INTECOL 2012

Loxahatchee Impoundment Landscape Assessment (LILA):

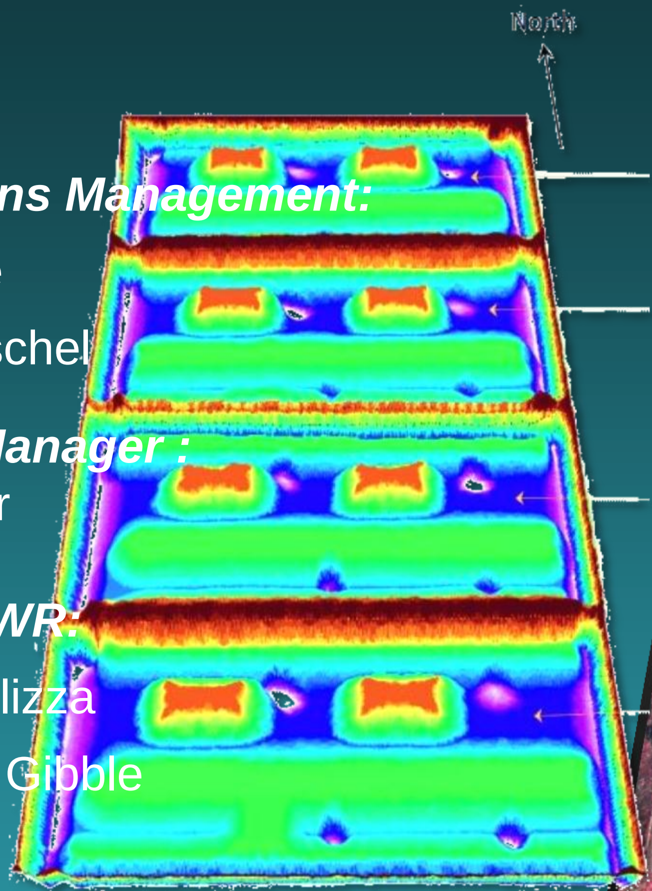
Large Scale Physical Model Replicating the Everglades Landscape

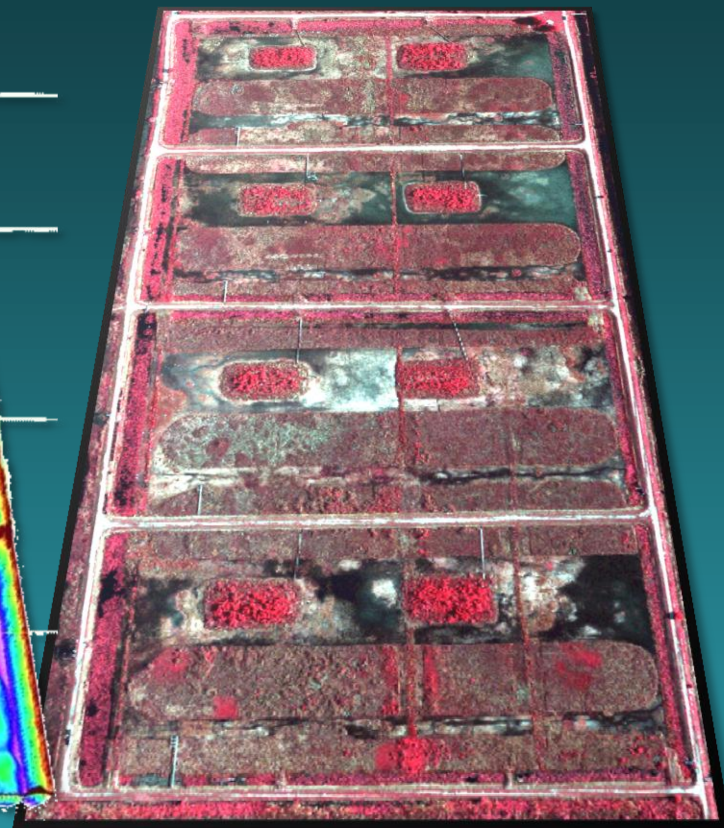
Eric Cline

Environmental Scientist
South Florida Water Management District
Everglades System Assessment Unit

sfwmd.gov

Loxahatchee Impoundment Landscape Assessment (LILA):





Operations Management:

Eric Cline

Tom Dreschel

Project Manager :

Fred Sklar

ARM LNWR:

Sylvia Pelizza

Rebekah Gibble

US Army Corps of Engineers ®

Southeast Environmental Research Center

Working to Restore and Protect our Unique Environment

Presentation objectives:

- **LILA toolbox**
- **How those tools have been used**

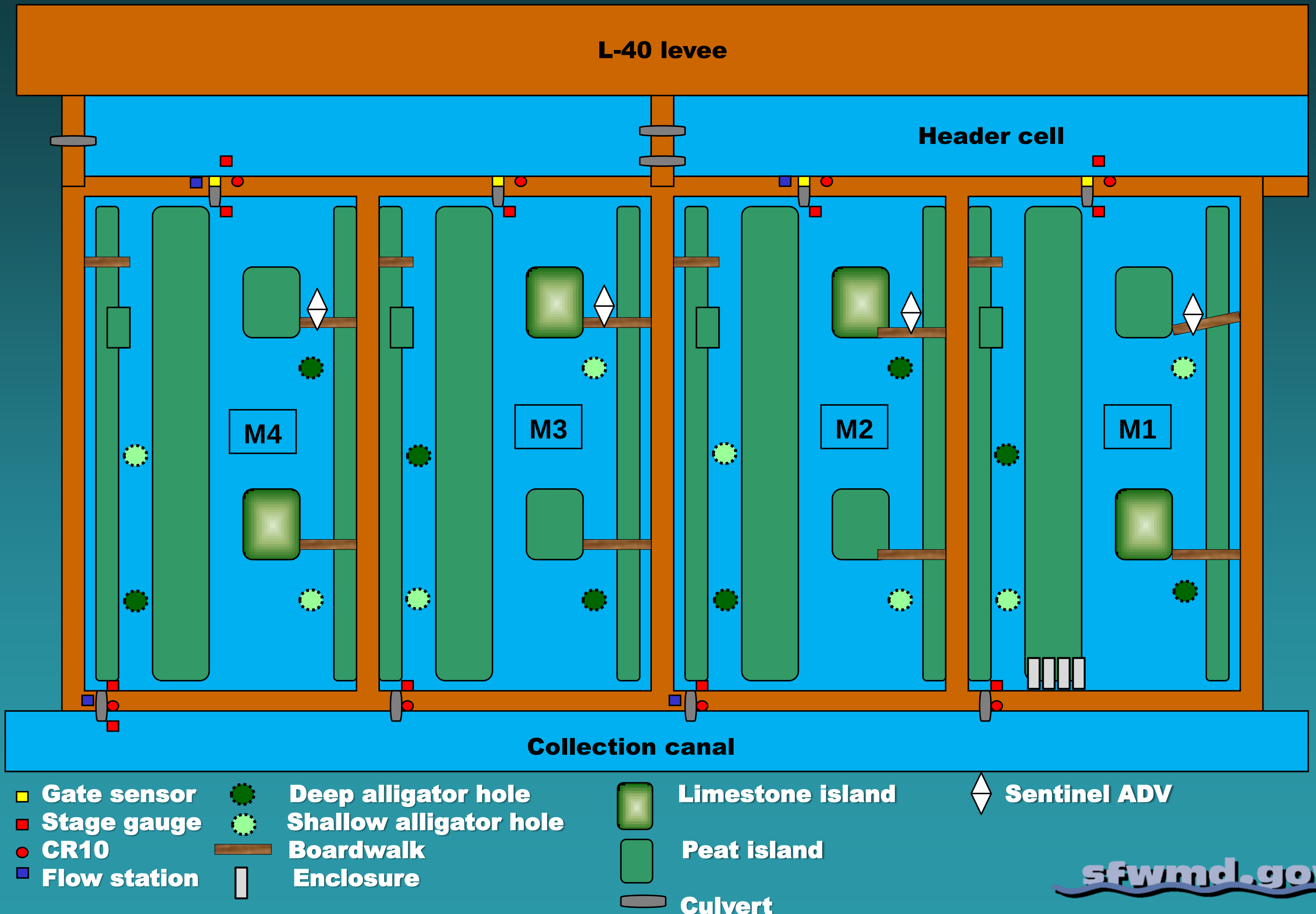
Objective:

Using LILA defined hydrologic regimes that sustain a healthy Everglades ecosystem including *tree island*, *ridge and slough* and *wading bird* communities

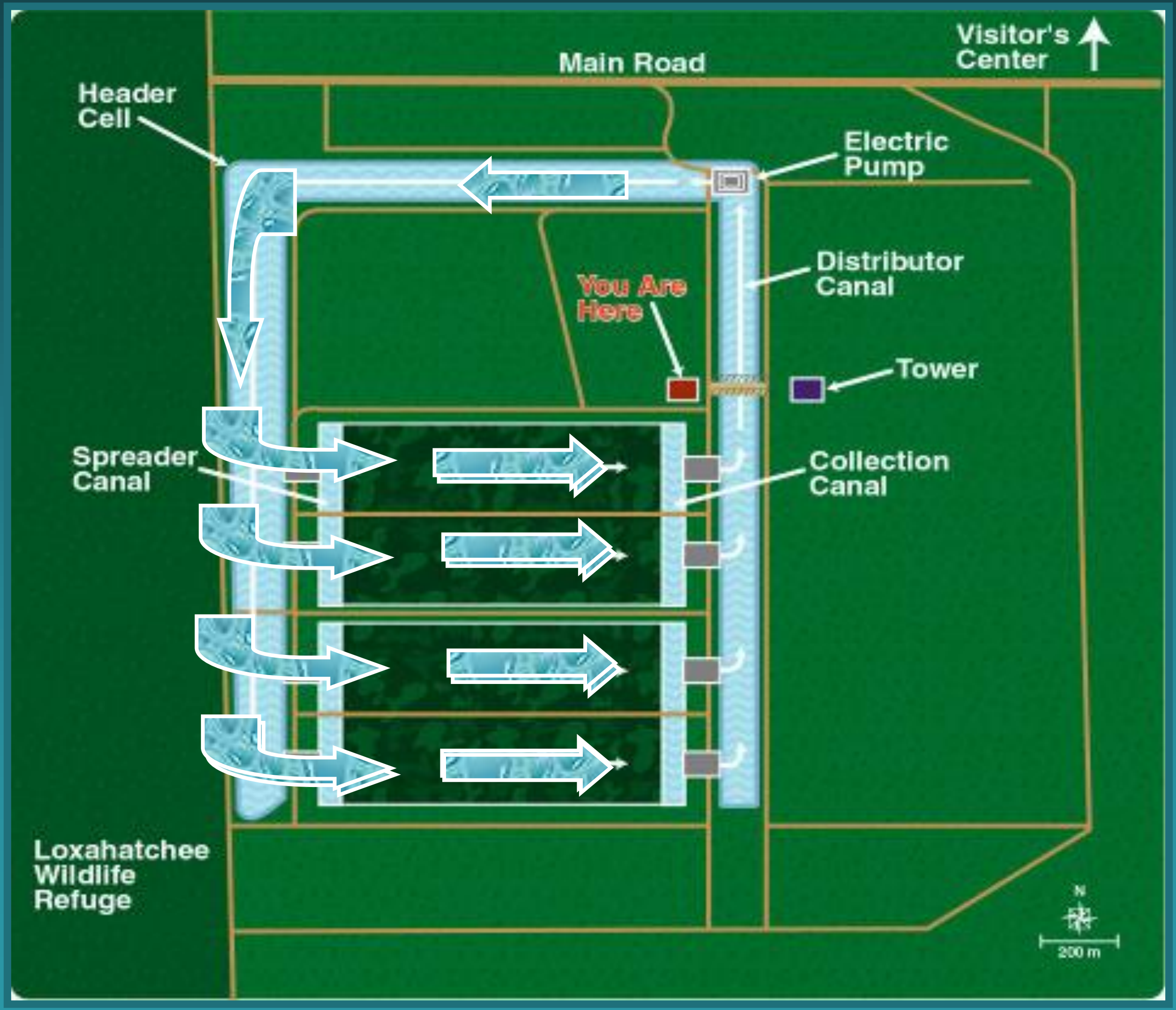
Hydrologic Control and Monitoring System

- 45,000 GPM electric pump
- Stilling well and float stage sensor (X12)
- Isco and Sontek shallow water uplooking ADV (x5)
- Custom notched flash boards
- ADV (point measure) (X9) & flow tracker

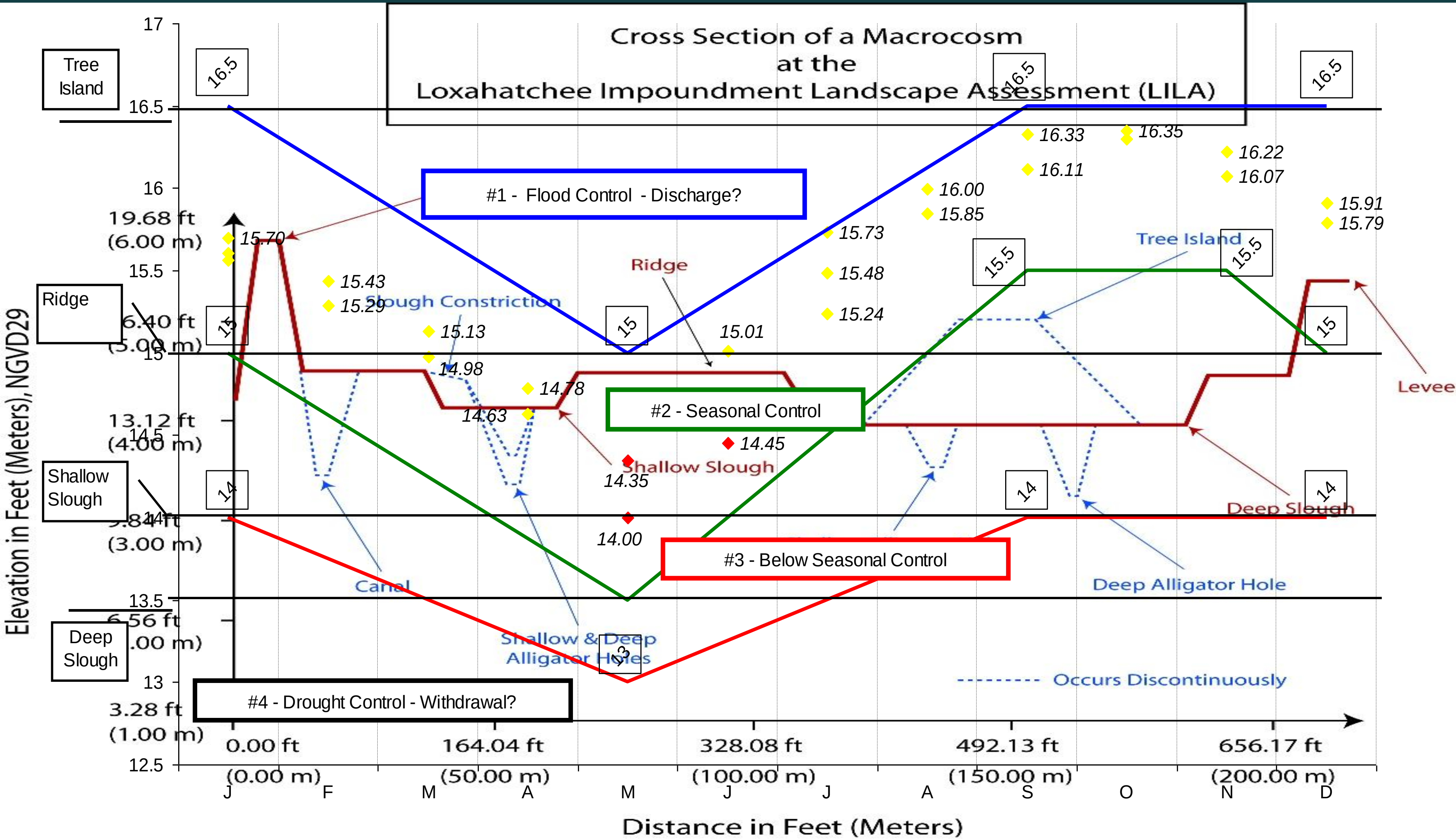
Hydrologic Control and Monitoring System



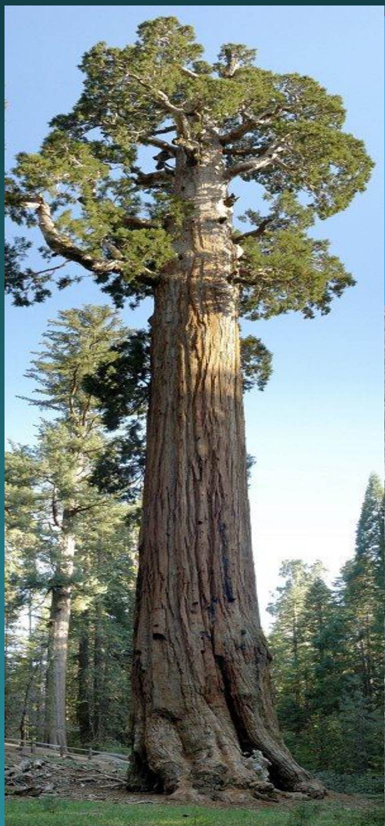
Hydrologic Control and Monitoring System: Flow

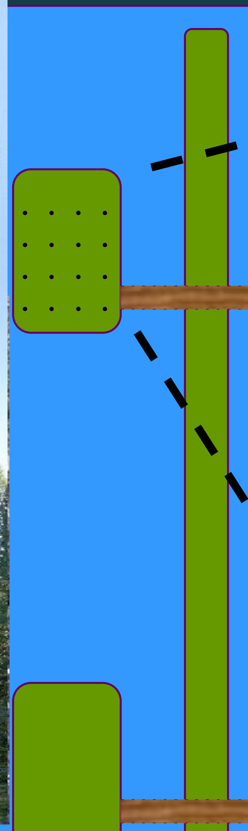


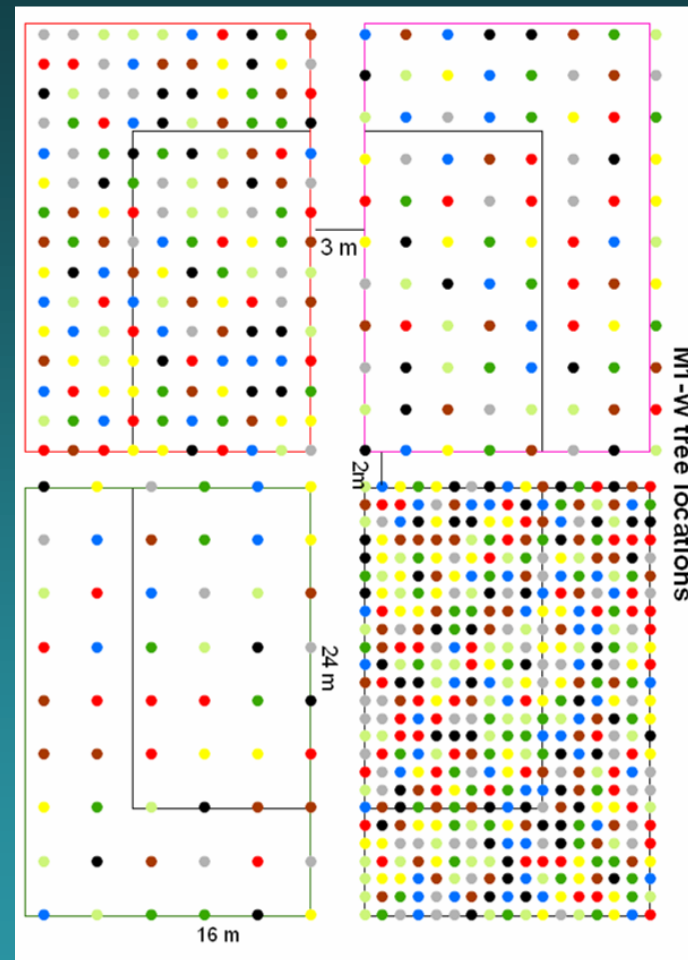
Hydrologic Control and Monitoring System: Stage



LILA Tree Island Tool Box: Trees

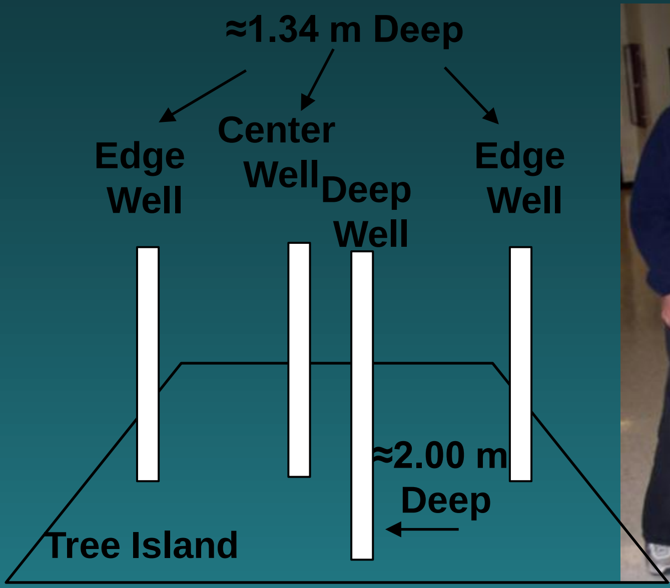


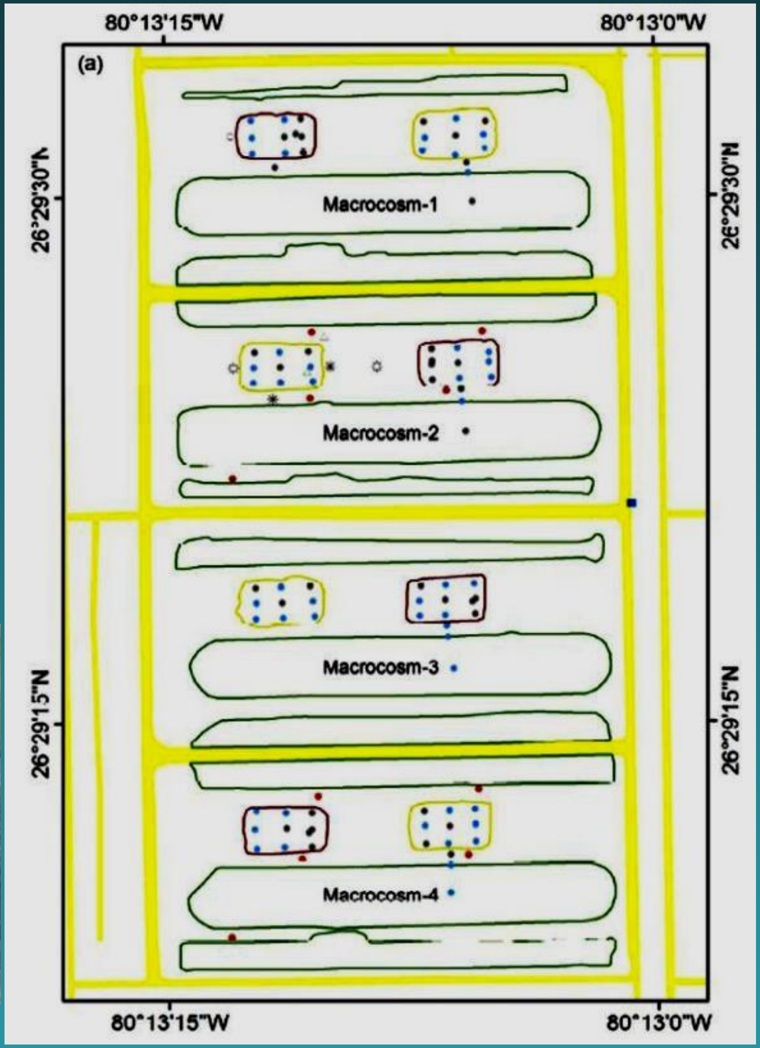




Five –thousand seven-hundred and thirty-six (5,736) native trees

LILA Tree Island Tool Box: Well points





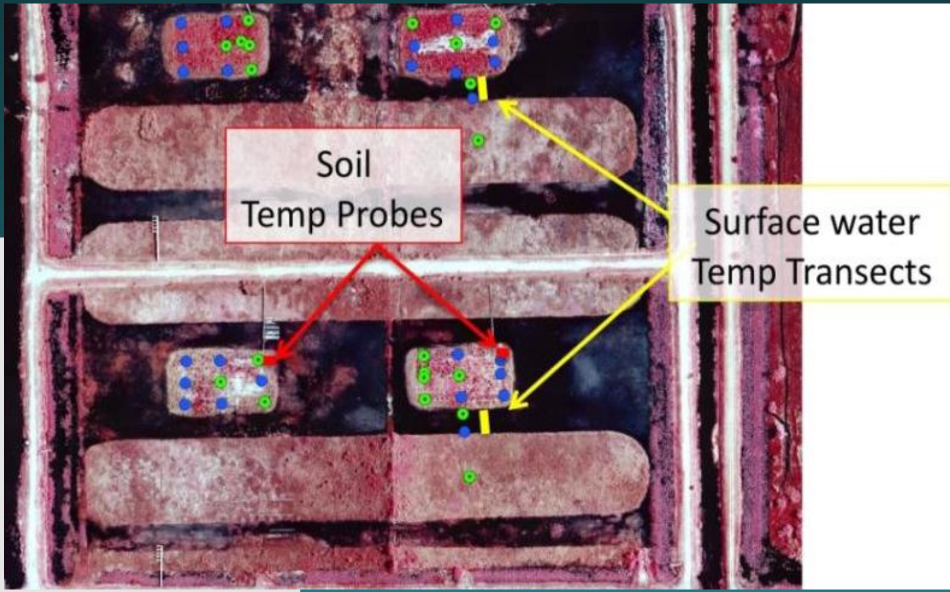
Seventy-six (76) groundwater wells on islands

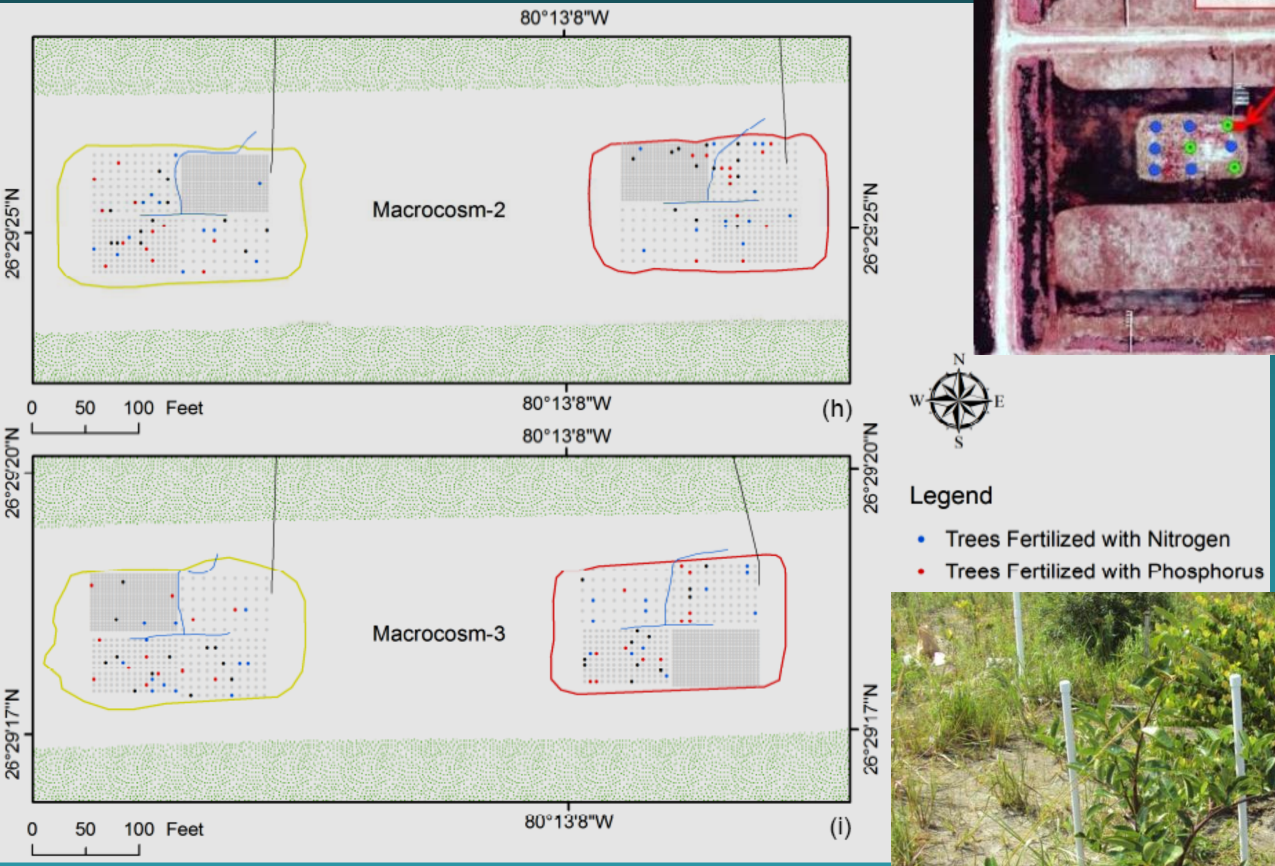
Twelve (12) well points in sloughs/ridges

LILA Tree Island Tool Box: Surface Elev. Tables

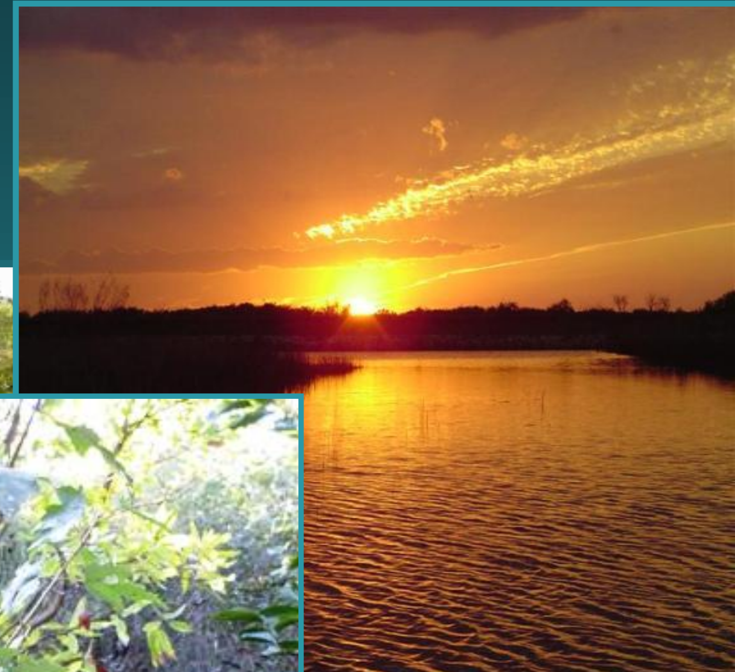
Thirty-six (36) SETs & Feldspar and Litter traps (X3)

LILA Tree Island Tool Box: Shallow well & Soil temp

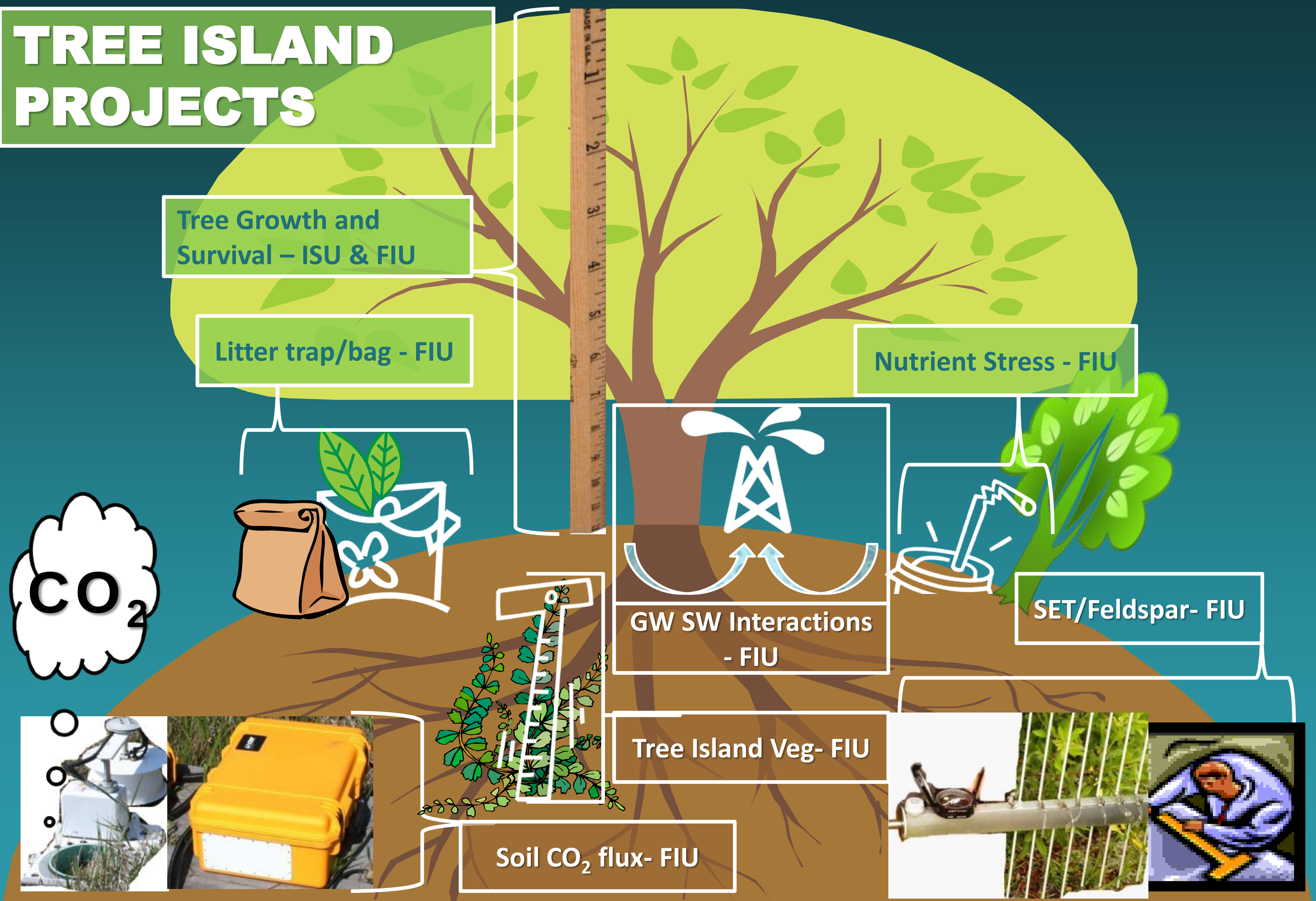


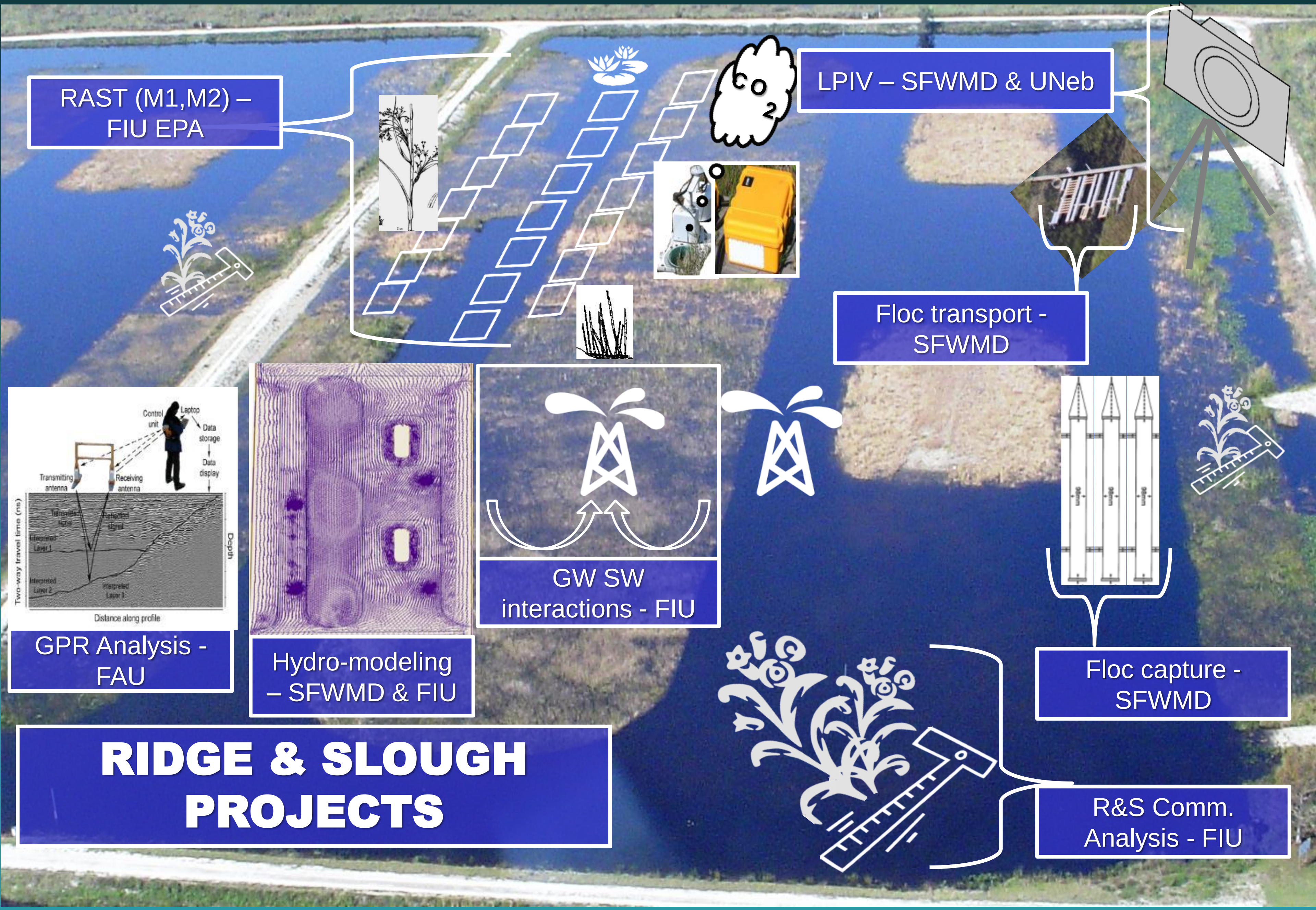


Research Overview

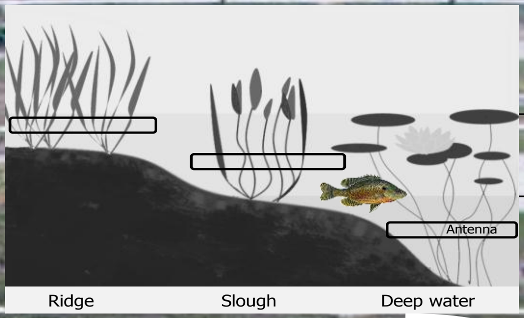


TREE ISLAND PROJECTS




RAST (M1,M2) – FIU EPA
CO_2
LPIV – SFWMD & UNeb
Floc transport - SFWMD
GPR Analysis - FAU
Hydro-modeling – SFWMD & FIU
GW SW interactions - FIU
Floc capture - SFWMD
R&S Comm. Analysis - FIU
RIDGE & SLOUGH PROJECTS

WILDLIFE PROJECTS



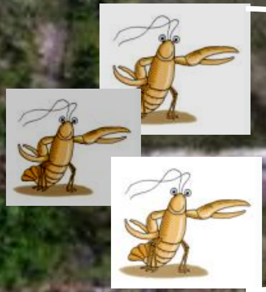
Fish Movement – FIU

Foraging success I & II – FAU

Predator Release – SFWMD & FAU

Non-native temp tolerance – SFWMD & USGS

Crayfish movement II – SFWMD & FAU



Crayfish movement I - SFWMD

Utilizing LILA's toolbox

LILA Research: Tree Island

Survival and growth responses of eight tree species along an hydrologic gradient on two tree island types

Mike Ross

Susanna Stoffella

Applied Vegetation Science

Survival and growth responses of eight Everglades tree species along an experimental hydrological gradient on two tree island types

Susana L. Stoffella, Michael S. Ross, Jay P. Sah, Rene M. Price, Pamela L. Sullivan, Eric A. Cline & Leonard J. Scinto

Abstract

A physical investigation of groundwater-surface water interaction

Rene' Price

Pamela Sullivan

Hydrologic processes on tree islands in the Everglades (Florida, USA): tracking the effects of tree establishment and growth

Pamela L. Sullivan · René M. Price · Michael S. Ross · Leonard J. Scinto · Susana L. Stoffella · Eric Cline · Thomas W. Drescbel · Fred H. Sklar

Abstract

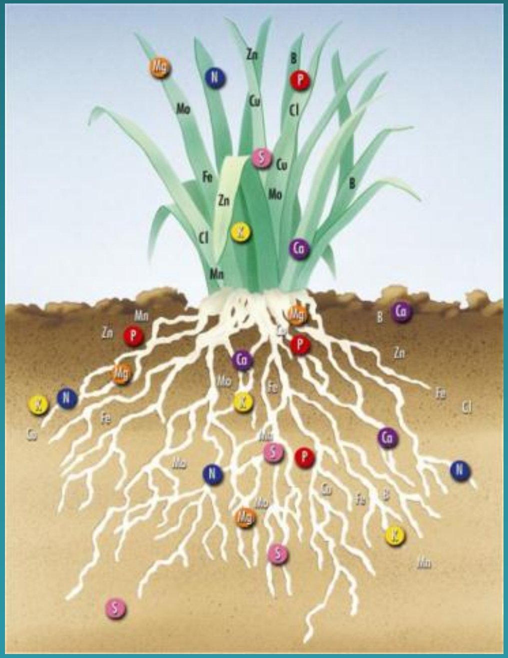
Keywords Groundwater/surface-water relations · Groundwater evapotranspiration · Tree islands · USA · Everglades

Introduction

Determination of nutrient limitation on trees growing on tree islands

Mike Ross

Suresh Subedi



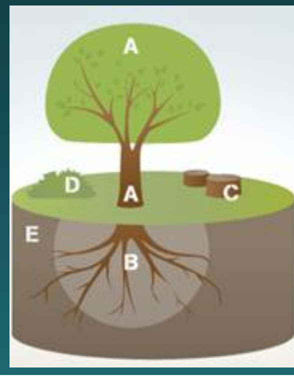
LILA Research: Tree Island

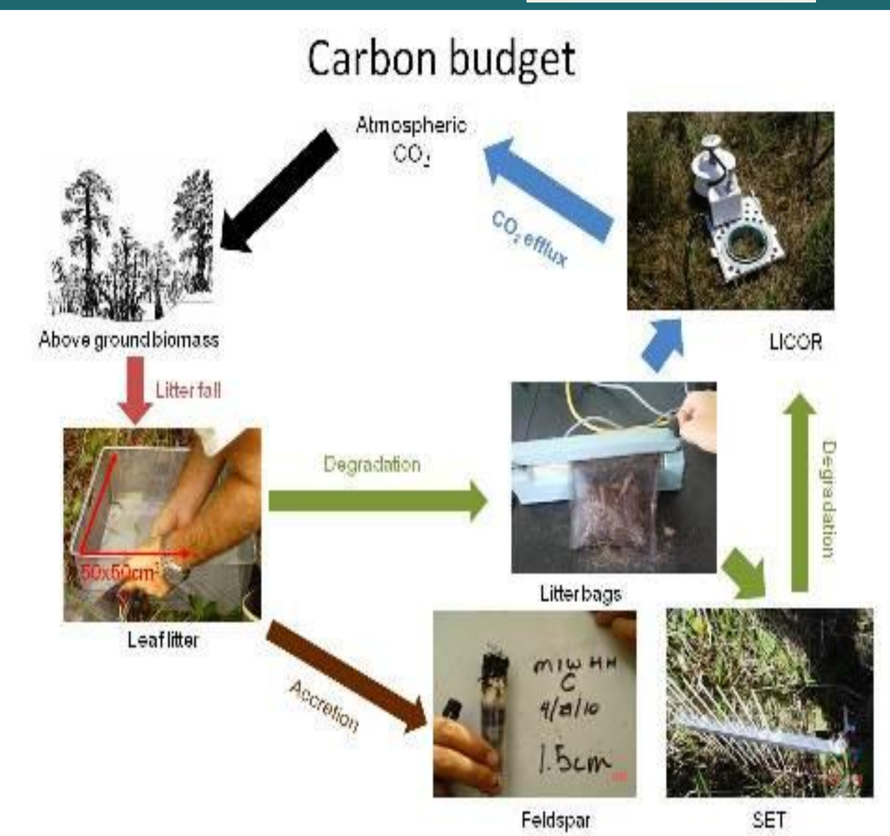
Tree Island Carbon Budget

Len Scinto

Ryan Desliu

Robert Schroeder



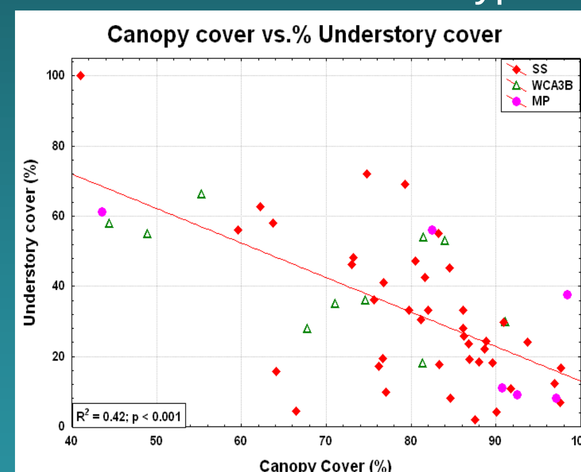


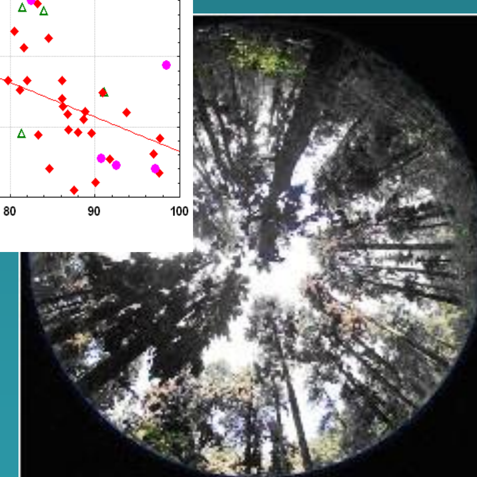
Tree Island Understory Vegetation

Mike Ross

Jay Sah

Understory biomass and species richness
Relationships with tree spacing, relative elevation and substrate type

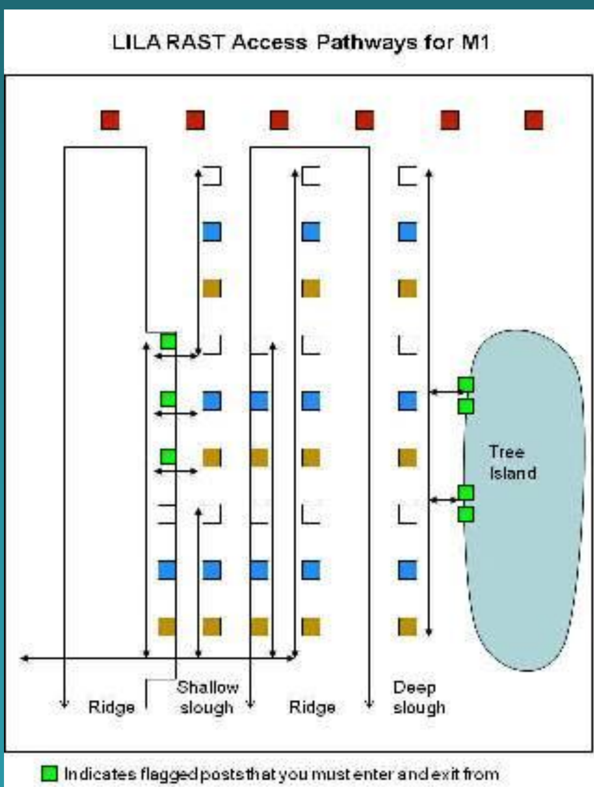




LILA Research: Ridge and Slough

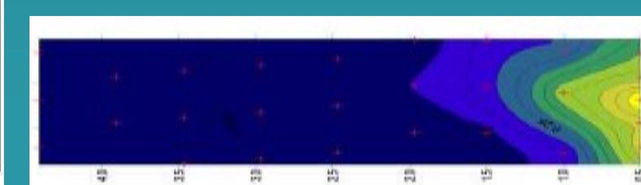
RAST: Ridge and Slough Transplant

Len Scinto
Jenny Richards
Ryan Desliu
Alex Serna



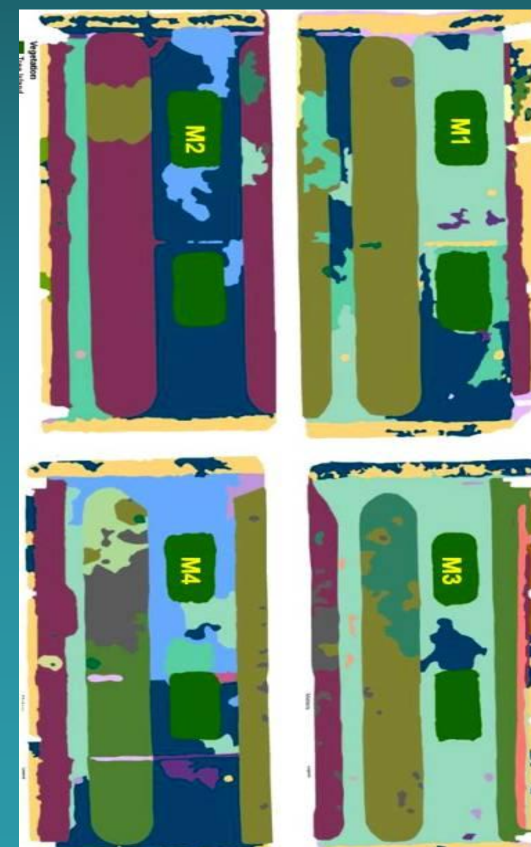
Characterization the Hydrodynamic Properties of Everglades Floc (POM)

Scot Hagerthey
Kevin Black
Sam Athey



Marsh Vegetation and Mapping

Mike Ross
Jenny Richards
Pablo Ruiz



LILA Research: Ridge and Slough

Preliminary non-invasive characterization of biogenic gas dynamics at M3E and M2SS (LILA) using ground penetrating radar

Xavier Comas

William Wright

WATER RESOURCES RESEARCH, VOL. 48, W04601, doi:10.1029/2011WR011654, 2012

Heterogeneity of biogenic gas ebullition in subtropical peat soils is revealed using time-lapse cameras

Xavier Comas[1] and William Wright[1]

Received 18 November 2011; revised 11 February 2012; accepted 7 March 2012; published 12 April 2012.

[1] We tested a set of biogenic gas traps combined with time-lapse cameras to investigate the heterogeneous nature of biogenic gas ebullition events in subtropical peat soils at both the laboratory and field scale. The main findings are: (1) ebullition events in peat soils are highly heterogeneous; (2) estimates of flux rate are directly influenced by temporal scale of measurement with rapid (i.e., hourly) releasing events exceeding daily averages by one order of magnitude; and (3) increases in atmospheric pressure result in gas release from shallow peat soils into the atmosphere (i.e., ebullition), as indicated by a positive linear relation between changes in biogenic gas content and changes in atmospheric pressure. These results suggest that biogenic gas releases from shallow subtropical peat soils are not constant with larger than average daily fluxes being potentially released within hours during periods of increased atmospheric pressure. Furthermore, this study also shows the potential of time-lapse cameras for autonomously assessing the temporal variation in biogenic gas flux to the atmosphere from peatlands, and questions what temporal scale of measurement should be appropriate to infer dynamics of biogenic gas release in peat soils.

Citation: Comas, X., and W. Wright (2012), Heterogeneity of biogenic gas ebullition in subtropical peat soils is revealed using time-lapse cameras, *Water Resour. Res.*, *48*, W04601, doi:10.1029/2011WR011654.

1. Introduction

[2] Total wetland area is currently estimated at between 8 to 10 million km^2, or 6% to 8% of the land surface of the Earth [*Lehner and Döll*, 2004]. Wetland distribution is roughly bimodal with approximately 50% located in boreal and arctic regions between 50 and 70°N and dominated by boreal peatlands, and about 35% located in tropical/subtropical regions between 20°N and 30°S and dominated by swamps and marshes [*Matthews*, 2000]. Peatlands are considered *wetlands* with 30 cm or more of *peat accumulated* [*Charman*, 2002]. Global extent of peatlands is currently estimated between 4 to 5 million km^2, and although this estimate represents less than 3% of Earth's land surface, recent estimates for C storage in global peatlands range between 528 and 694 Pg C (1 Pg = 10^{15} g) [*Hooijer et al.*, 2006; *Yu et al.*, 2010], approximately accounting for 72%–95% of the total 730 Pg C held in the atmosphere as CO_2 [*IPCC*, 2007]. Considering all peatlands, and mainly due to the uncertainties in peat thickness and C content, tropical and subtropical systems show the highest uncertainties in C storage estimates, with C stores ranging between 44 to 92 Pg C [*Yu et al.*, 2010; *Page et al.*, 2011] and representing 7%–15% of global peat C. Such uncertainties also extend to C releases into the atmosphere, in the form of greenhouse gases (i.e., methane and carbon dioxide).

[3] While most studies on biogenic gas emissions from peat soils have been traditionally directed toward boreal peatlands, some previous works have concluded that tropical/subtropical peatlands (such as the Everglades) may have higher rates of biogenic gas production than previously reported [*Whalen*, 2005]. For instance, natural wetlands located in tropical/subtropical areas likely contribute about 50%–75% of the overall annual emission of methane from natural wetlands [*Matthews*, 2000; *Megonigal et al.*, 2004]. Emissions in subtropical systems such as the Everglades may also be affected by seasonal and interannual variations in hydroperiod [*Matthews*, 2000]. Furthermore, annual patterns of biogenic gas emission from peatlands are highly influenced by its geographic distribution. Arctic and boreal peatlands are characterized by pronounced emissions during a 3 to 5 month period (as related to the thaw and summer season), while temperate and tropical peatlands show less variability and overall higher steady fluxes as compared to boreal peatlands [*Cui et al.*, 2005; *Whalen*, 2005]. Release of biogenic gas in peatlands occurs by diffusion, transport through vascular plants, or ebullition (bubbling) [*Blodau*, 2002]. Most studies have traditionally considered the first two mechanisms almost exclusively, and although investigations related to the significance and causes of ebullition have grown considerably during the last two decades, many uncertainties still remain, particularly as related to the temporal distribution of ebullition events. The main reason for such uncertainties can be related to the lack of monitoring methods at continuous temporal scales.

[4] Previous studies have shown that, aside from steady ebullitive fluxes, episodic ebullition from peat soils can result in large gas releases over a short time scale. Using an array of 4 to 12 h GPS surveys a day for a period of two months in a peatland in Minnesota, *Glaser et al.* [2004] estimated ebullition losses up to 35,000 mg CH_4 m^{-2} in

[1] Department of Geosciences, Florida Atlantic University, Davie, Florida, USA.

0043-1397/12/2011WR011654

LSPIV – Large Scale Particle Image Velocimetry

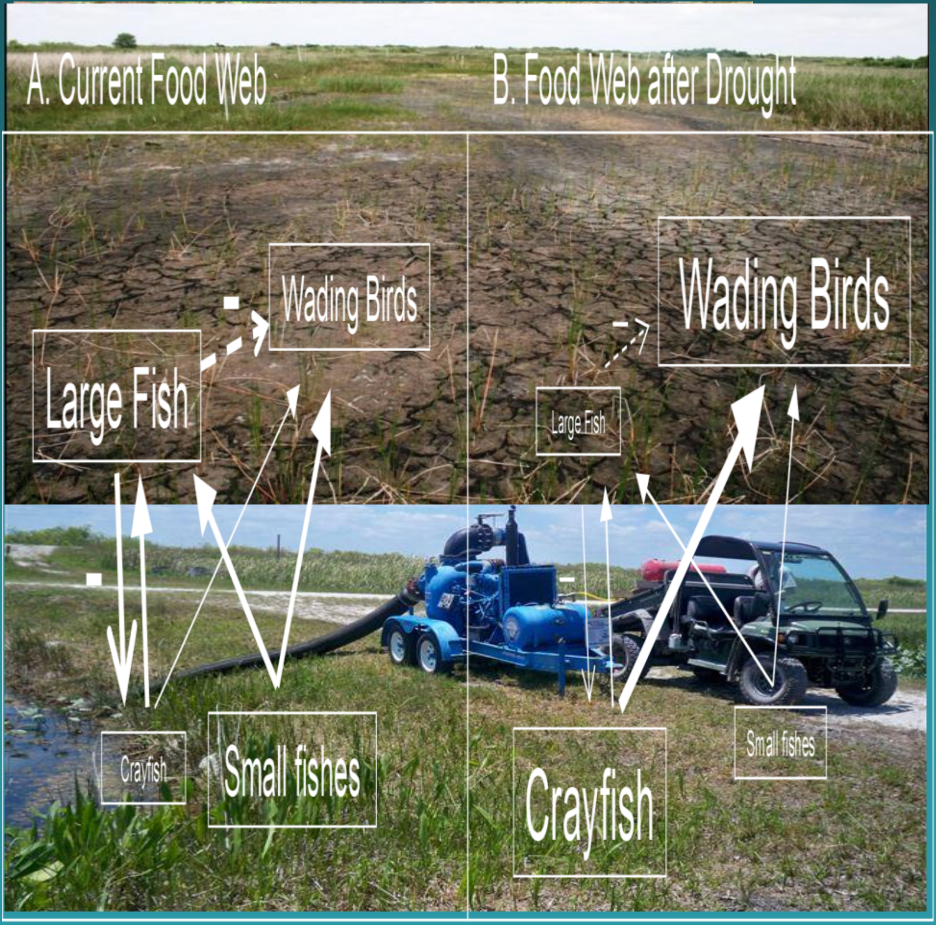
Juan Gonzalez

David Admiraal

LILA Research: Wildlife

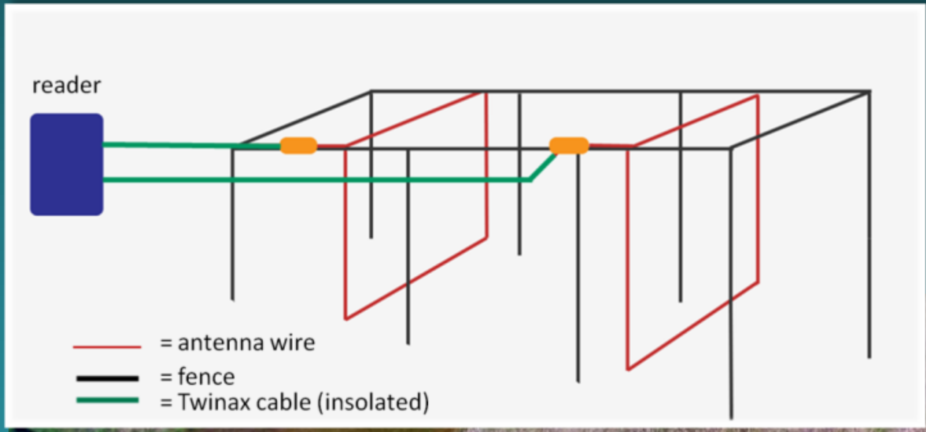
Pulsed Production / Predator Release – Crayfish Study

Nate Dorn
Mark Cook



Habitat Selection and Movement of Fish in Response to Hydrology

Jen Rehage
Mark Cook



LILA Research: Wildlife

The Effects of Water Depth and SAV on the Foraging Success of Wading Birds

The Condor 112(3):460–469
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THE EFFECTS OF WATER DEPTH AND SUBMERGED AQUATIC VEGETATION ON THE SELECTION OF FORAGING HABITAT AND FORAGING SUCCESS OF WADING BIRDS

SAMANTHA M. LANTZ,[1,3] DALE E. GAWLIK,[1] AND MARK I. COOK[2]

[1]*Biological Sciences, Florida Atlantic University, 777 Glades Road, 248 Sanson Science, Boca Raton, FL 33431*
[2]*South Florida Water Management District, 3301 Gun Club Road, West Palm Beach, FL 33406*

Abstract. Successful foraging by avian predators is influenced largely by prey availability, which encompasses not only the density of prey but also its vulnerability to capture. For wading birds (Ciconiiformes), habitat features such as water depth and density of vegetation are thought to affect the vulnerability of their aquatic prey. In January and April 2007 we experimentally manipulated the depth of water and density of submerged aquatic vegetation (SAV) in enclosures (10 × 10 m) with equal densities of fish to determine their effects on wading birds' selection of foraging habitat and foraging success. Analysis of the results with Manly's selection index showed that wading birds preferred habitat with shallow water and SAV. The two habitat components had little effect on the birds' foraging success, however, as capture rate did not vary with water depth or SAV density. Capture efficiency did not vary by SAV density and was actually lower in shallow water, contrary to our expectations. Our results suggest that birds selected habitat on the basis of environmental cues such as water depth and SAV but that these factors did not affect foraging success strongly. We hypothesize that wading birds were selecting habitat with shallow water and SAV because of an anticipated benefit to foraging through elevated density and vulnerability of prey, but the relatively high and uniform density of prey stocked in the enclosures, as well as the scale of the enclosures, effectively equalized the vulnerability of prey across treatments.

Key words: *foraging, prey availability, Everglades, foraging-habitat selection, foraging success.*

Efectos de la Profundidad del Agua y de la Vegetación Acuática Sumergida sobre la Selección de Ambientes de Alimentación y el Éxito de Forrajeo de Aves Vadeadoras

Resumen. El forrajeo exitoso de las aves depredadoras es influenciado de forma importante por la disponibilidad de presas, la cual no sólo comprende la densidad de las presas sino también su vulnerabilidad a ser capturadas. Se cree que ciertas características del hábitat como la profundidad del agua y la densidad de la vegetación afectan la vulnerabilidad de las presas acuáticas de las aves vadeadoras (Ciconiiformes). Para determinar sus efectos sobre la selección del hábitat de alimentación y el éxito de forrajeo de las aves vadeadoras, manipulamos experimentalmente la profundidad del agua y la densidad de la vegetación acuática sumergida (VAS) en áreas cercadas (10 × 10 m) con densidades iguales de peces en enero y abril de 2007. Nuestros análisis de los resultados con el índice de selección de Manly mostraron que las aves vadeadoras prefirieron ambientes con aguas someras y VAS. Sin embargo, los dos componentes del hábitat tuvieron efectos débiles sobre el éxito de forrajeo de las aves, pues la tasa de captura no varió con la profundidad ni con la densidad de la VAS. La eficiencia de captura no varió con respecto a la densidad de la VAS y, de hecho, fue menor en aguas someras, un resultado contrario a lo que esperábamos. Nuestros resultados sugieren que las aves seleccionaron el hábitat con base en señales ambientales como la profundidad del agua y la VAS, pero esos factores no afectaron al éxito de forrajeo fuertemente. Planteamos la hipótesis de que las aves vadeadoras estaban seleccionando ambientes con aguas someras y VAS debido a que anticipaban un beneficio relacionado con el forrajeo mediante niveles mayores de densidad y vulnerabilidad de las presas. Sin embargo, la densidad relativamente alta y uniforme de las presas ubicadas en las áreas cercadas, así como la escala de estas áreas, efectivamente condujeron a igualar la vulnerabilidad de las presas entre los tratamientos.

INTRODUCTION

Food availability can be a major factor limiting avian populations (Skutch 1949, Lack 1954, 1966). The availability of food depends on both its density and accessibility. For organisms that forage by capturing mobile prey, the potential of prey escape is an additional factor that emphasizes the importance of prey vulnerability. Prey availability is thus a composite variable consisting of both prey density and the vulnerability of that prey to capture, the latter being affected by various characteristics of the predator, prey, and environment (Wiens 1984, Sutherland 1996, Gawlik 2002).

Manuscript received 28 August 2009; accepted 12 February 2010.
[3]E-mail: slantz1@fau.edu

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The Dispersal Response of the Slough Crayfish to Water Recession

Erynn Call
Mark Cook

LILA Low-Temperature Tolerance of Non-Native Everglades Fishes

Pamela J. Schofield
Mac Kobza
Mark Cook

ORIGINAL PAPER

Tolerance of nonindigenous cichlid fishes (*Cichlasoma urophthalmus, Hemichromis letourneuxi*) to low temperature: laboratory and field experiments in south Florida

Pamela J. Schofield · William F. Loftus · Robert M. Kobza · Mark I. Cook · Daniel H. Slone

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LILA Research: Tree Island

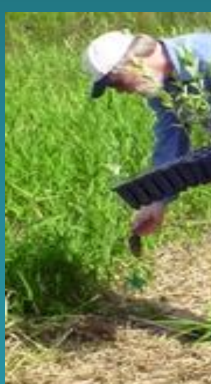
Restoring Tree Islands in the Everglades: Experimental Studies of Tree Species Survival and Growth

Arnold van der Valk

Paul Wetzel

Eric Cline

Fred Sklar



Restoration Ecology
THE JOURNAL OF THE SOCIETY FOR ECOLOGICAL RESTORATION INTERNATIONAL

Restoring Tree Islands in the Everglades: Experimental Studies of Tree Seedling Survival and Growth

Arnold G. van der Valk,[1,2] Paul Wetzel,[3] Eric Cline,[1,4] and Fred H. Sklar[5]

Abstract

In May 2004, 400 tree seedlings of seven different species found on tree islands in the Florida Everglades were planted at different elevations along five transects on eight newly constructed tree islands, four with and four without limestone cores. Seedlings suffered between 40 and 85% mortality during the first 120 days, the period with the lowest water levels. *Ilex cassine* L., *Salix caroliniana* Michx., *Chrysobalanus icaco* L., and *Annona glabra* had the highest number of surviving seedlings, whereas *Magnolia virginiana* L., *Myrica cerifera* L., and *Acer rubrum* L. had the fewest. During the remainder of the study, water levels were mostly higher and sometimes covered the entire islands for months at a time. After 220 days, nearly all seedlings of *M. virginiana* and *My. cerifera* had died. At the end of the study, seedlings of *I. cassine* and *A. glabra* had the highest survivorship rates. Seedling biomass of *C. icaco* and *I. cassine* was greatest at the highest elevations, whereas seedlings of *A. glabra* had similar biomass at all elevations. Seedling survivorship was not statistically different between islands with and without limestone cores; however, when seedlings of all species were combined, island core type was significantly different for aboveground biomass, seedling height, and canopy width. Because of the higher survivorship under both low and high water conditions, *A. glabra*, *I. cassine*, and *S. caroliniana* are the most suitable species for establishing tree species on restored tree islands in the Everglades.

Key words: Everglades, flooding tolerance, peatland, restoration, revegetation, wetland.

Introduction

Tree islands (Fig. 1) are an important component of the Everglades and many other wetlands around the world (Wetzel 2002*b*). They form due to internal redistribution processes within wetlands that result in small increases in local elevations that become colonized by tree species (Wetzel et al. 2005). In the Everglades, the vegetation of tree islands, which are only slightly higher in elevation than surrounding sloughs, wet prairies, and Sawgrass (*Cladium jamaicense* Crantz) flats, contains a number of terrestrial tree, shrub, and herbaceous species that are found nowhere else in this wetland (Davis 1943; Loveless 1959; Armentano et al. 2002; Heisler et al. 2002). Tree islands are also essential habitat for many animal species. In the Everglades, White-tailed deer (*Odocoileus virginianus*), American alligators (*Alligator mississipiensis*), small mammals, reptiles, and many bird species use tree islands for nesting, foraging, and resting (Meshaka et al. 2002). For example, more songbird species are found on tree islands than any other habitat in the central Everglades (Gawlik & Rocque 1998).

Many different tree species dominate the vegetation on tree islands in the Everglades (Armentano et al. 2002; Heisler et al. 2002; Mason & van der Valk 2002; Wetzel 2002*a*), and field studies have shown that their distribution on a given island and among islands seems to some extent to be a function of elevation, that is, how long an area where individuals of a tree species are growing is flooded annually (Armentano et al. 2002; Heisler et al. 2002; Wetzel 2002*a*; Ross & Jones 2004). Low islands have tree species that are mostly found at the lower elevations of high islands, and high islands have species that are typically restricted only to the higher parts of these islands and that are rarely found on low islands. Unfortunately, little data on the flooding tolerances of the tree species, especially their seedlings, are available (Conner et al. 2002). It is not known whether the distribution of tree species along elevation gradients is due largely or in part to recruitment patterns, plant-plant interactions, plant-animal interactions, or some combination of them.

In the central Everglades, in which water slowly flows from north to south, tree islands are typically tear shaped and consist of two parts, the head and the tail. The head,

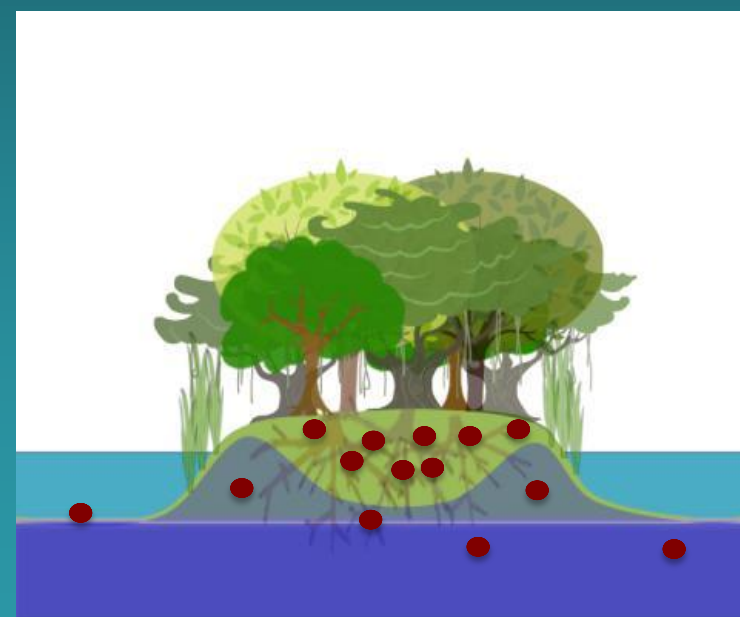
[1] Department of Ecology, Evolution and Organismal Biology, Iowa State University, Ames, IA 50011, U.S.A.
[2] Address correspondence to A. G. van der Valk, email valk@iastate.edu
[3] Department of Biological Sciences, Smith College, Northampton, MA 01063, U.S.A.
[4] Present address: Southeast Environmental Research Center, Florida International University, Miami, FL 33199, U.S.A.
[5] South Florida Water Management District, West Palm Beach, FL 33406, U.S.A.

doi: 10.1111/j.1526-100X.2007.00311.x

The role of recharge and evapotranspiration as hydraulic drivers of ion concentrations in shallow groundwater on Everglades tree islands

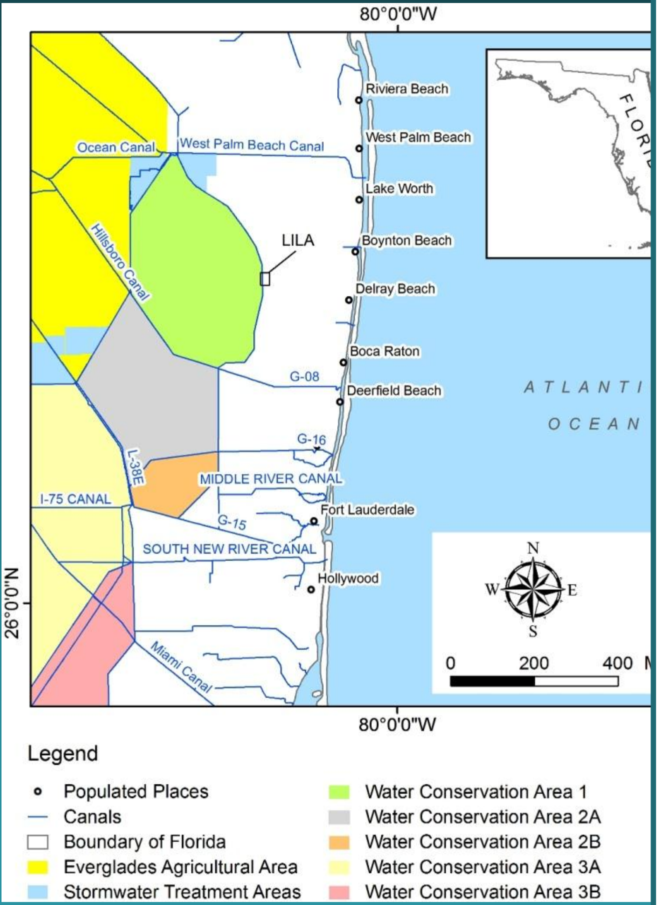
Rene' Price

Pamela Sullivan



LILA Research: GIS

The Development of a Geographic Information System (GIS) to Document Research in an Everglades Physical Model



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DAVID PUBLISHING

The Development of a Geographic Information System (GIS) to Document Research in an Everglades Physical Model

S. Aich[1], T.W. Dreschel[2], E.A. Cline[2] and F.H. Sklar[2]
1. Photo Science Geospatial Solutions, St. Petersburg, Florida 3371, USA
2. South Florida Water Management District (SFWMD), West Palm Beach, Florida 33406, USA

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Abstract: The Loxahatchee Impoundment Landscape Assessment (LILA) facility is a unique physical model of the Everglades ecosystem. LILA has a closed-loop water delivery system and consists of four 0.08 square kilometer (~8 ha) macrocosms, created to be replicates of one another and of the Everglades landscape. Built in 2003, LILA's purpose is to provide scientists with an opportunity to design and implement research concerning Everglades restoration techniques in an accessible, controlled and replicated Everglades environment. Key Everglades habitats were sculpted within LILA: tree islands, ridges, sloughs and alligator holes. Water levels and flows in each macrocosm are controlled independently, so that researchers can study the effects of hydrology on Everglades landscape and ecology. Studies have focused upon measuring survival and growth of native trees planted on the tree islands; measuring surface water and ground water movement and chemistry; studying wading bird feeding and the movement of prey species (crayfish); and measuring erosion and accretion on tree islands and ridges. We developed a Geographic Information System (GIS) data set to identify, characterize, and spatially reference the features of LILA and document research activities. This development included mapping the boundaries of the landscape features, creating a theoretical Digital Elevation Model (DEM) and describing the research projects being carried out. The creation of this GIS data set enhances the ability to schedule and coordinate research, assist scientists in the visualization and spatial representation of their research, and provide a resource for the storage, analysis and synthesis of valuable scientific information.

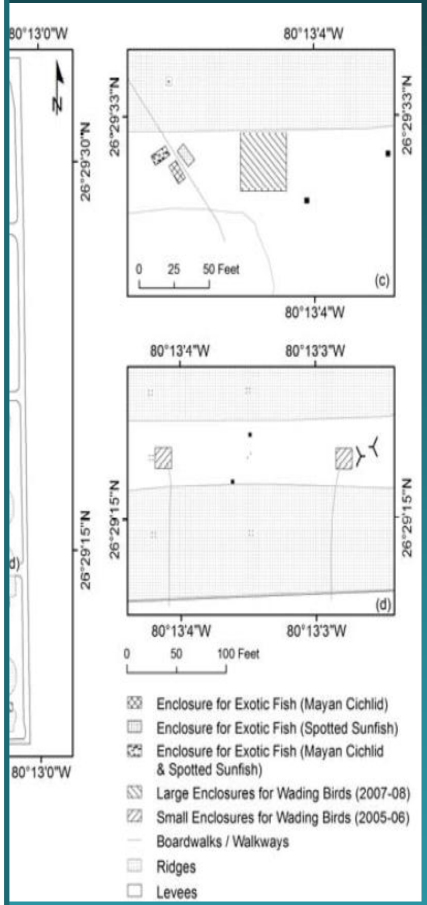
Key words: CERP, everglades, everglades forever act, GIS, LILA, ridge and slough, tree island

1. Introduction

The Everglades is one of the most vast and diverse ecosystems in the world [1]. The large extent of the Everglades precludes ready access for manipulative research and so an accessible physical model of the Everglades was constructed to accommodate these kinds of investigations, the Loxahatchee Impoundment Landscape Assessment (LILA). This unique research platform is a large-scale physical model of the Everglades, where scientists perform systematic "cause and effect" field experiments to understand why changes may be occurring in the Everglades, and what can be done to help restore the currently impacted Everglades to its natural conditions [2]. For the studies being conducted at LILA, the cause (independent variable) is defined as the manipulation of only one aspect of the environment (water depth or flow) and the effect (dependent variable) is revealed by measuring changes in landscape patterns, and/or plant and animal responses to that cause [2]. LILA is located at the Arthur R. Marshall Loxahatchee National Wildlife Refuge (ARMLNWR) in Boynton Beach, Florida (Fig. 1).

This living laboratory operates on the principles of "adaptive resource management", which uses experiments that directly reveal process impacts. LILA

Corresponding author: T.W. Dreschel, Ph.D., research fields: environment, ecology, wetlands. E-mail: tdresche@sfwmd.gov.



Sumanjit Aich
Tom Dreschel
Eric Cline
Fred Sklar

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