Calibrating a rapid wetland assessment method to an intensive method in the Nanticoke Basin, Delaware and Maryland, USA

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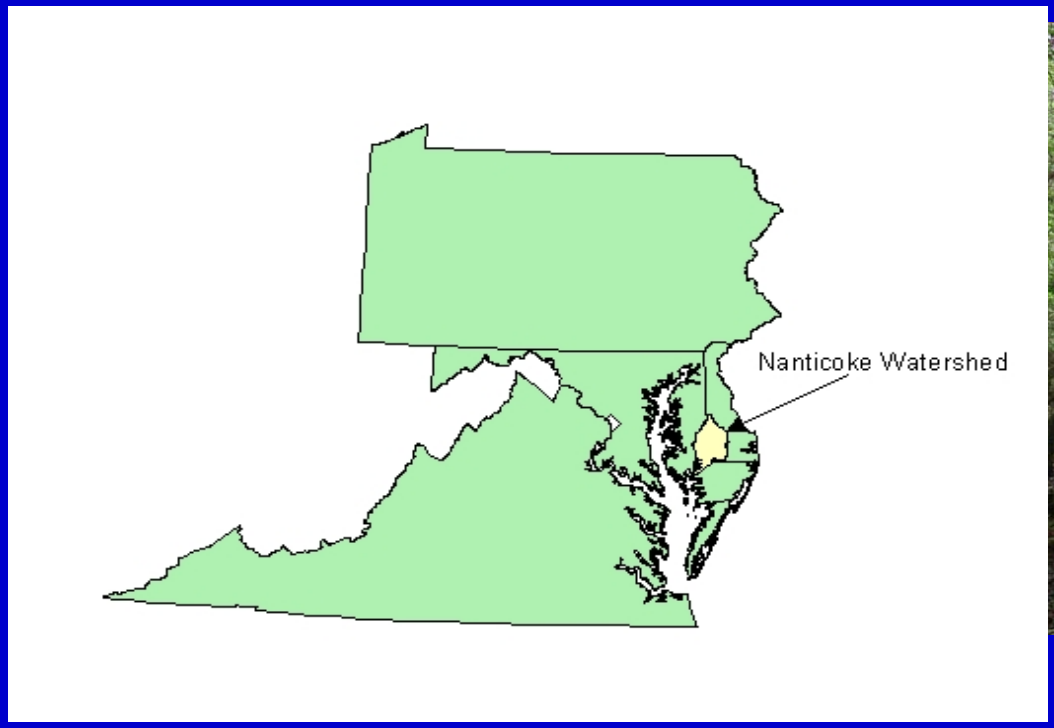
Overview

- Objective: Develop a calibrated overall rapid indicator of wetland condition for Nanticoke
- Process
  - Develop one overall Index of Wetland Condition based on HGM functions (Intense IWC)
  - Use Delaware rapid method stressor observations to develop rapid Index of Wetland Condition (Rapid IWC)
  - Statistical method to relate to calibrate rapid IWC to intensive IWC
    - Identify stressor variables to include
    - Score stressor variables

Data Collection – Nanticoke Basin



- Collected data on over 200 randomly selected sites selected by EMAP in Flat, Riverine, and Depression wetlands, 2003-2004
- Sampled reference sites and developed HGM models

Development of an Index of Wetland Condition (IWC)

- Wanted an overall rating of condition
- Needed similar measure to compare to rapid
- Based on HGM variables
- Functions can still be calculated

HGM Variables for Flats – Scored 0-1

$V_{DISTURB}$ – Evidence of vegetation disturbance

V_{DRAIN} – Percent of assessment area affected by drainage

V_{FILL} – Presence of anthropogenic derived sediment

V_{HERB} – Species of herb indicator species

V_{MICRO} – Presence of microtopographic features

V_{RUBUS} – Presence of *Rubus* sp.

V_{SHRUB} – Shrub density

$V_{SHRUBSP}$ – shrub sp. composition

V_{SNAG} – Density of standing dead trees

V_{TBA} – Basal area of trees

V_{TDEN} – Tree density

V_{SAPDEN} – Sapling density

V_{TREE} – Tree species composition

V_{BUFFBA} – Basal area in buffer

$V_{BUFFUSE200}$ – Surrounding landuse

$V_{BUFFIMP}$ – Impervious surface surrounding site

$V_{BUFFRD200}$ – Road density surrounding site

Development of an Index of Wetland Condition (IWC) - Flats

Screen HGM variables (EMAP IBI approach)

- Range Test
- Responsiveness
  - Use BPJ low, medium, high qualitative site rating
  - Variable should discriminate low vs. high
    - F-Test for significance
- Redundancy
  - Don’t use two variables if r > 0.7
- Sum selected variables, normalize to 0-100

HGM variables in IWC for Flats

- Vdrain
- Vfill
- Vmicro
- Vherb
- Vrubus
- Vshrub
- Vtba
- Vtree
- Vdisturb
- Vbuffuse200*

Category	Original Weights
Hydrology	30%
Vegetation	60%
Landscape	10%

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- Vdrain
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- Vmicro
- Vherb
- Vrubus
- Vshrub
- Vtba
- Vtree
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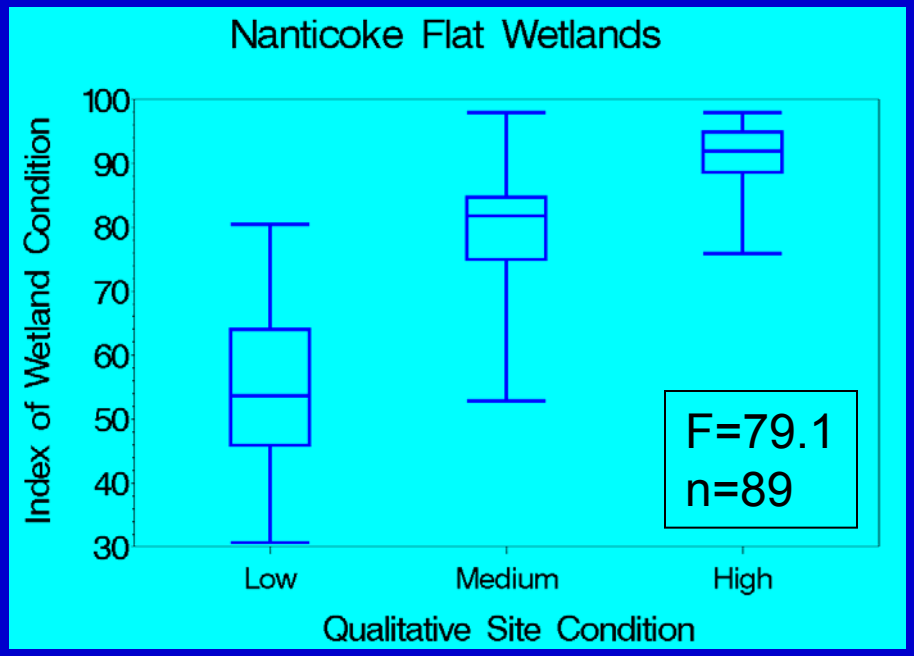
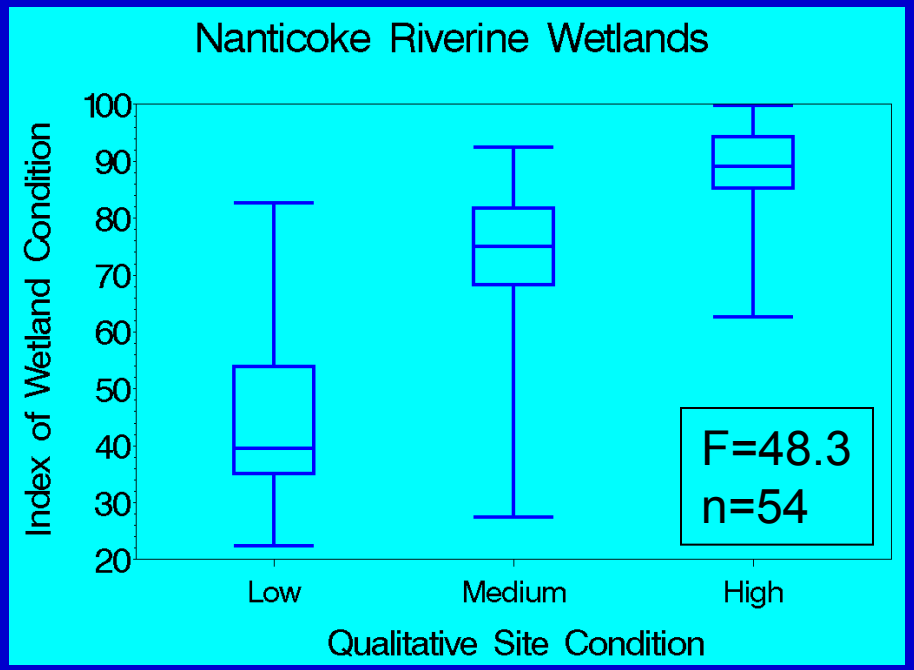
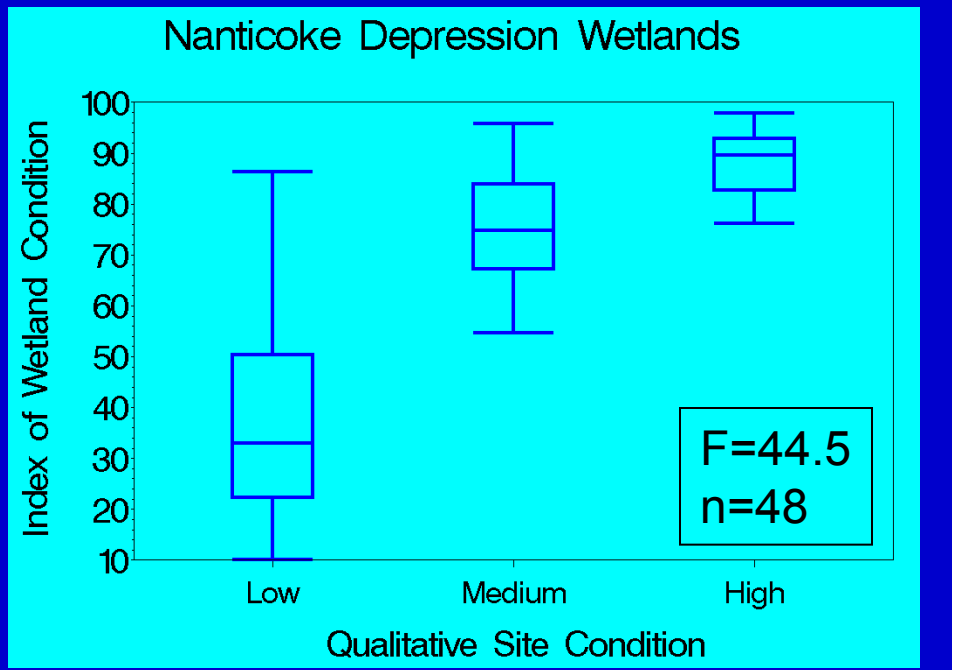
Category	Original Weights	Adjusted Weights
Hydrology	30%	40%
Vegetation	60%	50%
Landscape	10%	10%

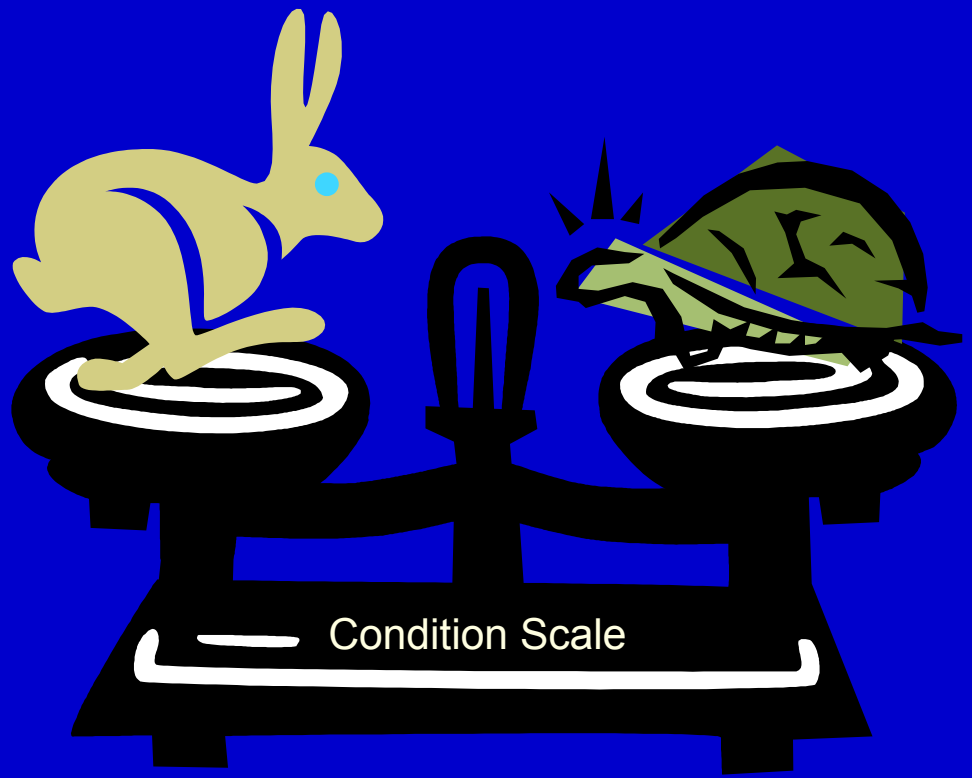


Discriminating ability of intense IWC among wetland condition classes (one-way ANOVA F-test)





Rapid Assessment Refinement and Calibration



Is the Rapid Assessment Method producing results similar to the Intensive Method?

Delaware Rapid Wetland Assessment

- Requires a site visit
- Rapid, no detailed data collected
- Applies to all types of wetlands
- Useful for prioritizing restoration and protection
- Stressors worked best
  - Habitat/Plants
  - Hydrology
  - Buffer Landscape

Initial Scoring (0-30):

- 10 points for each category
- BPJ assignment of negative "points" for each stressor

Field Form Habitat Section

DELAWARE RAPID ASSESSMENT Version 3.0 DRAFT

Site # _____ Site Name _____ Date _____

Observers _____

HGM Subclass _____ Reference or Assessment Site (circle one)

Natural Re-establishment Establishment Rehabilitation Enhancement (circle one)

Watershed _____ Potential Reference Standard? yes or no (circle one)

lat/long _____ Photos _____

AA moved from original location? yes or no (circle one) If yes, reason _____

AA split? yes or no (circle one) If yes, list below the vegetation zones and coverage of the original AA

veg zone _____ % of AA _____ veg zone _____ % of AA _____

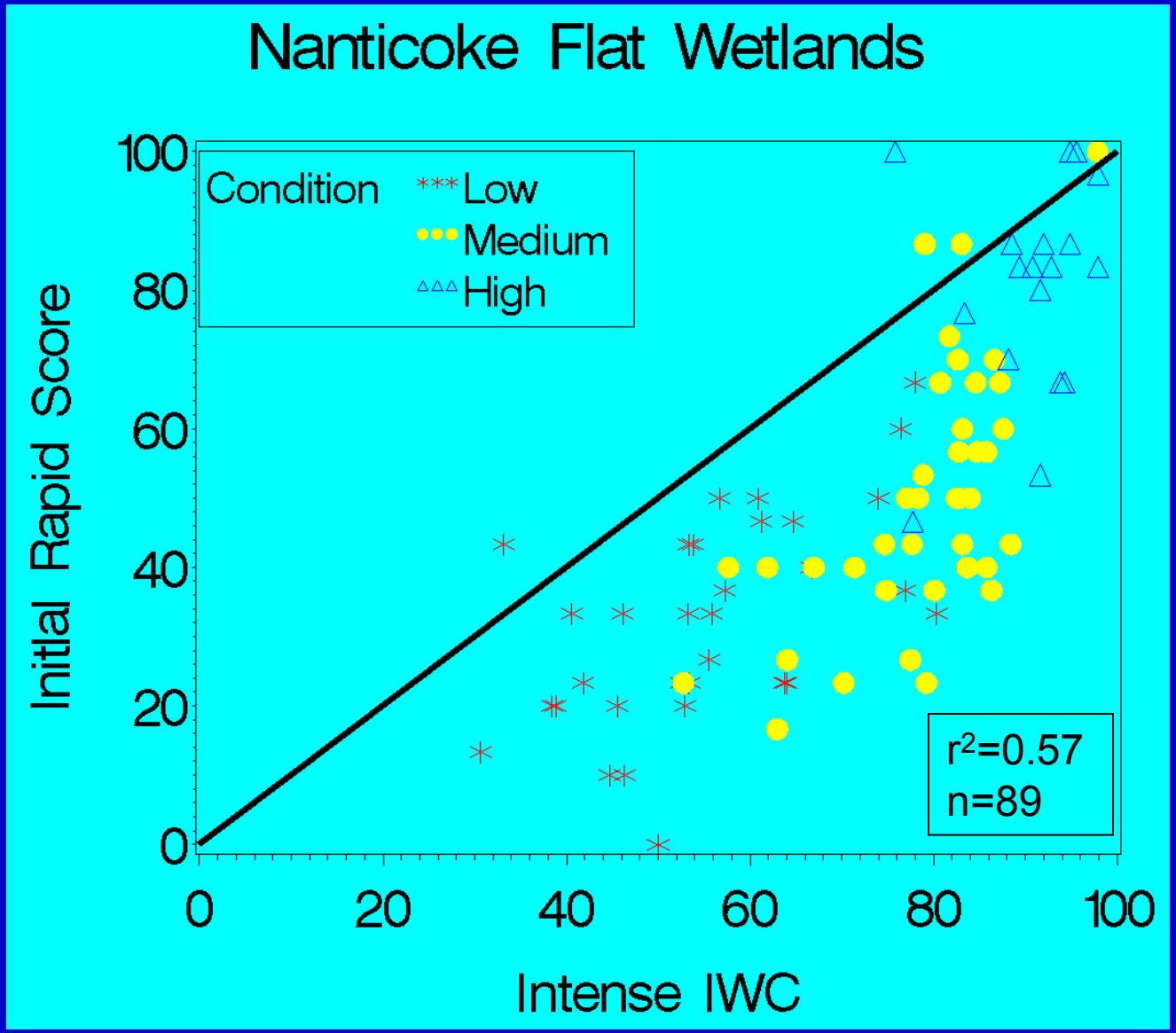
Qualitative Condition Rating Least Disturbed 1 2 3 4 5 6 Highly Disturbed (circle one number)

HABITAT/PLANT COMMUNITY (within site)	Weight
☐ MOWING	
☐ FARMED	
☐ GRAZING	
FOREST HARVESTING Clear Cut ☐ Selective Cut ☐ unsure ☐ ☐ No forestry activity within last 50 years ☐ Forestry activity within last 30-50 years ☐ Forestry activity within last 15-30 years ☐ Forestry activity with last 15 years ☐ Clear cut within past 2 years ☐ Cleared land not recovering ☐ Forest activity <10% of site	
☐ EXCESSIVE HERBIVORY/PINEBARK BEETLE/ GYPSY MOTH	
PRESENCE OF INVASIVE SPECIES ☐ Dominating the site ☐ Do NOT dominate the site	
☐ CHEMICAL DEFOLIATION	
☐ MANAGED OR CONVERTED TO PINE	
☐ BURNED	

HABITAT/PLANT COMMUNITY (within site) (CONTINUED)	Weight
☐ TRAILS	
☐ GARBAGE/ISOLATED DUMPING	
INCREASED NUTRIENT ☐ Direct application/runoff into site ☐ Dense algal mats	
ROAD ☐ Logging road ☐ Dirt or gravel constructed road ☐ Paved constructed road	
☐ OTHER _____	
SUBTOTAL HABITAT/PLANT COMMUNIT	
COMMENTS ON HABITAT/PLANT COMMUNITY	

IWC versus Rapid Score

0-30 Rapid score normalized to 0-100 Scale



Calibrating DERAP

- **Want Rapid Score to Fit Intensive IWC**
- Initially tried to improve fit by changing value of negative scoring points by hand
  - Looked for stressors that were scoring the medium and low sites down
  - Evaluated residuals off the line
- Combine some of the stressor categories into one
  - Channelized one side, channelized both sides
  - Impounded 10-75%, impounded >75%
- Mild success but we weren't real satisfied with results
- Need for statistical approach

Statistical Approach

- Want an objective way of assigning weights to each rapid stressor to formulate total rapid condition score
- Want to maximize correlation to intense IWC
- Use multiple regression
  - Dependent variable = Intense IWC
  - Independent variables = Rapid Stressors
  - Identify important stressor variables
  - Assign weights from regression coefficients

Multiple Regression Approach

- Fit a model

Intense IWC = $A + B_1X_1 + B_2X_2 + \ldots + B_nX_n$

Where A = Intercept
B_i = Regression Coefficient
X_i = Stressor i
0 if absent
-1 if present

- The B_i are in effect the negative weight for each stressor i that best calibrate the rapid score to the intensive IWC

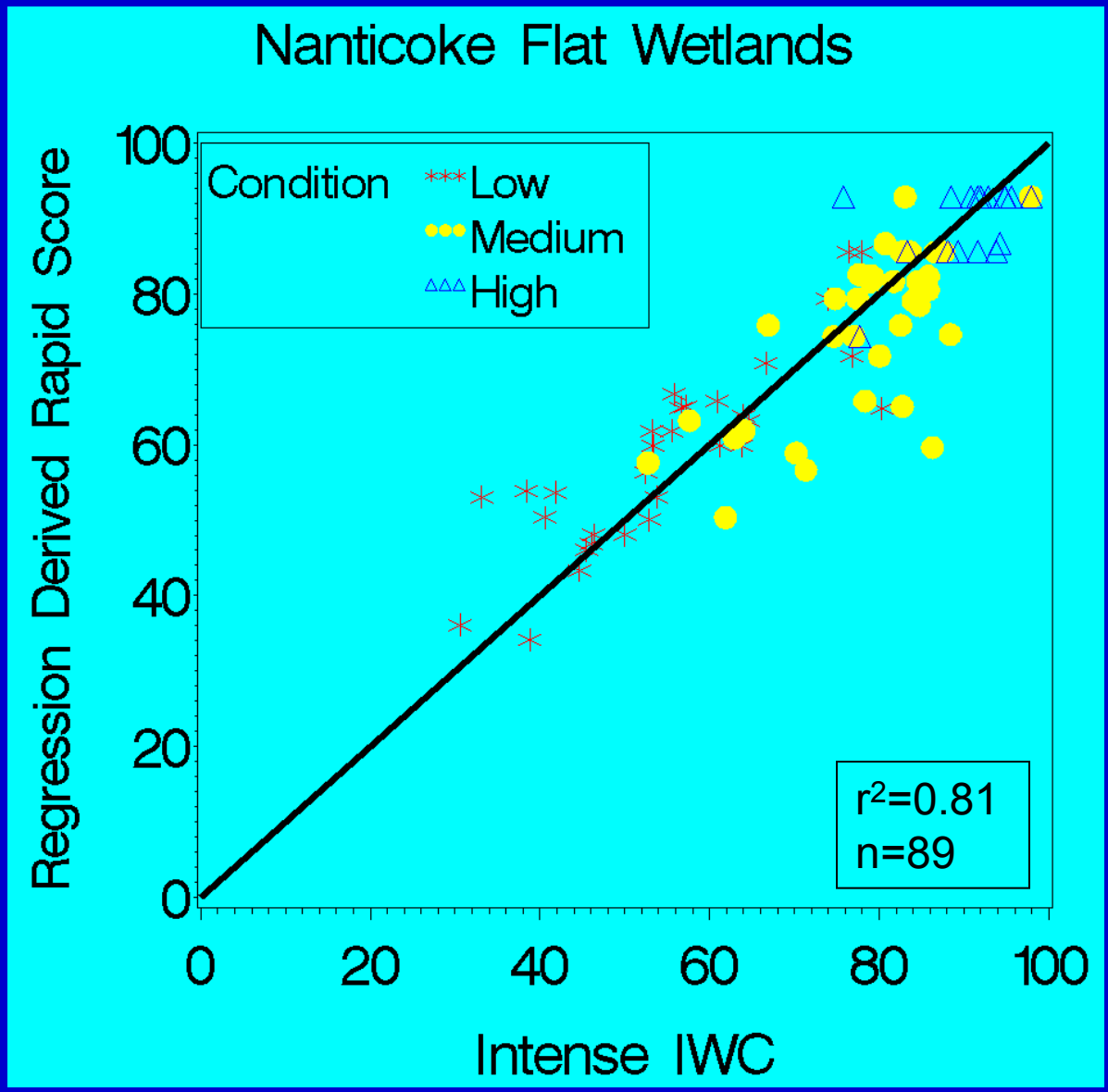
Multiple Regression Procedure

- How to fit model? -- Avoid over fitting
- Used all subsets regression and AIC
  - Calculate $\Delta AIC = AIC_{model} - AIC_{min}$
    - keep all models with $\Delta AIC < 4$.
  - Weight each model by $\exp(-0.5 * \Delta AIC)$
  - Calculate the importance of each stressor by proportion of models it occurs in (weighted)
- Variables in over 0.4 of all models used in final regression model
  - One variable with negative coefficient dropped

Fitted Regression Model for Flat Wetlands (n=89)

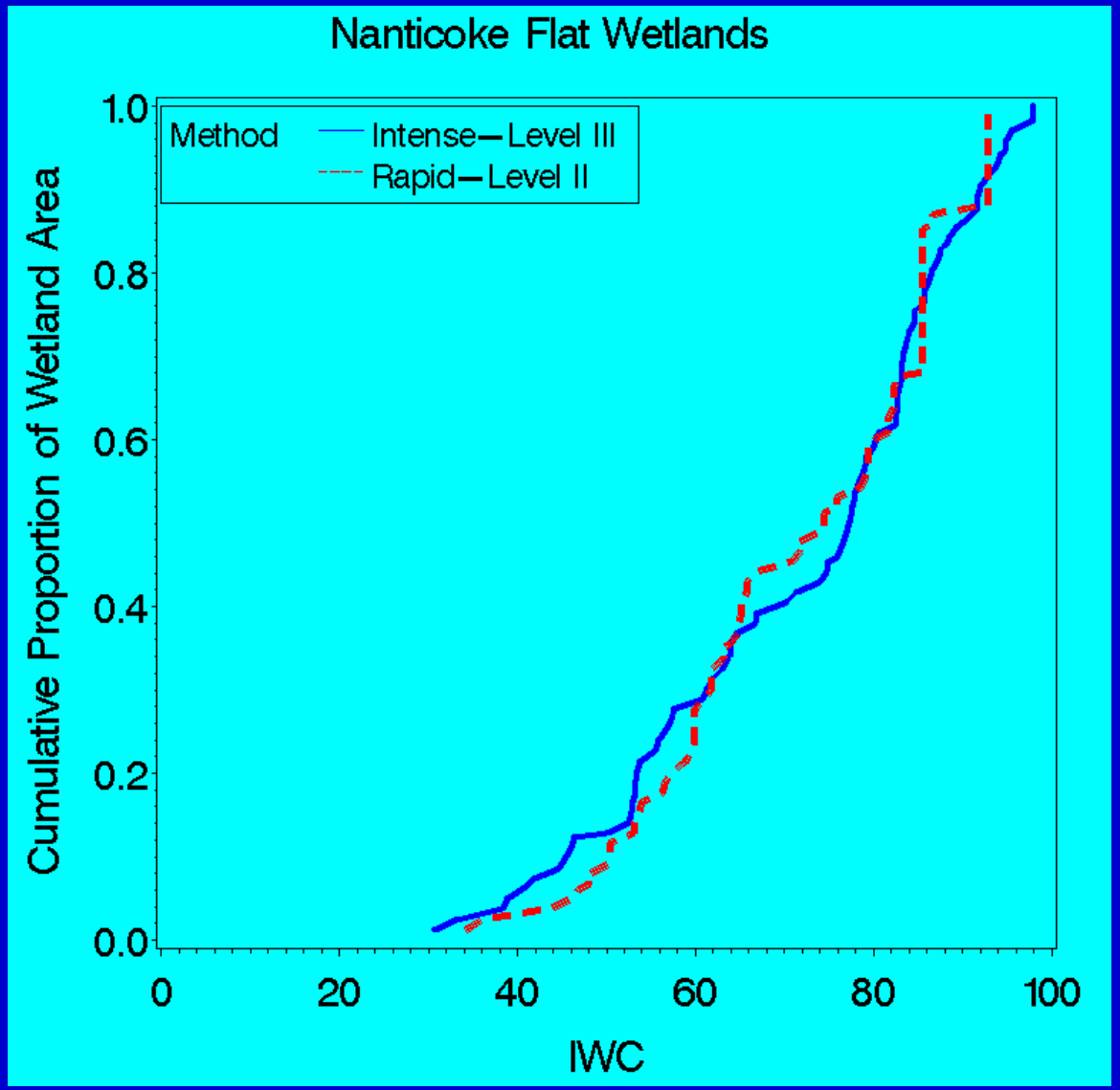
Variables	Proportion of Models	Coefficient (Scoring)
Intercept	**----**	**93**
Forest harvest – recent	1.00	-22
Forest harvest - recovering	1.00	-7.3
Mowed area	1.00	-11
Microtopographic alteration 10-100%	1.00	-15
Ditching – severe	1.00	-18
Ditching - moderate	1.00	-14
Ditching - slight	0.99	-13
Managed or converted to pine	0.88	-5.9
Microtopographic alteration <10%	0.55	-5.0
Road - Dirt/Paved	0.51	-3.2
Development	0.48	-3.0

Regression Derived Rapid Score vs. Intense IWC



Population estimates of condition

Used site weights from probability design to make inference to entire wetland area in Nanticoke



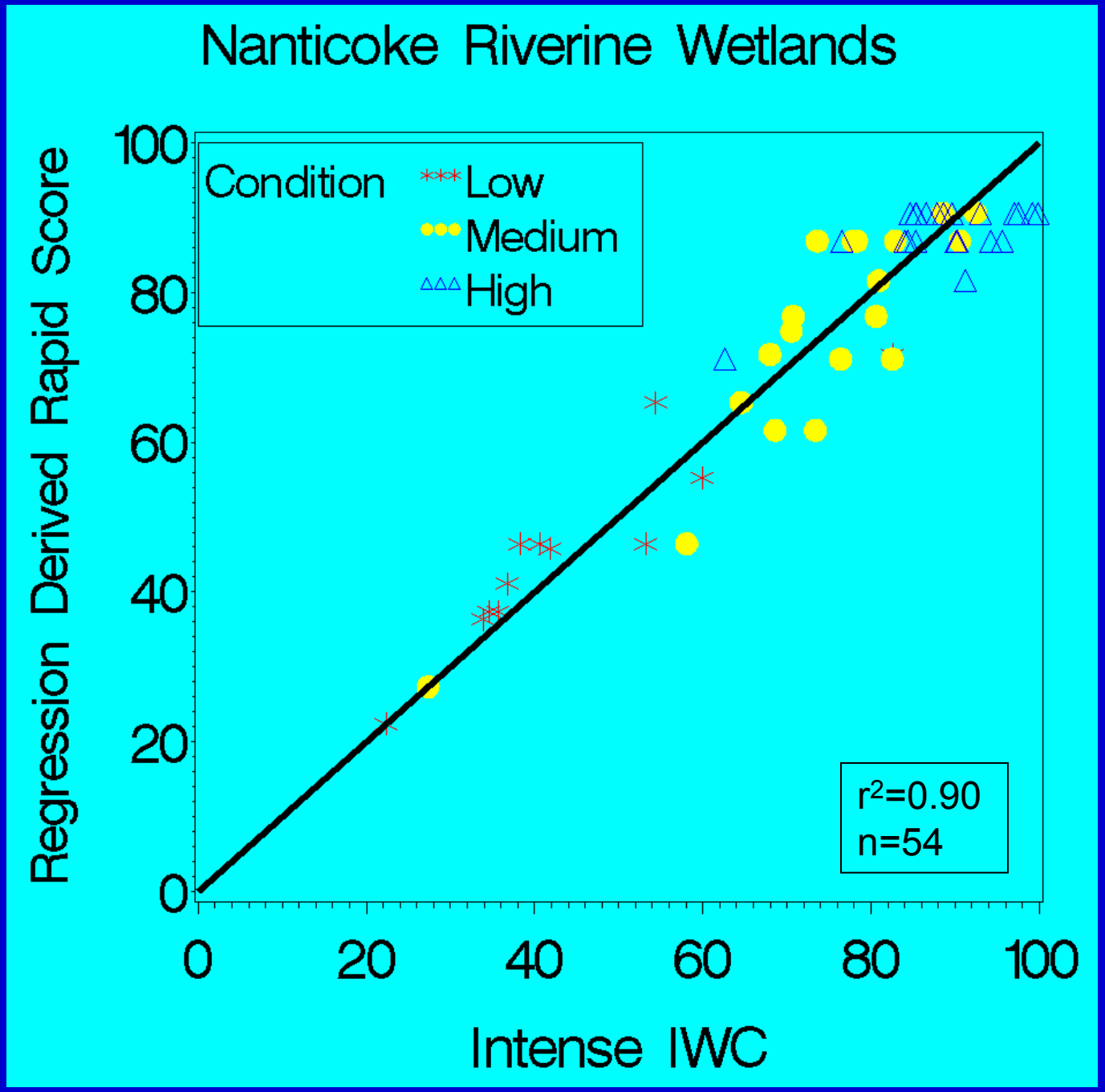
Regression Derived Rapid Scoring Equations

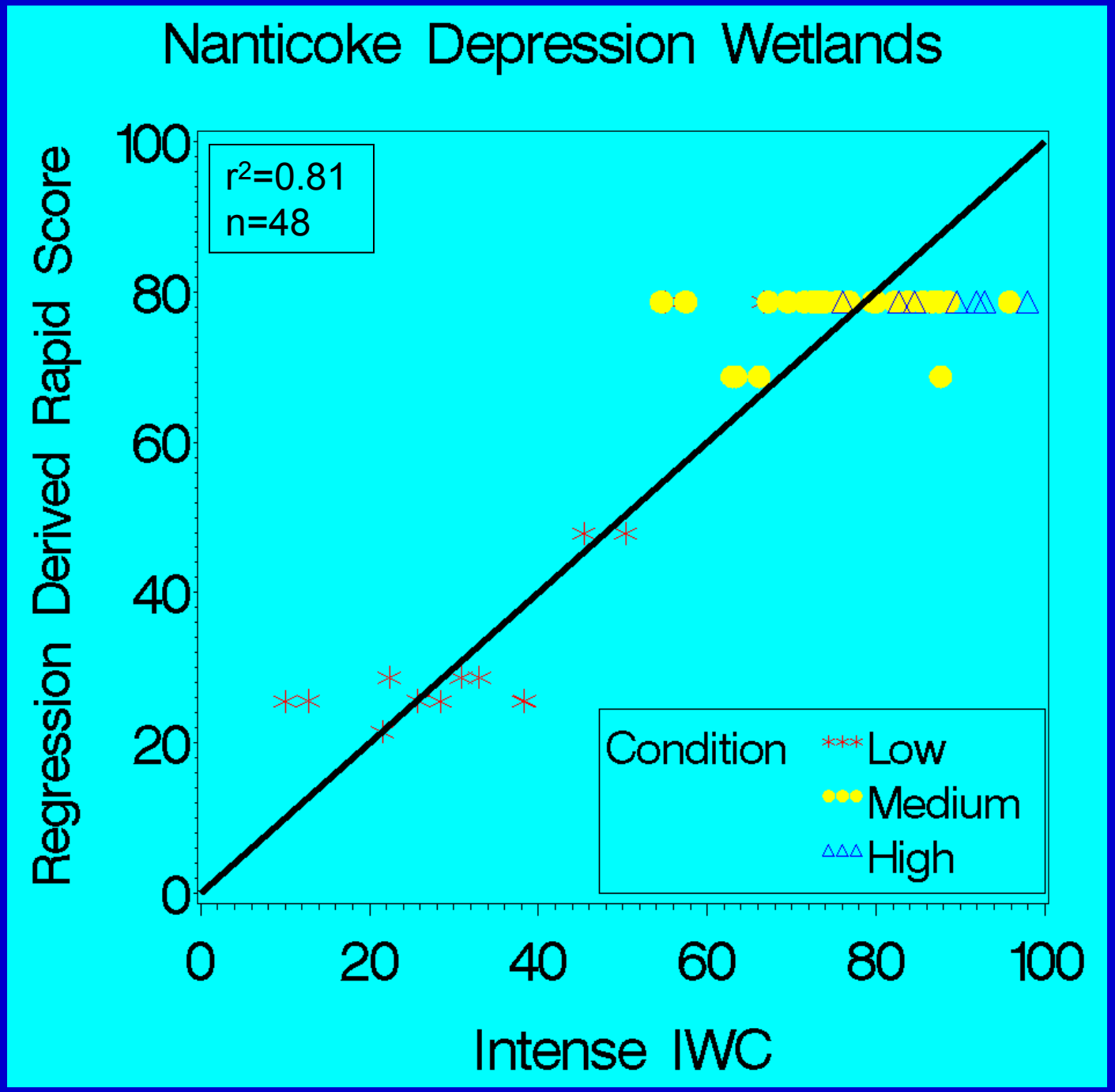
Riverine

Variable	Scoring
Intercept	90.6
Filling 10-100%	-19
Microtopo. Alt. 10-100%	-34
Channelized	-25
Impoundment 10-100%	-16
Invasives - dominant	-23
Forest harvest-recent	-10
Ag - row crops, nursery	-4
Forest harvest-recover	-5

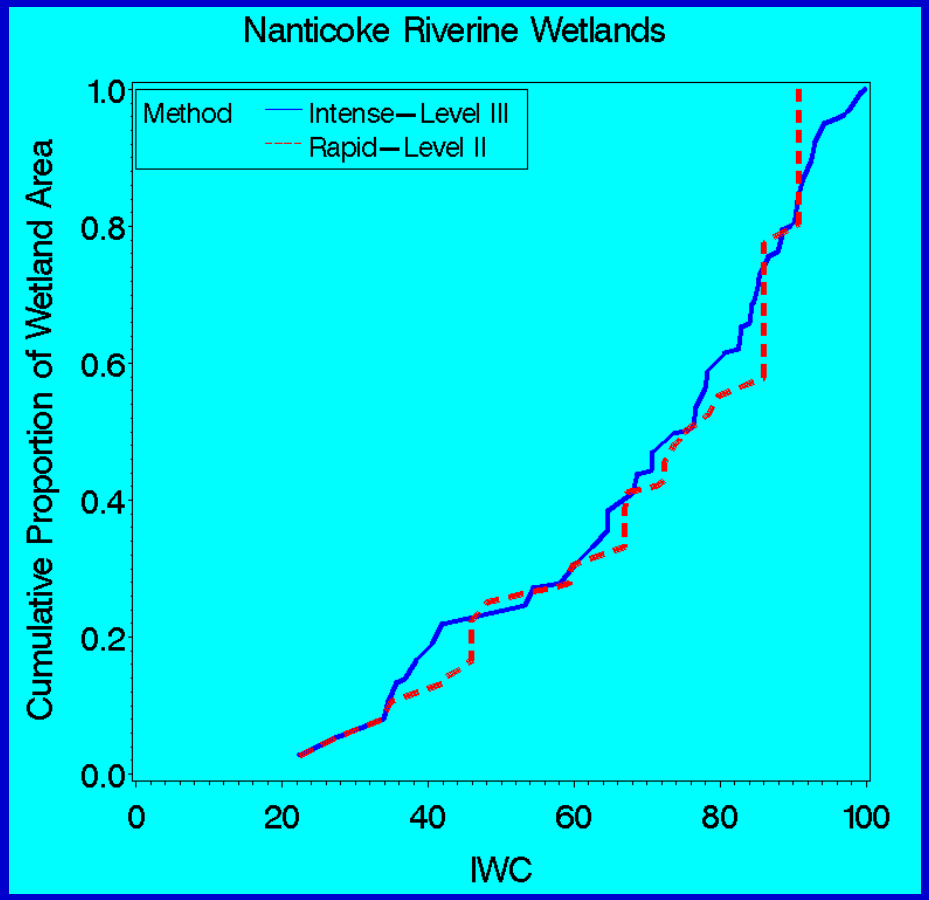
Depressions

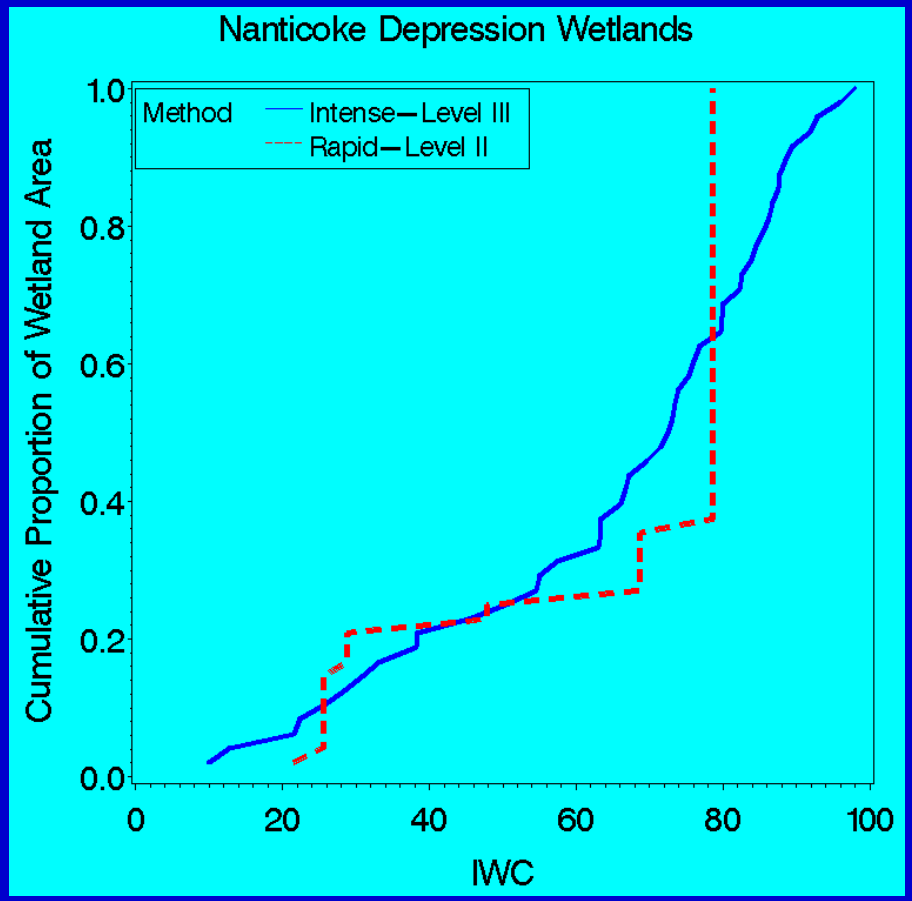
Variable	Scoring
Intercept	78.7
Chemical defoliation	-57
Garbage/dumping	-50
Farmed	-53
Mowed area	-31
Forest harvest-recover	-53
Ditching - moderate	-10





Riverine and Depression Population Estimates





Statistically Derived Rapid Scoring Pros and Cons

- Objective, quantifiable process for
  - Selecting significant stressors
  - Scoring coefficients
- Excellent agreement with intense IWC for flats and riverine, fair agreement for depressions

- Rare stressors may not show up in model
- Fitted to specific data
  - Needs to be validated
  - Calibration necessary for each new region or wetland type
- Rapid scoring is based on observed stressors not function, assumes constant effect of stressor

Summary

- Developed one overall intense IWC that was highly discriminatory of three condition classes
- We were able to calibrate the Delaware rapid method stressor observations to the intense IWC to get a rapid IWC that can be done with much less effort
- Future efforts will work on extending to other systems and validation with new data

Special Thanks to
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- Rich Sumner
- John VanSickle
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