Assessment of Vegetation, Soils, and Water Quality of Hawai‘i’s Coastal Wetlands

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2008 HCC Coastal Wetland Symposium

Introduction

- Development, agriculture, invasive species have contributed to degradation & loss of coastal lowland wetlands (CLWs) in Hawai‘i
- Numerous wetland restoration, creation projects are being undertaken
- Understanding of vegetative, soil, water quality characteristics of CLWs is limited
- CLWs link terrestrial & marine environments

Objective:

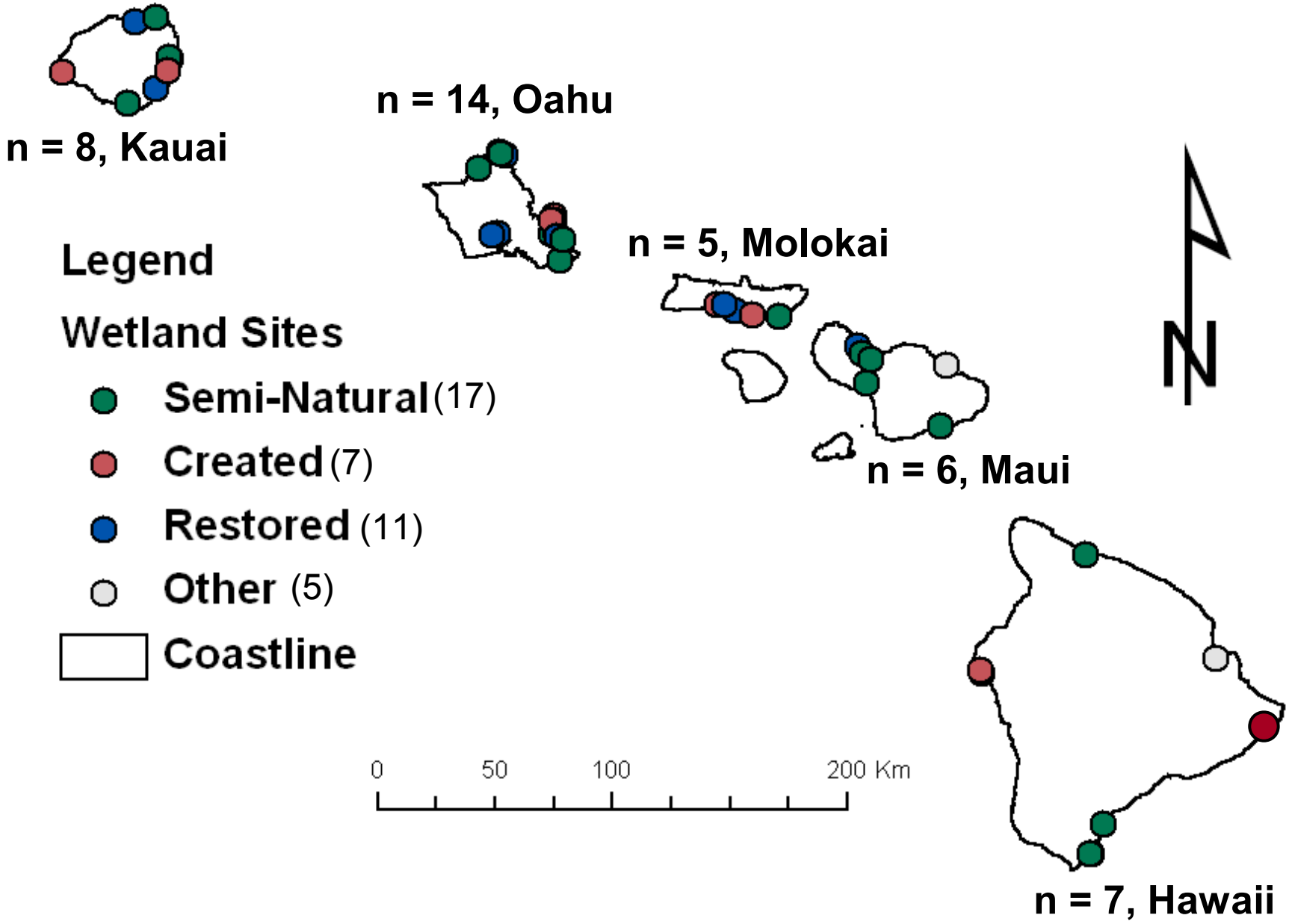
Document vegetative, soil, water quality characteristics of CLWs in the Hawaiian Islands & to compare these characteristics among semi-natural, restored, & created wetlands

Wetland Types

Semi-Natural: relatively-undisturbed wetlands with hydric soils, water tables near the soil surface in the growing season, that support some native vegetation

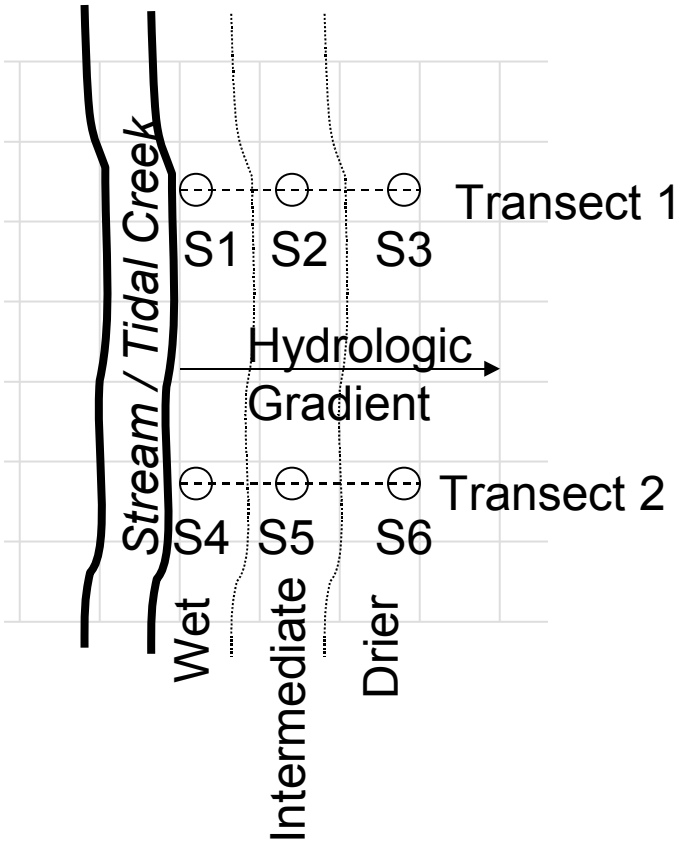
Restored: sites that were originally wetland, have been degraded by human activities, for which actions are taken to reestablish wetland hydrology & vegetation

Created: wetlands constructed on sites which were originally marine or upland

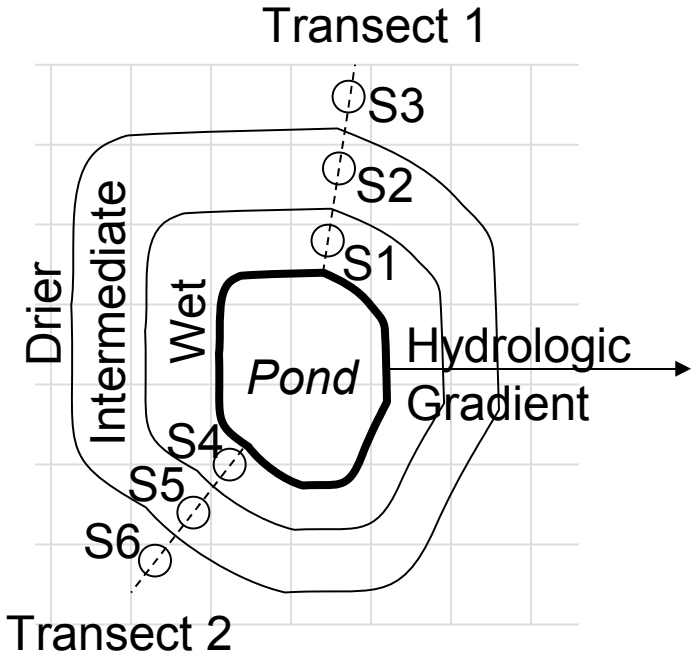

n = 8, Kauai
n = 14, Oahu
n = 5, Molokai
n = 6, Maui
n = 7, Hawaii
Legend
Wetland Sites
Semi-Natural (17)
Created (7)
Restored (11)
Other (5)
Coastline
0
50
100
200 Km
N

Sampling Design

a. Riparian or tidal sites



b. Isolated wetland sites



Vegetation Sampling

- 1-m^2 quadrat/zone
- Species Composition
- Percent Cover

Soil Sampling & Analyses

- Soil samples from upper 0-20 cm collected with a piston corer

- **Lab Analyses**:
  - Moisture (%)
  - Bulk density ($g \cdot cm^{-3}$)
  - Soil organic matter (%)
  - Texture (%)
  - pH
  - TC & TN (%)
  - Olsen extractable P ($\mu g \cdot g^{-1}$)
  - Conductivity (mM)

Water Quality Sampling & Analysis

- Surface water sampled in wet zones at each site

- **YSI**:

  Temperature (^{o}C)
  Dissolved oxygen ($mg \cdot L^{-1}$)
  pH
  Conductivity ($\mu s \cdot cm^{-1}$)
  Salinity (ppt)

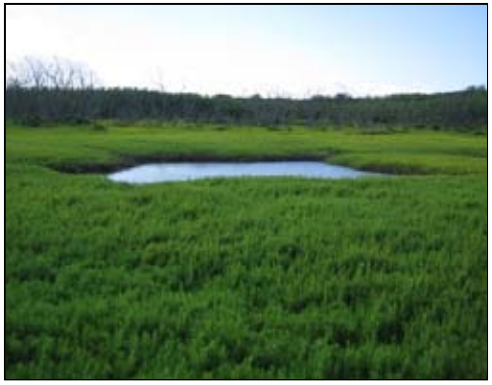
- **UH Hilo MSAL**:

  NH_4-N (USGS Method I-2525-89)
  NO_2/NO_3-N (EPA Method 353.2)
  Total dissolved N (ASTM Method D5176)
  PO_4-P (EPA Method 365.1)
  Total P (USGS Method I-4650-03)

Vegetation Results

- 102 plant species identified across 40 sites
- Only 18 species (17.5%) native
- 3 most common species: *Urochloa mutica* (California grass), *Batis maritima* (pickelweed), *Paspalum vaginatum* (seashore paspalum) are exotic & considered highly invasive (Erickson & Puttock 2006)

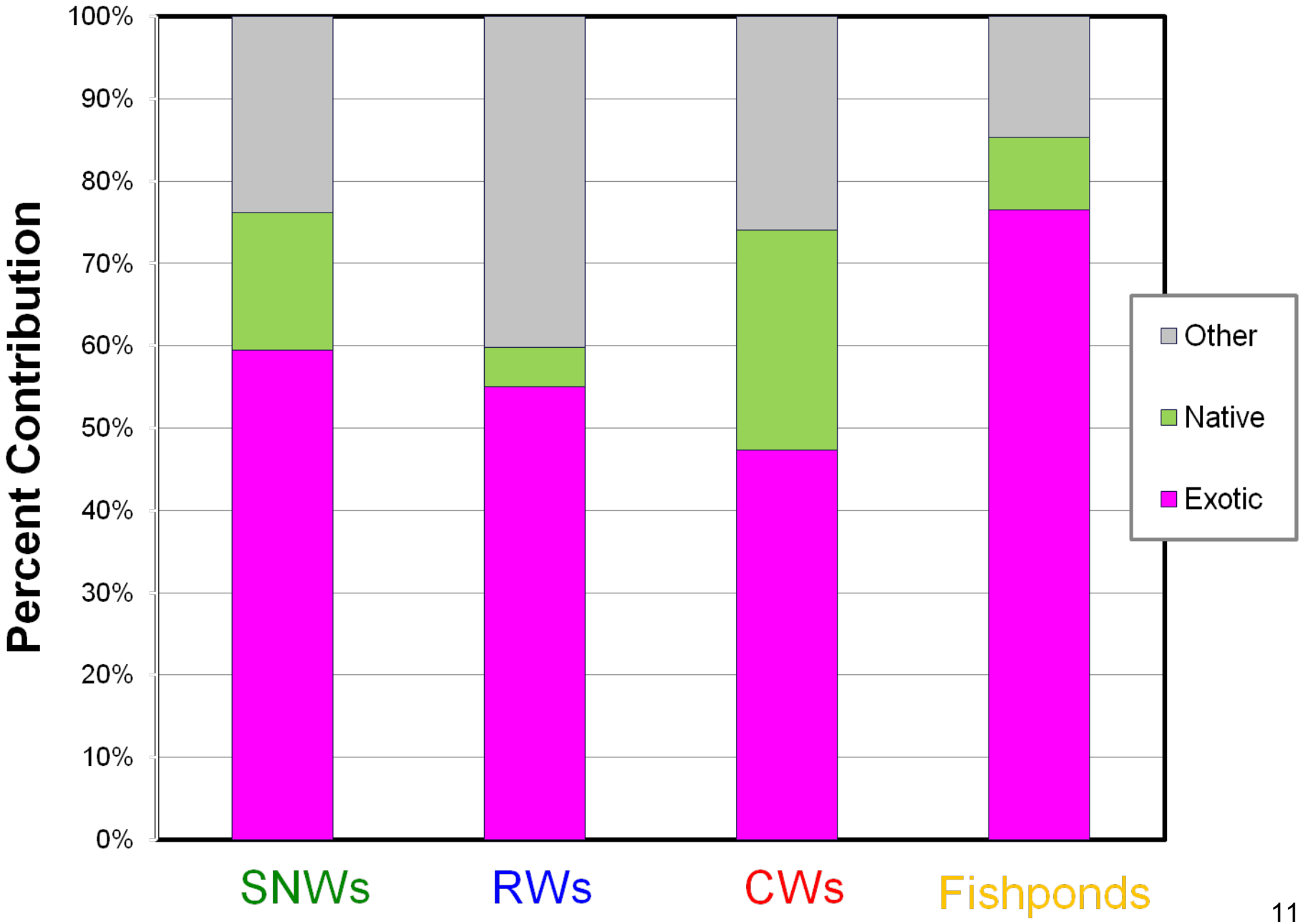
***U. mutica* (Kauai)**



***B. maritima* (Moloka'i)**

- Spp. Richness
  - SNWs: 59 spp
  - RWs: 49 spp
  - CWs: 31 spp

- Wet zone: 28 spp; Int zone: 47 spp; Drier zone: 63 spp

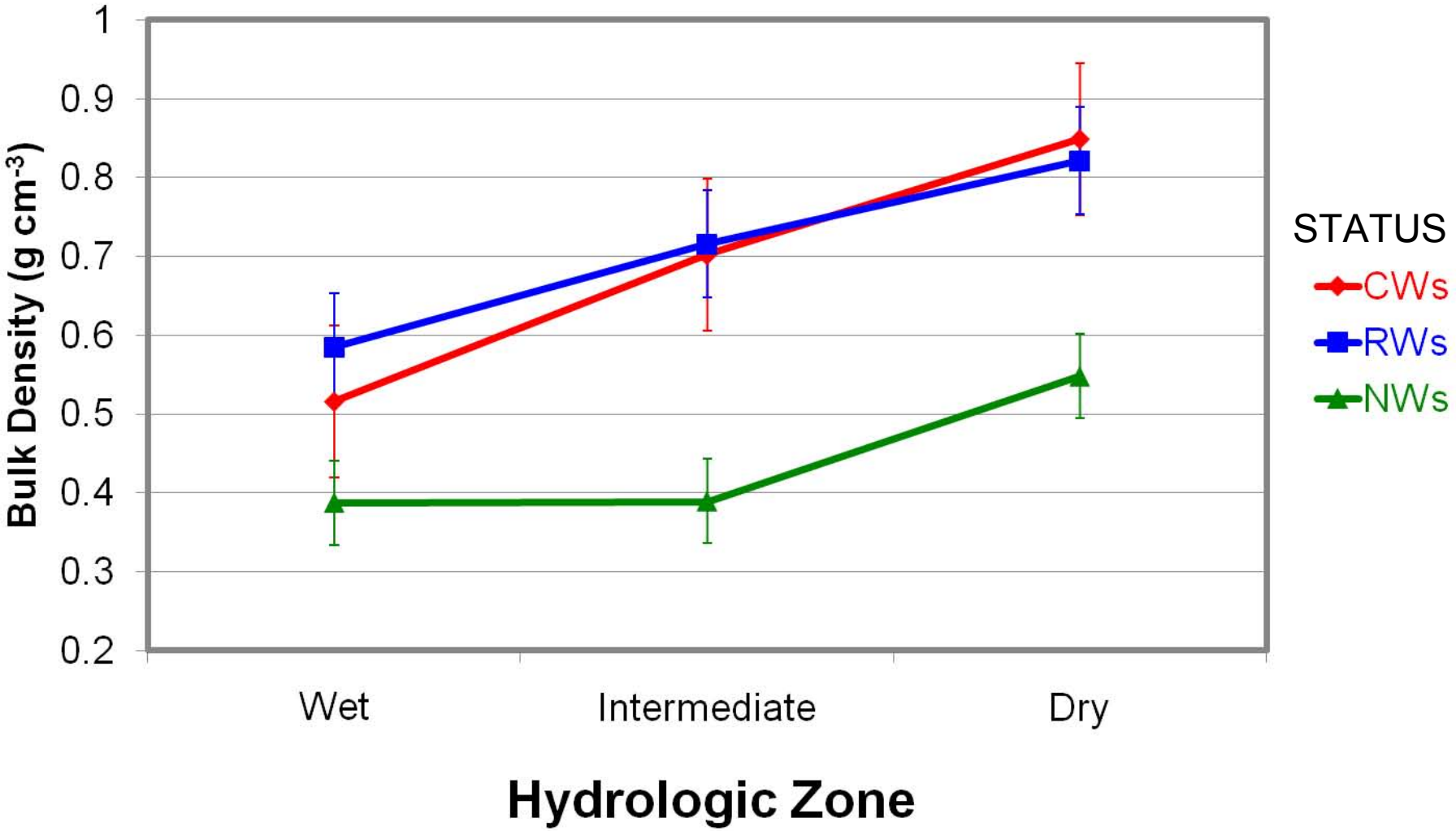

Percent Contribution
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
SNWs
RWs
CWs
Fishponds
Other
Native
Exotic

Soil Summary Statistics

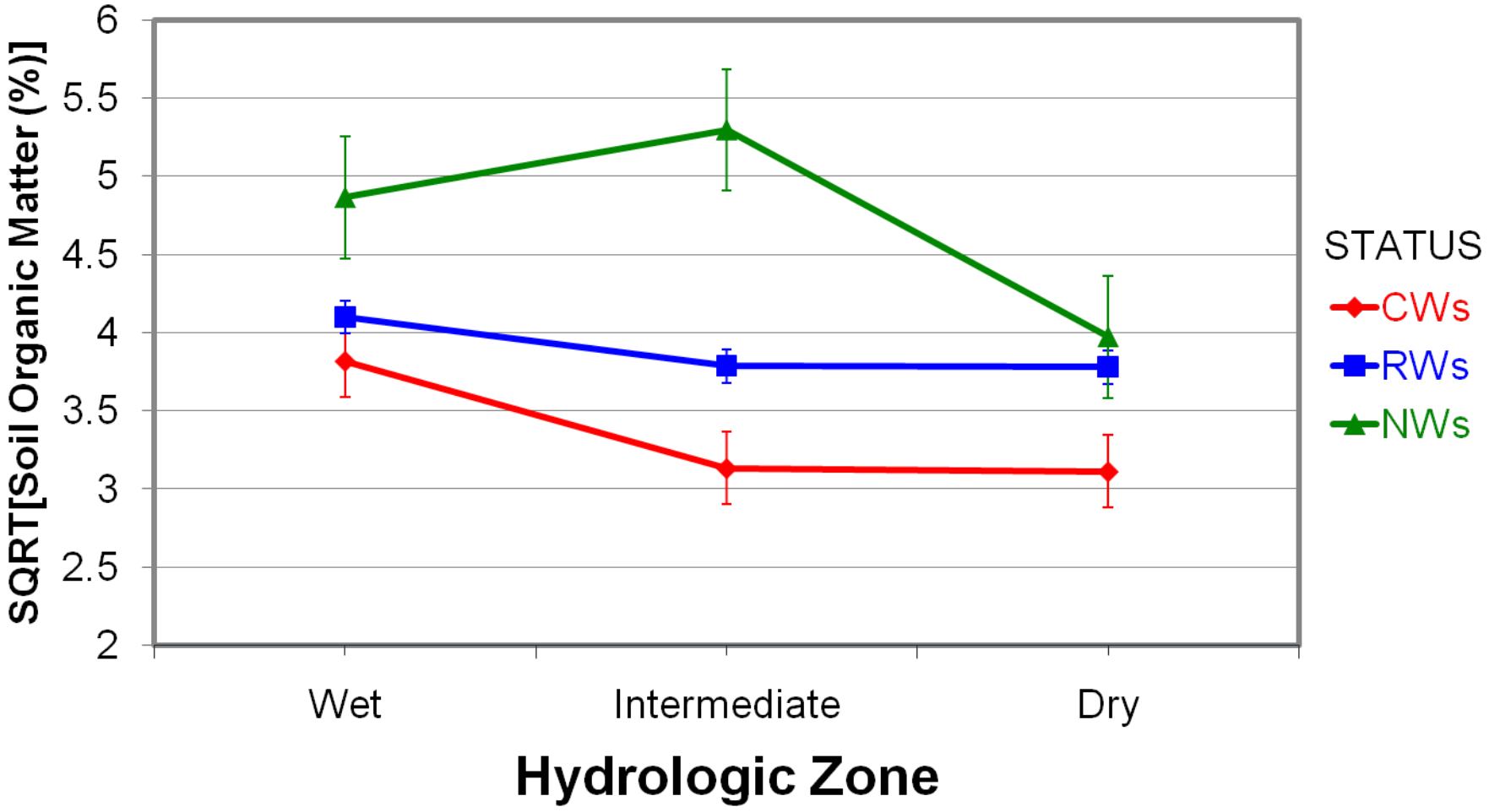
	BD	LOI	pH	Cond	TC	TN	Sand
	g cm^{-3}	%	-	mM	%	%	%
Mean	0.55	22.4	6.87	28.7	9.96	0.53	33.6
Median	0.55	17.5	7.30	9.8	6.32	0.28	22.5
St. Dev	0.33	18.6	1.24	70.0	10.2	0.64	32.5
Min	0.02	1.5	3.50	0.40	0.74	0.01	**0.0**
Max	1.76	88.9	8.80	400.0	56.5	2.96	**100**
n	236	236	236	236	235	235	138

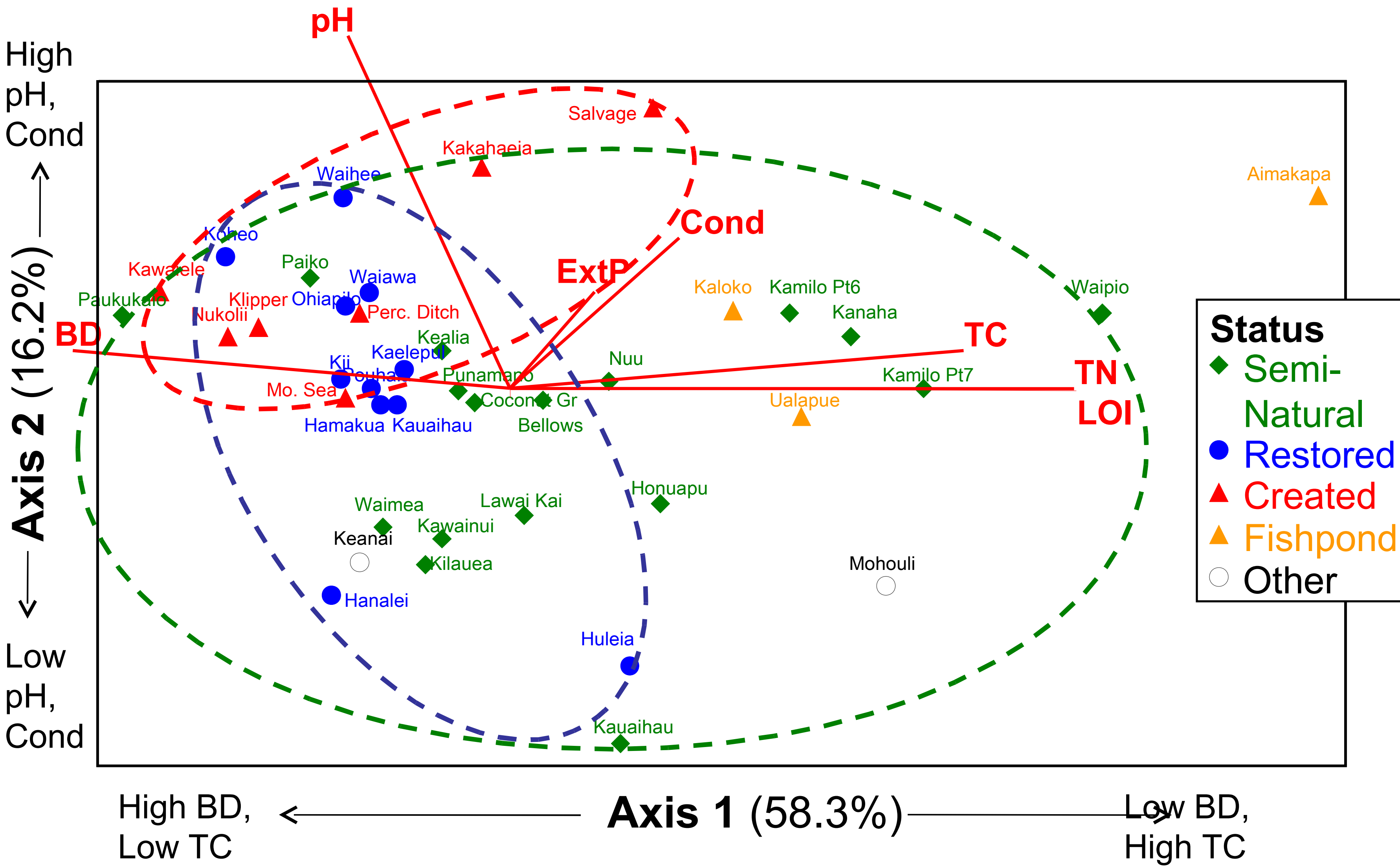
Soil Results

	F	p-value
Status	**12.7**	**<0.001**
Zone	**6.24**	**0.003**
S*Z	0.45	0.77



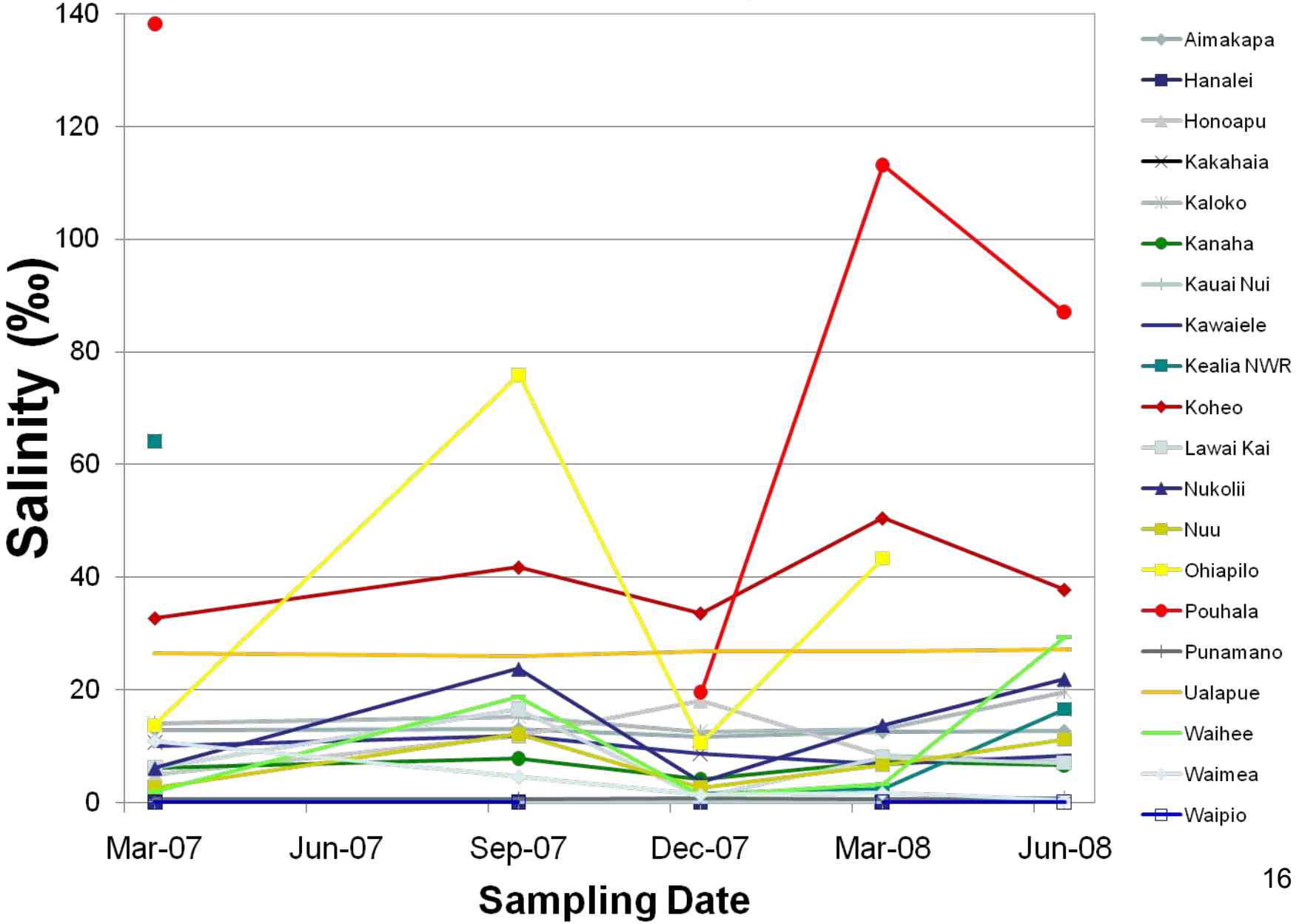
	F	p-value
Status	**8.43**	**<0.001**
Zone	2.73	0.07
S*Z	1.08	0.37

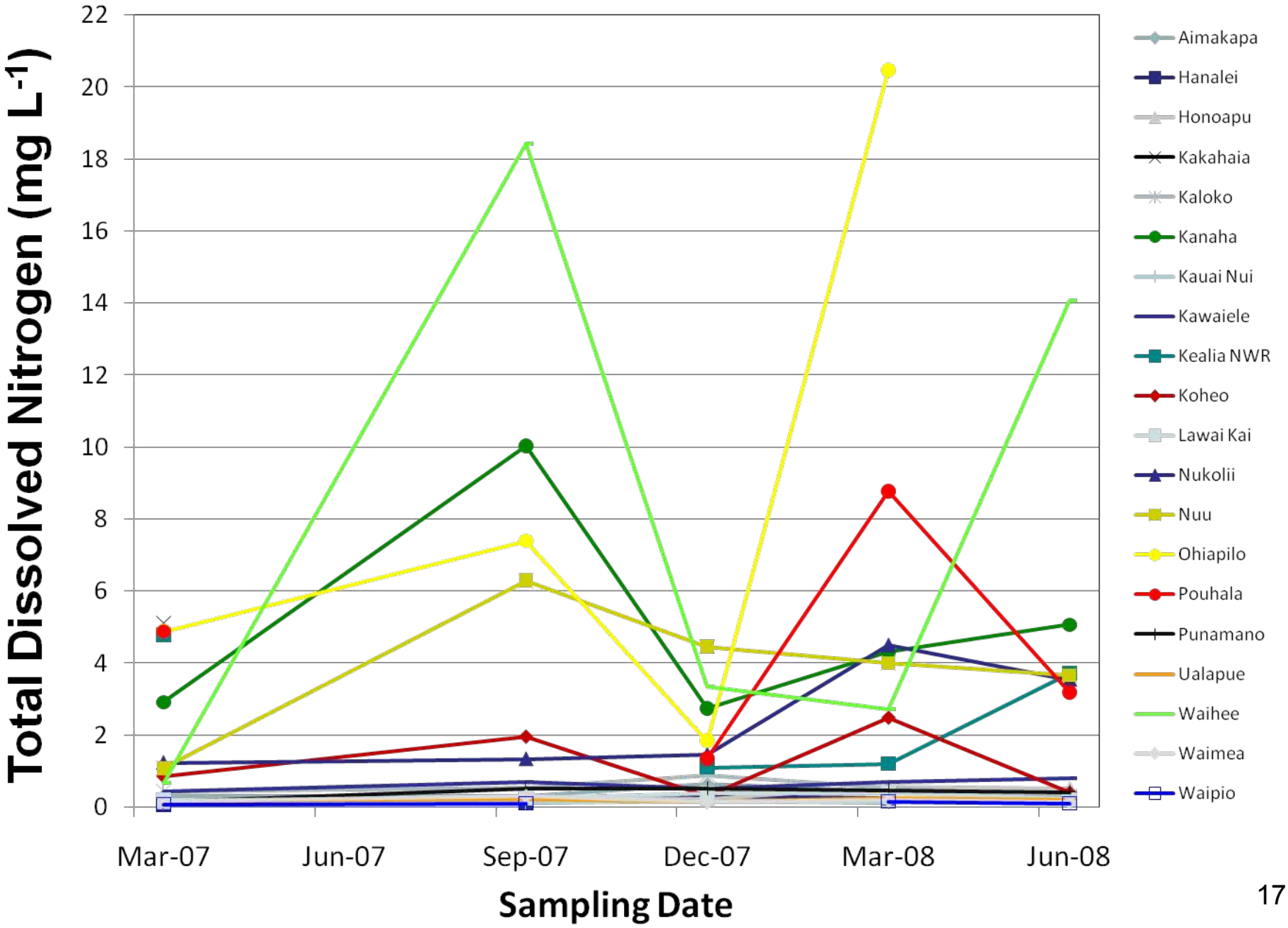




High pH, Cond
Low pH, Cond
Axis 2 (16.2%)
High BD, Low TC
Axis 1 (58.3%)
Low BD, High TC
pH
Cond
ExtP
BD
TC
TN
LOI
Salvage
Kakahaeia
Aimakapa
Waihee
Koheo
Paiko
Waiawa
Kawaiele
Paukukalo
Klipper
Ohiapilo
Nukolii
Perc. Ditch
Kealia
Kaelepulu
Kii
Mo. Sea
Punamano
Hamakua
Kauaihau
Bellows
Nuu
Kaloko
Kamilo Pt6
Kanaha
Waipio
Kamilo Pt7
Ualapue
Honuapu
Waimea
Lawai Kai
Kawainui
Keanai
Kilauea
Hanalei
Mohouli
Huleia
Kauaihau
Status
Semi-Natural
Restored
Created
Fishpond
Other

Water Quality Results




Total Dissolved Nitrogen (mg L-1)
22
20
18
16
14
12
10
8
6
4
2
0
Mar-07
Jun-07
Sep-07
Dec-07
Mar-08
Jun-08
Sampling Date
Aimakapa
Hanalei
Honoapu
Kakahaia
Kaloko
Kanaha
Kauai Nui
Kawaiele
Kealia NWR
Koheo
Lawai Kai
Nukolii
Nuu
Ohiapilo
Pouhala
Punamano
Ualapue
Waihee
Waimea
Waipio

Conclusions

- Vegetation: Semi-natural, restored, created dominated by invasive species; difficult to find “reference” sites

- Soils: Variable, significant differences across hydrologic gradients & among semi-natural, restored, created

- Water Quality: Org N & P >> Inorganic N & P; sites subject to drying, fluctuations in WQ

- Management Implications:
  - Need for invasive vegetation control programs
  - More attention to substrate/soils at restored, created sites

Acknowledgements

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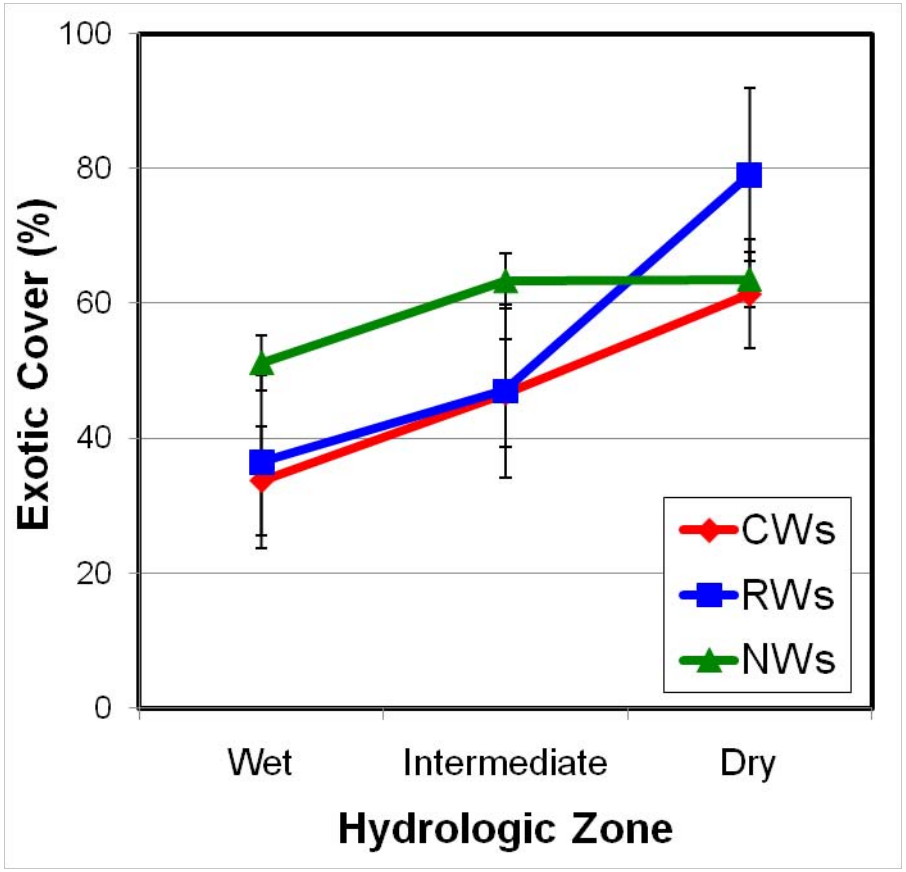
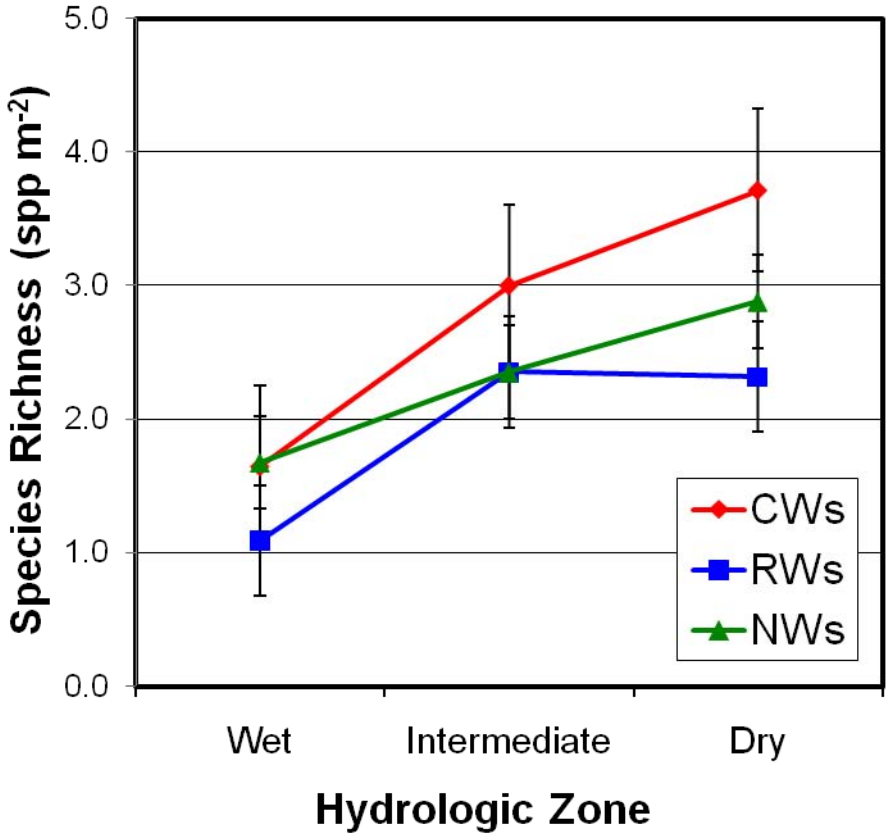
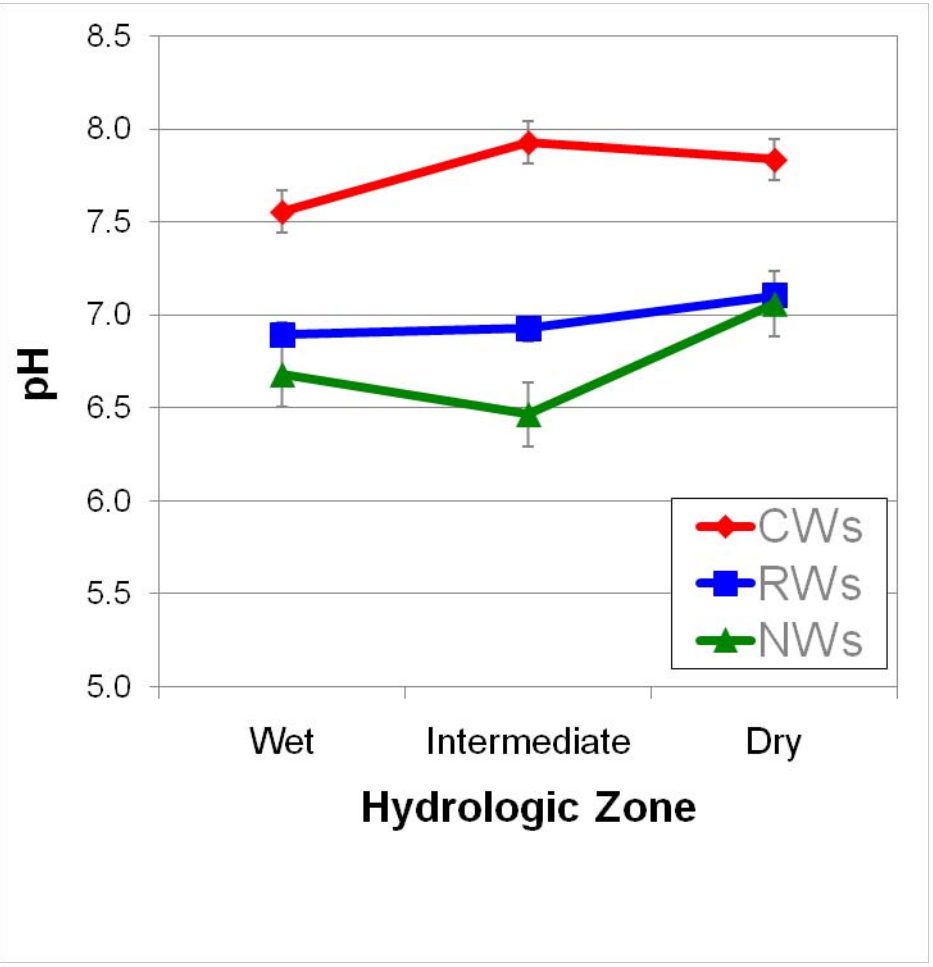
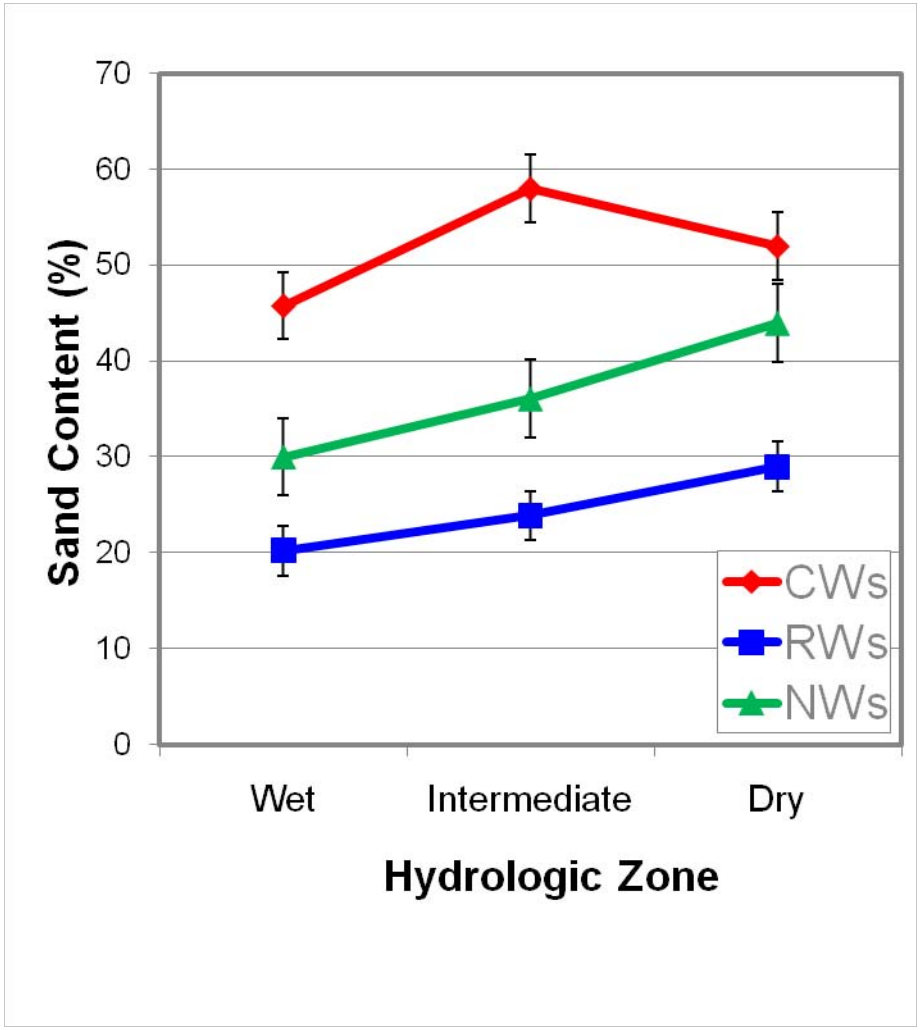
For more information: http://www.ctahr.hawaii.edu/brulandg/


100
80
60
40
20
0
Exotic Cover (%)
CWs
RWs
NWs
Wet
Intermediate
Dry
Hydrologic Zone


5.0
4.0
3.0
2.0
1.0
0.0
Species Richness (spp m-2)
CWs
RWs
NWs
Wet
Intermediate
Dry
Hydrologic Zone

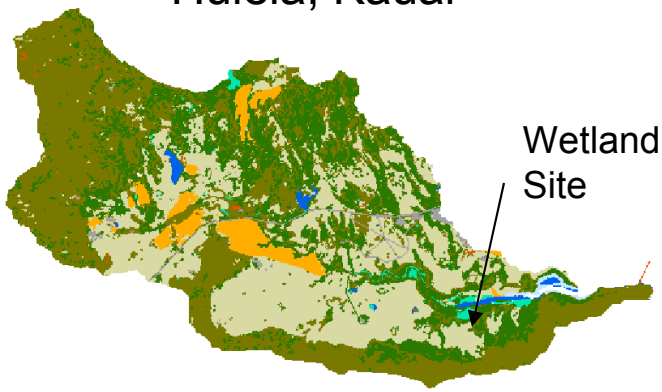

8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
pH
CWs
RWs
NWs
Wet
Intermediate
Dry
Hydrologic Zone


70
60
50
40
30
20
10
0
Sand Content (%)
CWs
RWs
NWs
Wet
Intermediate
Dry
Hydrologic Zone

Watershed Characteristics

Waimea, Oahu

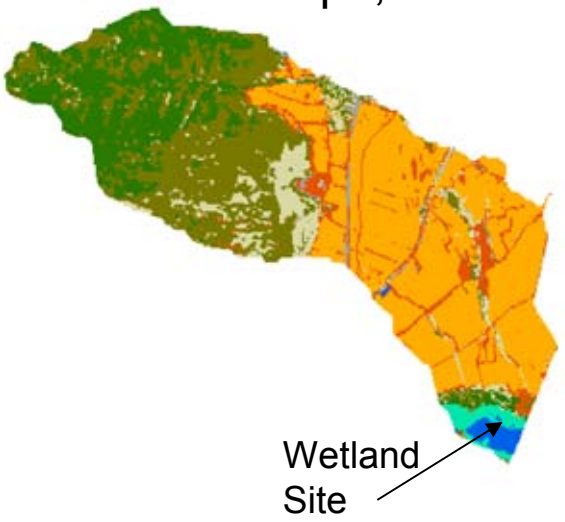
Huleia, Kauai



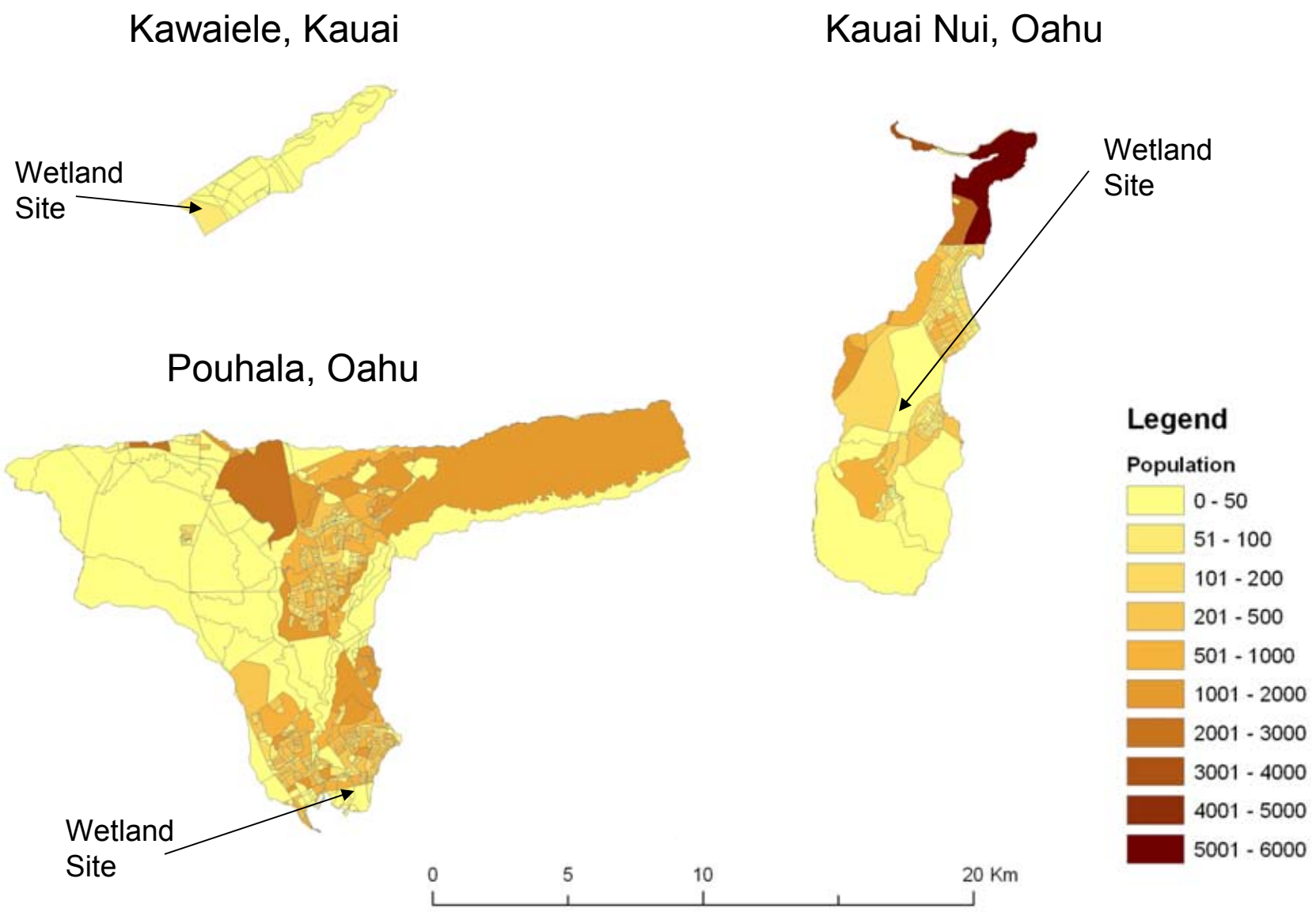
Legend

- Other
- Developed
- Cultivated
- Grassland
- Forest
- Shrub-Scrub
- Palustrine Wetland
- Estuarine Wetland
- Unconsolidated Shore
- Bare
- Water

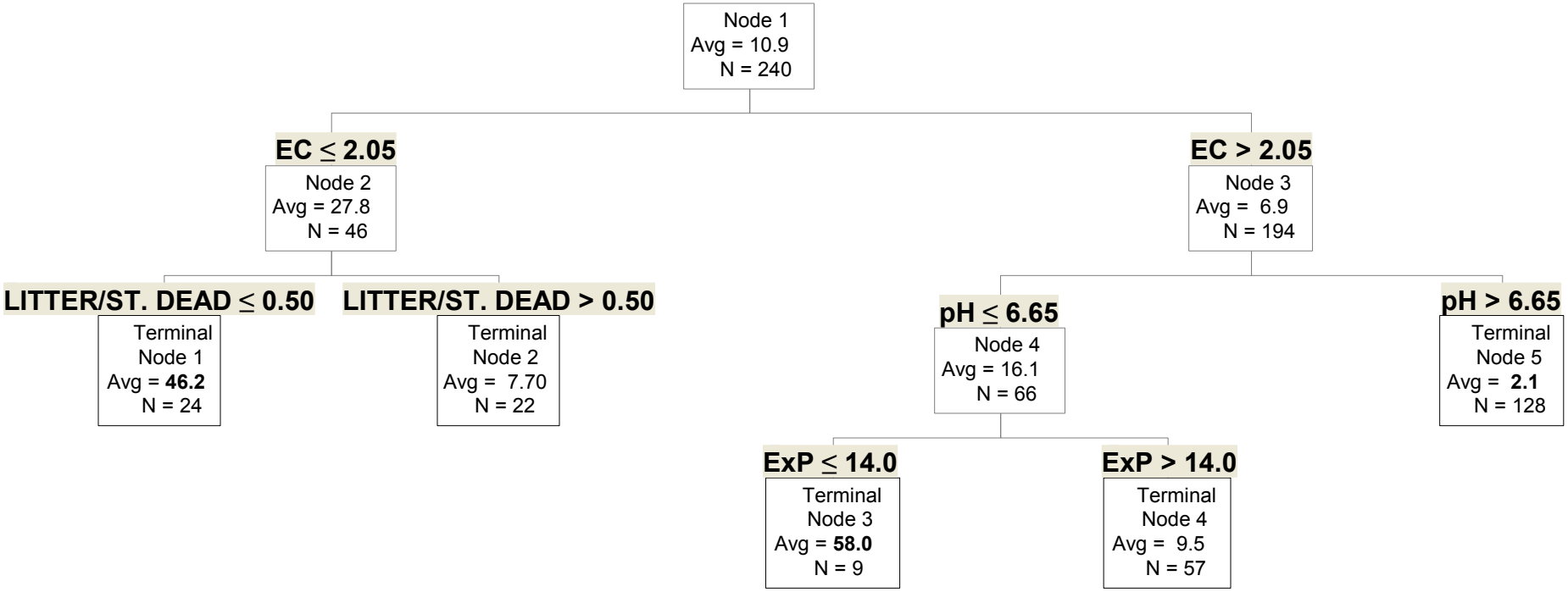
Waikapu, Maui



Population

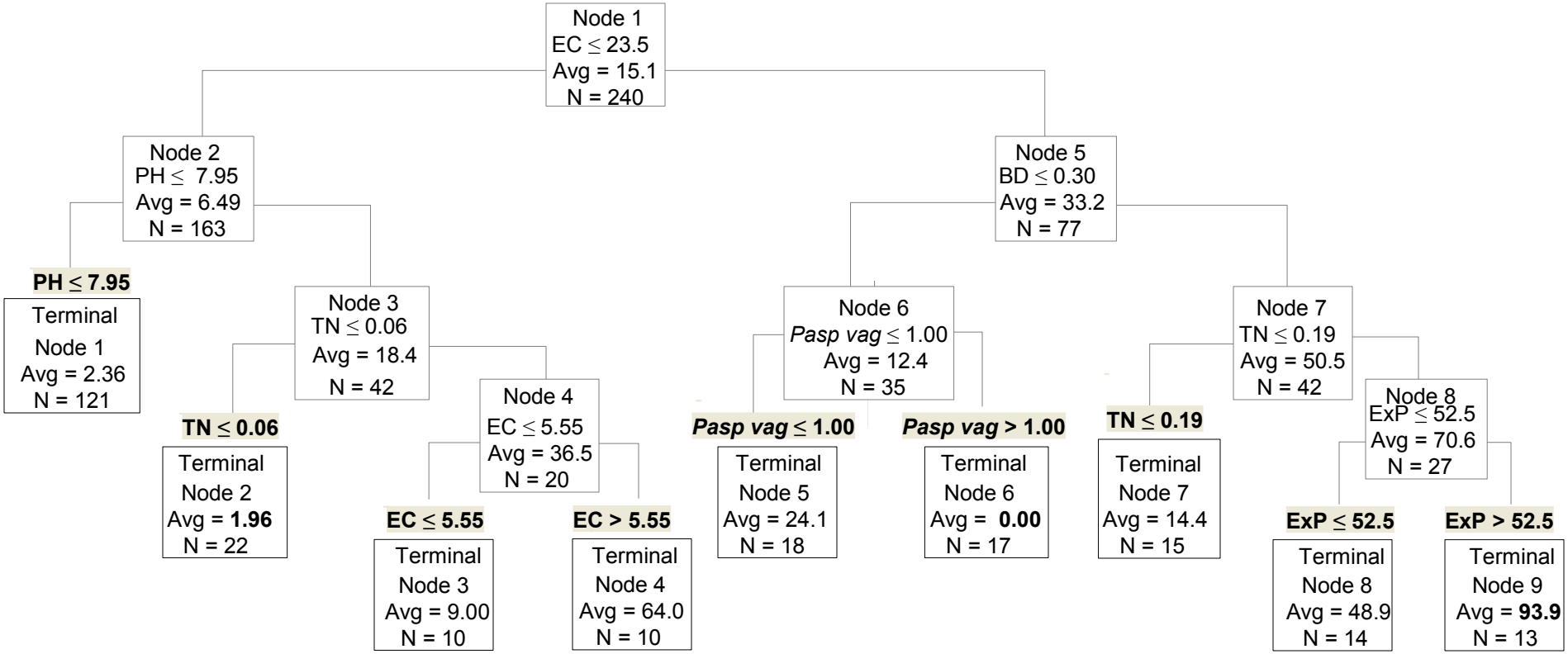

Kawaiele, Kauai
Wetland Site
Kauai Nui, Oahu
Wetland Site
Pouhala, Oahu
Wetland Site
Legend
Population
0 - 50
51 - 100
101 - 200
201 - 500
501 - 1000
1001 - 2000
2001 - 3000
3001 - 4000
4001 - 5000
5001 - 6000
0
5
10
20 Km

Regression Tree: *Urochloa* Cover (%)

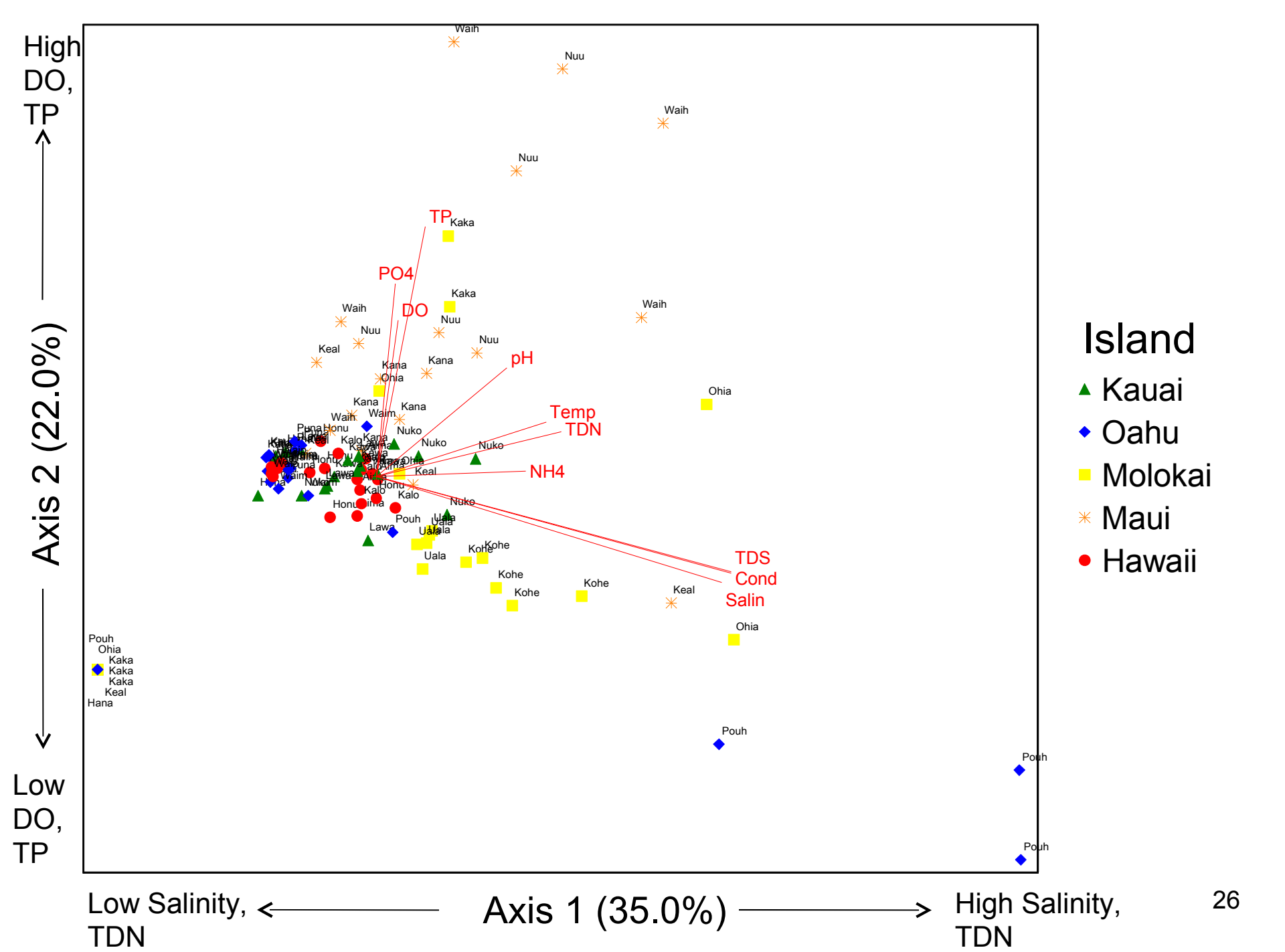


$R^2 = 0.35$

Regression Tree: *Battis* Cover (%)



$R^2 = 0.58$


High DO, TP
Axis 2 (22.0%)
Low DO, TP
Low Salinity, TDN
Axis 1 (35.0%)
High Salinity, TDN
TP
PO4
DO
pH
Temp
TDN
NH4
TDS
Cond
Salin
Island
Kauai
Oahu
Molokai
Maui
Hawaii