Predicting Response of Small Marsh Fishes to Hydrologic Variation in the St. Johns River, Florida USA

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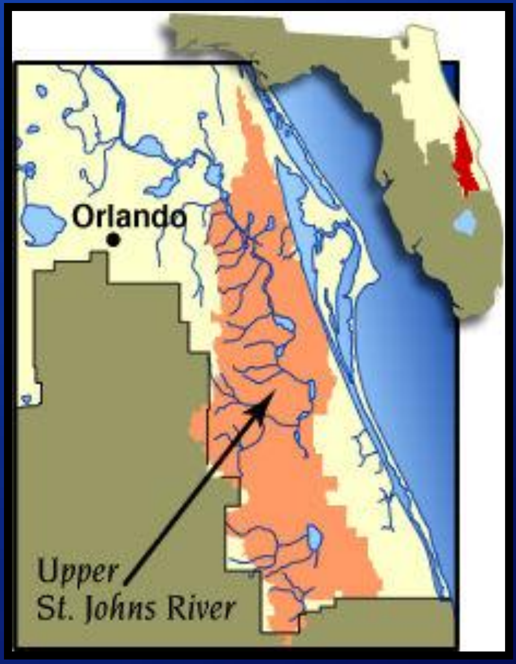
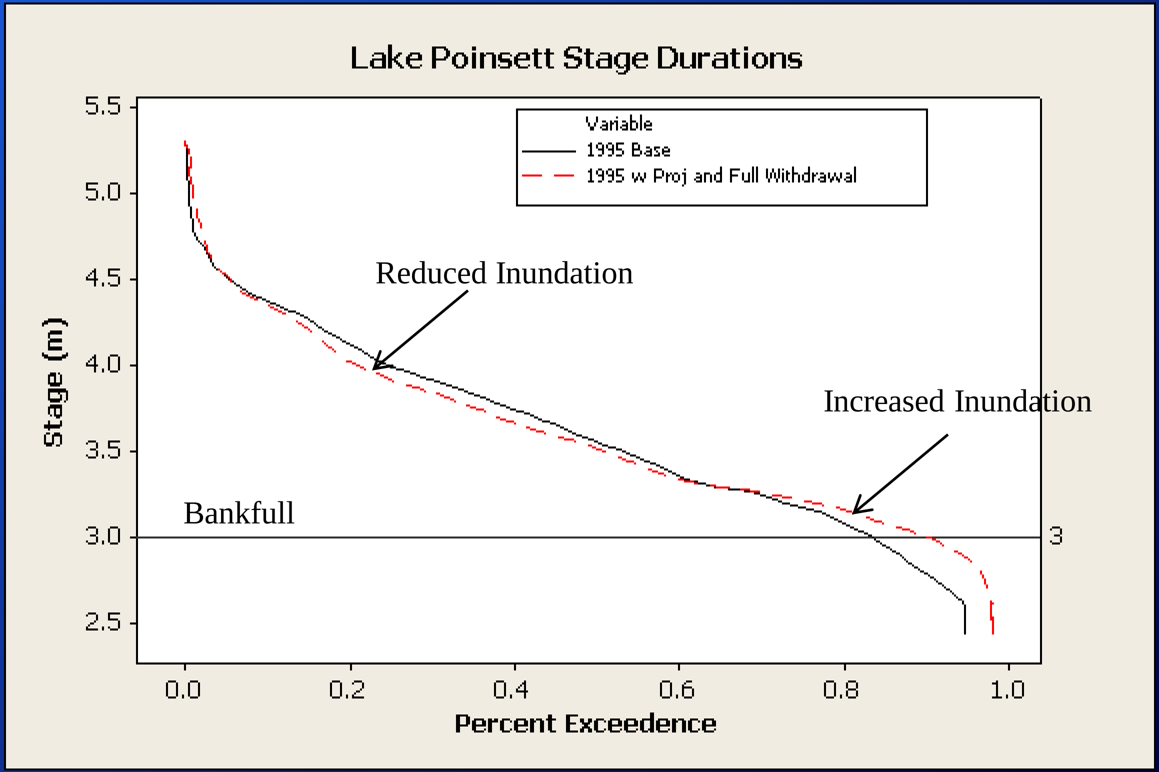
Objective:

To present and discuss a simple model relating small fish densities to flooding duration that we used to assess potential effects of surface water withdrawals on the St. Johns River ecosystem.



Why a focus on small fishes?

Greatest withdrawal effects were on duration of floodplain inundation



Typical St. Johns River Floodplain Habitat

Fish Community of Floodplain Marshes

Dominated in Numbers and Diversity by:

- Poeciliids (live-bearers)
- Fundulids (topminnows and killifishes
- Cyprinodontids (flagfishes)
- Elassomatids (pygmy sunfish)
- Centrarchids (small sunfishes)

Mosquitofish

Bluefin kiilifish

Least killifish

Everglades pygmy sunfish

Golden topminnow

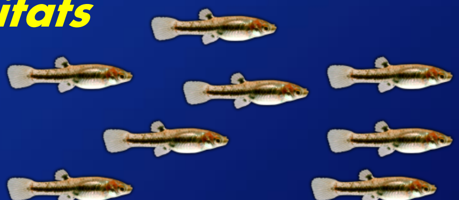
Sailfin molly

Flagfish

Common Species Attributes:

- Small size (< 8 cm SL)
- Found almost exclusively in dense vegetation
- Short life spans
- Mature rapidly
- Have protracted spawning seasons
- Tolerant of low dissolved oxygen
- Tolerant of high water temperatures

These characteristics make them highly adapted to occupying and becoming abundant in seasonally flooded shallow floodplain habitats



Important Food Web Link

Sport Fishes

Primary Production

Invertebrates → Small Marsh Fishes →

Wading Birds

Detritus

Only Limited Sampling of the Small Fish Assemblage has Occurred in St. Johns River Marshes

Blue Cypress

Avg. Density = 280,00 fish ha $^{-1}$

Biomass= 35.3 kg ha $^{-1}$ (32 lbs ac $^{-1}$)

Lake Washington

Avg. Density = 45,000-230,000 fish ha $^{-1}$

Biomass= 15-133 kg ha $^{-1}$ (13-101 lbs ac $^{-1}$)

Relationship between abundance and hydrology unknown

Everglades $$$$

St. Johns $$

SJR

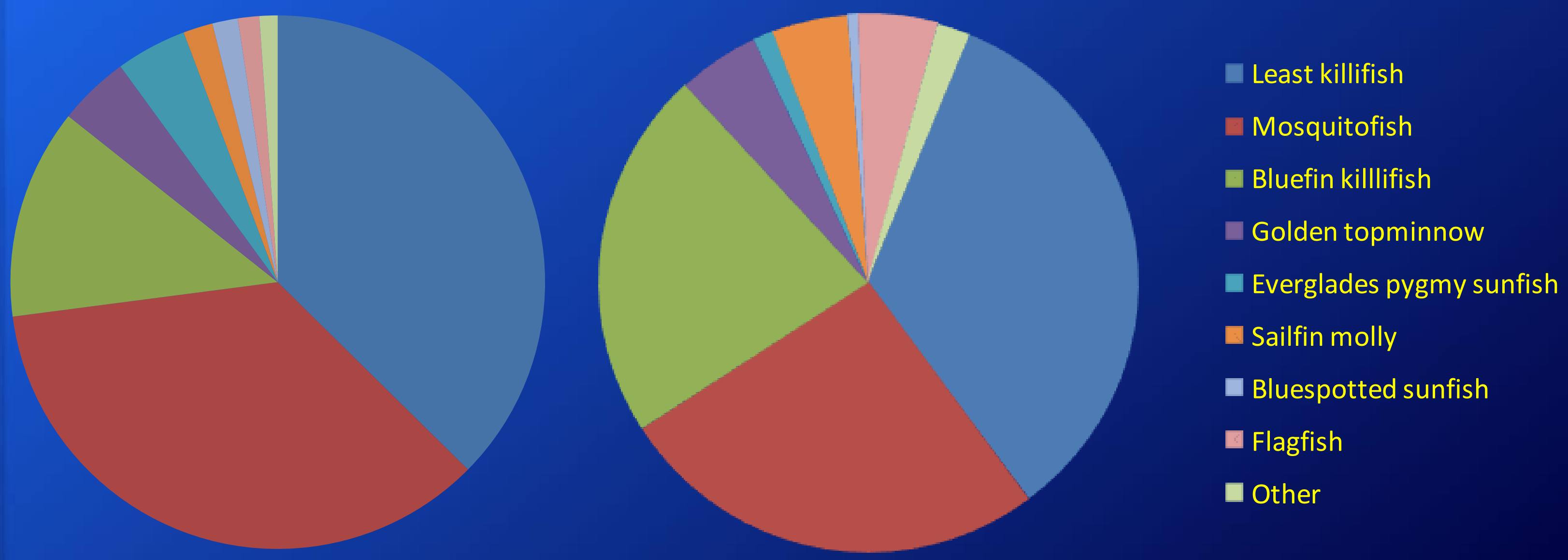
Everglades

Duration of flooding most important factor regulating abundance of small marsh fishes. explaining 60-70% of observed variability

Comparison of Small Fish Assemblage

Blue Cypress Marshes

Everglades



Same dominant top three species in other St. Johns marsh samples. Everglades data from Trexler et .al .2002

DeAngelis, D. L., W. F. Loftus, J. Trexler, C., and R. E. Ulanowicz. 1997. Modeling fish dynamics and effects of stress in a hydrologically pulsed ecosystem. Journal of Aquatic Ecosystem Stress and Recovery 6: 1-13.

Model Included:

- Effects of changes in water level on abundance of fishes
- Interactions of fishes with their resource base of periphyton, macrophytes, meisoinvertebrates, macroinvertebrates and detritus,
- Interactions of small and large predatory fishes
- Effect of deeper water refugia

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Conclusions regarding small fishes

- Access to deep water refugia is important
- There is an effective threshold in hydroperiod length (>9 months) needed to reach high fish densities
- Large piscivorous fishes do not appear to have major impact on small fishes in marsh habitat
- Recovery following a drought may take up to a year

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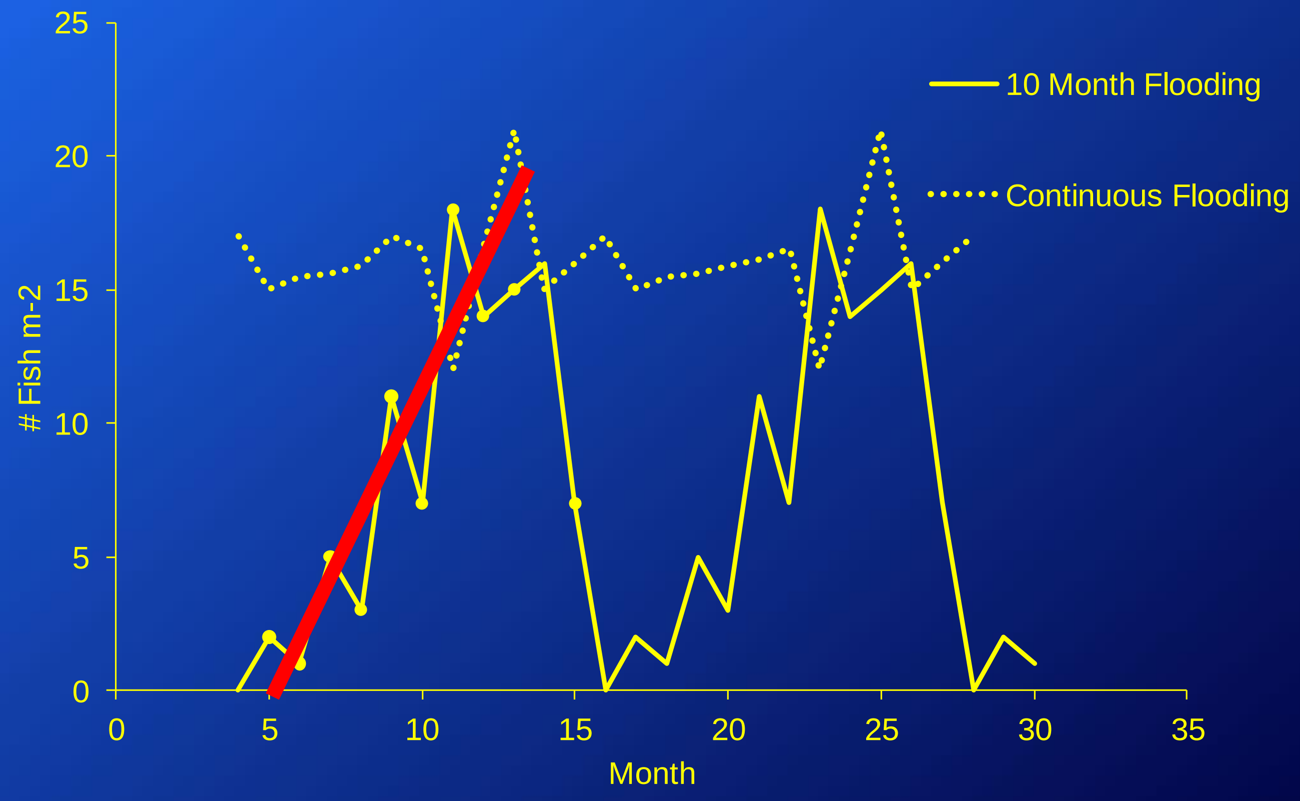


Predicted small fish densities under 10 months flooding followed by 2 months drying

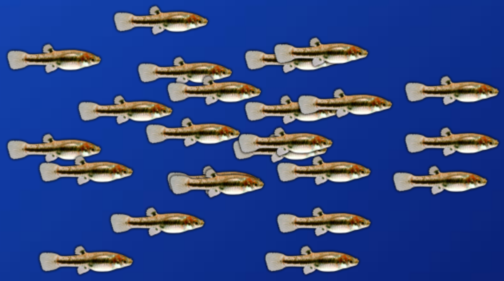
To look water withdrawal effects need :

1). Estimate of fish density as a function of flooding duration

2). Predicted hydrology

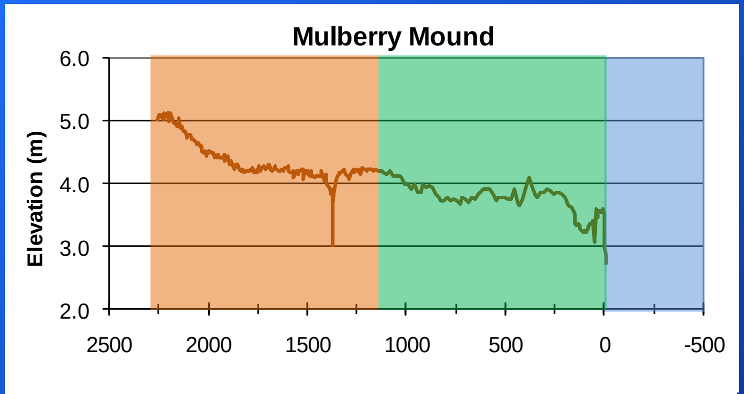
3). Stage area-curves, DEM, or surveyed transect data

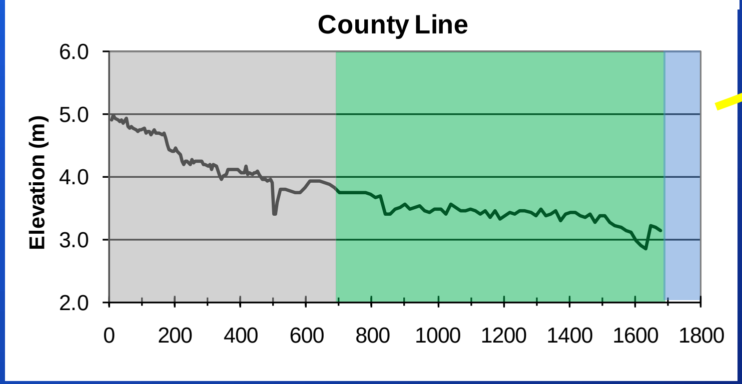
Baseline

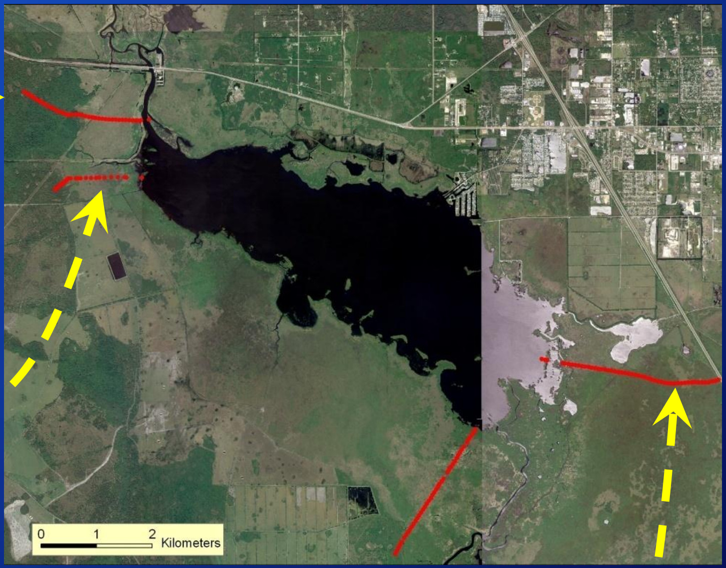


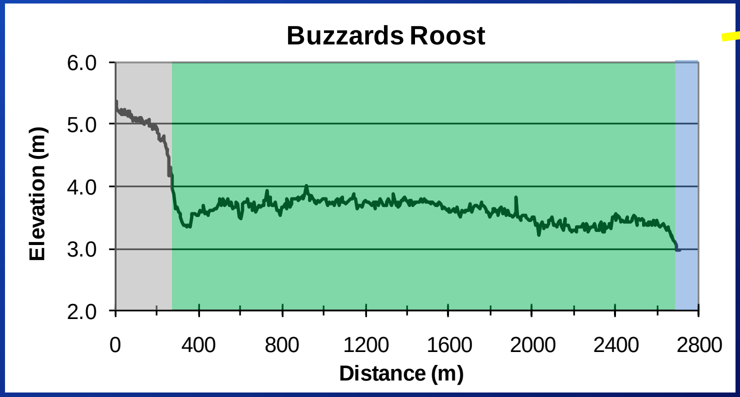
Withdrawal

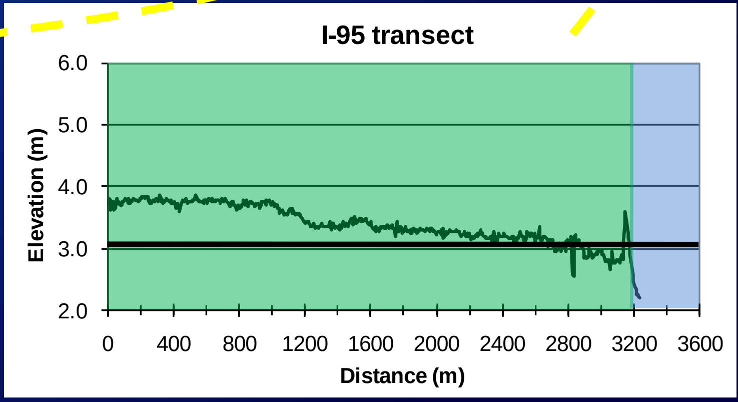
We used survey transect data collected for MFL's

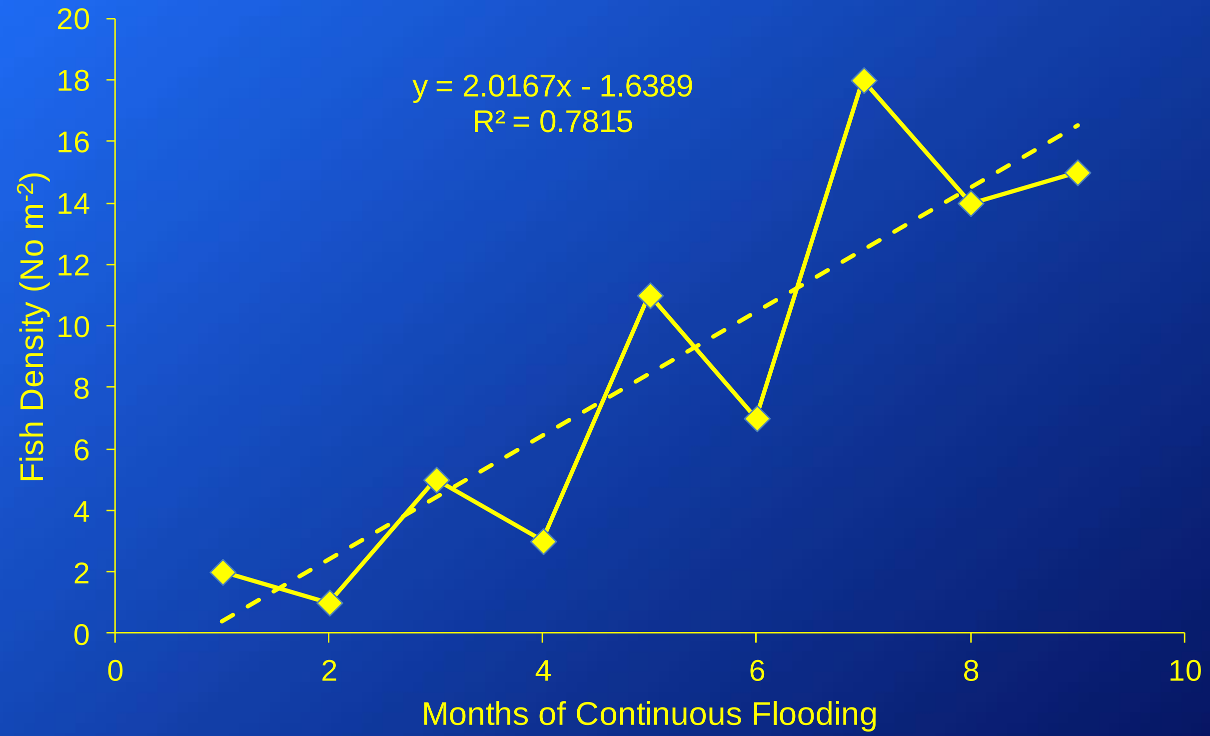






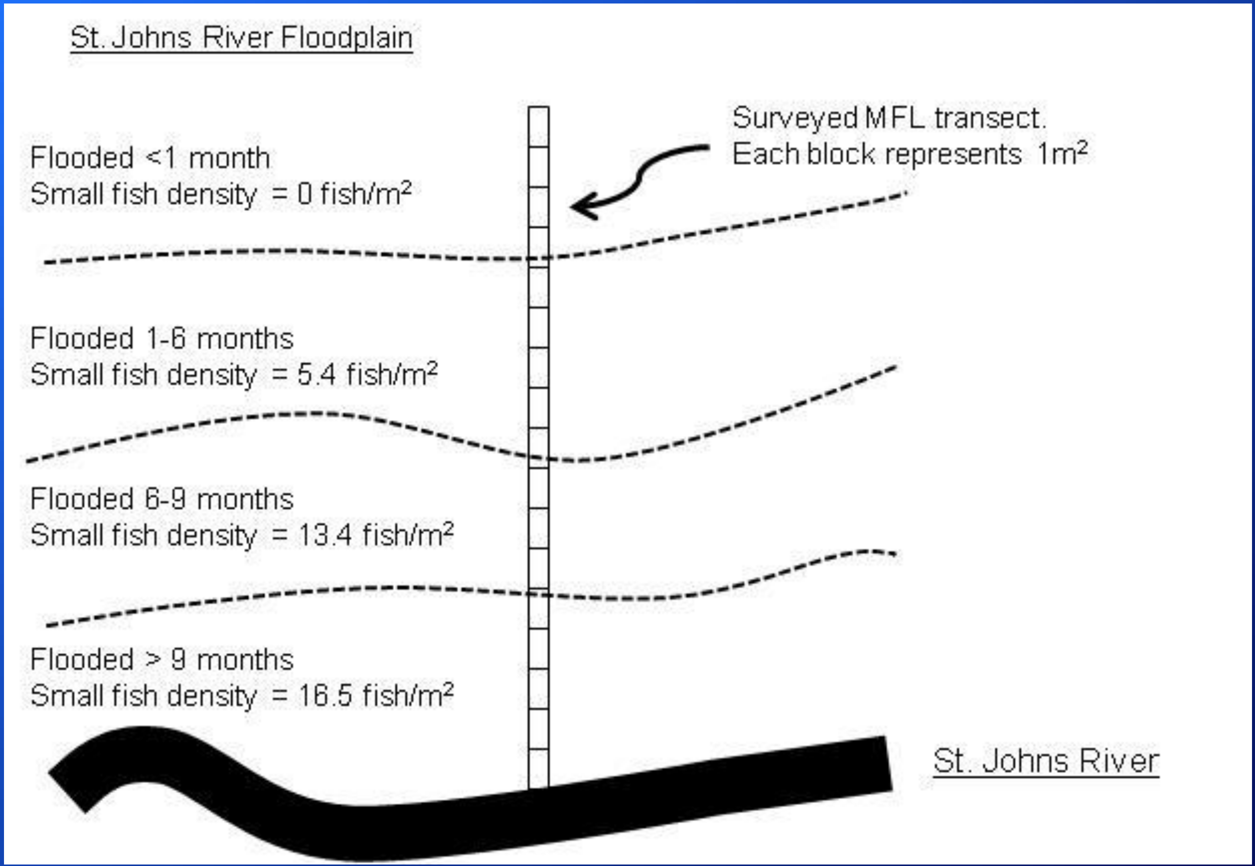






Derived estimated density for 4 flooding categories

0-1 Months	0 fish m^2
1-6 Months	5.4 fish m^2
6-9 Months	13.4 fish m^2
> 9 Months	16.5 fish m^2

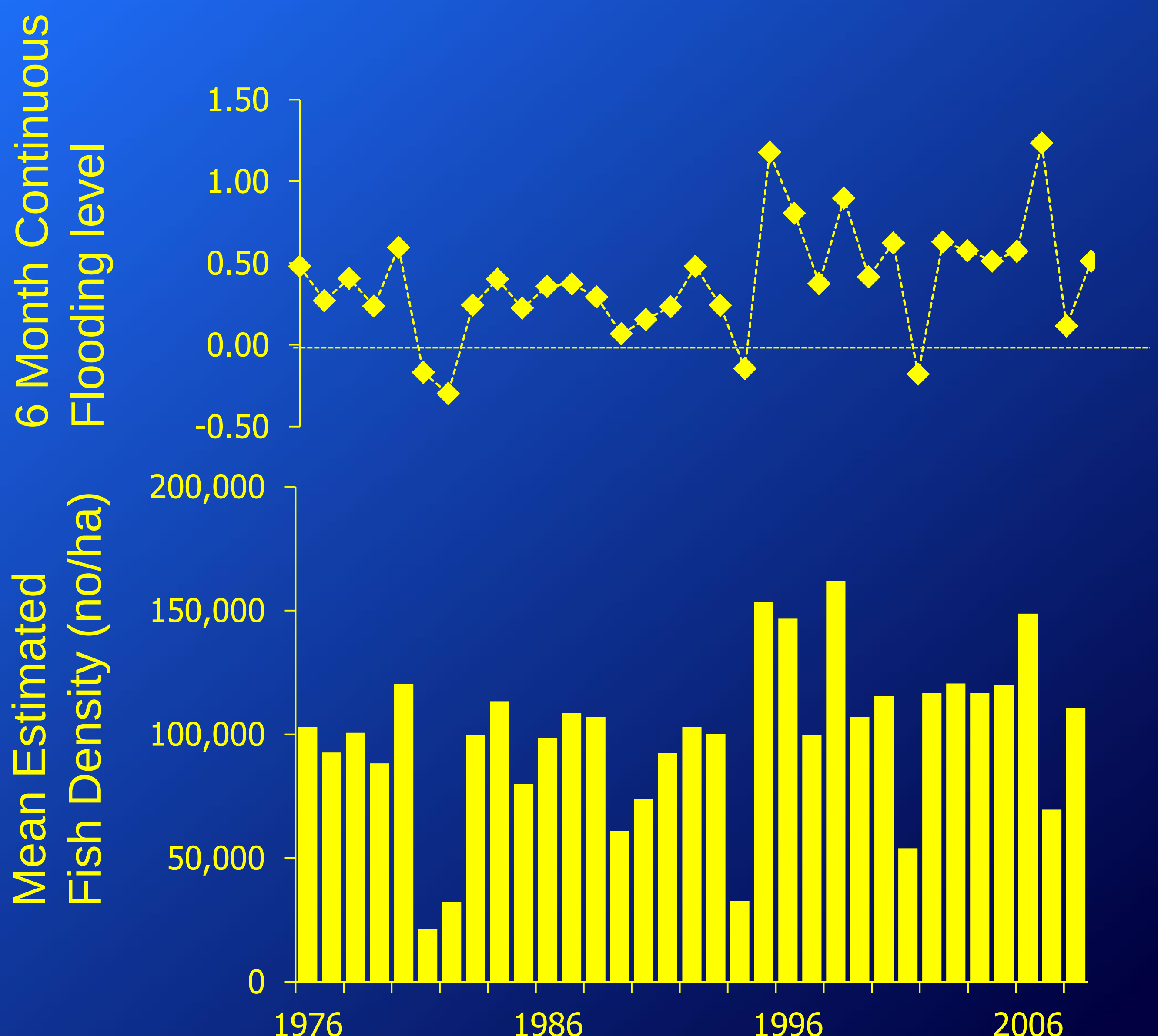


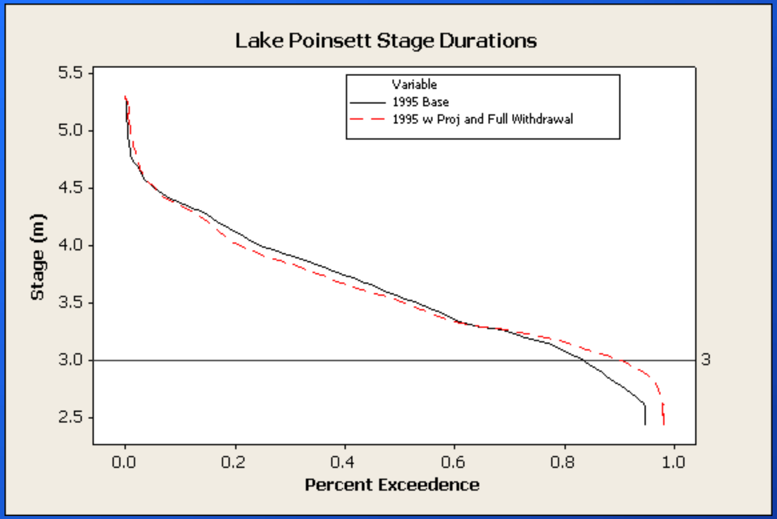
Total Small Fish Abundance = Area flooded < 1 month X 0
+ Area flooded 1 to 6 months X 5.4 fish m^{-2}
+ Area flooded 9 to 9 months X 13.4 fish m^{-2}
+ Area flooded > 9 months X 16.5 fish m^{-2}

Total Small Fish Biomass = Total small fish abundance X 0.4 g fish

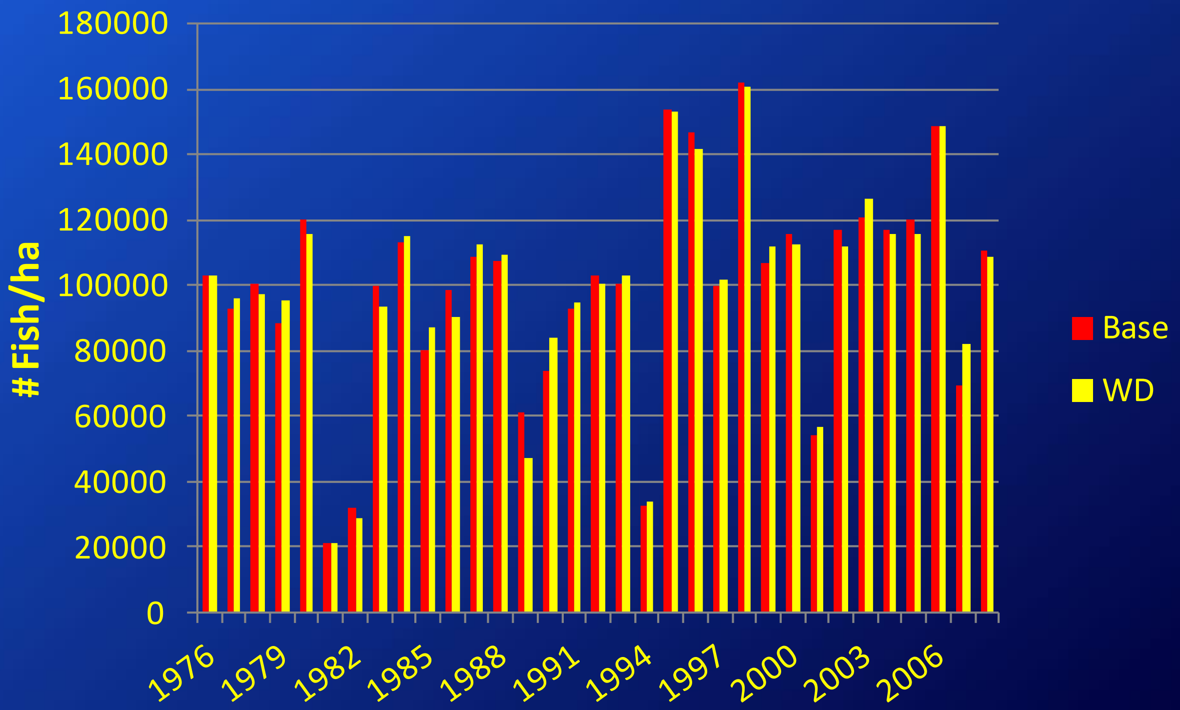
Results extrapolated to No/ha for entire floodplain x-section

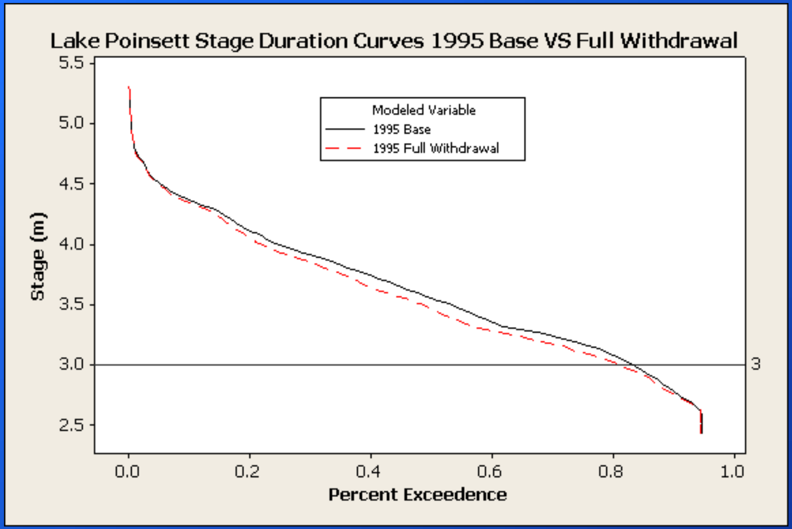
Maximum Abundance (I 95 Transect –Lake Poinsett)



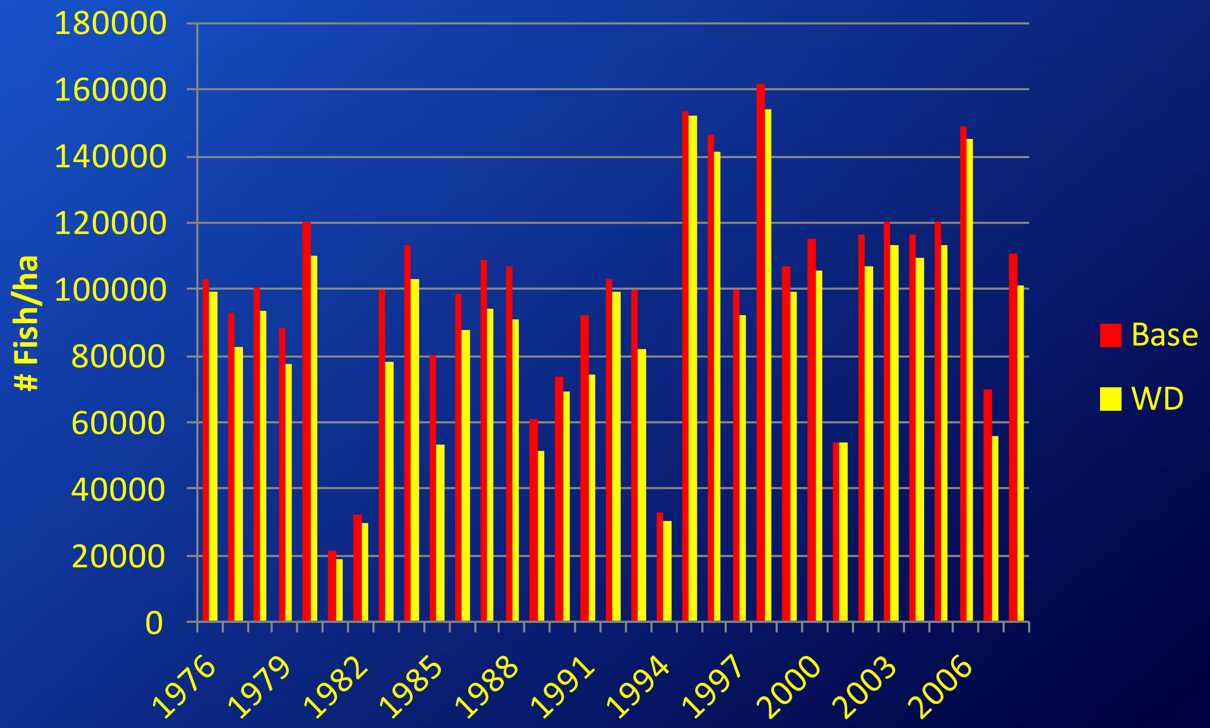


Mean fish density increased 0.2% under withdrawal scenario due to augmentation





Mean fish density decreased 10.3% under extreme withdrawal scenario



Changes in Modeled Biomass of the Small Fish Assemblage

Site	0/95/-USJP/SLR	/95/-USJP/SLR		/95/+USJPR/SLR		/30/+USJR /SLR+	
Withdrawal (mgd)		155	77.5	155	77.5	155	77.5
Lake Poinsett/SR520	(kg/ha)						
I 95	37.82	-10.3%	-5.6%	+0.2%	+2.4%	+4.1%	+6.5%
Buzzards Roost	26.65	-12.8%	-6.9%	-3.7%	+2.0%	+2.1%	+7.7%
County Line	26.73	-12.8%	-6.1%	-2.7%	+0.1%	+1.8%	+5.4%
Mulberry Mound	16.21	-8.1%	-4.3 %	-8.3%	-4.5%	-1.7%	+3.6%
Tosohatchee @ 528	21.11	-11.1%	-5.8%	-3.6%	+0.3%	+2.7%	+7.4%
Great Outdoors	24.77	-9.0%	-7.6%	-6.6%	+0.2%	+4.4%	+10.4%
Tosohatchee North	16.94	-7.3%	-4.2%	-6.6%	-3.3%	-0.1%	+5.2%
H1	27.55	-10.1%	-5.5%	-5.2%	-1.7%	+2.9%	+6.6%
Lake Monroe	12.01	-3.8%	-2.3%	-1.3%	-0.8%	+2.2%	+4.1%
North Emanuel Bend Transect 2	16.60	-10.7%	-4.0%	-8.5%	-2.5%	+2.5%	+2.5%
Pine Island	21.41	-12.0%	-6.1%	-11.7%	-2.0%	+3.9%	+7.9%
Lake Woodruff	34.65	-0.2%	0.0%	-0.6%	-0.4%	+1.2%	+4.5%
Dexter Point	38.40	-1.8%	-0.6%	-2.5%	-0.6%	+0.9%	+3.2%

Conclusions:

Model is useful for predicting relative abundance (%) changes between baseline conditions and various withdrawal scenarios for the St. Johns River.

Our approach predicts maximum abundance on entire floodplain at site specific transect locations. Results are useful only for scenario comparisons at these transect locations .

Our numbers do represent accurate small fish densities on the floodplain at any particular point in time.

Wide interannual variability in floodplain production may make withdrawal effects difficult to detect.

Questions???