

Revised Landscape Development Intensity (LDI) Index

Accounting for a Non-Linear Human Disturbance Gradient

Kelly Chinnners Reiss^{1,2} & Mark T. Brown²

¹American Public University System, Charles Town, WV

²University of Florida, Gainesville, FL

10th National Monitoring Conference

G2 Integrating Watershed Assessments to
Promote Protection and Restoration Synergy

Tampa, Florida

Wednesday May 4, 2016

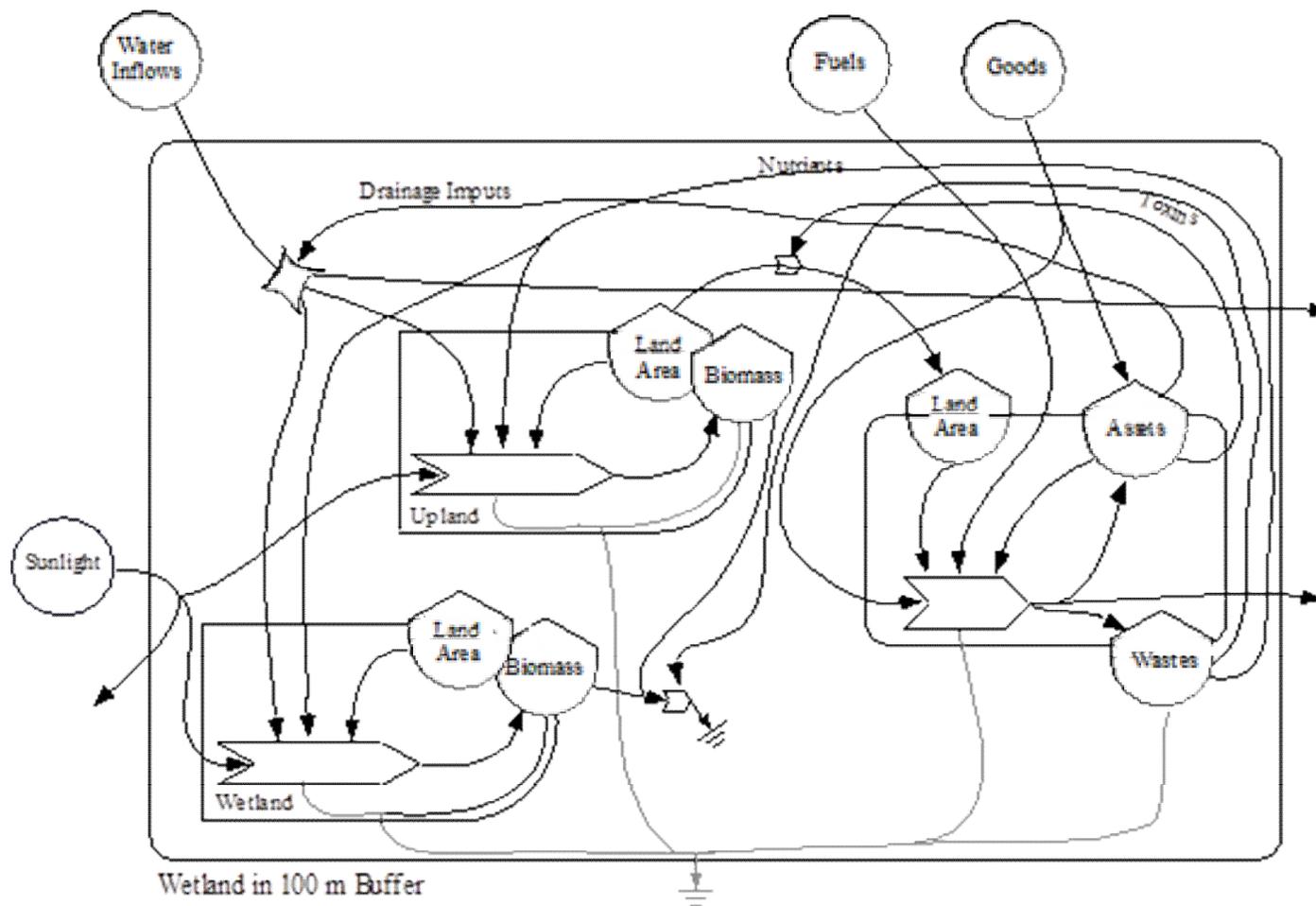




Human Impact



Wetlands in the Developed Landscape



“Natural Habitats” or Reference Standard

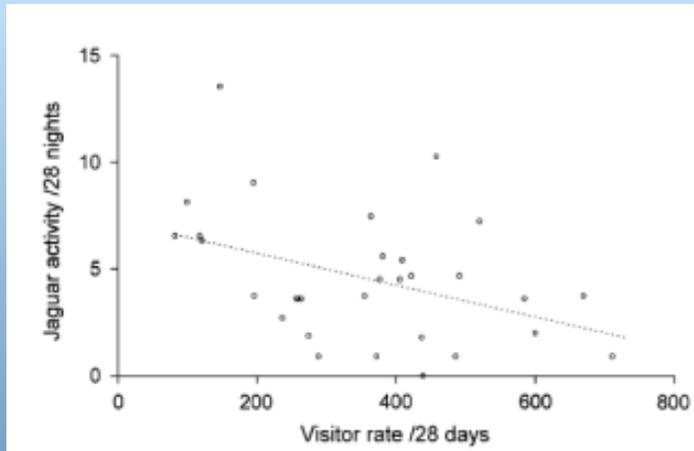


The condition of wetlands surrounded by undeveloped landscapes and without *apparent* human induced alterations

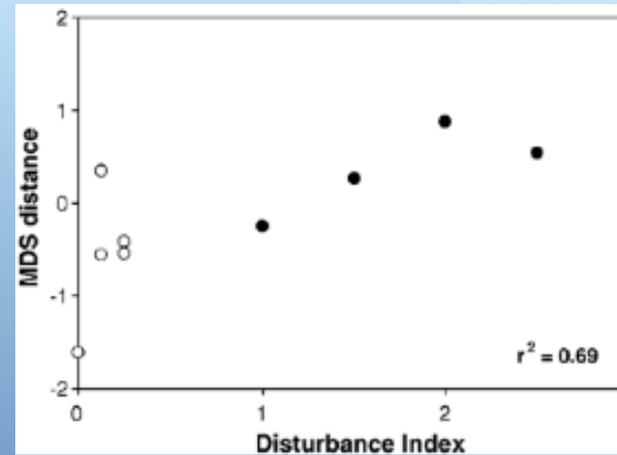
Disturbance: Definitions

- “Any relatively discrete event in time that **disrupts** ecosystem, community, or population **structure** and changes resources, substrate availability, or the physical environment.” (White & Pickett, 1985)
- “Relatively discrete event in time coming from the outside that **disrupts** ecosystems, communities, or populations, changes substrate and resource availability, and creates **opportunities for new individuals or colonies** to become established.” (Smith 1990)

Disturbance Gradients in Practice



Jaguar activity vs visitor rates (Foster et al., 2010)



Stream biota changes with logging (Davies et al., 2005)

Original LDI Index

$$LDI_{total} = \sum \%LU_i * LDI_i$$

where

LDI_{total} = LDI ranking for landscape unit

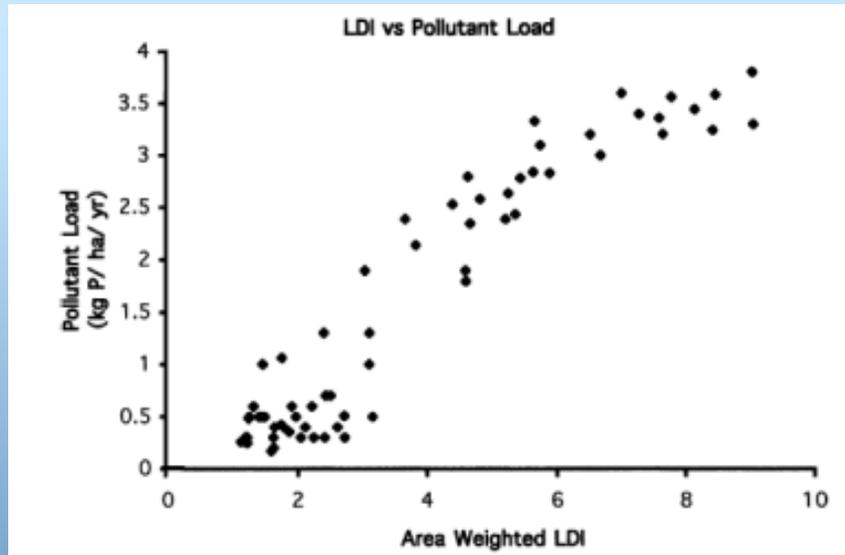
$\%LU_i$ = percent of the total area of influence in land use i

LDI_i = landscape development intensity coefficient for land use i

(Brown & Vivas, 2005)

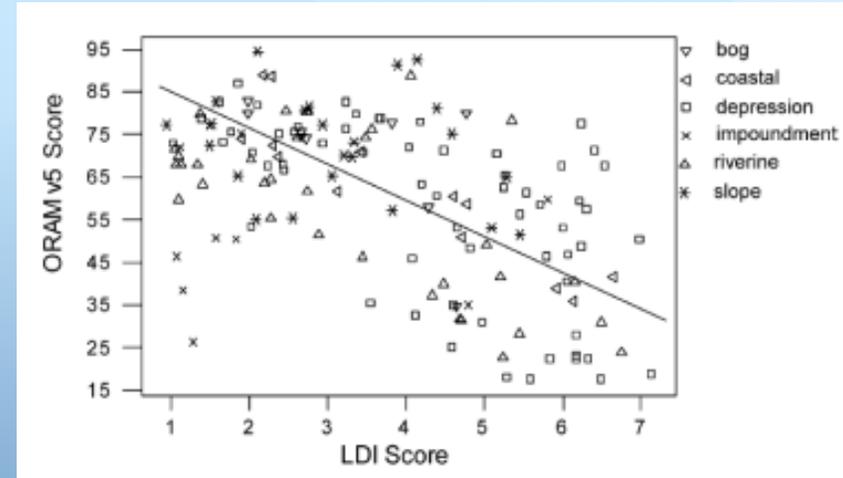
EXAMPLES: Land Use/Land Cover	LDI Coefficient
Natural system	1.00
Improved pasture- high-intensity (w/livestock)	3.74
Row crops	4.54
Single family residential- low-density	6.90
Low-intensity commercial	8.00
Central business district (avg. 4 stories)	10.00

Application of the Original LDI Index

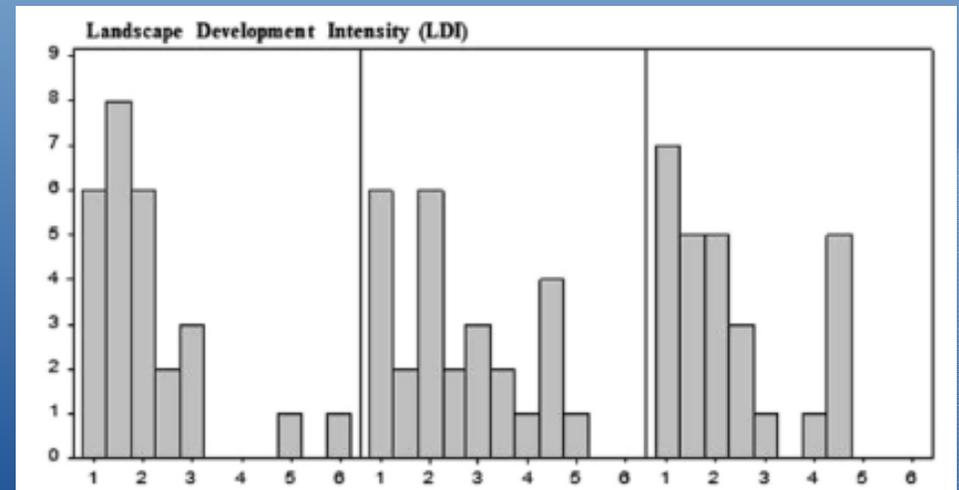


Pollutant Load (Florida: Brown & Vivas, 2005)

- Correlation with nutrients - logistic? linear?
- Polynomial regression for ORAMv5
- Few “most disturbed” in test data sets



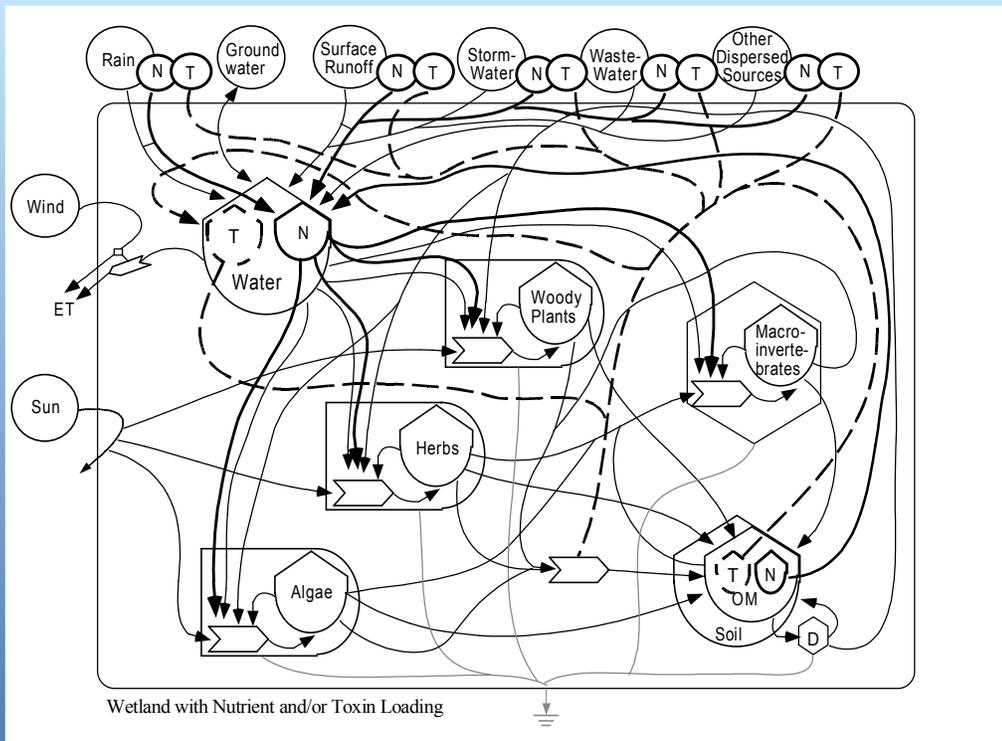
Polynomial Regression (Ohio: Mack, 2006)



LDI all ≤ 6 (Hawaii: Margriter et al., 2014)

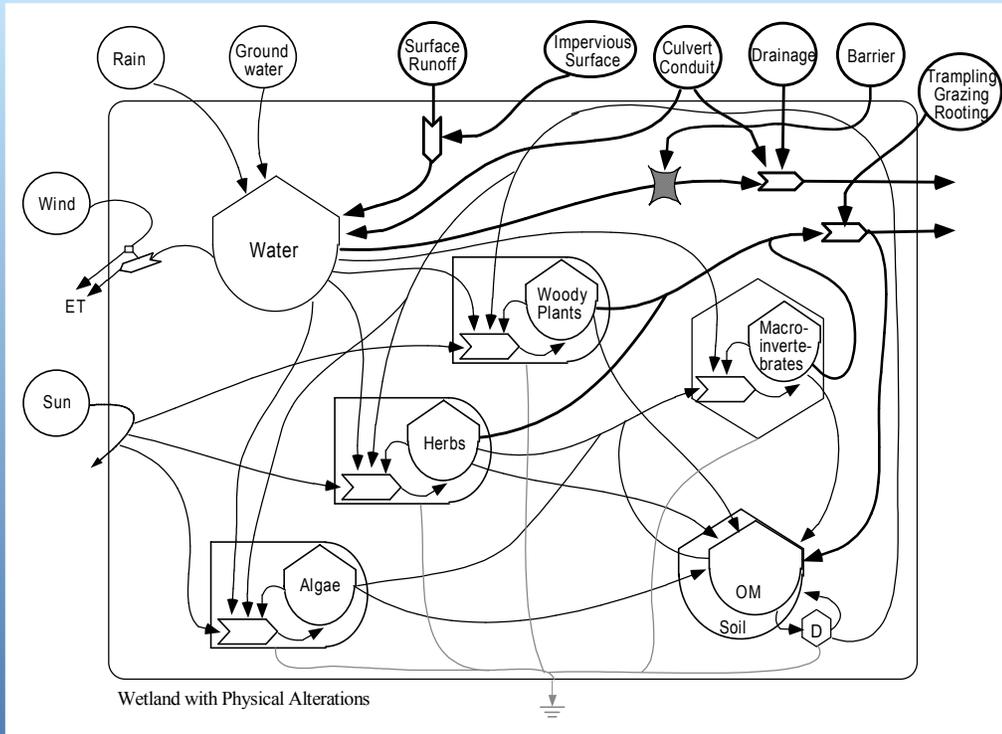
Local Variance in Human Impact

NUTRIENTS



Local Variance in Human Impact

PHYSICAL DISTURBANCE



Physical, Chemical, or Biological Change



?



Human Disturbance Gradient

Revised LDI Index

$$\text{LDI} = 10 * \log_{10} (\text{AEI}_{\text{Total}} / \text{AEI}_{\text{Ren}})$$

where $\text{AEI}_{\text{Total}}$ is the total areal empower intensity (including the background environment) within the polygon

AEI_{Ren} is the areal empower intensity of the background environment (1.99 E15 sej/ha-yr, chemical potential for rain in Florida)

$$\text{AEI}_{\text{Total}} = \text{AEI}_{\text{Ren}} + \sum (\% \text{LU}_i * \text{AEI}_i)$$

where $\% \text{LU}_i$ is the percent of influence in land use i

AEI_i is the nonrenewable areal empower intensity for land use i

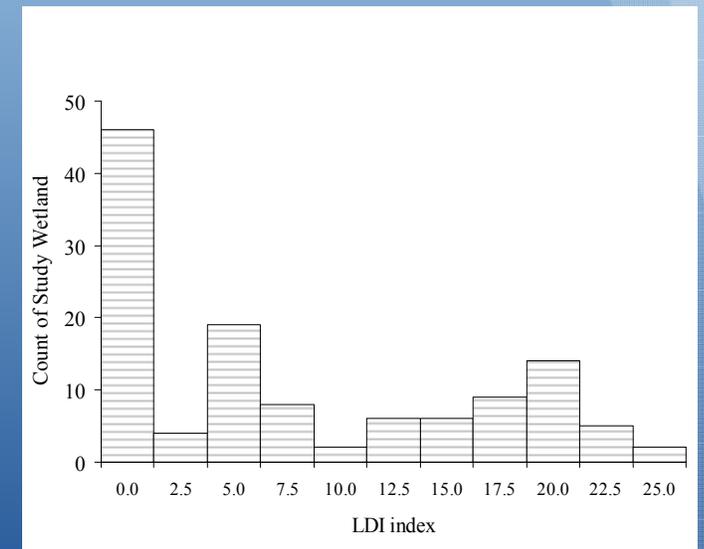
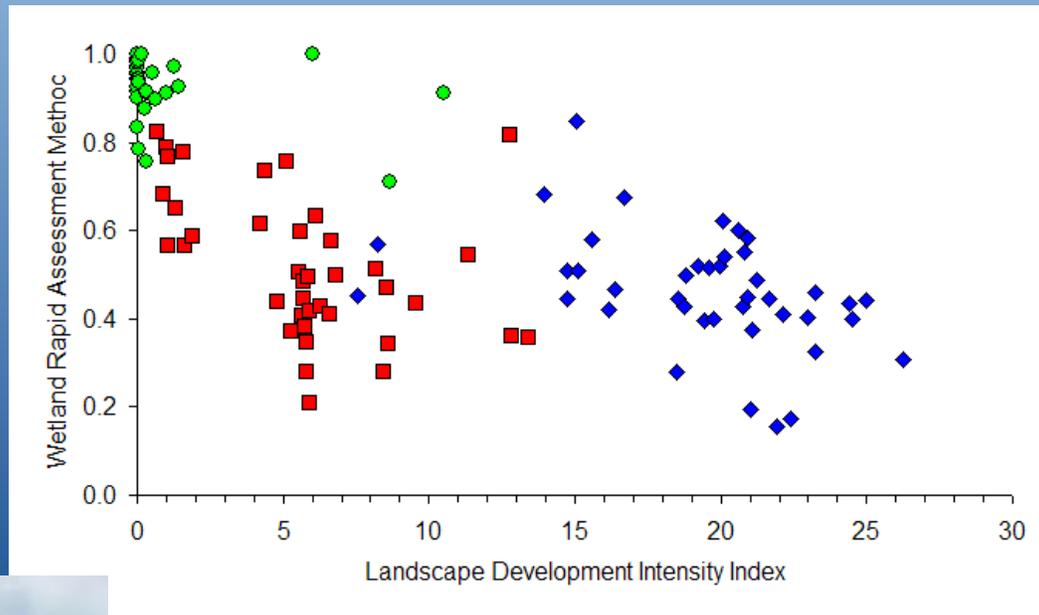
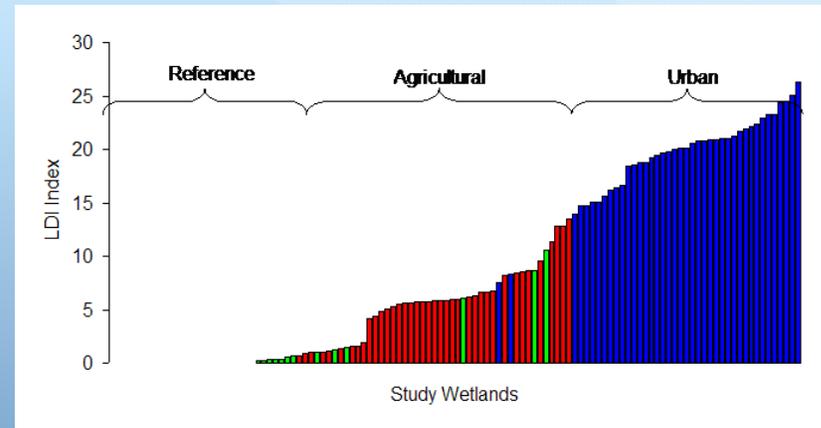
Revised LDI Index



- Non-linear response to human disturbance
- Separate sites across orders of magnitude of human activities and energy use
- Spreads data in low ranges to identify natural variability
- Displays constant %change as straight line, stabilizes variance, and presents more linear relationship with condition

Application of Revised LDI Index

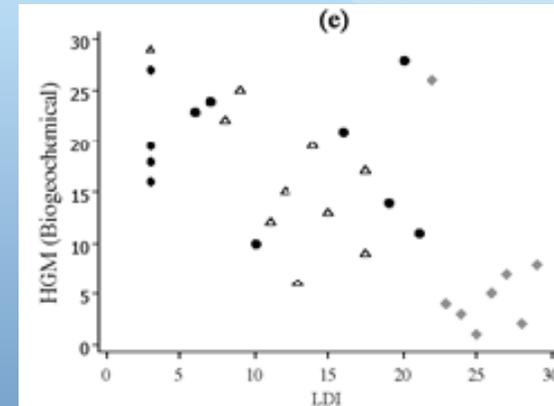
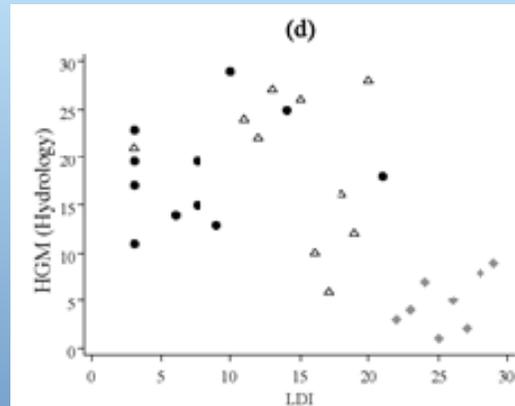
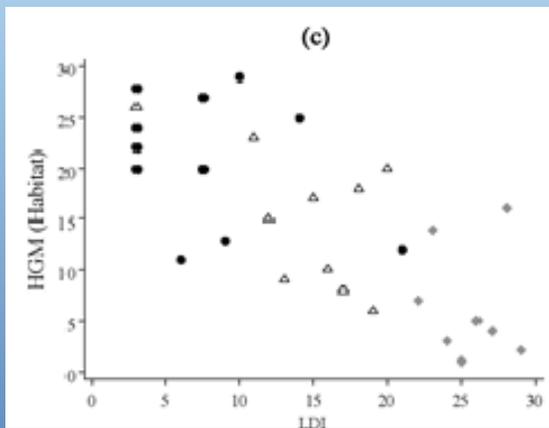
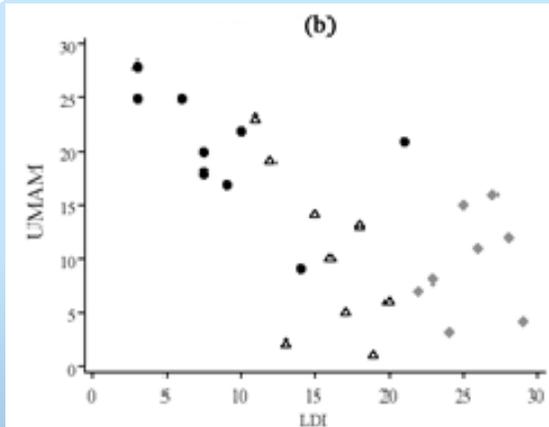
- Florida bioassessment data
- Rapid assessment method spread along LDI_{100m}



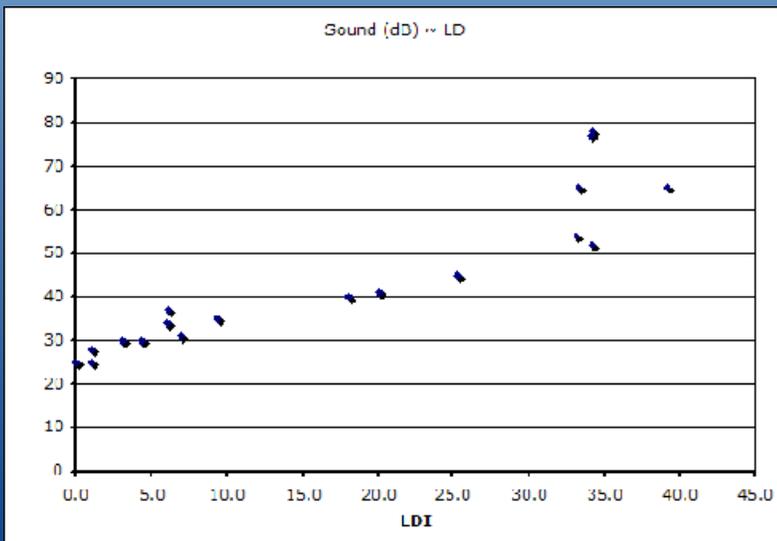
Spearman $r = -0.75$
 $p < 0.01$



Application of Revised LDI Index



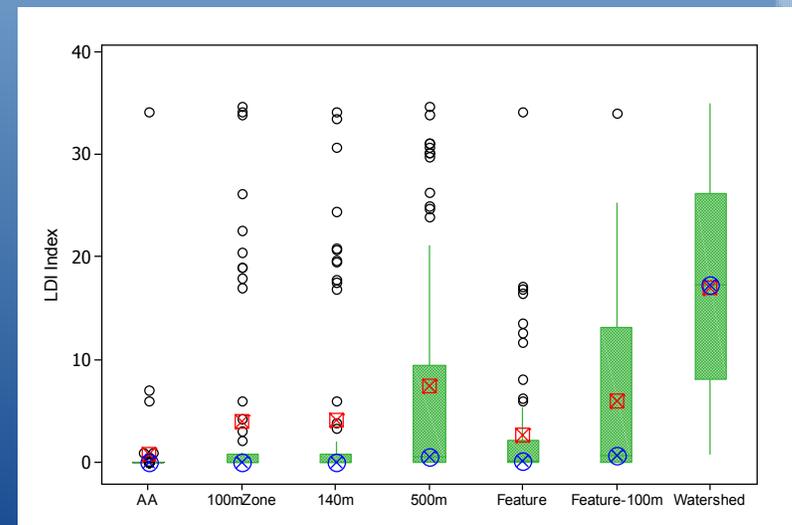
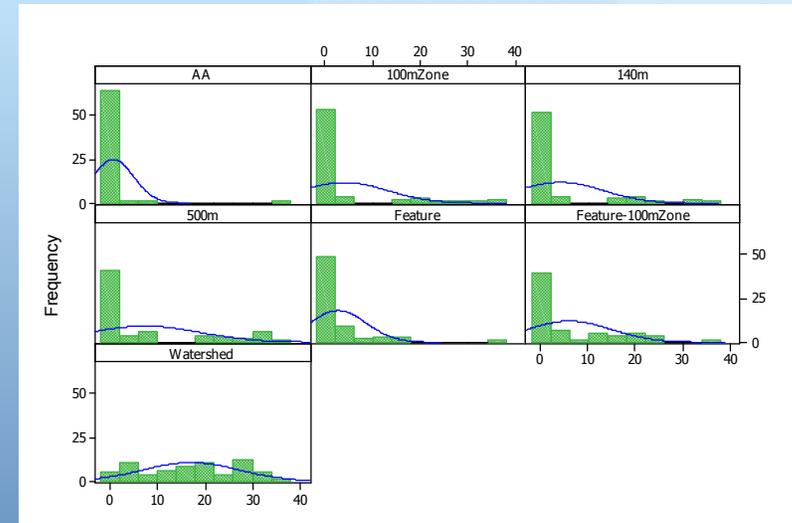
- Rapid assessment and functional capacity indices show similar trends
- Local and watershed scales
- Correlation with sound recorded in wetlands



(Brown & Vivas ,2006)

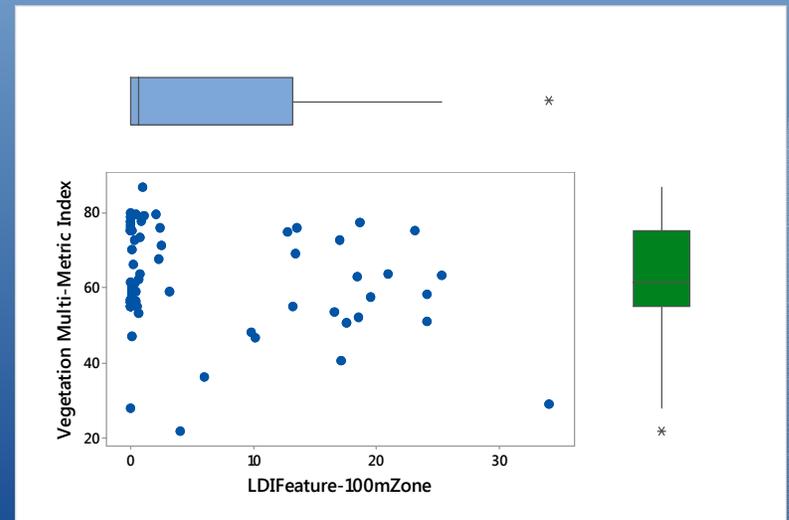
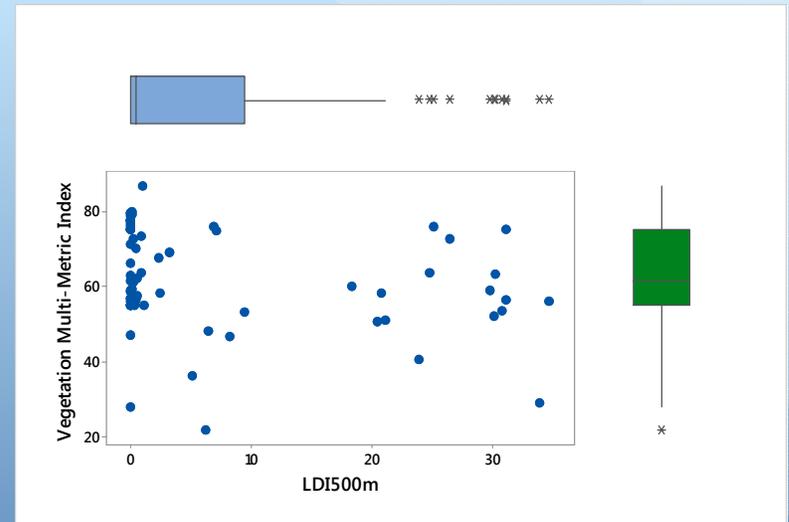
Application of Revised LDI Index

- National Wetland Condition Assessment (NWCA) 2011 Florida
- 7 scales from 40m radius circle to 12 digit HUC watershed
- 4 different wetlands had highest LDI across scales
- Watershed scale had spread distributions, others skewed (Reiss et al., 2012)



Application of Revised LDI Index

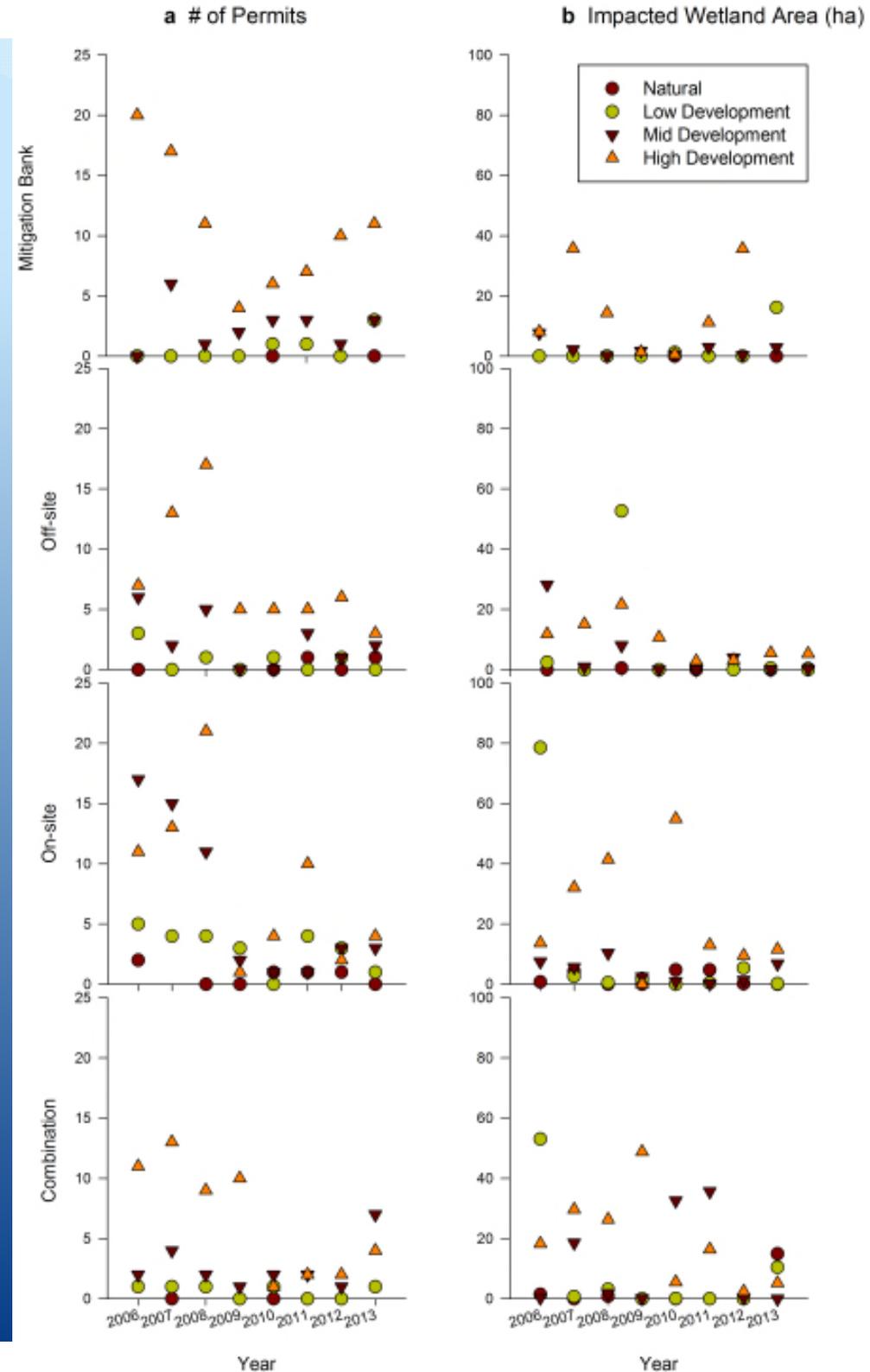
- National Wetland Condition Assessment (NWCA) 2011 Florida
- Comparison to vegetation, buffers, USA-RAM, metals, stressor
- Consideration of scale



Application of Revised LDI Index

- NE Florida Wetland Mitigation review 2006-2013
- Most permit parcels in High Development LDI category (Goldberg & Reiss, 2016)

LDI Category	LDI Range
Natural Lands and Least Developed	$LDI \leq 3$
Low Development	$3 < LDI \leq 15$
Mid Development	$15 < LDI \leq 25$
High Development	$25 < LDI$



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References

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