction of levees, pumps, and water storage areas for flood control
- Canals have become a feature in the Everglades landscape



SAWGRASS LITTORAL ZONE CANAL



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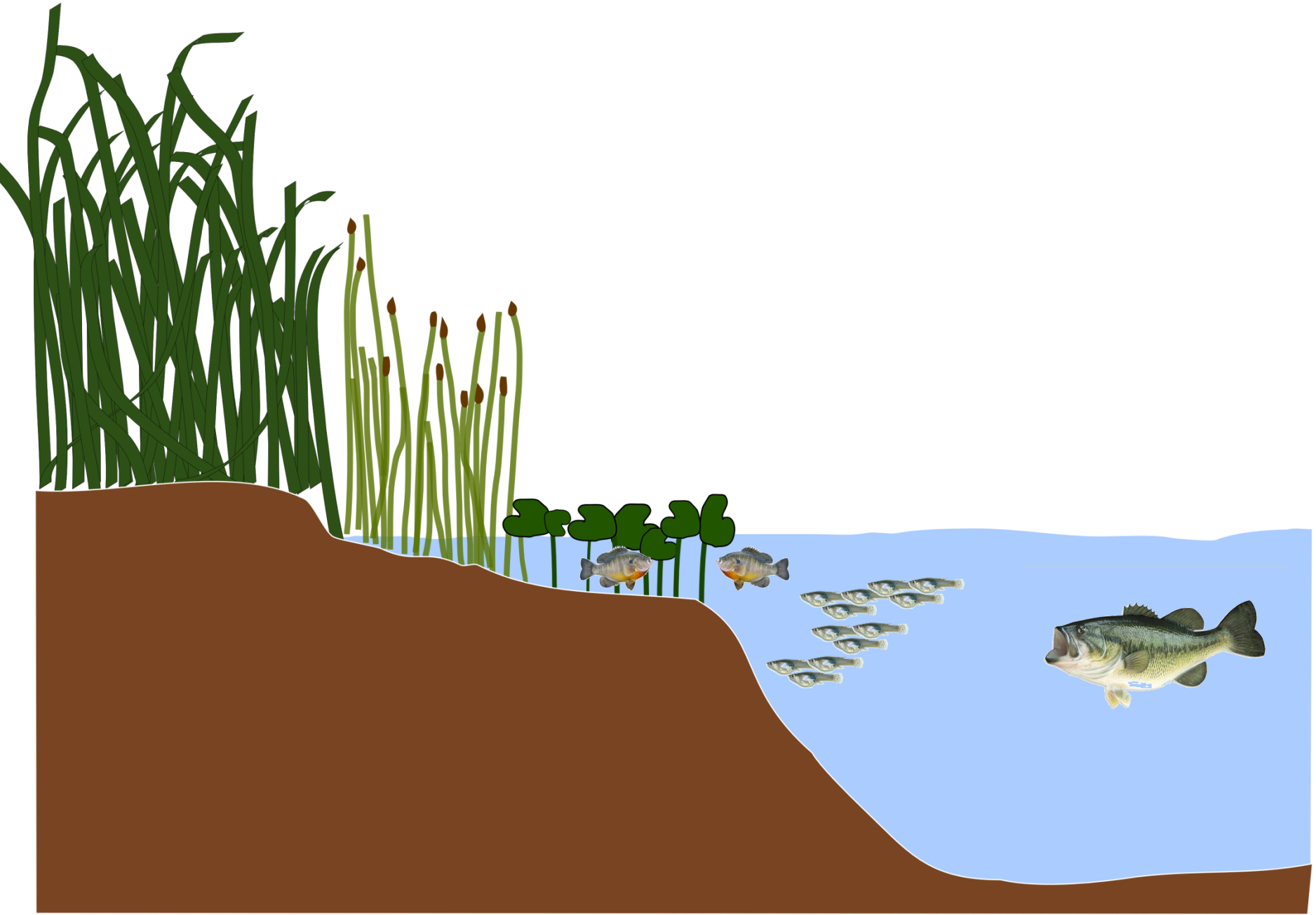
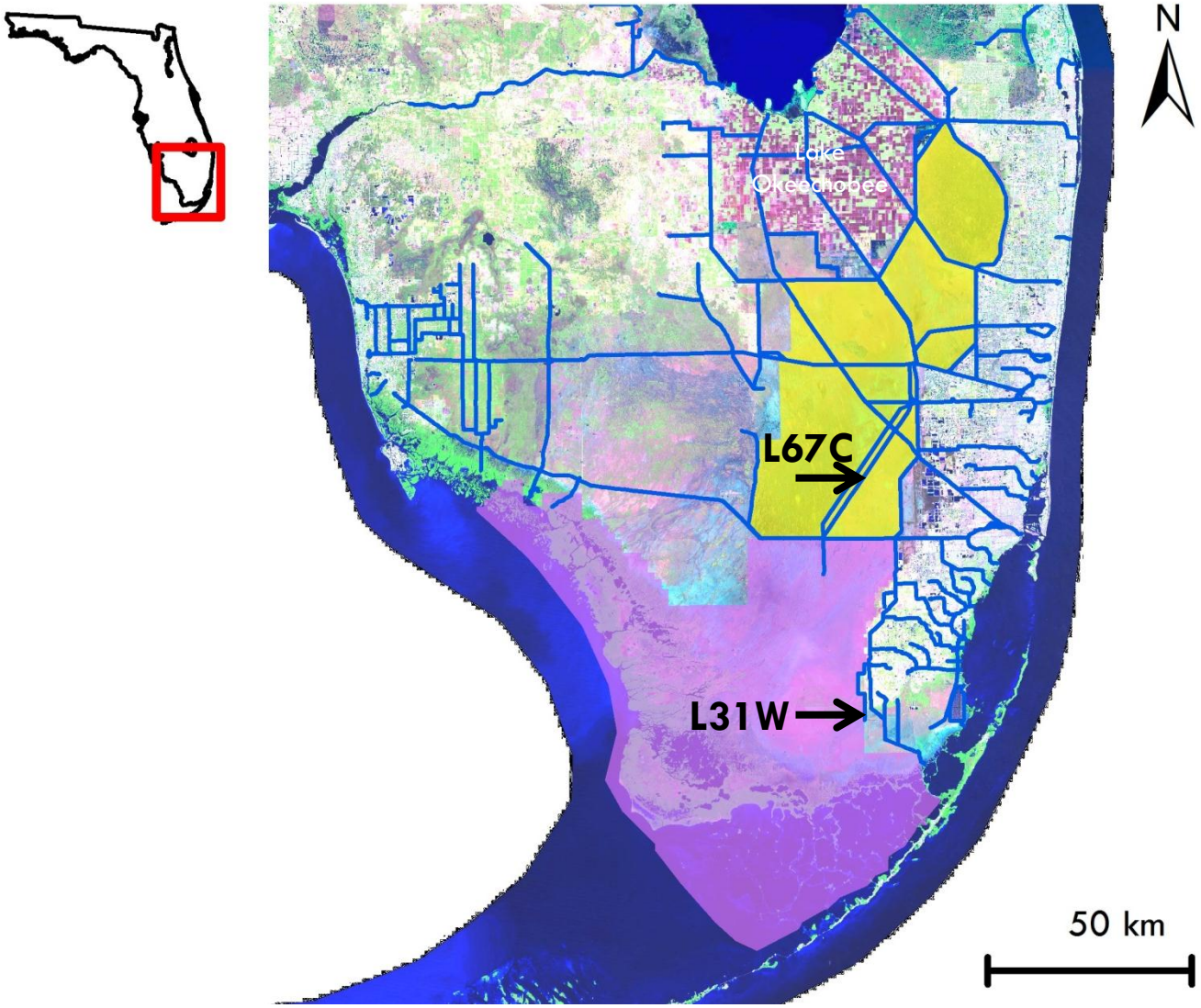


Goal

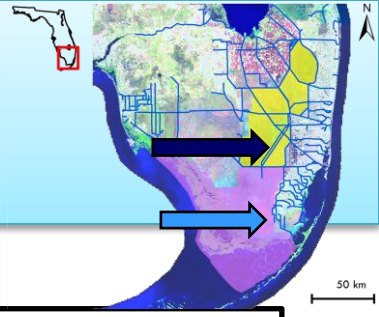
- Investigate how seasonal changes in landscape connectivity influences the decision-making process of fish, yielding “non-consumptive effects” on prey fish.

- Using novel, non-invasive sampling techniques.

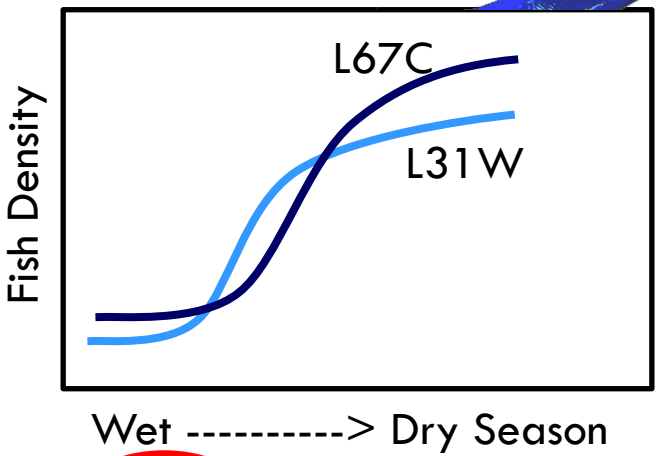
Study Sites

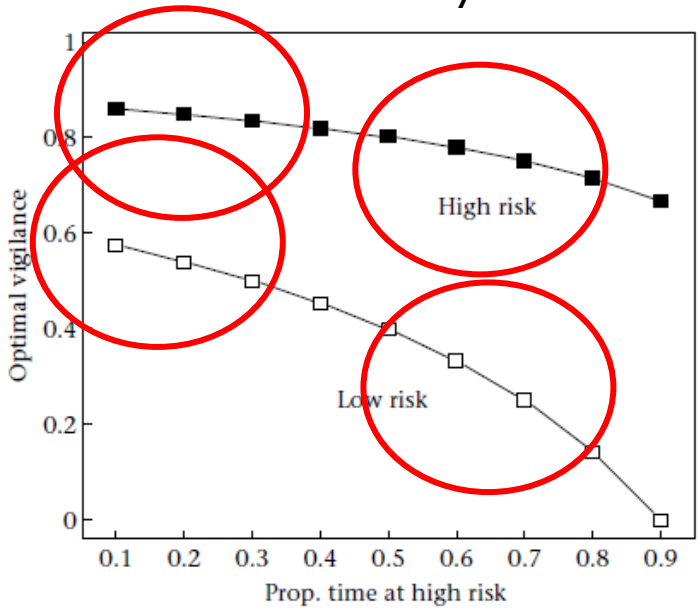


Hypotheses



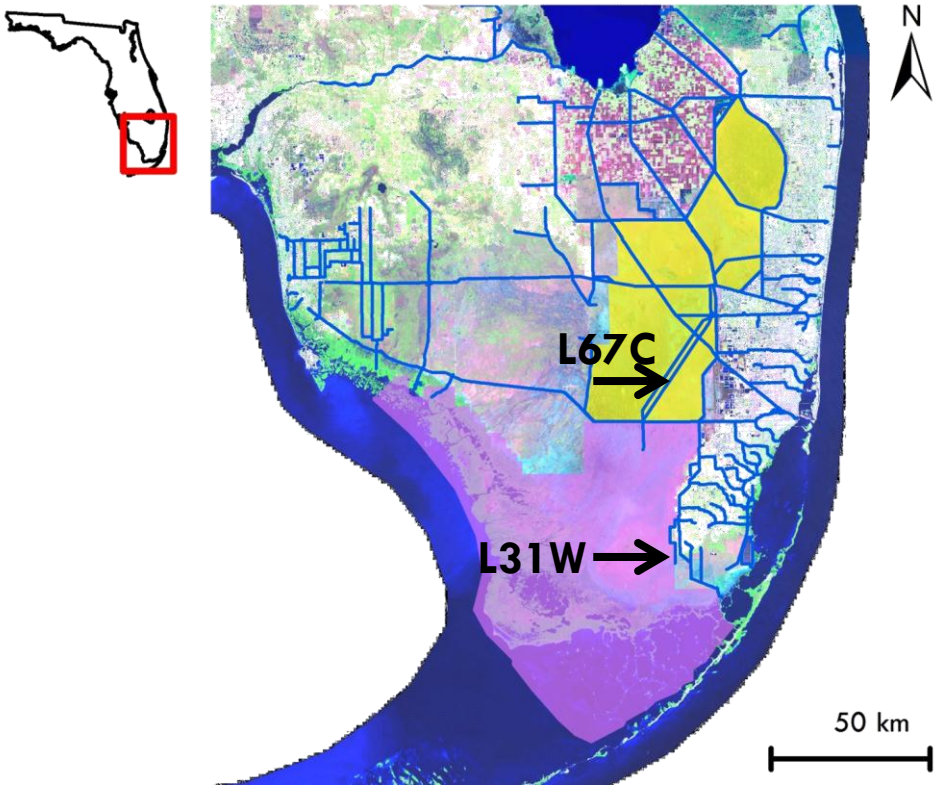
- Fish density will increase with the onset of the dry season and then stabilize.
- If exposed to risk in the wet season:
  - Prey fish in the L67C would show higher vigilance than in the L31W
- If exposed to risk in the dry season:
  - Prey fish in the L67 would show higher vigilance than in the L31W



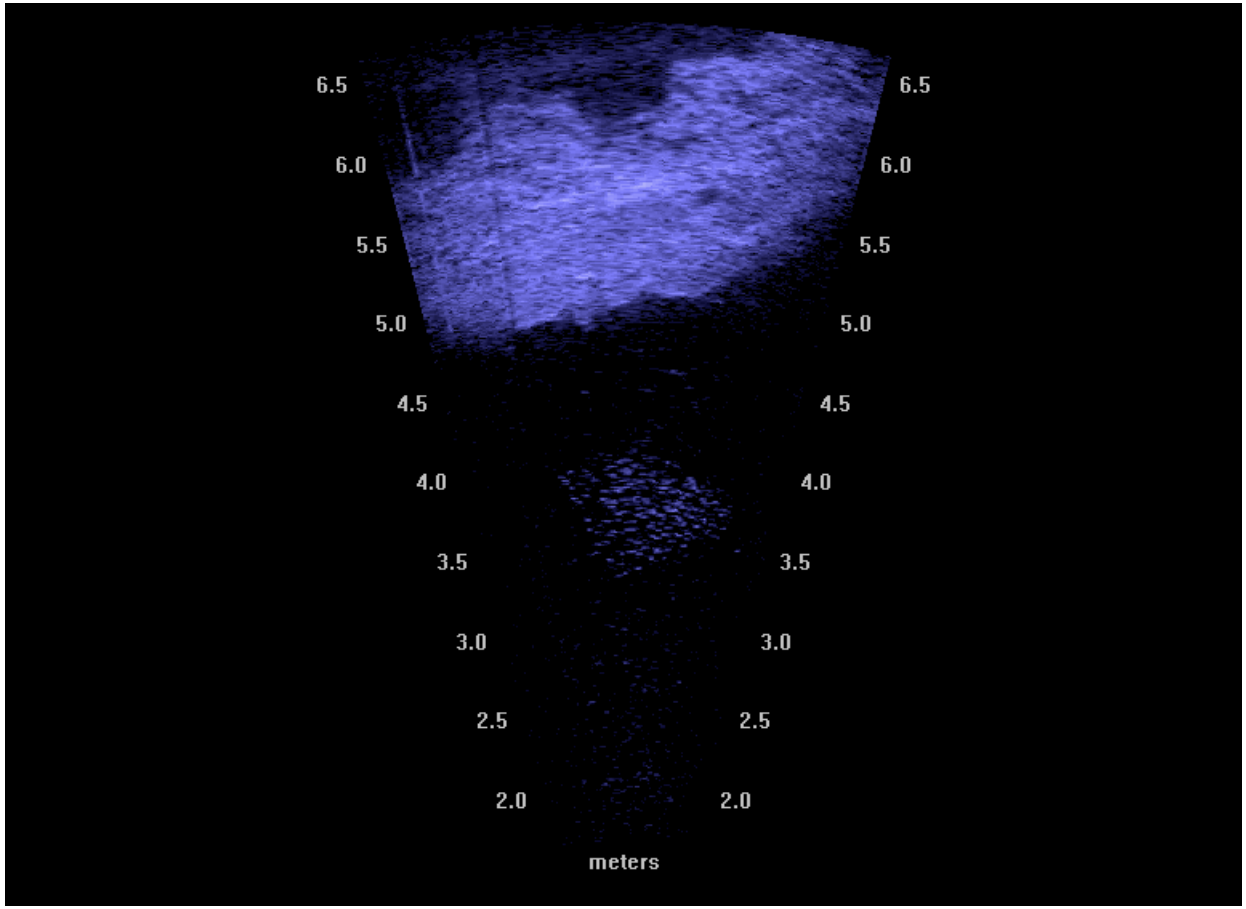


Methods

- Sampled monthly from Dec. 2010-Oct 2011
  - (except July 2011)
- 3 sites per canal
  - 3 videos per site
- Recorded 5 minute acoustic "videos" using a Dual- Frequency Identification Sonar (DIDSON)

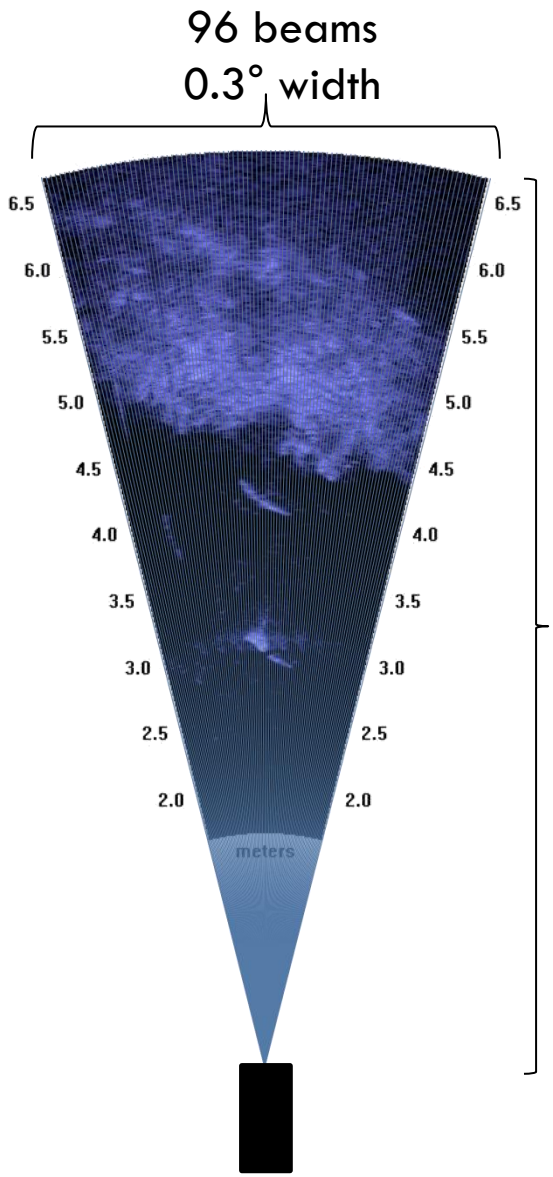


Dual Frequency Identification Sonar



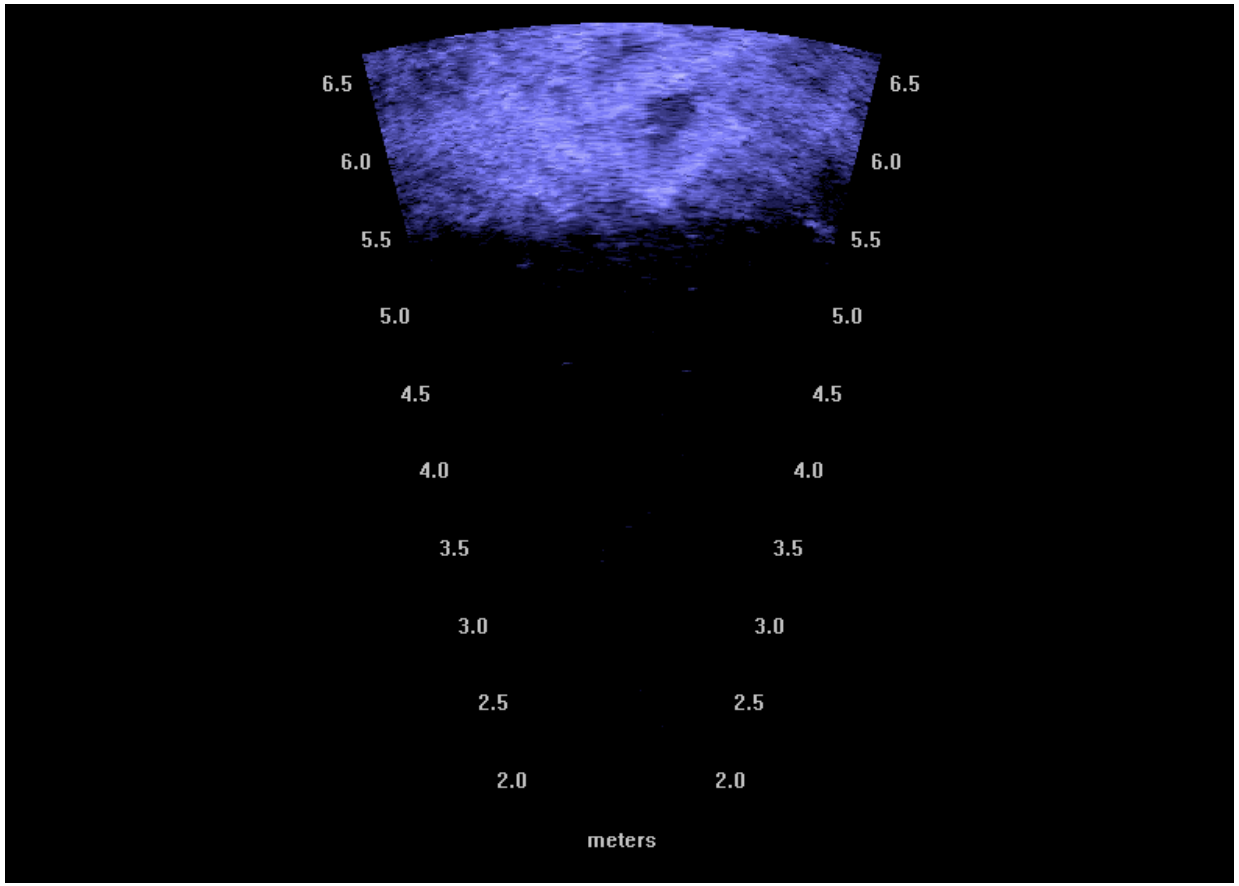
DIDSON


14°

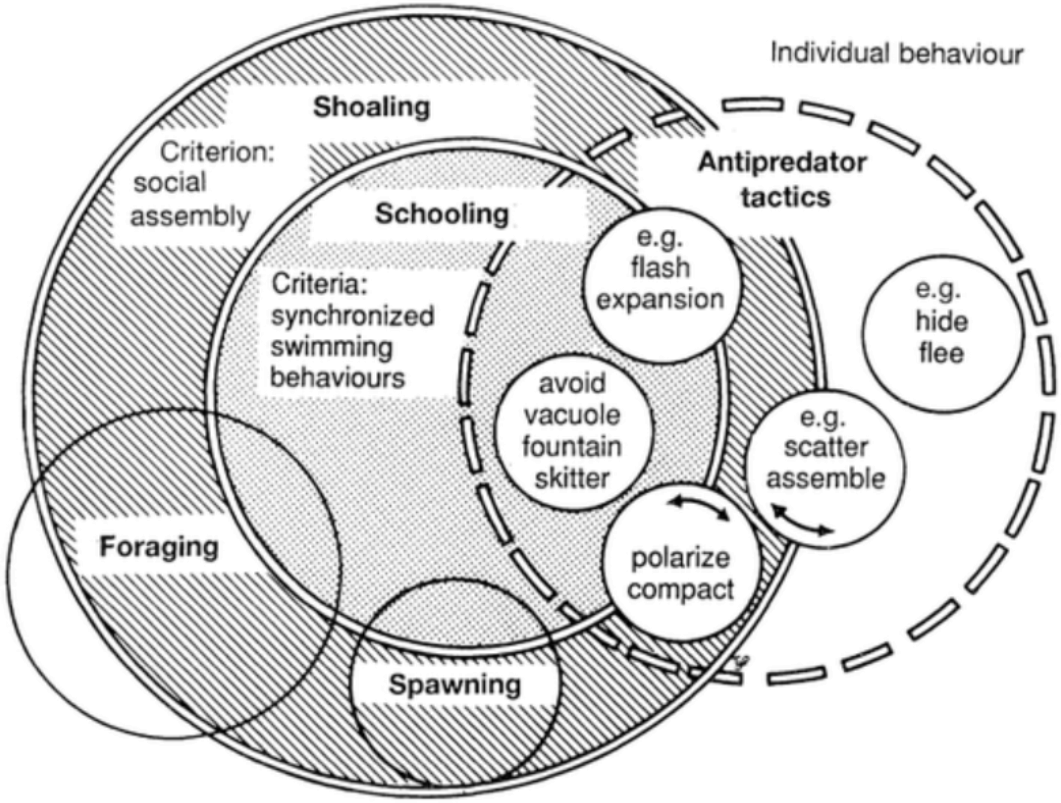

96 beams
0.3° width
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
meters
512 pixels per beam

Analysis

- Fish density / m^2
- Fish length (cm)
- Number of Schools
  - # fish
  - Mean distance to centroid
  - Mean nearest neighbor
  - School area

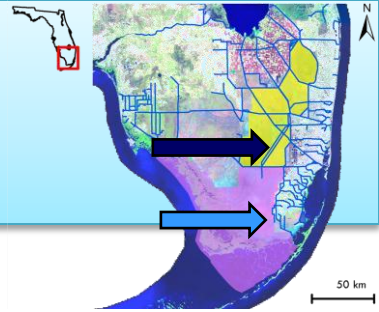


Shoaling vs. Schooling

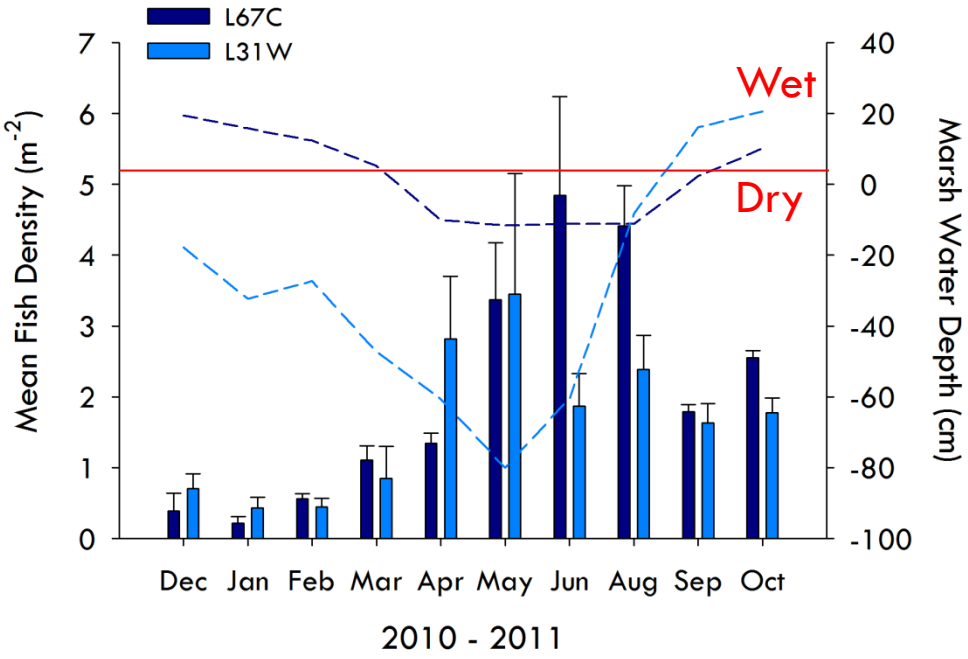


(Pitcher, 1993)

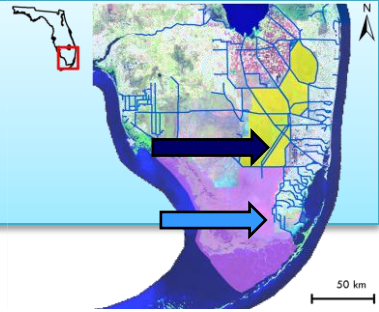
Results



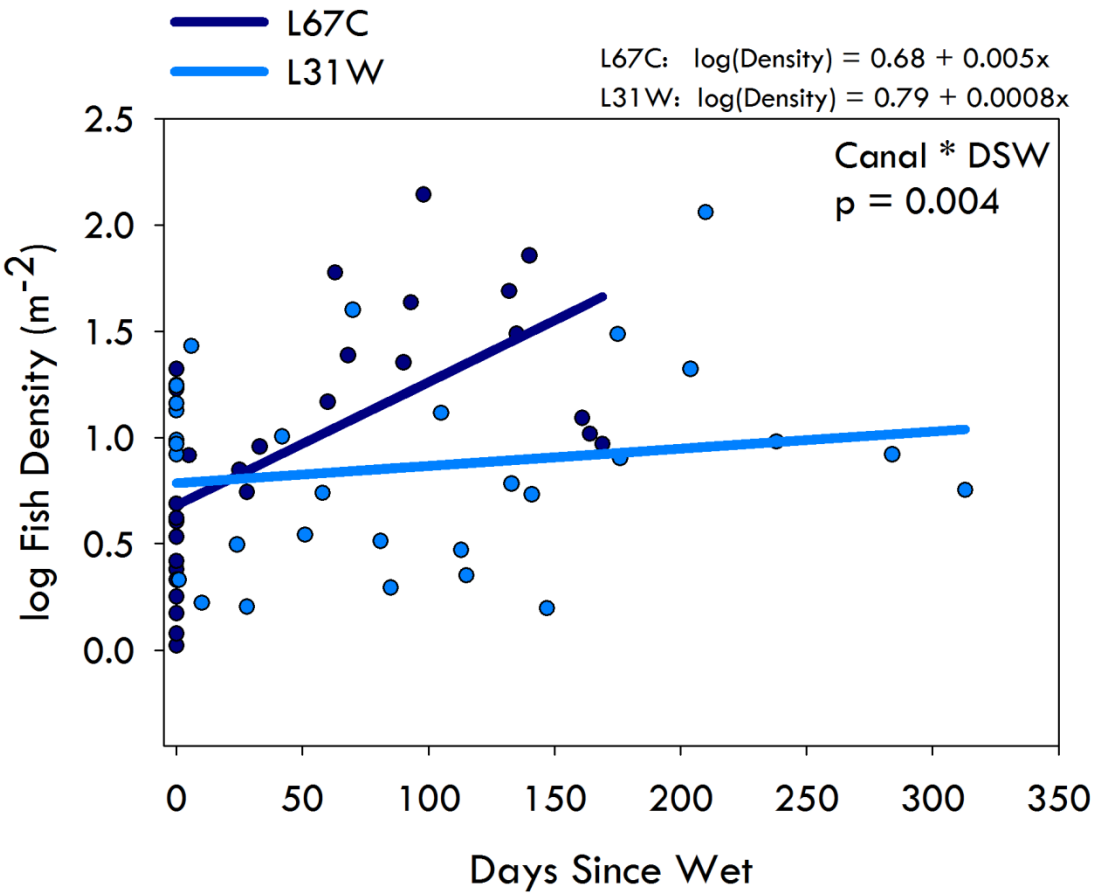
- Marsh water levels receded in the L31W prior to start of study.
- Densities appear to increase as the dry season prolongs.
- Densities drop as marsh is re-flooded.



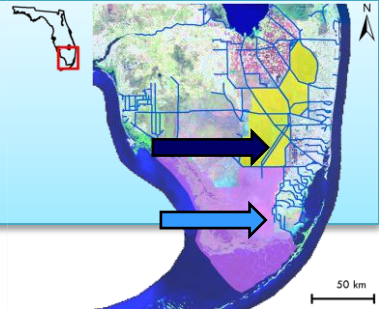
Results



- Fish densities increased in both canals
- Rate of increase higher in the L67C
- Why is fish density increasing if marsh access is cut off and system is “closed?”



Results



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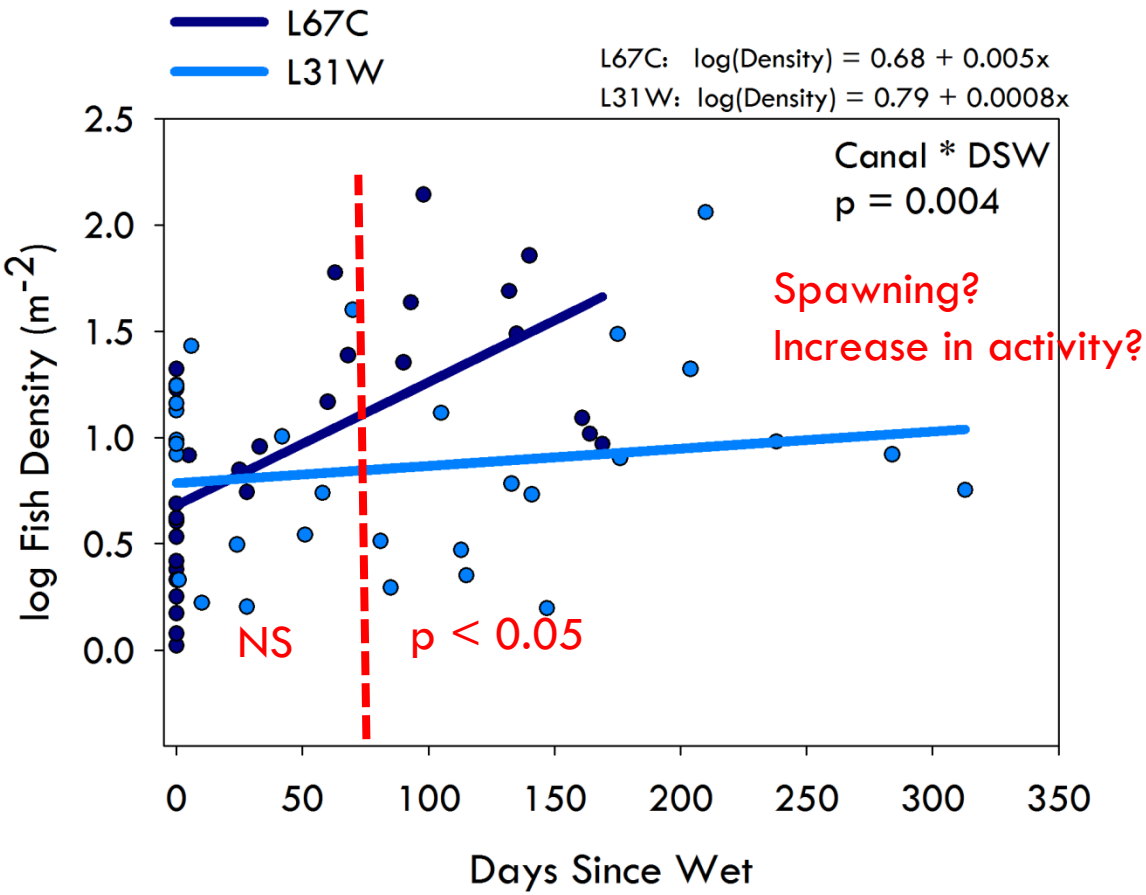
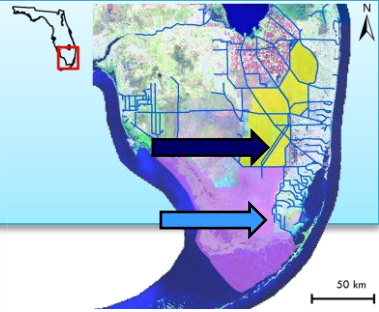
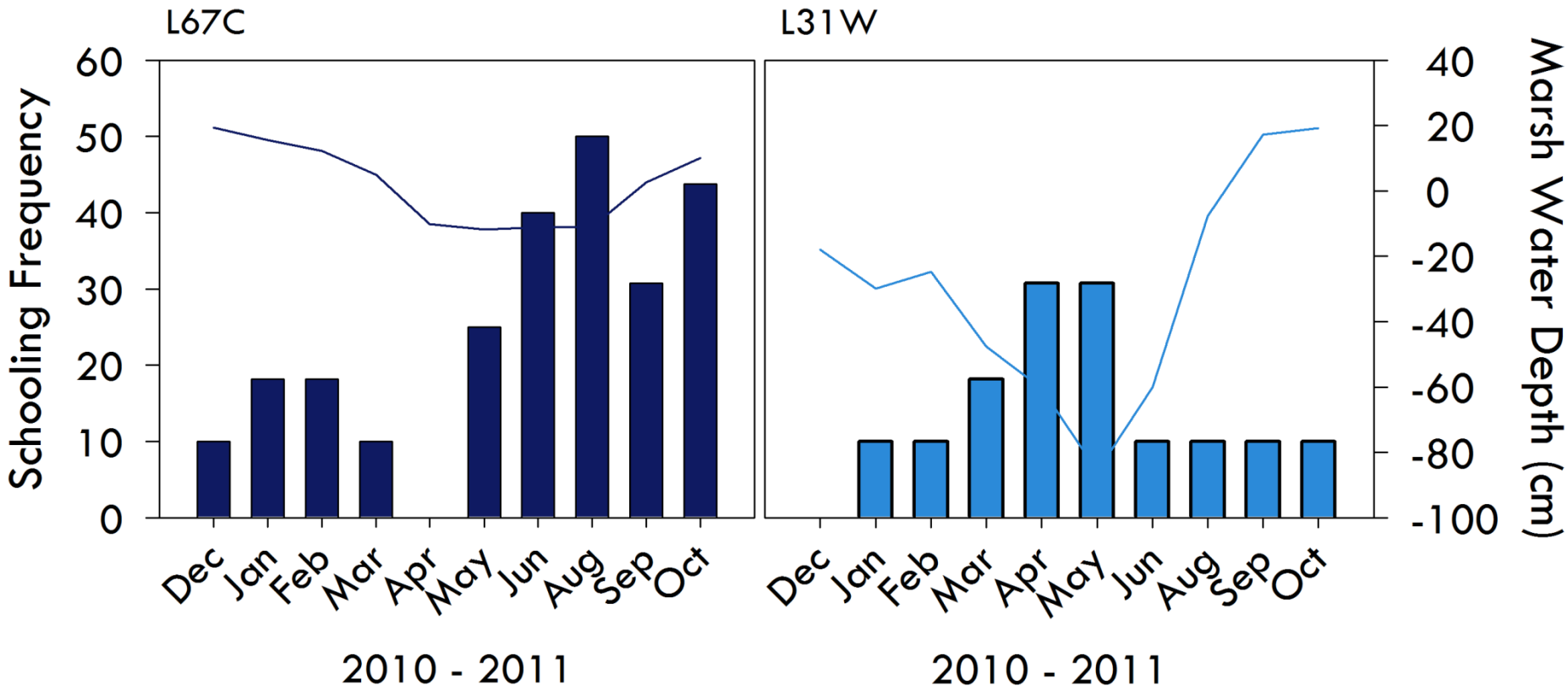
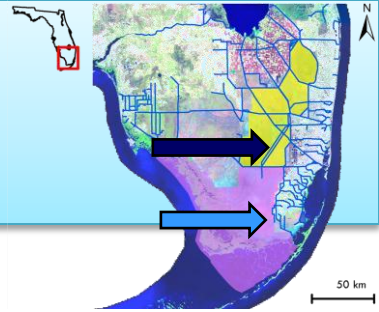


Results


N
50 km

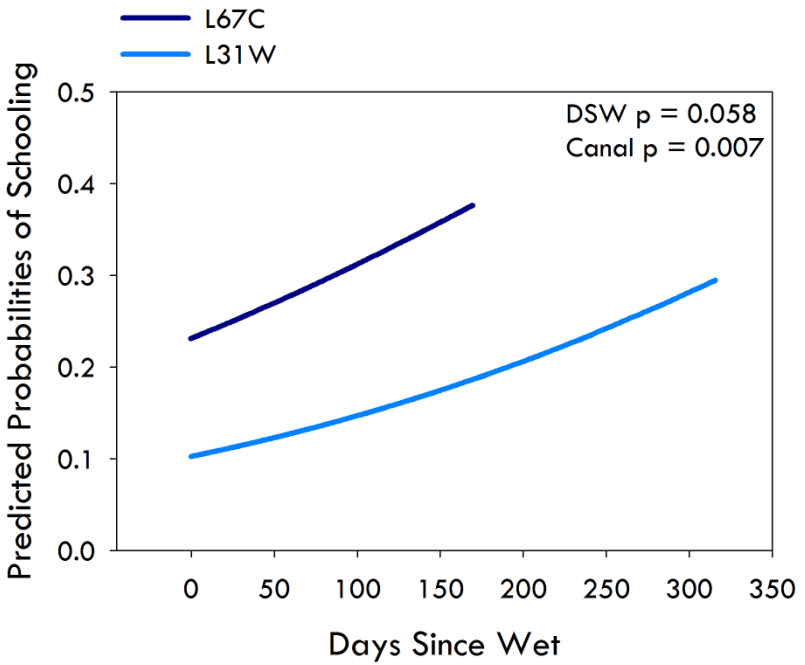

L67C
L31W
Schooling Frequency
Marsh Water Depth (cm)
60
50
40
30
20
10
0
40
20
0
-20
-40
-60
-80
-100
Dec
Jan
Feb
Mar
Apr
May
Jun
Aug
Sep
Oct
2010 - 2011
2010 - 2011

Results

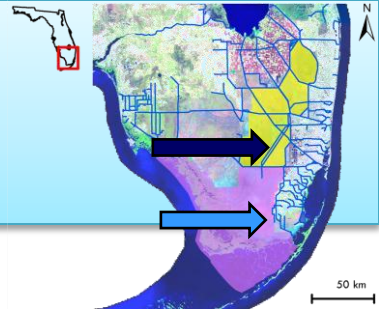


- Probability of schooling increases as length of dry season increases

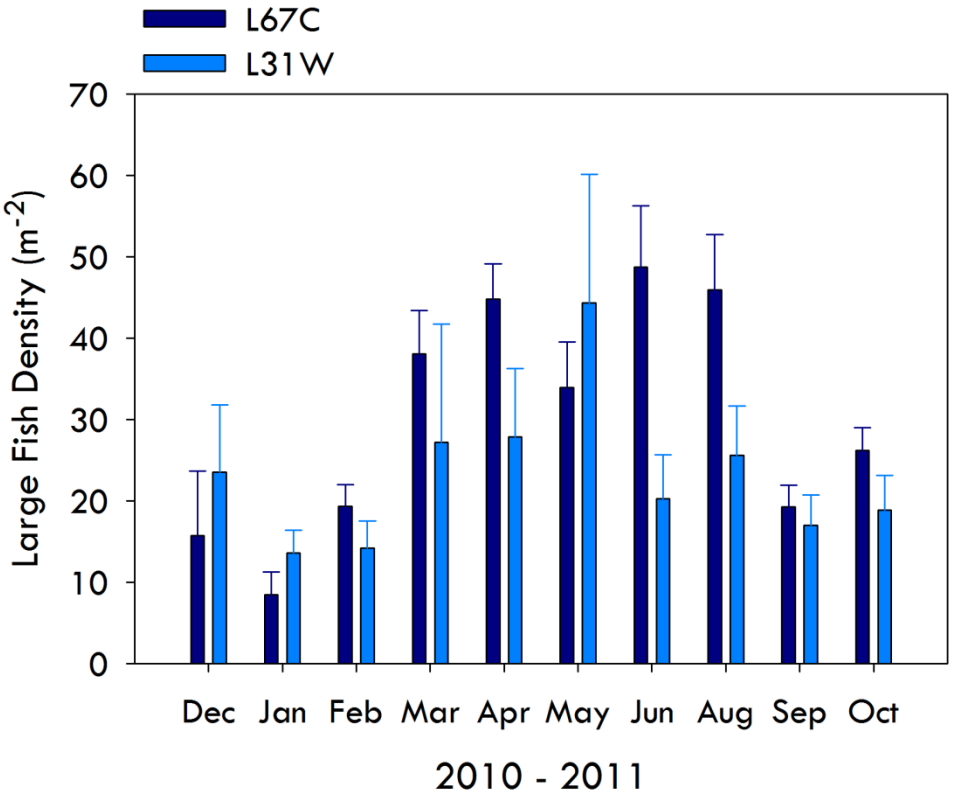
- Probability of schooling significantly higher in the L67C



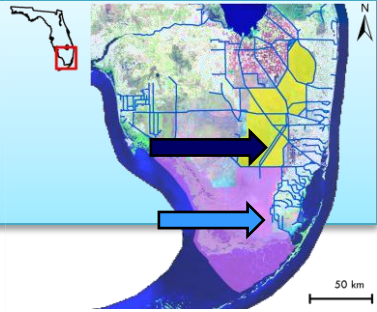
Results



- Does the presence of these large predators (> 20 cm) cause an increase in the schooling frequency?

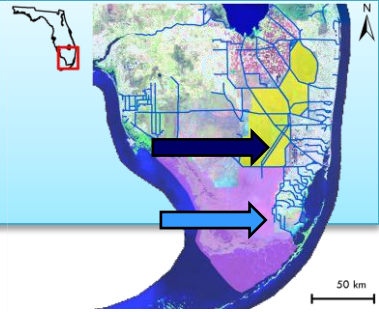


Results

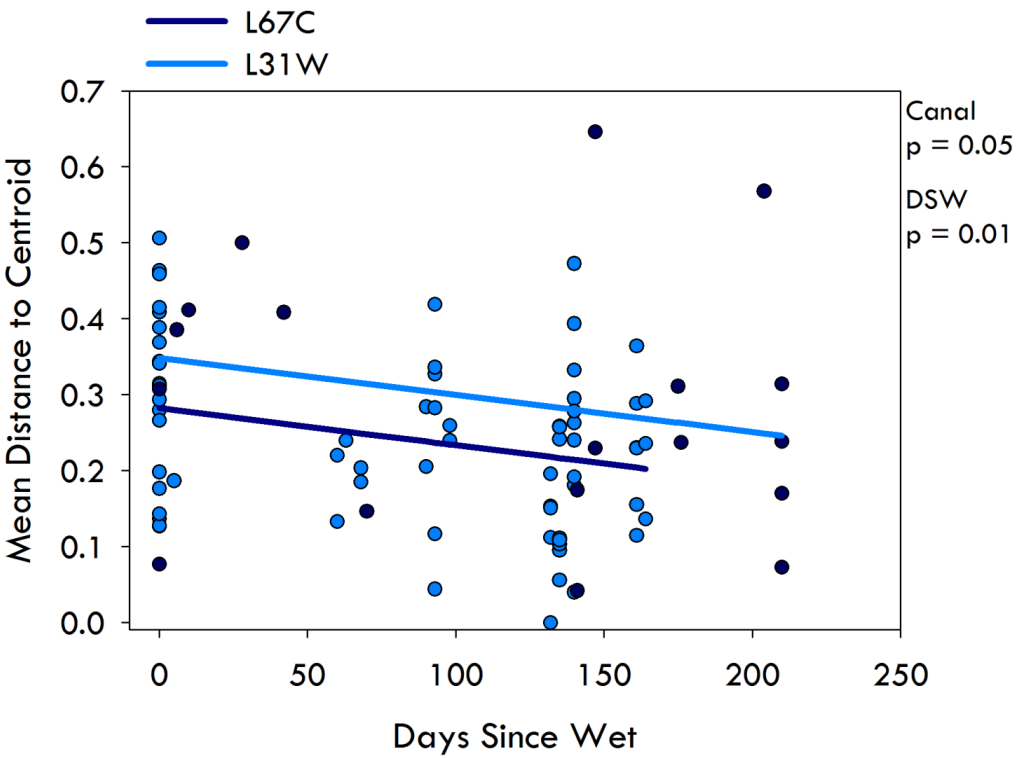


- No significant relationship between the density of large fish and presence of school.

Results



- Mean distance to centroid decrease as dry season prolongs.
  - Fish are forming smaller, compact groups.
- Schools are more compact in the L67C than L31W.

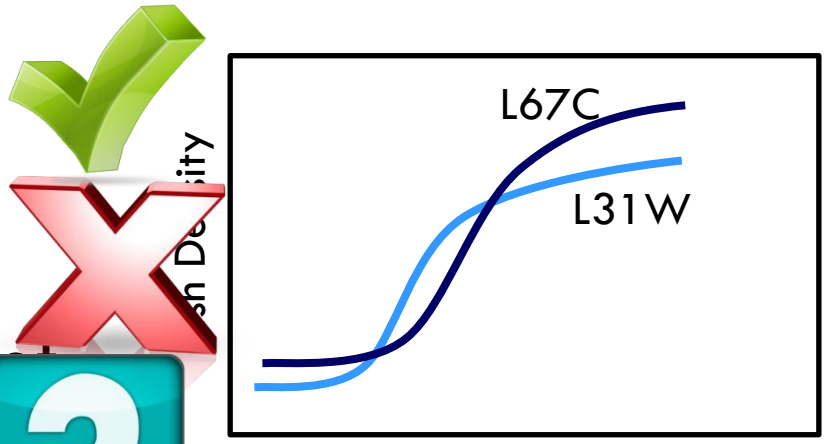


Summary

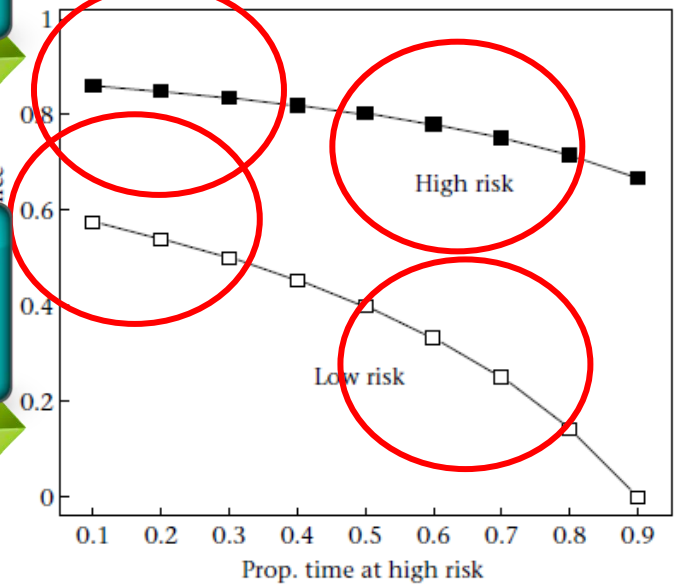
- Fish density increased as the “days since wet” increased.
  - Densities similar in two canals until day 75, then L67C has higher densities.
- Schooling frequency increased as the “days since wet” increased.
  - Probability of detecting a school is higher in the L67C than L31W.
- Schools became more compact in shape as “days since wet” increased.

Hypotheses

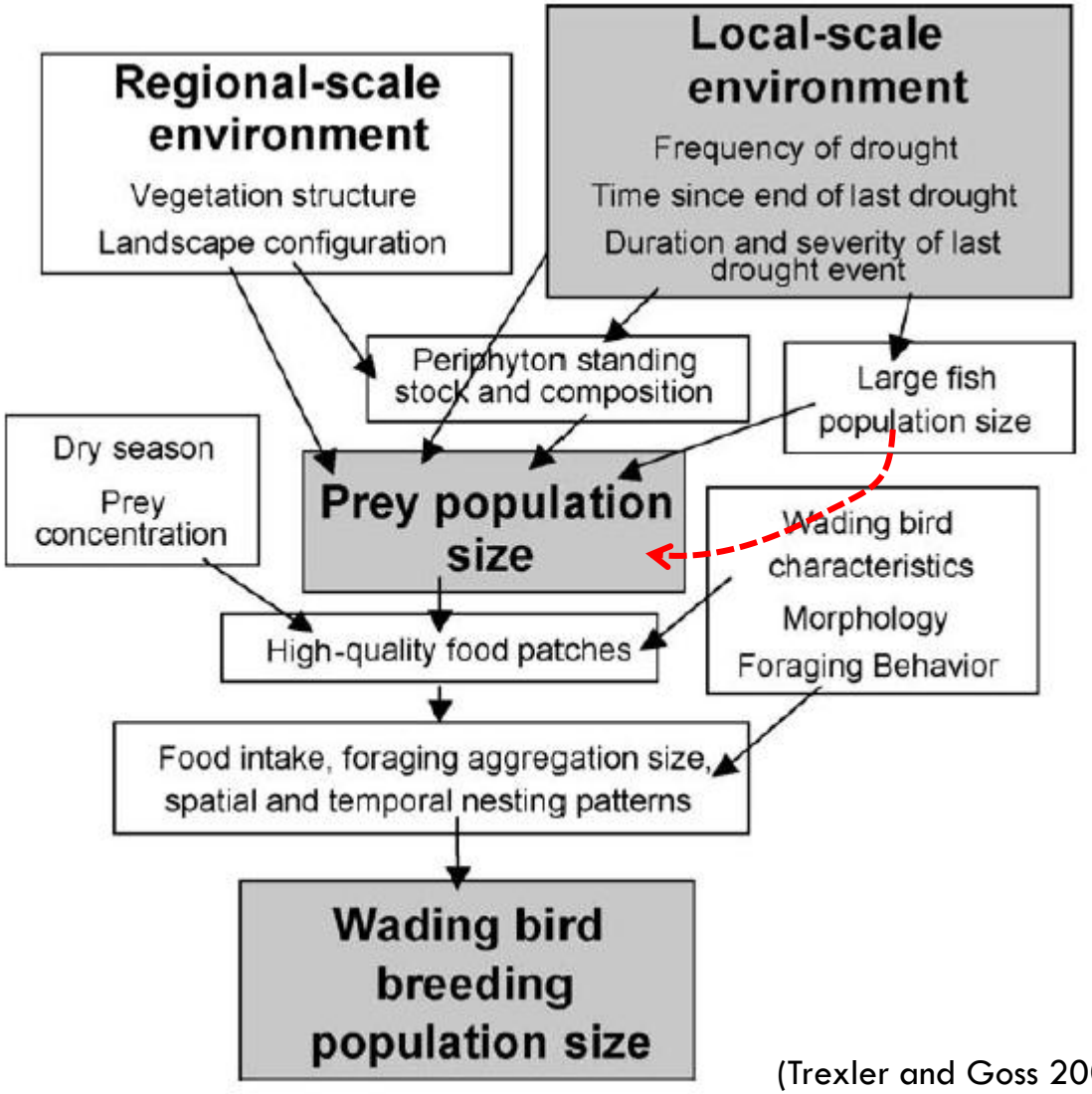
- Fish density will increase with the onset of the dry season and then stabilize.
- If exposed to risk in the w season:
  - Prey fish in the L67C would show higher vigilance than the L31W
- If exposed to risk in the d season:
  - Prey fish in the L67 would show higher vigilance than in the L31W



Wet ----------> Dry Season



Implications



(Trexler and Goss 2009)

Acknowledgements

- Field and lab assistance
  - Jim Easton
  - Adriana Weil
  - Eric Fortman
  - Mike Bush
- Funding Sources
  - USGS DECOMP Physical Model
  - Everglades National Park Interim Operations Plan

Questions?