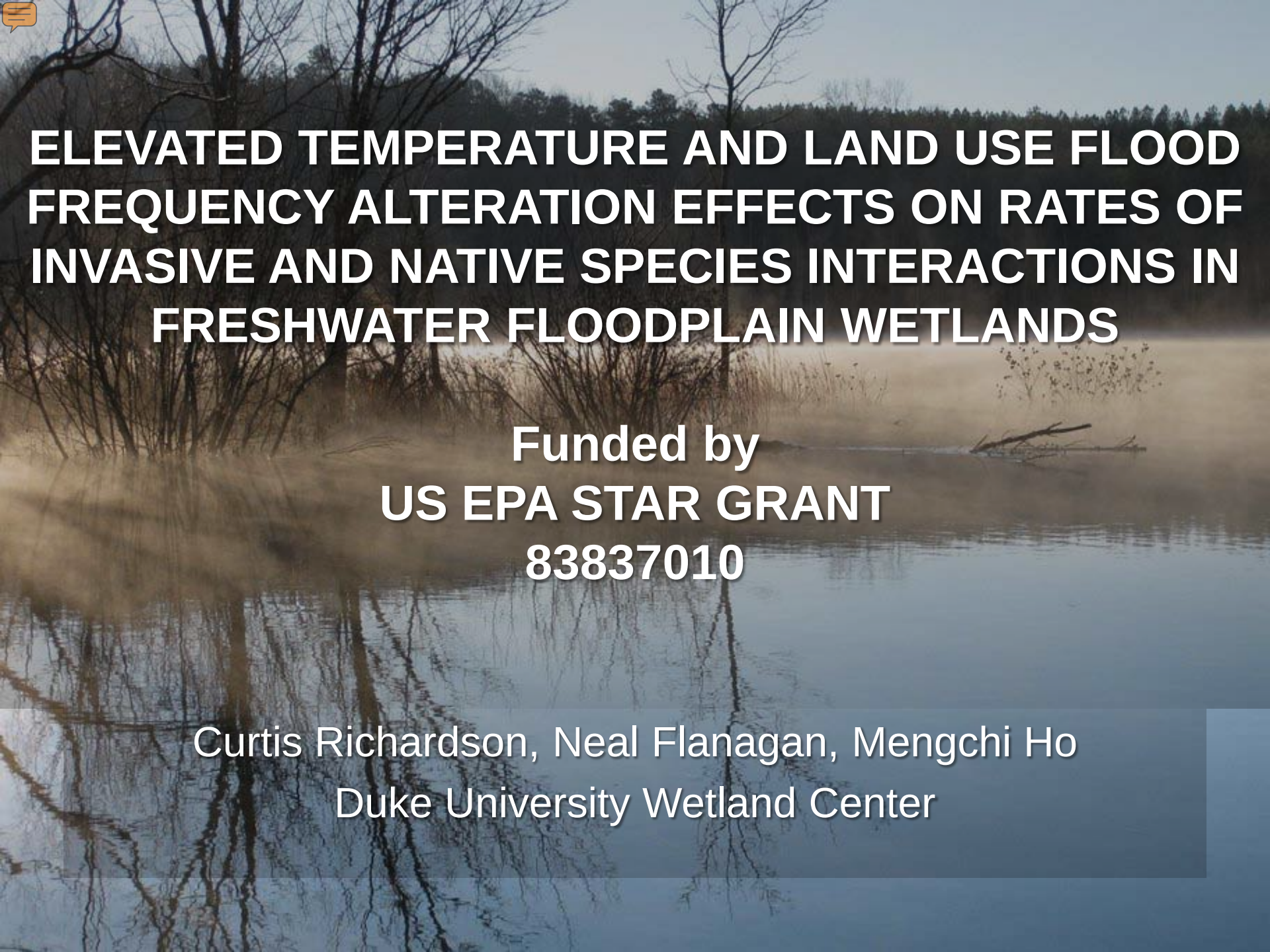


ELEVATED TEMPERATURE AND LAND USE FLOOD FREQUENCY ALTERATION EFFECTS ON RATES OF INVASIVE AND NATIVE SPECIES INTERACTIONS IN FRESHWATER FLOODPLAIN WETLANDS

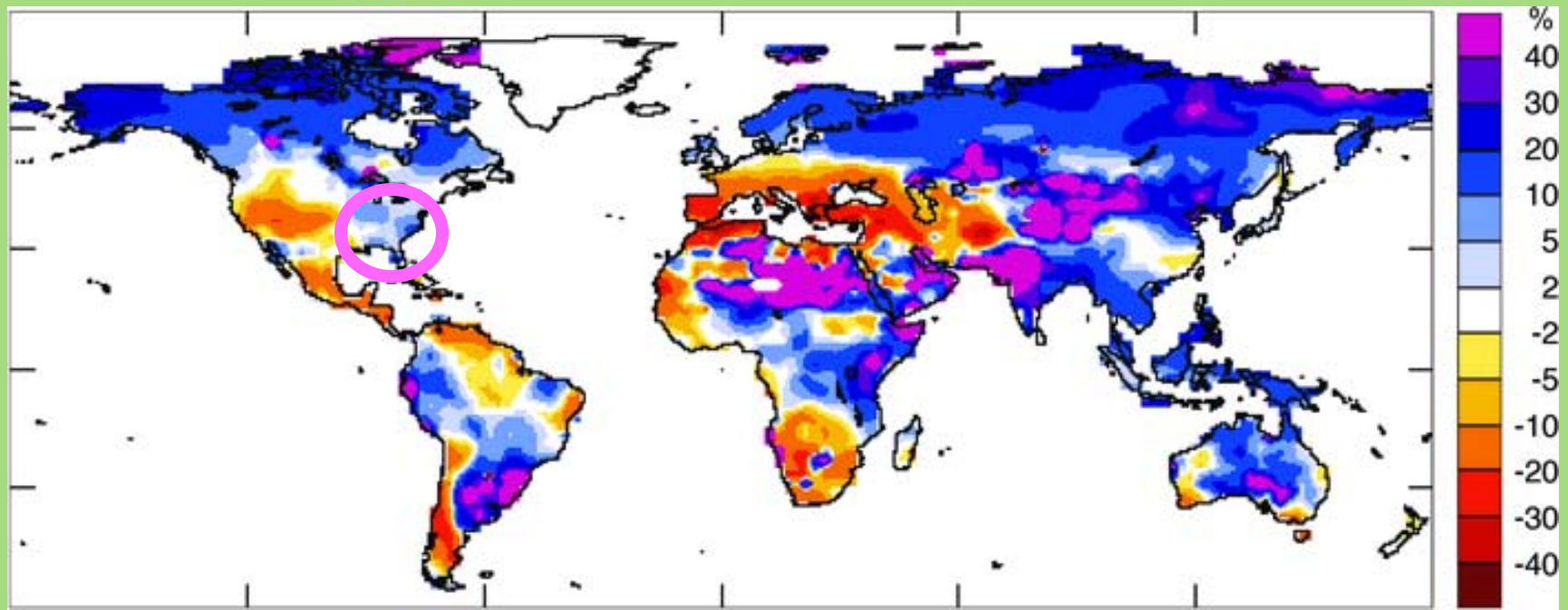
Funded by
US EPA STAR GRANT
83837010

Curtis Richardson, Neal Flanagan, Mengchi Ho
Duke University Wetland Center

Future Climate Scenario

Global climate change and regional freshwater ecosystem models (IPCC) agree on two key findings;

1. water temperatures will increase 2 to 3°C and,
2. the frequency of high intensity rainfalls and large flood events will increase.



Likely Future Scenario

- Southeastern freshwater wetlands;
  - greater number of rapid wetting and drying cycles

    -(i.e. large magnitude Pulses).
  - Larger flood pulses will be punctuated by lower baseflow,

Study Questions

1. How do species-richness, diversity, and “degree of invasion” differ under varying pulse water and temperature regimes?
2. How have interactions between hydrology and temperature affected the current community composition/invasibility of southeastern floodplain ecosystems at the regional scale?

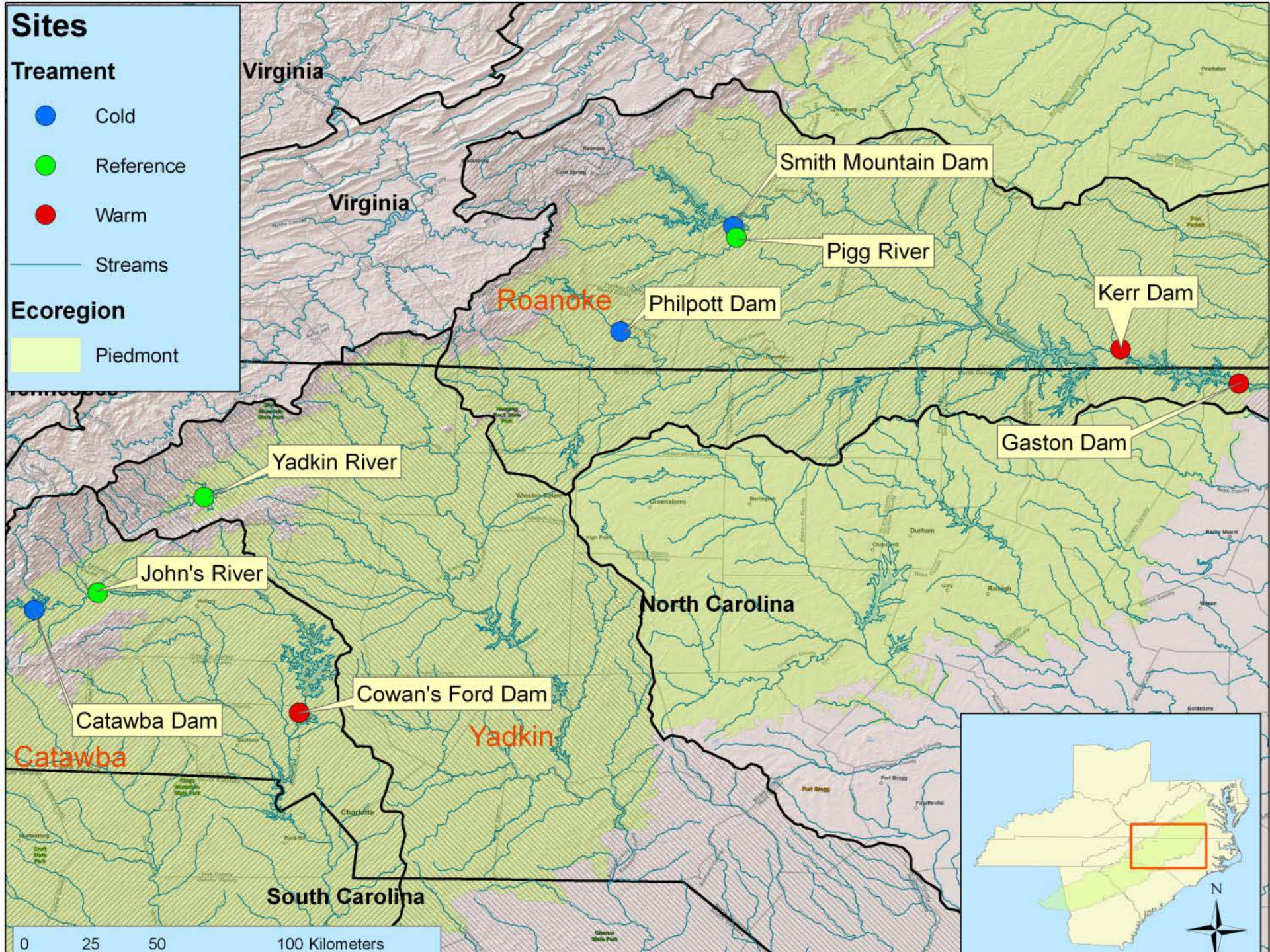
Methods

Site Layout

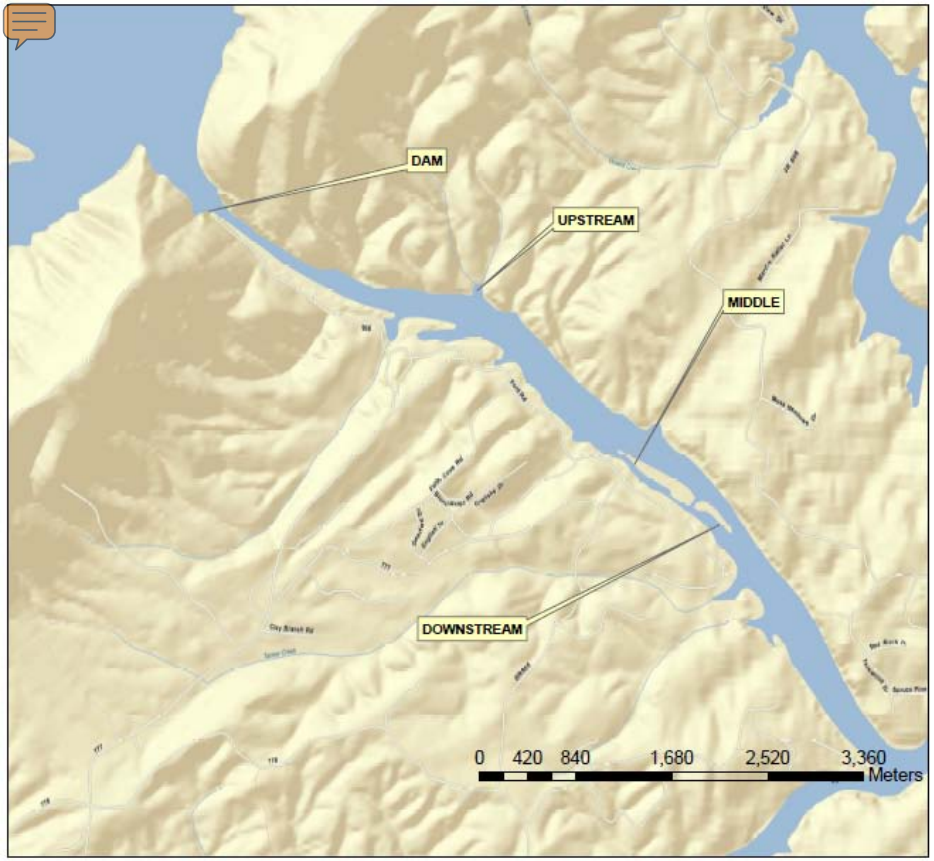
- Nine floodplains wetlands located on rivers throughout the North Carolina and southern Virginia.
- Downstream of:
  - 3 surface-drawing dams (warm water)
  - 3 bottom-releasing dams (cool water)
  - 3 undammed reference watersheds

Site Selection Criteria

- Temperature regime
- Located within the Piedmont Ecoregion
- Headwaters in mountains
- Primarily rural (forest and agriculture)
- High degree of hydrologic connectivity,
  - Frequently flooded
- Similar nutrient regimes
- Reference sites have no upstream dams on perennial reaches

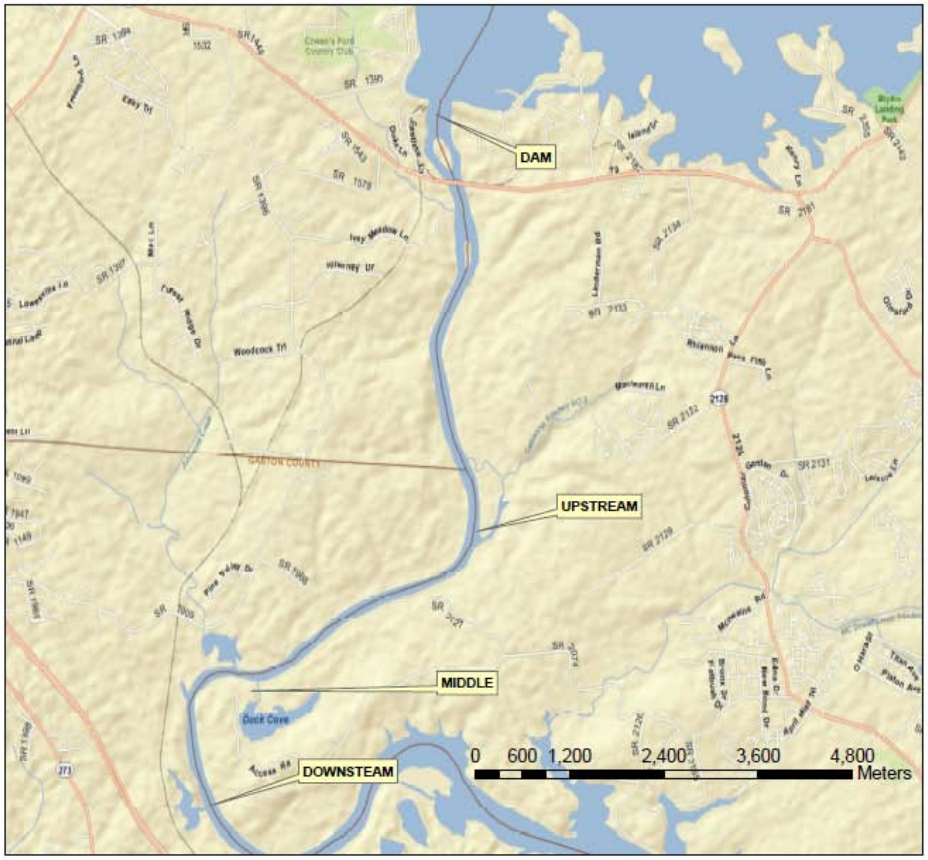

Sites
Treament
Cold
Reference
Warm
Streams
Ecoregion
Piedmont
Virginia
Virginia
Smith Mountain Dam
Pigg River
Roanoke
Philpott Dam
Kerr Dam
Gaston Dam
Yadkin River
John's River
North Carolina
Catawba Dam
Cowan's Ford Dam
Yadkin
Catawba
South Carolina
0
25
50
100 Kilometers
N

GRADIENT SITES - COLD

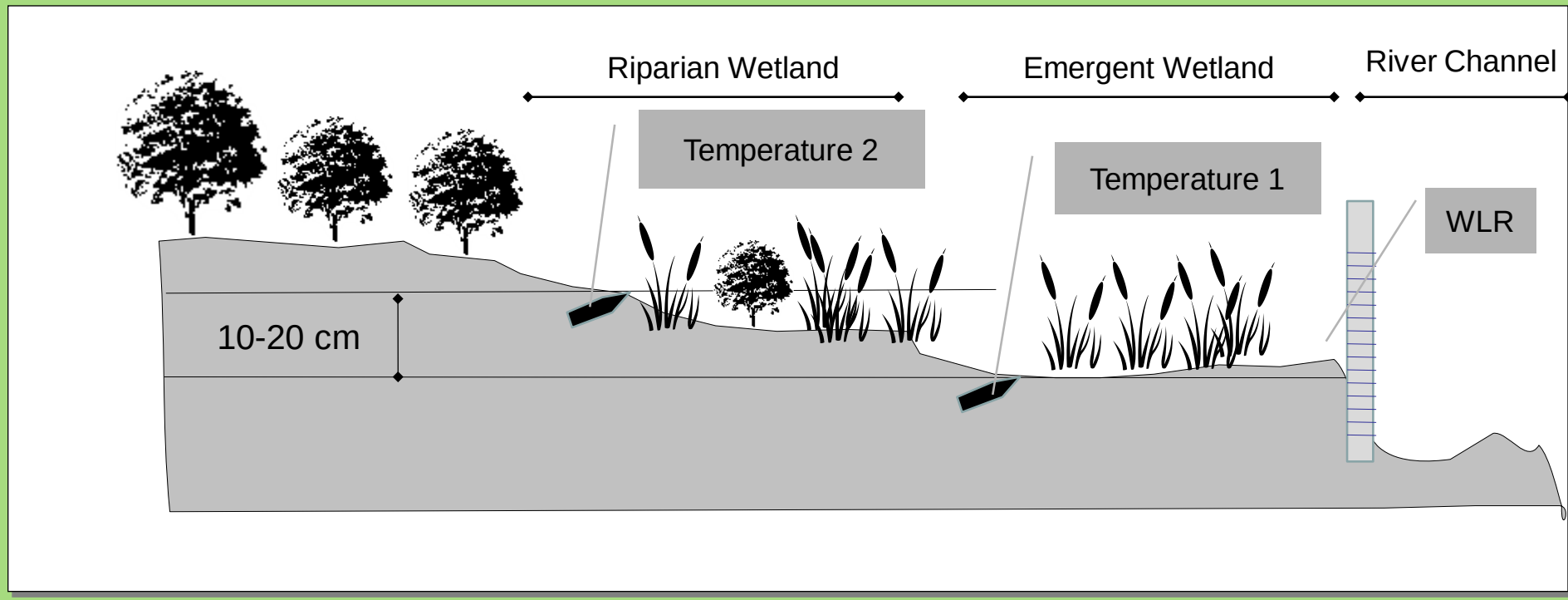


- Three sites with similar
  - Soils,
  - Hydrology
  - Propagule source
- Tempurature gradient toward ambient with movement away from dam

GRADIENT SITES-WARM

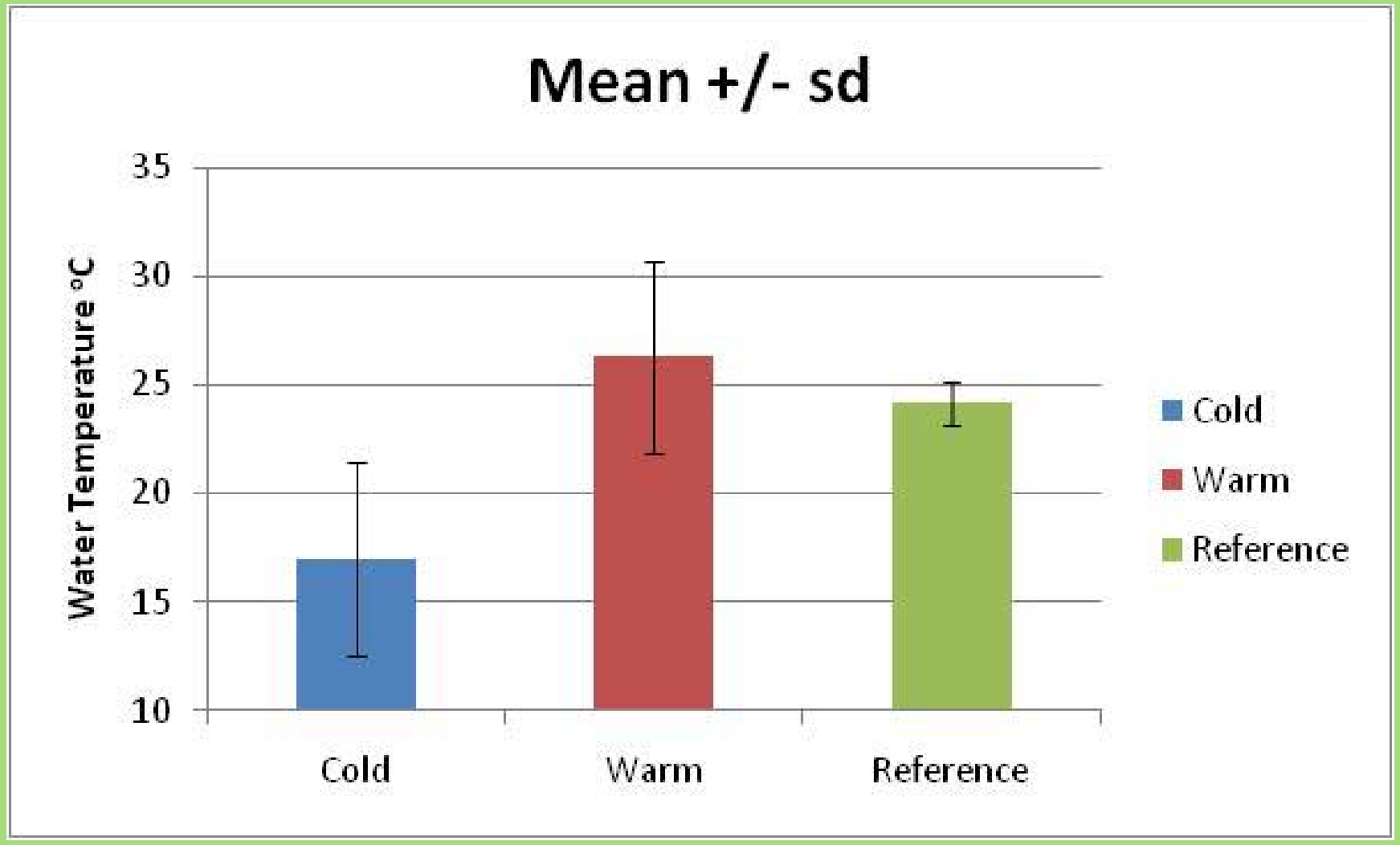


Site Layout

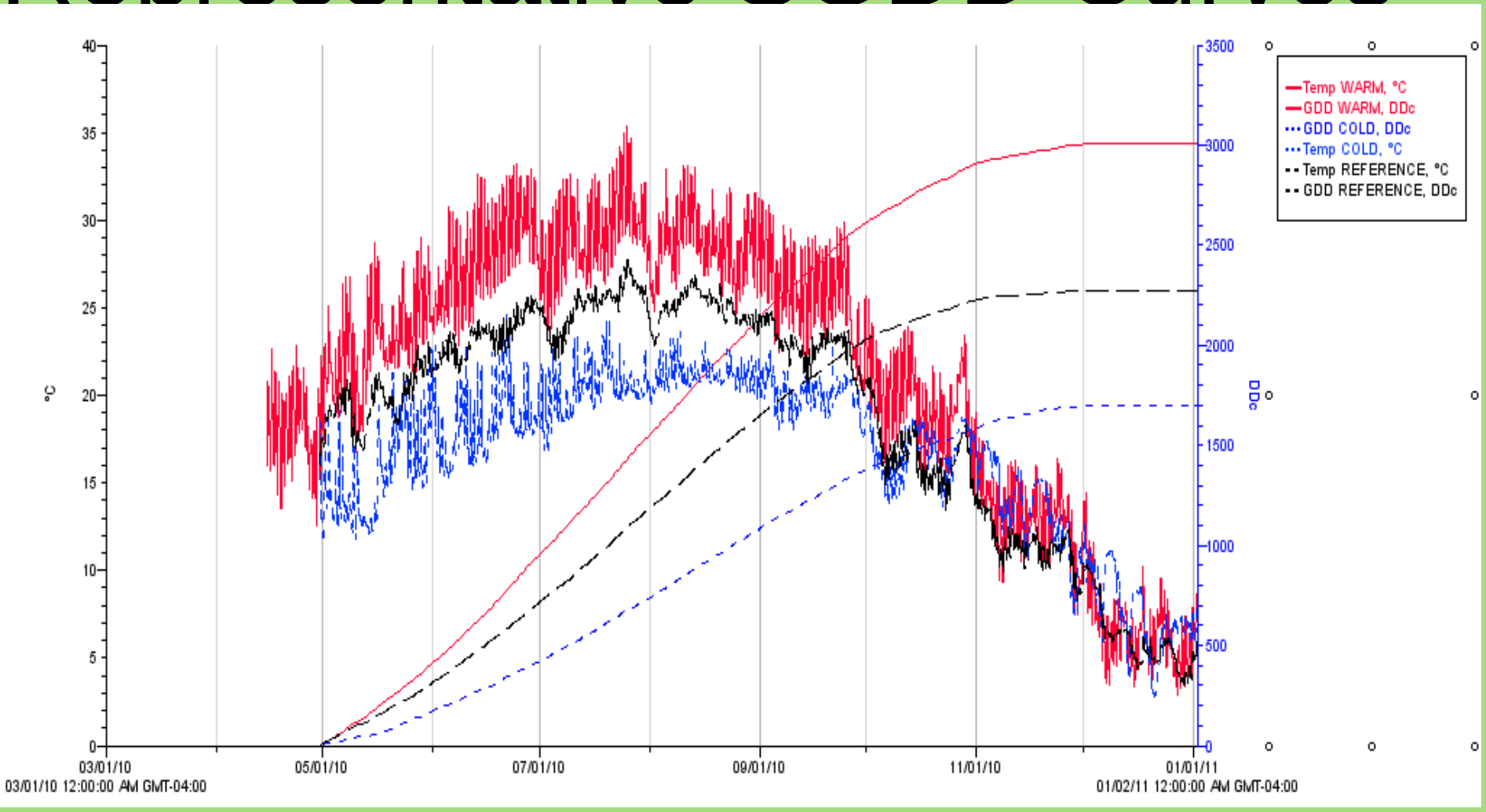

Riparian Wetland
Emergent Wetland
River Channel
Temperature 2
Temperature 1
WLR
10-20 cm


RESULTS

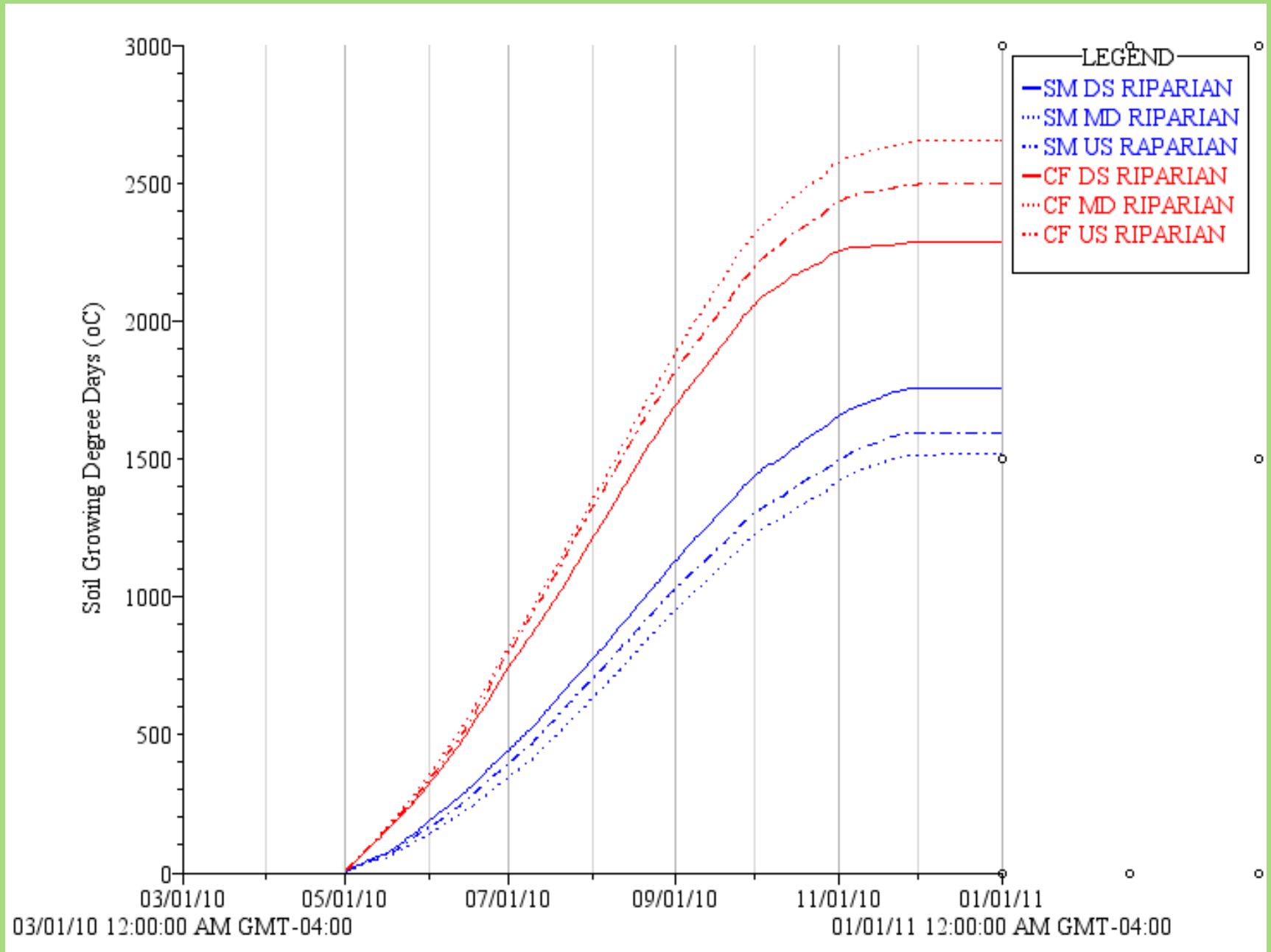
Mean June Water Temperature



Representative SGDD Curves



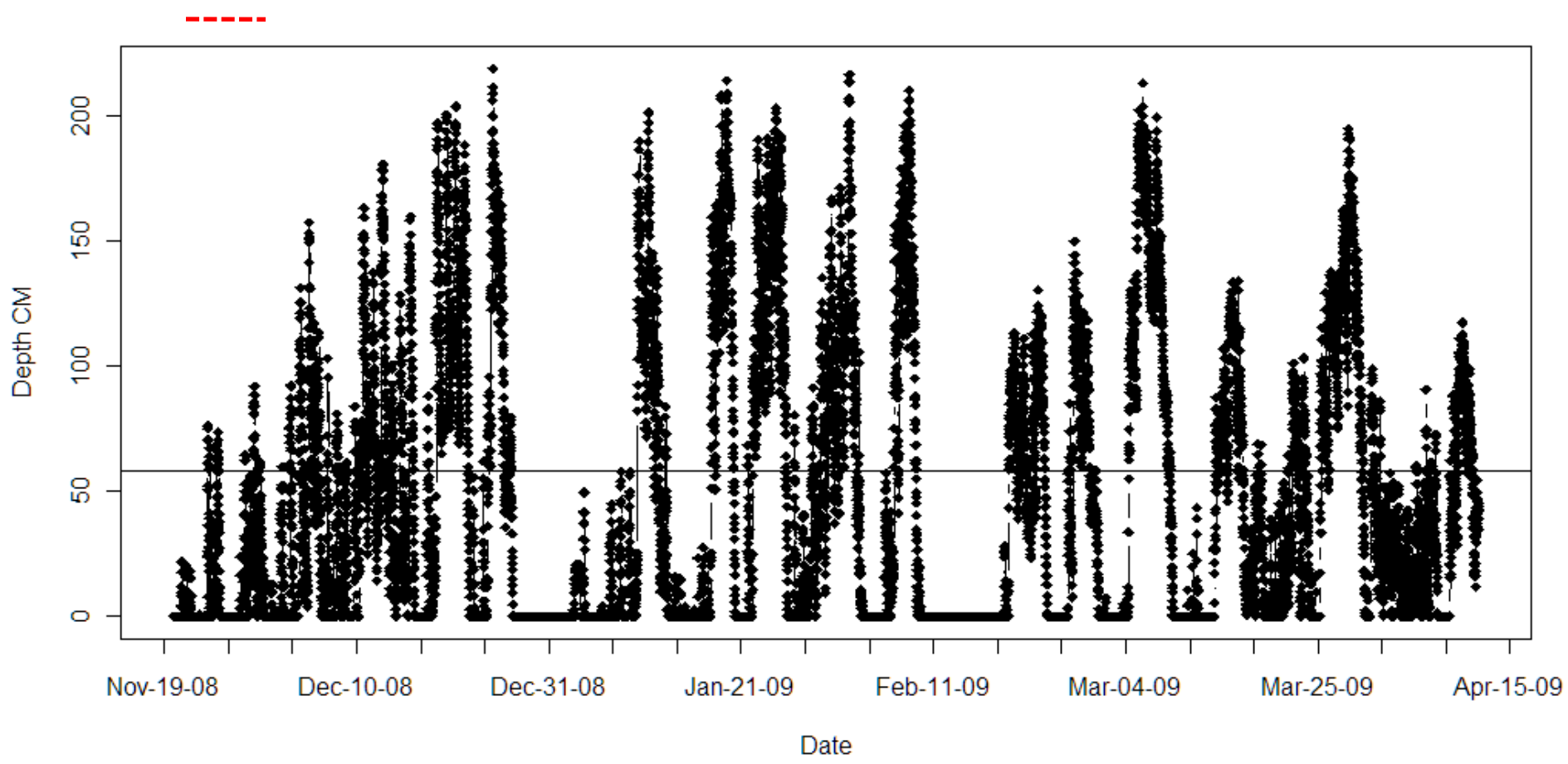
SGDD – Gradient Sites



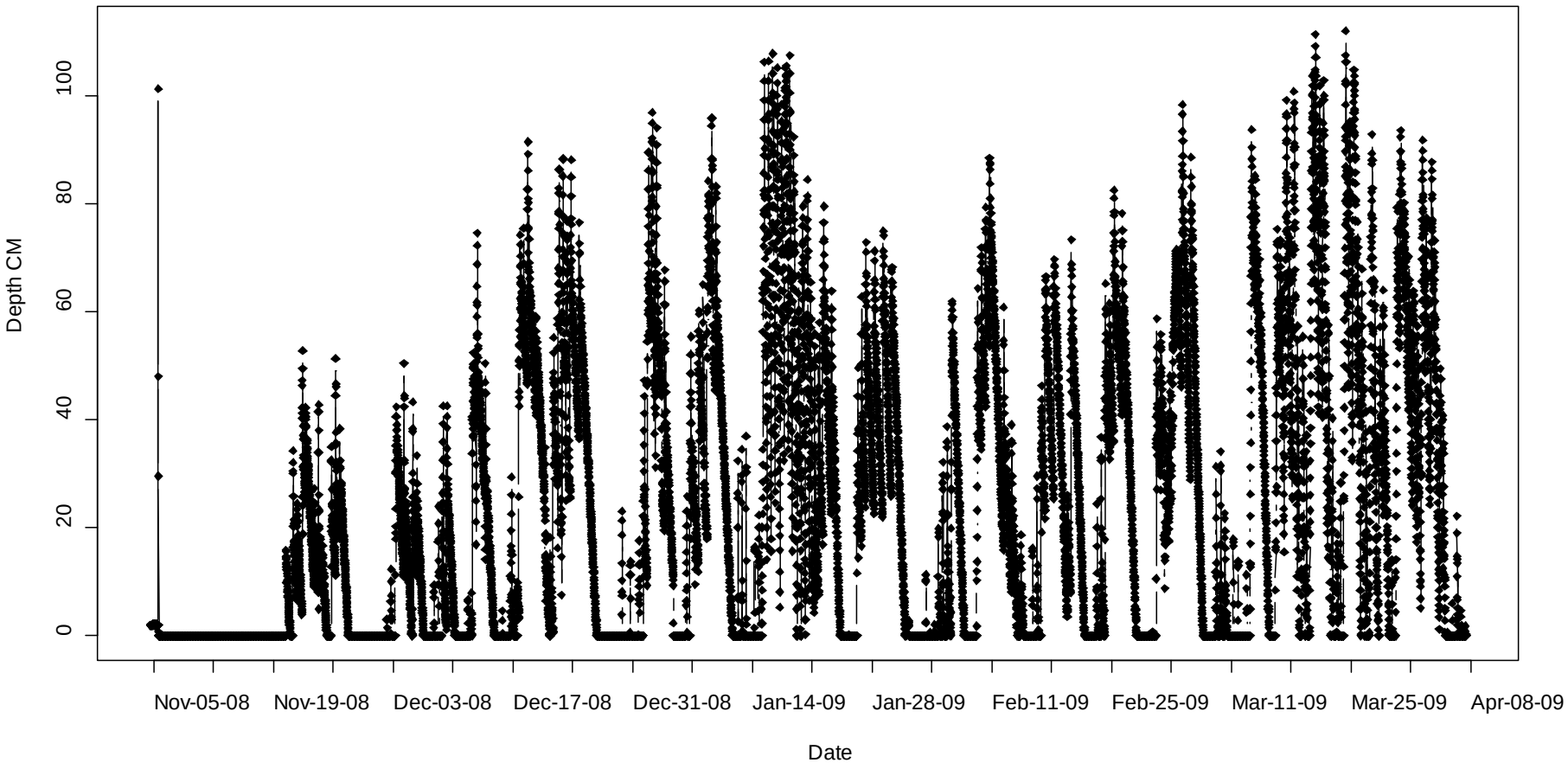
Water TN Concentration by Treatment

Water TP Concentration by Treatment

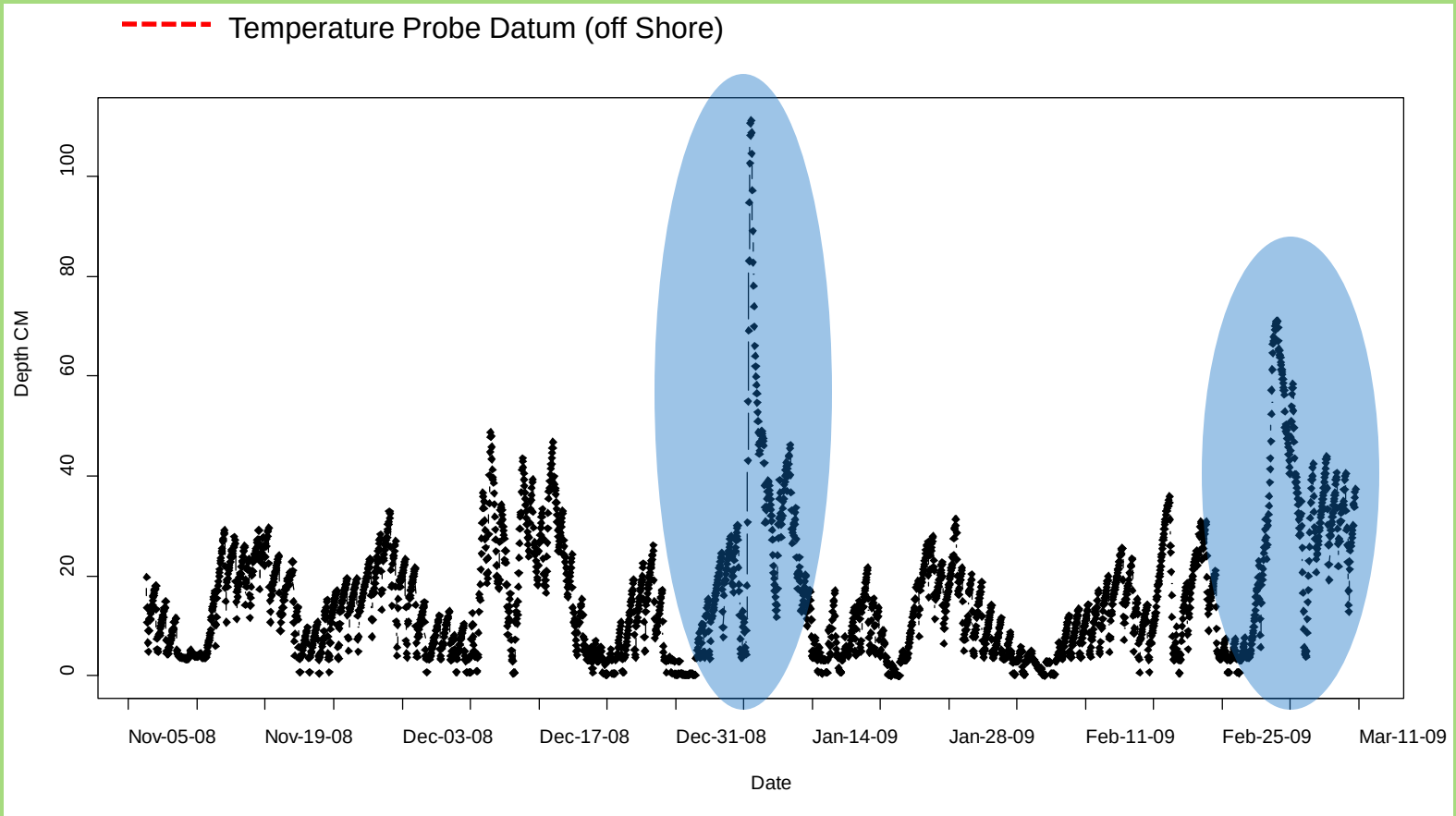
Smith Mountain Dam - Cold



Gaston Dam - Warm



Johns River - Reference



Hydrology Numerical Summary

Warm	432	4.26	1842	38.7	121
Reference	306	10.7	3291	90	84
Cold	485	4.3	2099	34.4	173

Analysis of Plant Community Indices

- Site specific indices of diversity, species richness and degree-of-invasion
- Alpha Diversity

Most common Non-native Invasive Plants in Research Sites

(small carpgrass)

(sericea lespedeza)

(Chinese privet)

(Japanese honeysuckle)

(Nepalese browntop)

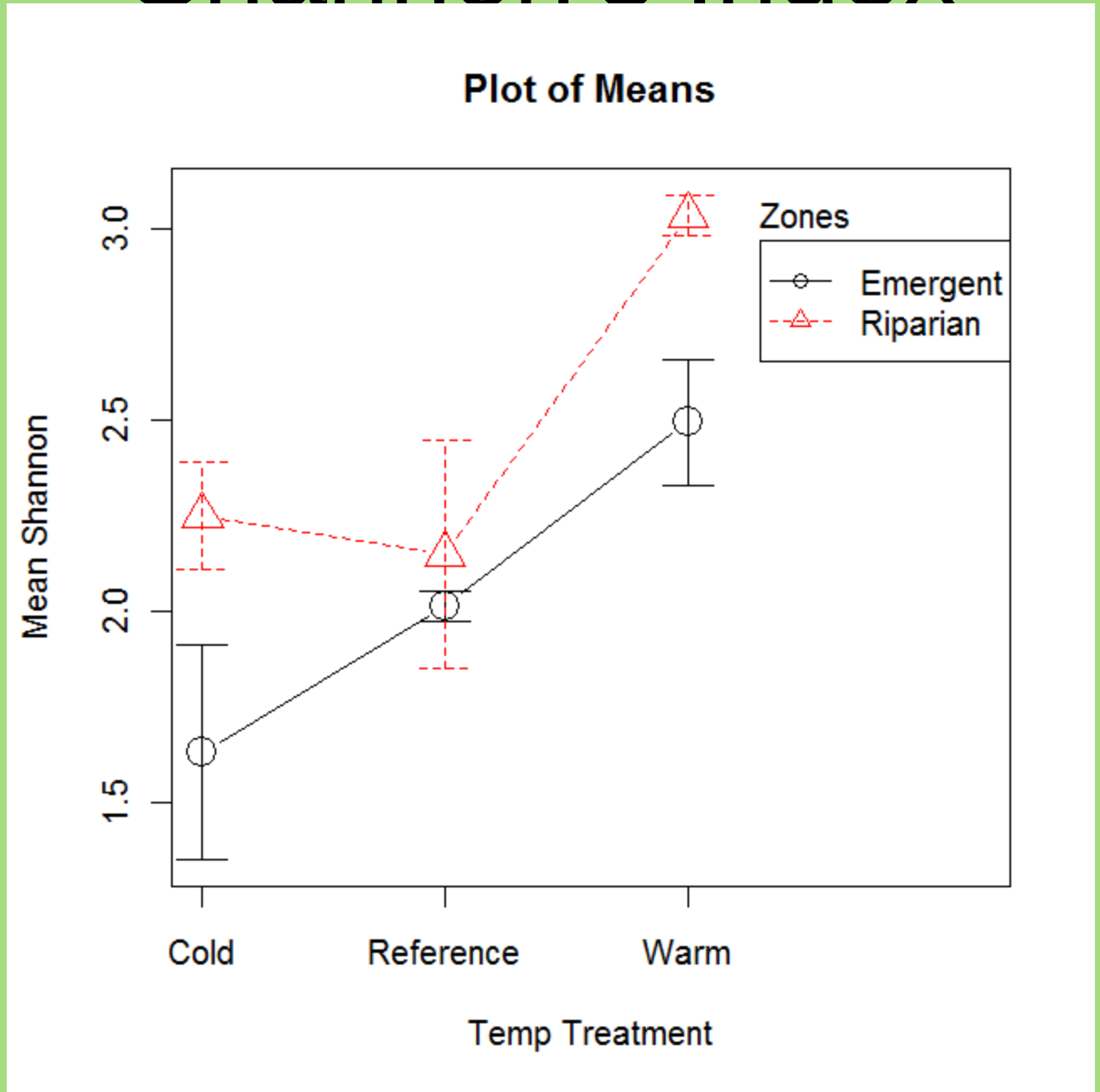
(watermoving herb)

(true forget-me-not)

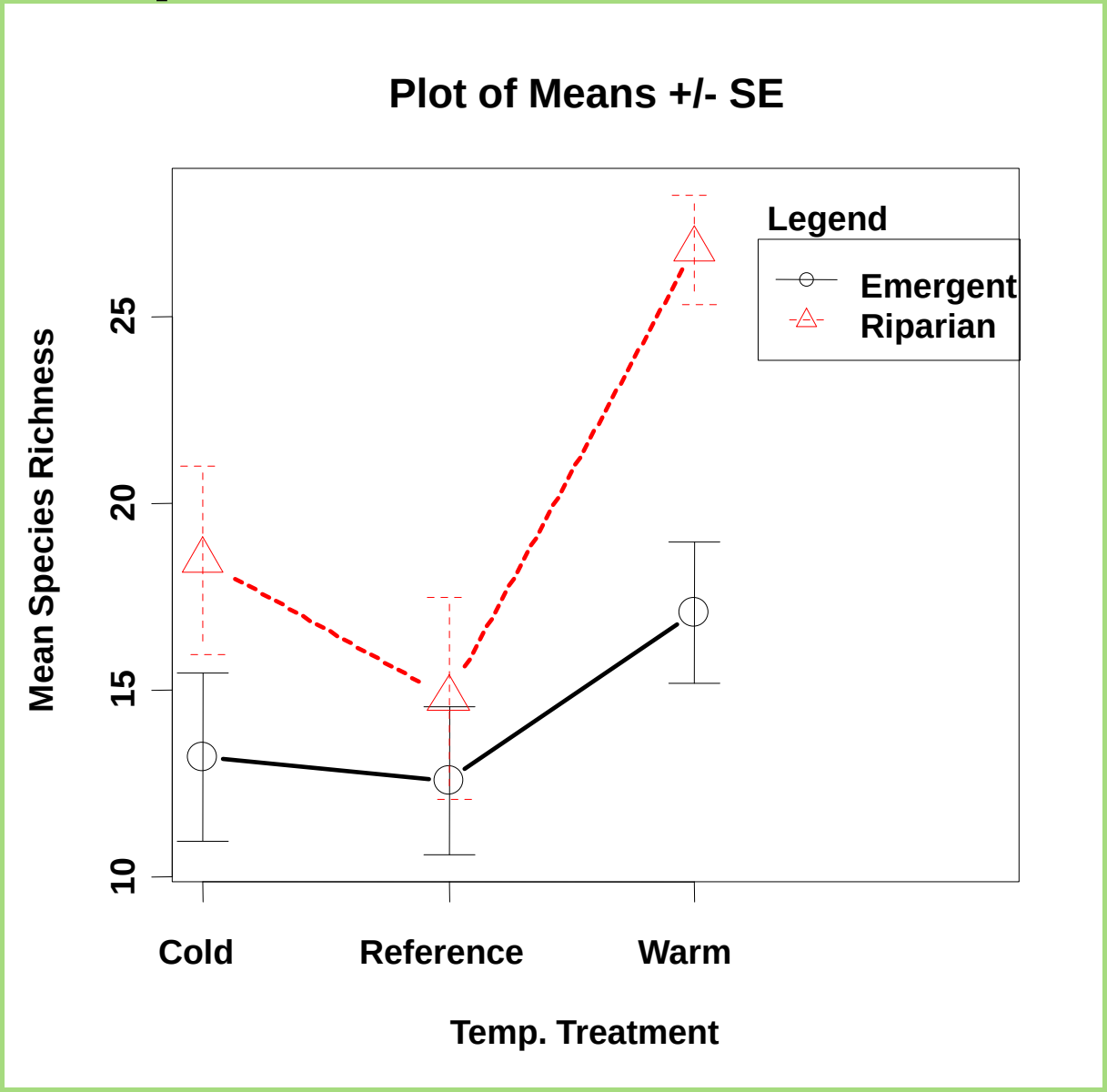
(Oriental lady’s thumb)

(marshpepper knotweed)

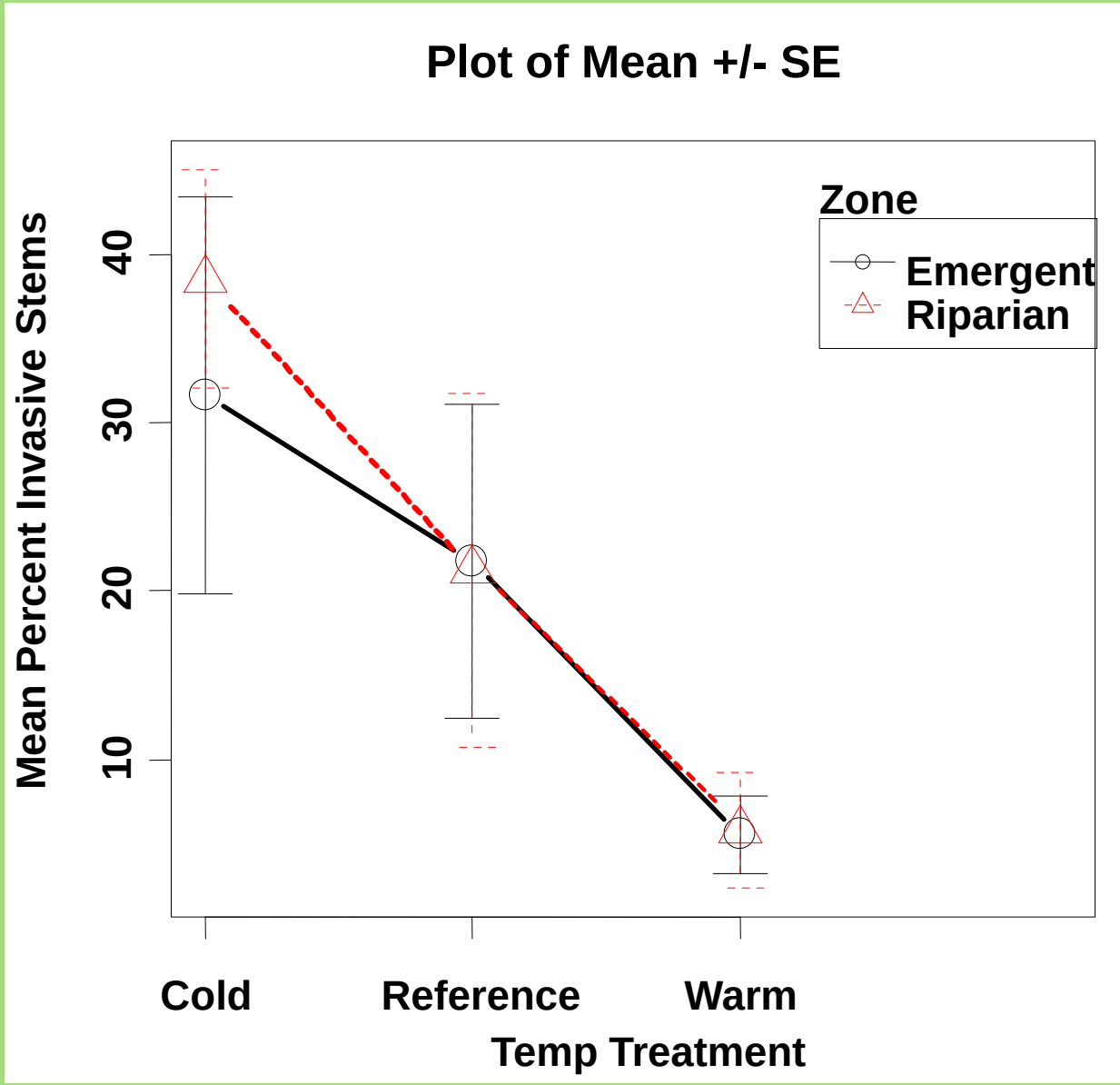
Shannon's Index



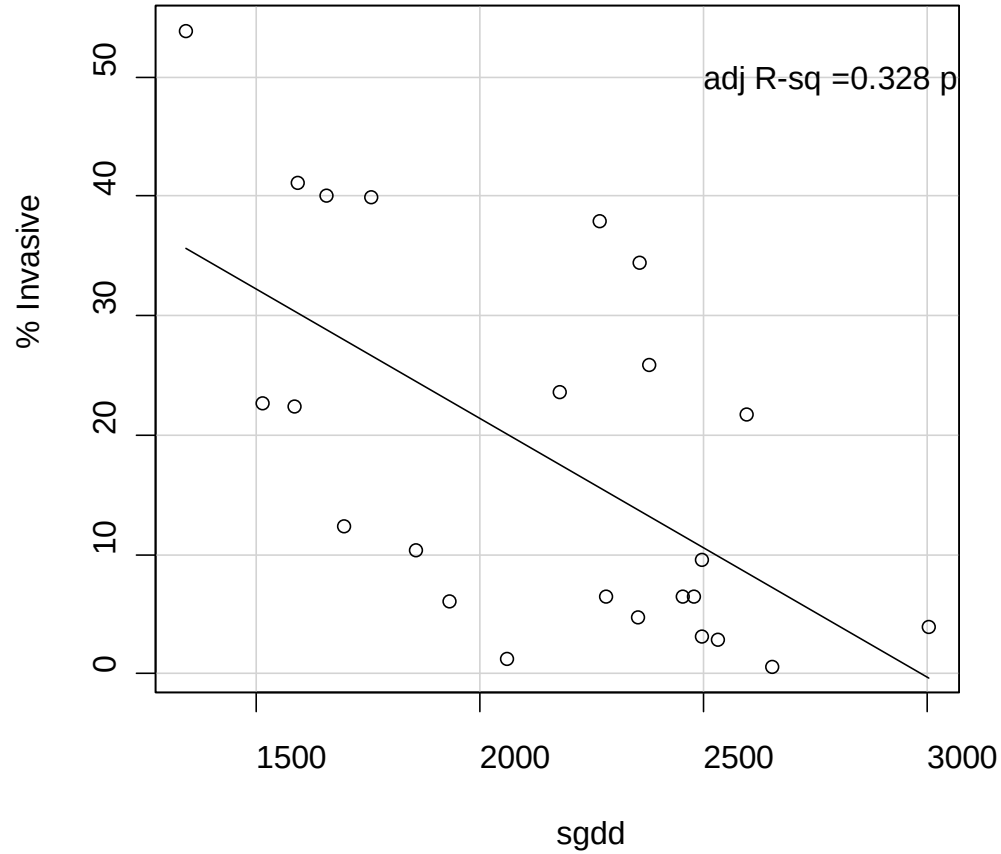
Species Richness



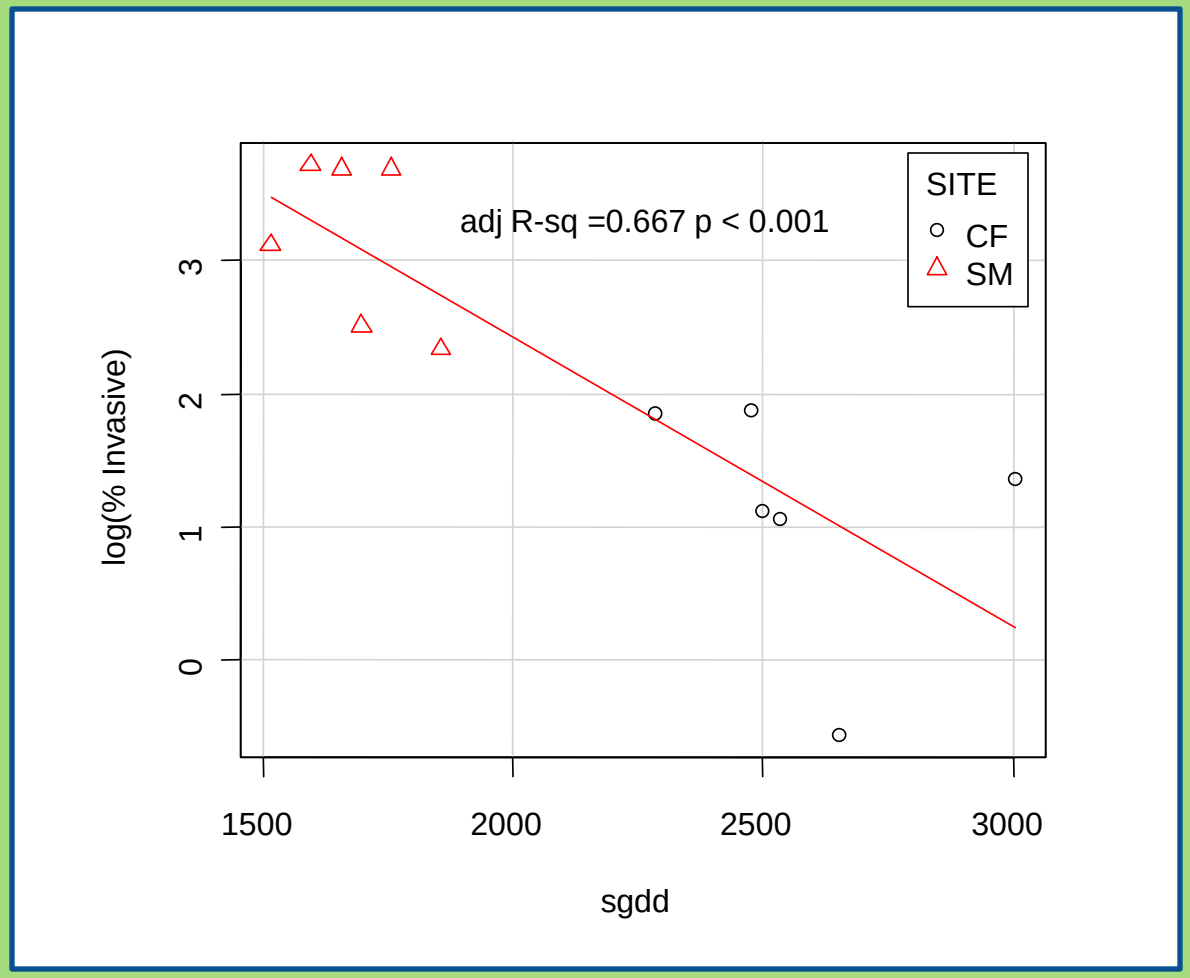
Percent Stems Non-Native



% Invasive v. SGDD
All Sites



% Invasive v. SGGD Gradient sites



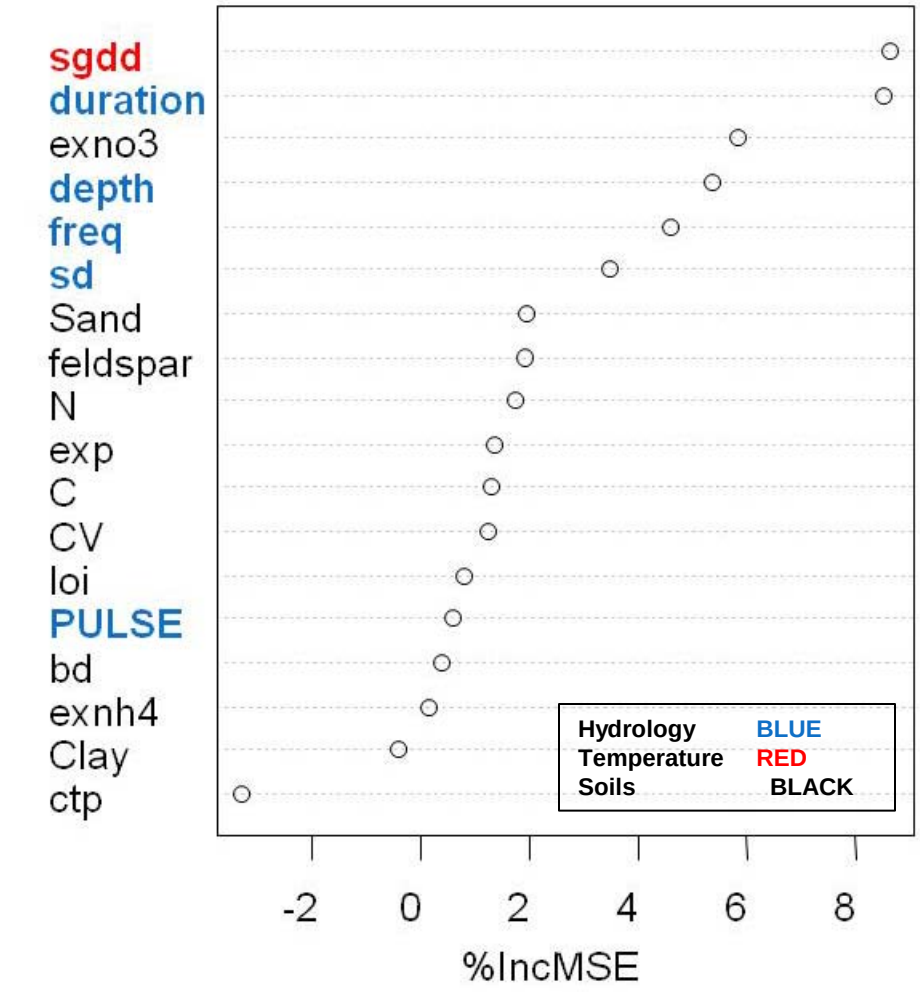
Correlation of Community Indices with Environmental Factors

Procedure: Random Forest

Diversity	
Shannon	52.8
Species Richness (rarefy)	48.2
Degree of Invasion	
% Stems Non-Native	36.4

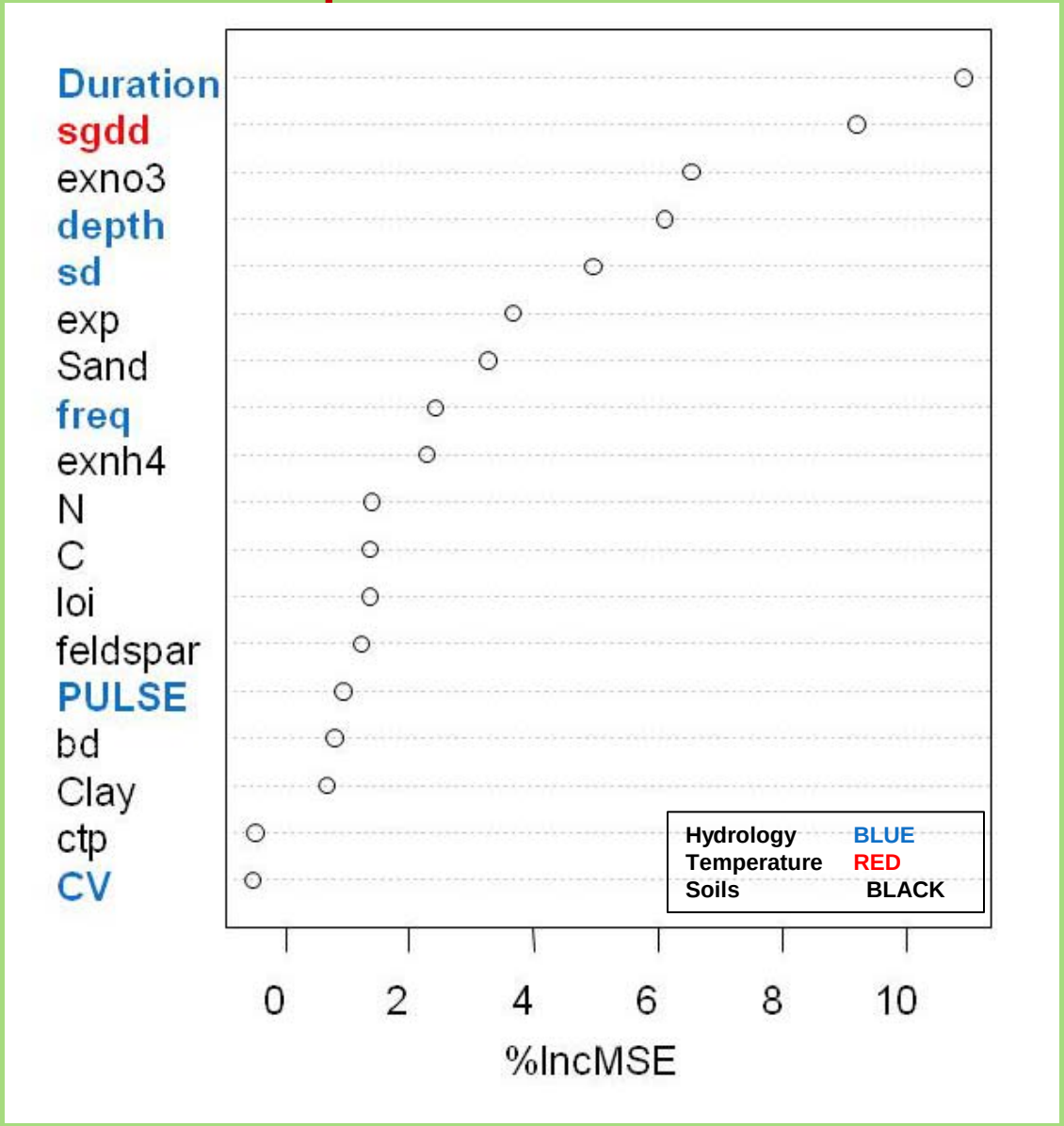
Random Forest Variable Importance

Diversity Index (Shannon)



Random Forest Variable Importance

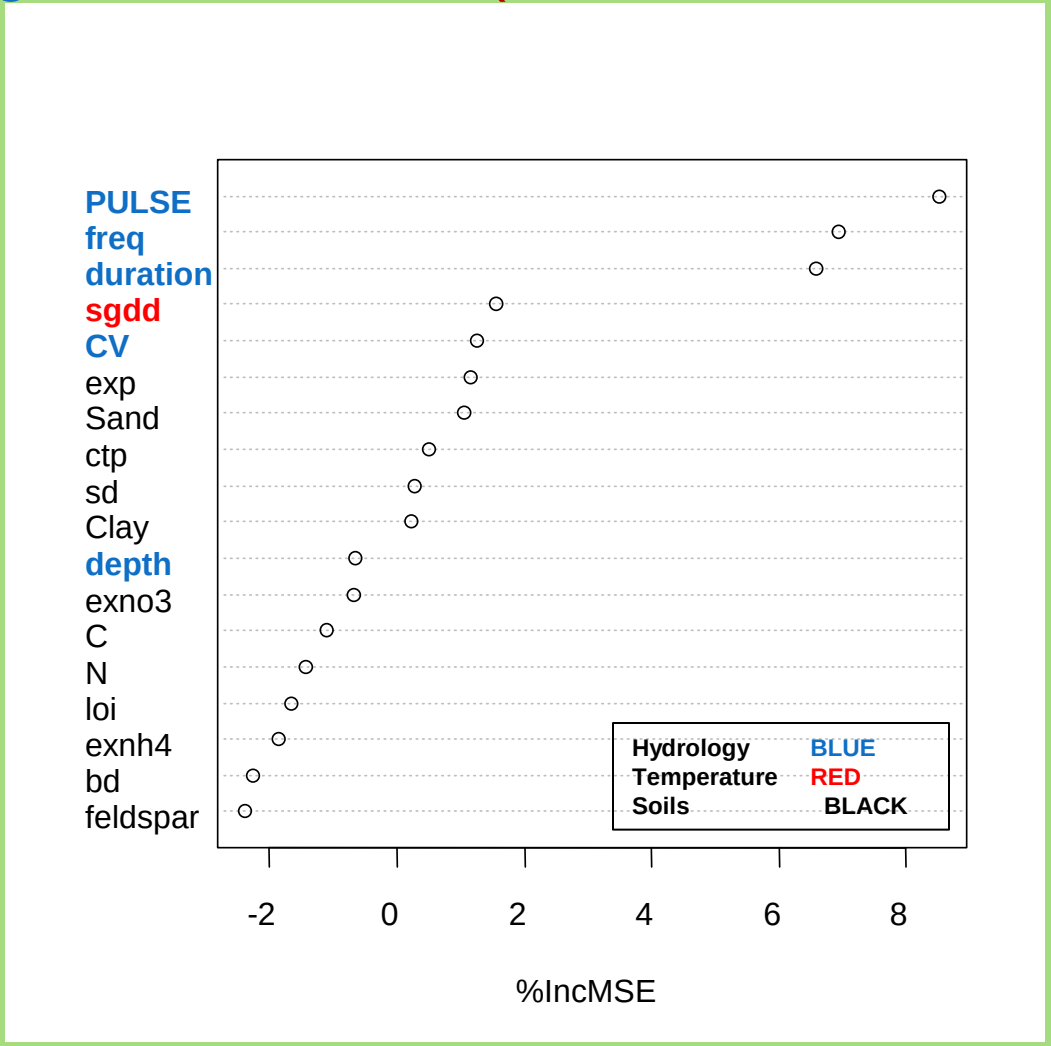
Species Richness



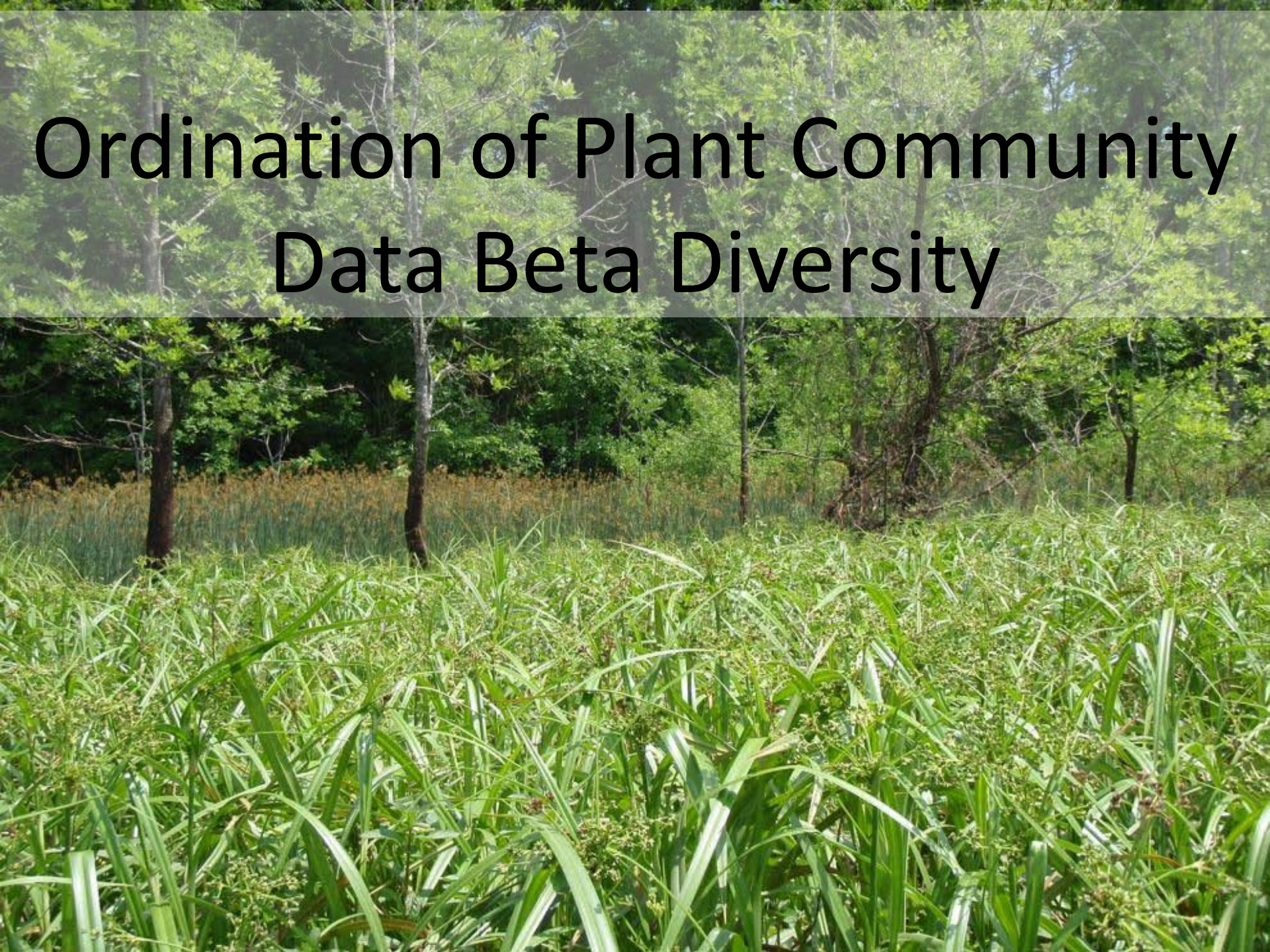
MSE increase when variable is randomly permuted

Random Forest Variable Importance

Degree of Invasion (% Non-Native Stems)

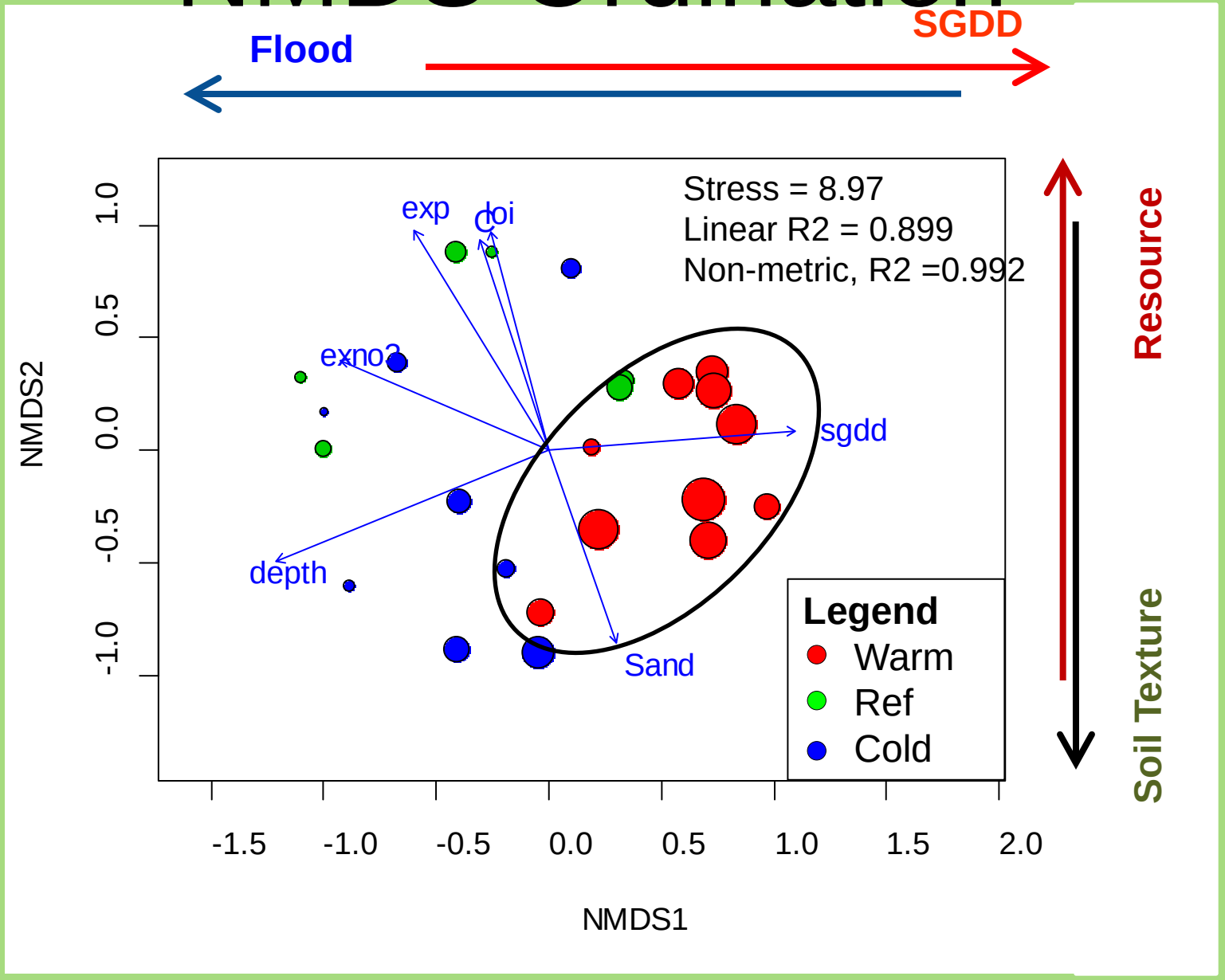


Ordination of Plant Community Data Beta Diversity




SEAARK
EVINRUDE
NC0666WN

NMDS Ordination



Symbol size scaled by Species Richness (rarefied)

Summary

- Degree-of-Invasion
  - (+) Pulse 1º
  - (-) Soil temp 2º
- ShannonDiversity
  - (+) Soil temp 1º
  - (-) Flood Duration 2º

- Species Richness
  - (+) Duration 1º
  - (-) Soil temp 2º

Climate Change Scenario

- Temperature associated with;
  - diversity
  - degree of invasion
- Flooding associated with;
  - diversity (Duration)
  - degree invasion (Pulse)

- Outcome of climate change will depend on tradeoff of hydrology and temperature

Future Research

- Established a set of sites that can be used to examine many temperature driven processes
  - Microbial communities
    - Sequencing microbial DNA
  - Gas Exchange
    - Effects of temperature and hydrology on greenhouse gas emission oand uptake
  - Plant biomass

ACKNOWLEDGEMENTS

- **DUWC STAFF**

  Jonathan Bills

  Wes Willis
- **US Army Corps of Engineers**
- **NC Wildlife Commission**

- **FUNDING PROVIDED BY**

  US EPA Science to Achieve Results (STAR) Grant

Contact Information

Curtr@duke.edu

Neal.flanagan@duke.edu