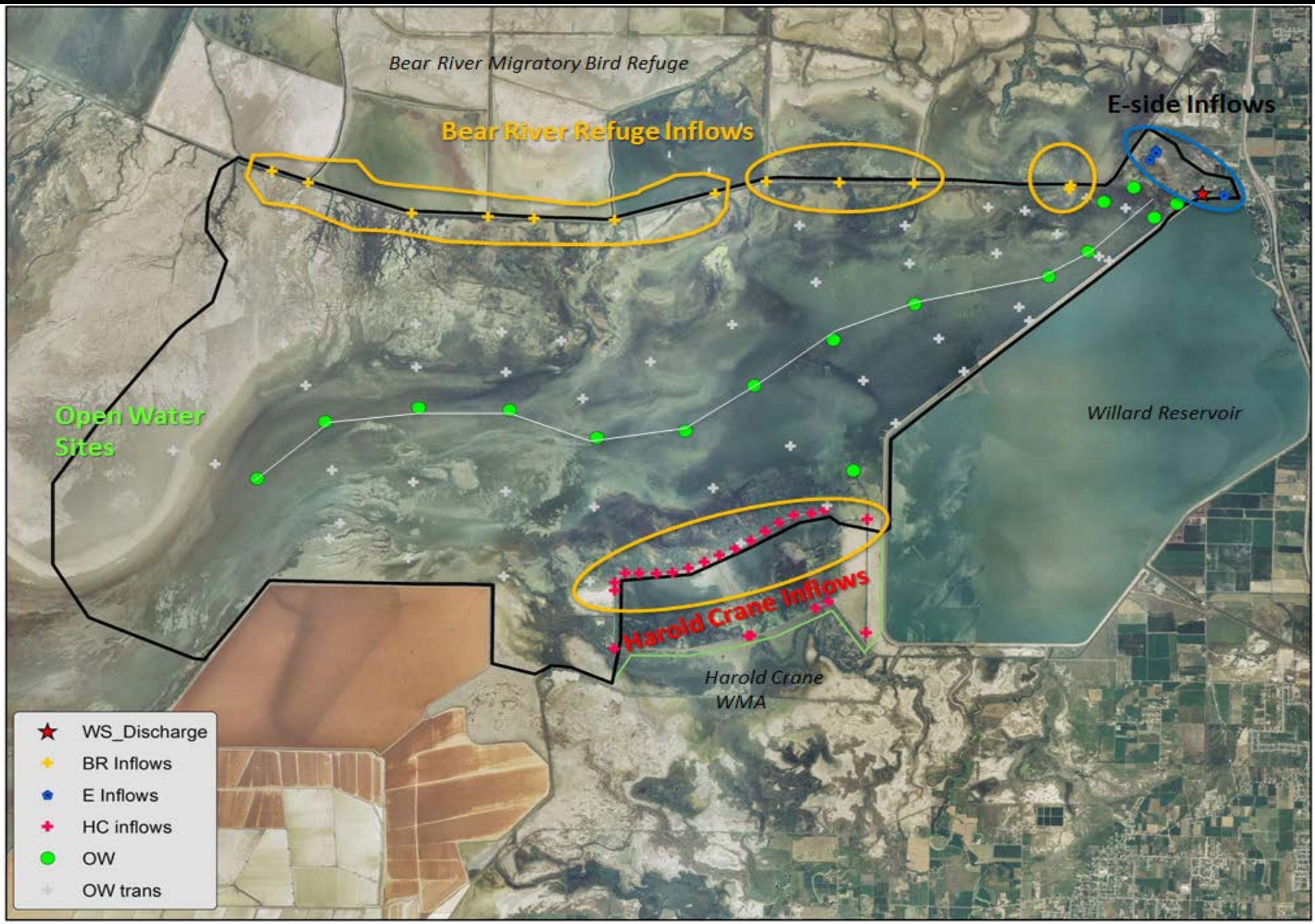
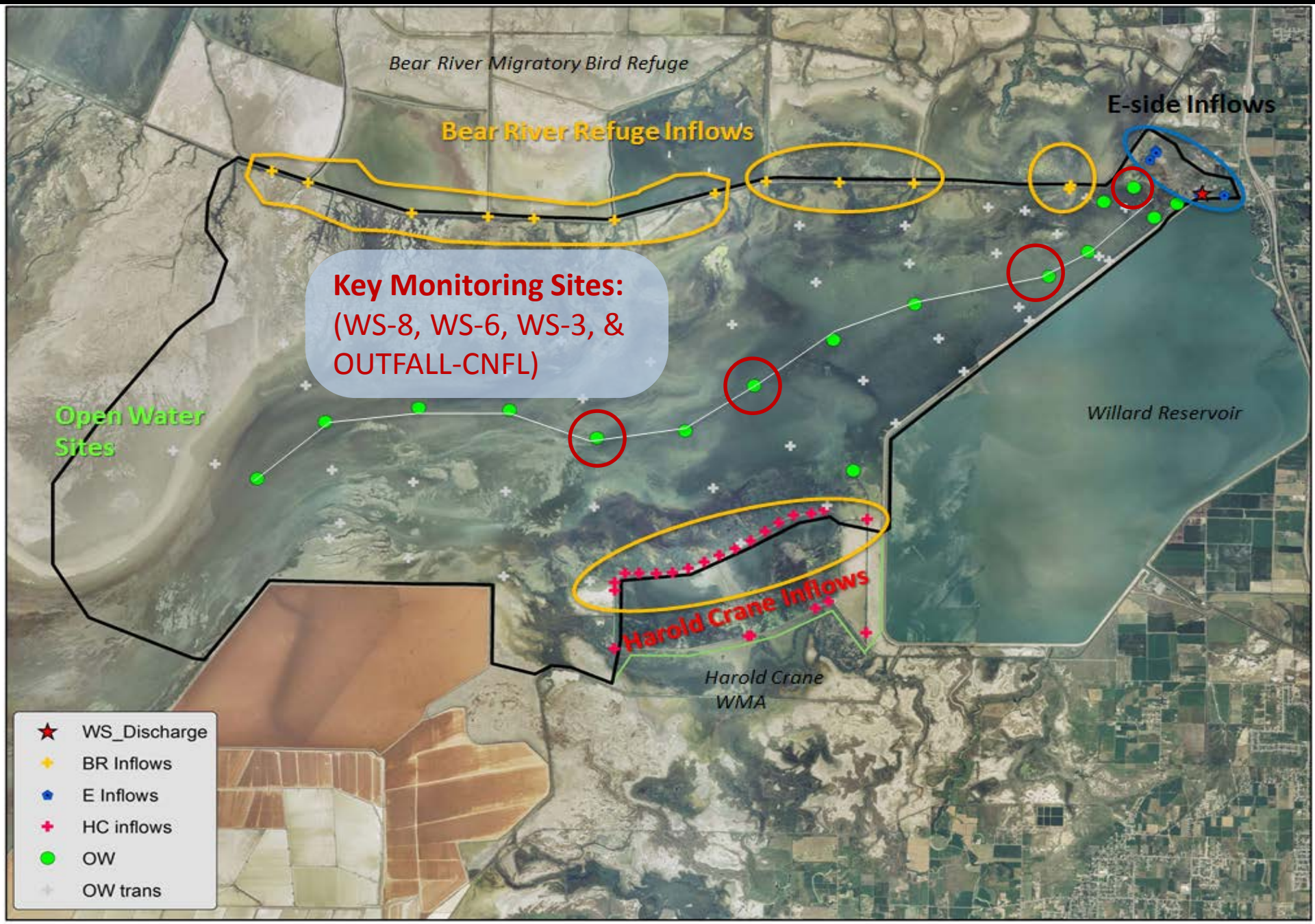
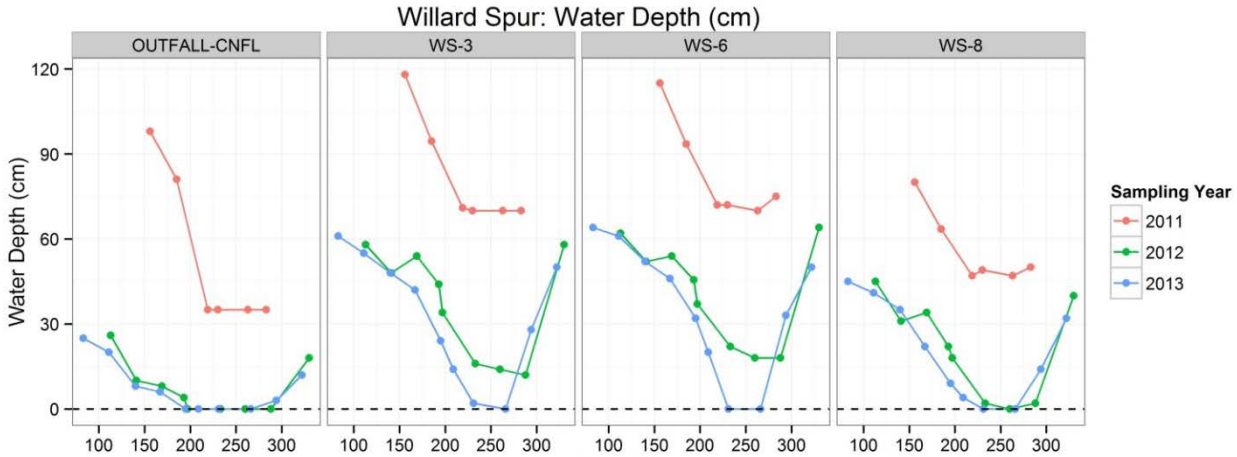
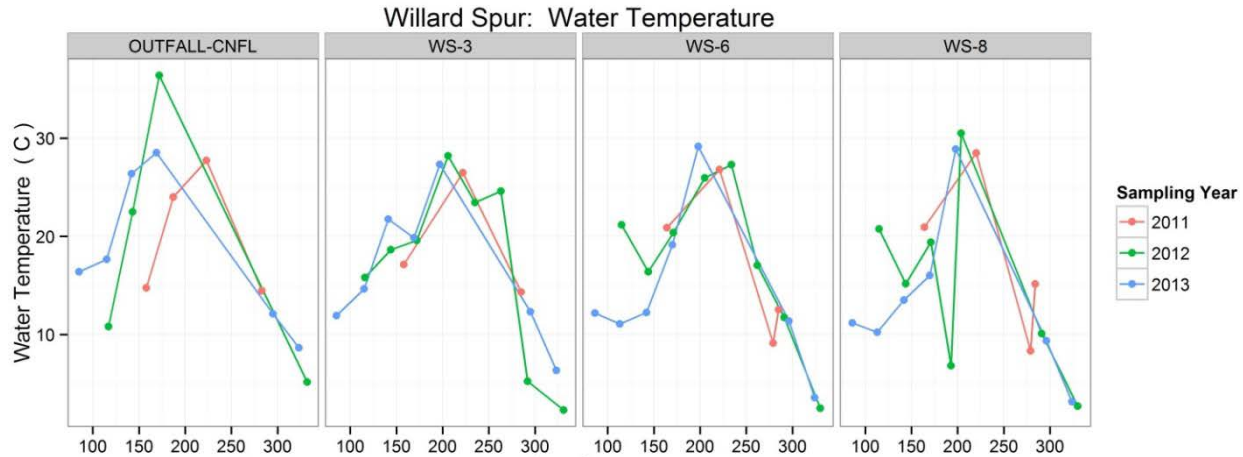
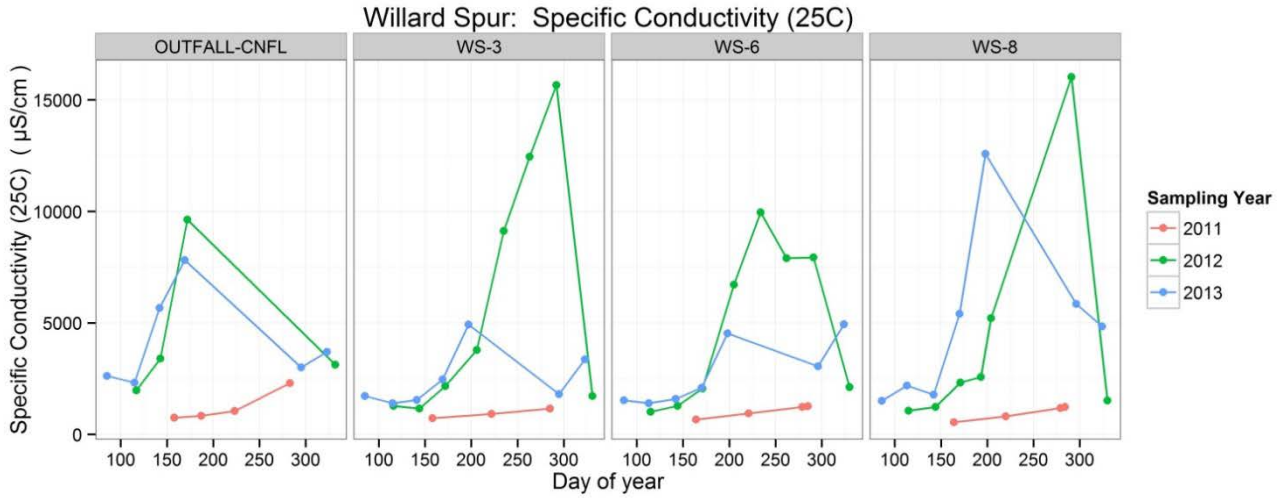
Summary of Open Water Conditions in Willard Spur (2011-2013)

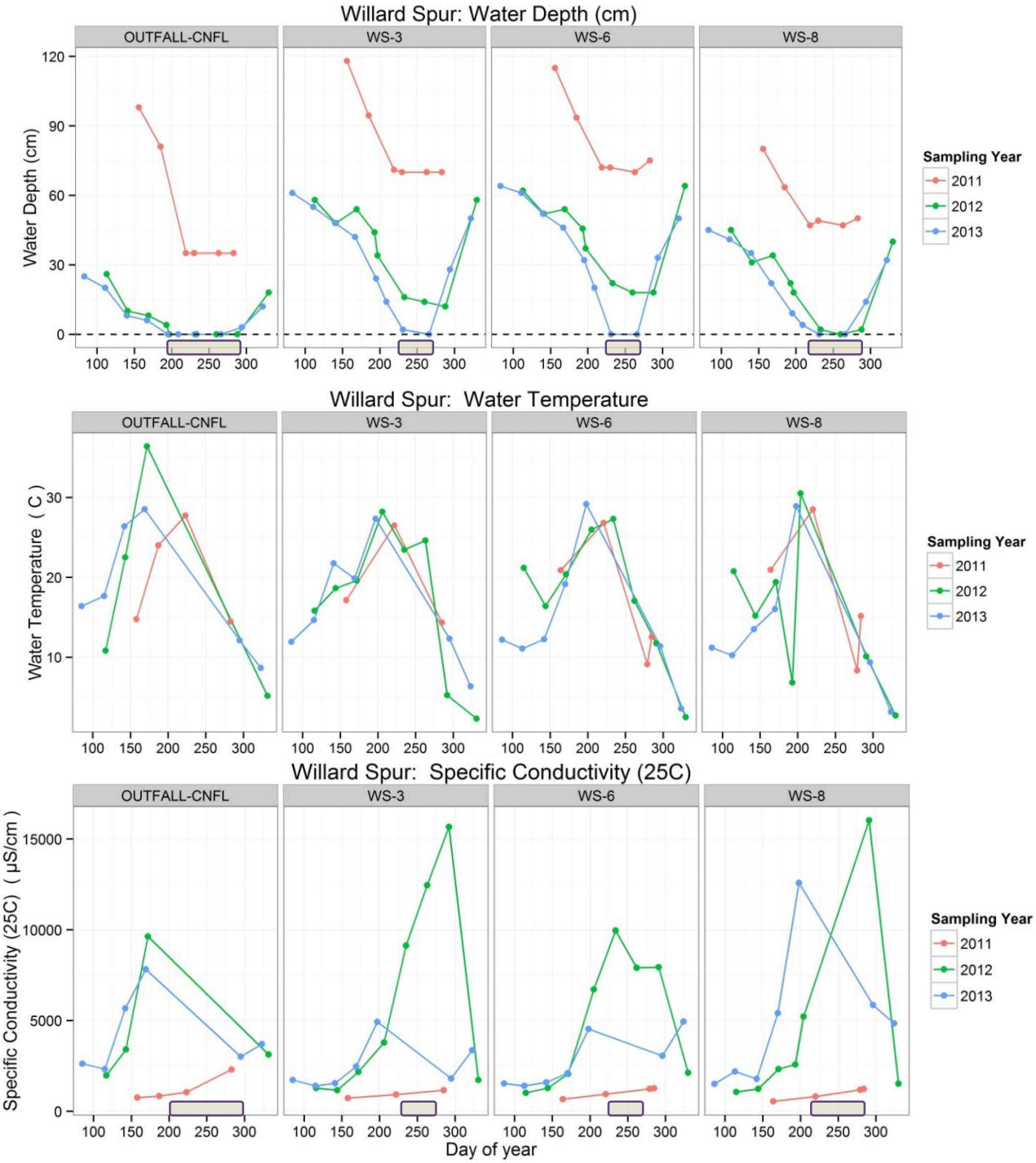

Bear River Migratory Bird Refuge
Bear River Refuge Inflows
E-side Inflows
Open Water Sites
Willard Reservoir
Harold Crane Inflows
Harold Crane WMA
WS_Discharge
BR Inflows
E Inflows
HC inflows
OW
OW trans

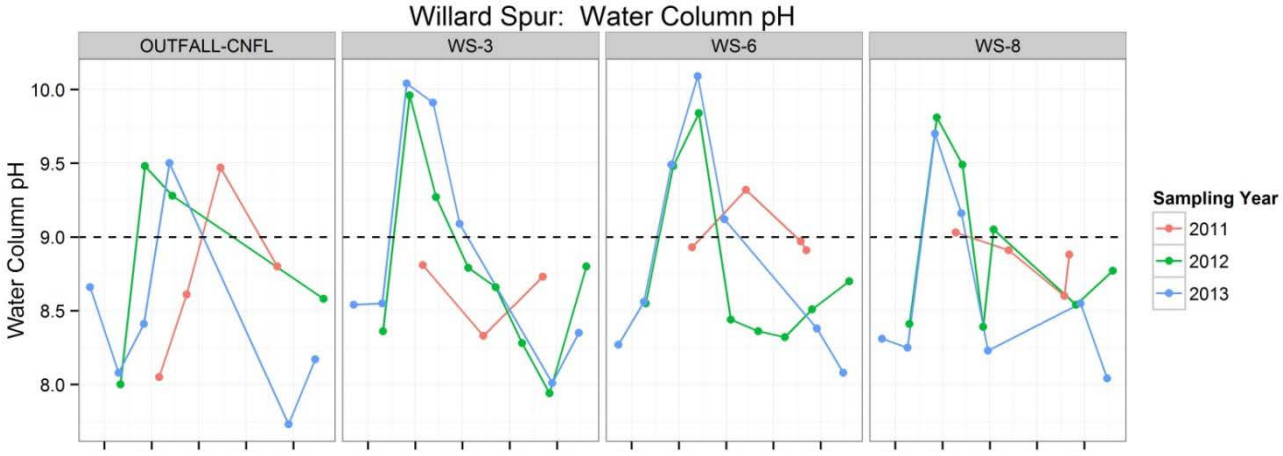

Bear River Migratory Bird Refuge
Bear River Refuge Inflows
E-side Inflows
Key Monitoring Sites:
(WS-8, WS-6, WS-3, &
OUTFALL-CNFL)
Open Water
Sites
Willard Reservoir
Harold Crane Inflows
Harold Crane
WMA
WS_Discharge
BR Inflows
E Inflows
HC inflows
OW
OW trans

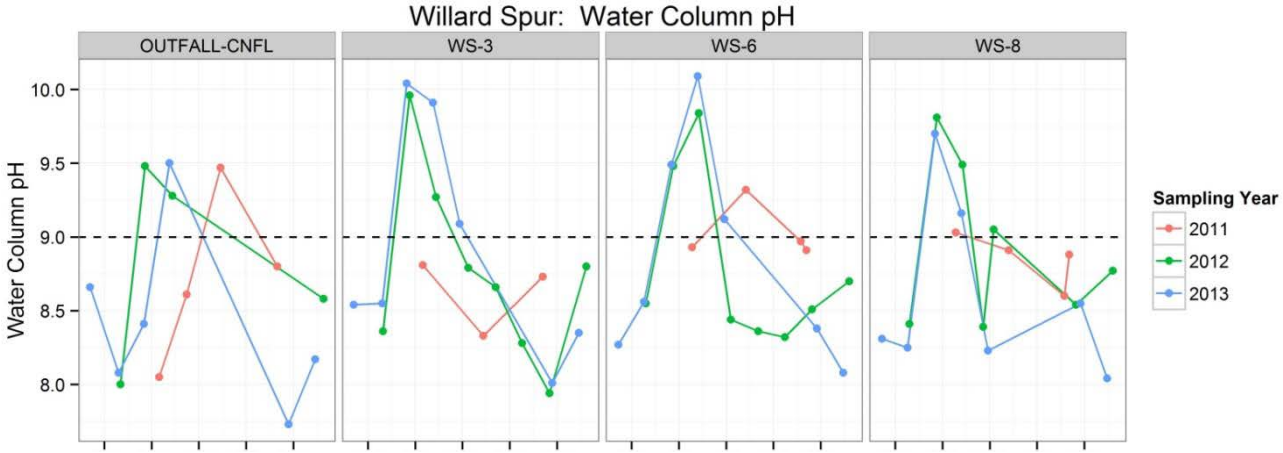

Willard Spur: Water Depth (cm)
OUTFALL-CNFL
WS-3
WS-6
WS-8
Water Depth (cm)
Sampling Year
2011
2012
2013

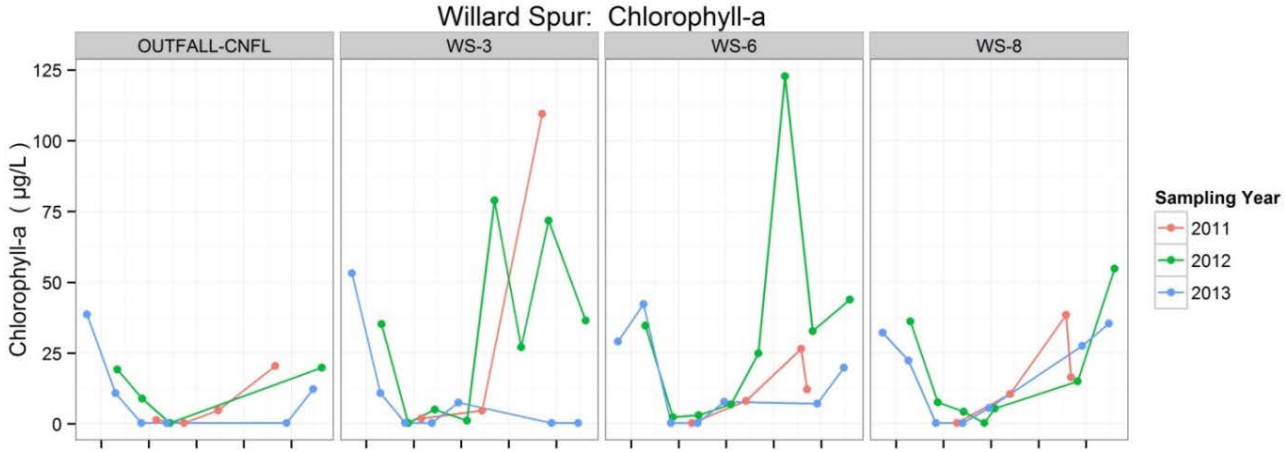

Willard Spur: Water Temperature
OUTFALL-CNFL
WS-3
WS-6
WS-8
Water Temperature (C)
Sampling Year
2011
2012
2013

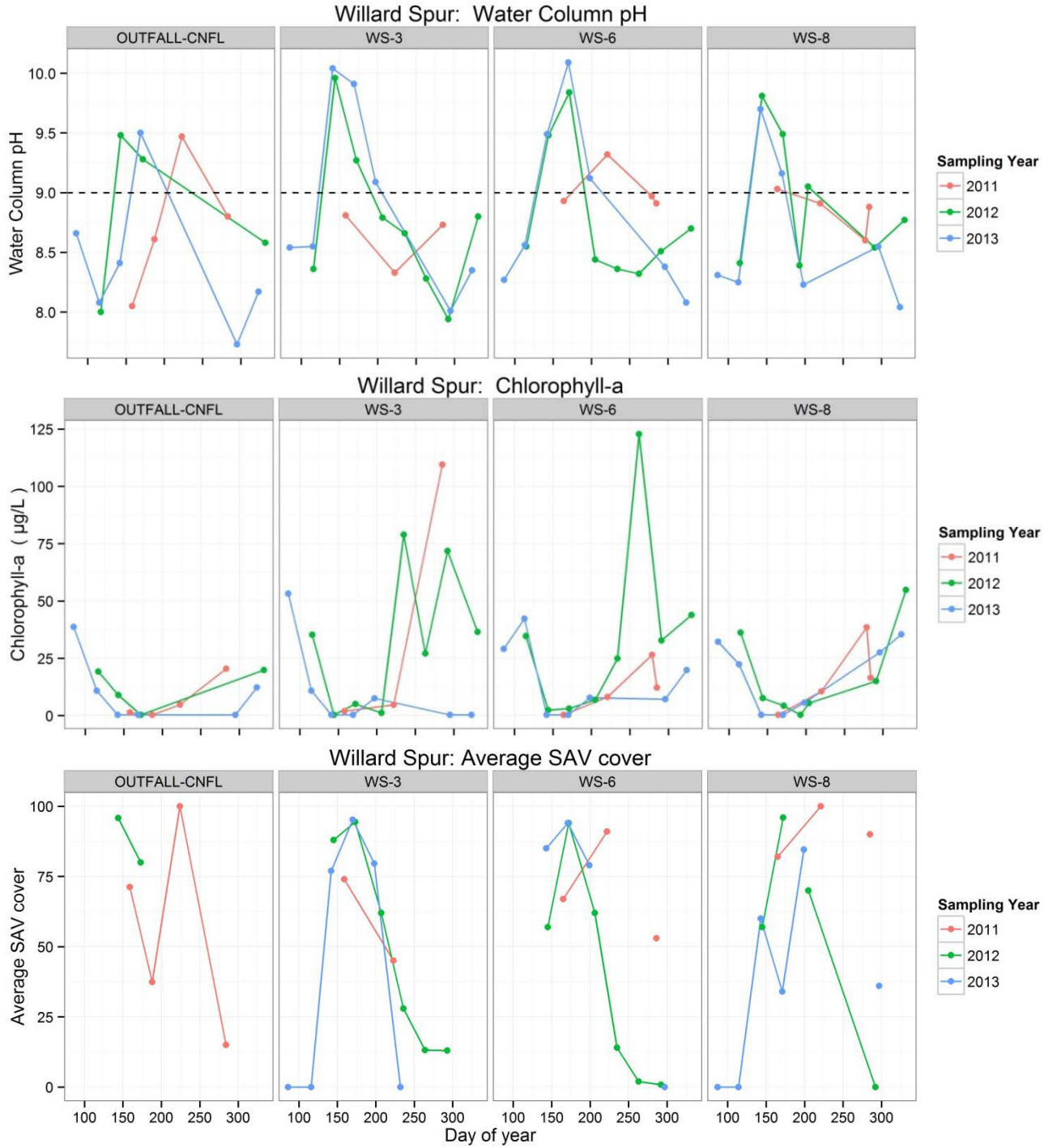

Willard Spur: Specific Conductivity (25C)
OUTFALL-CNFL
WS-3
WS-6
WS-8
Specific Conductivity (25C) (µS/cm)
Day of year
Sampling Year
2011
2012
2013

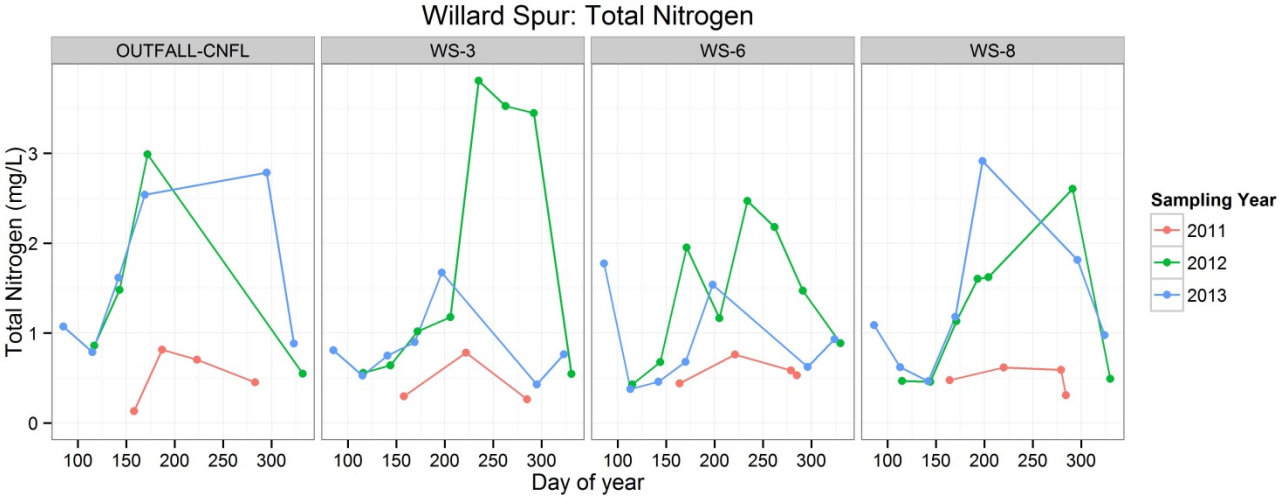

Willard Spur: Water Depth (cm)
OUTFALL-CNFL
WS-3
WS-6
WS-8
Water Depth (cm)
Sampling Year
2011
2012
2013
Willard Spur: Water Temperature
Water Temperature (C)
Willard Spur: Specific Conductivity (25C)
Specific Conductivity (25C) (µS/cm)
Day of year

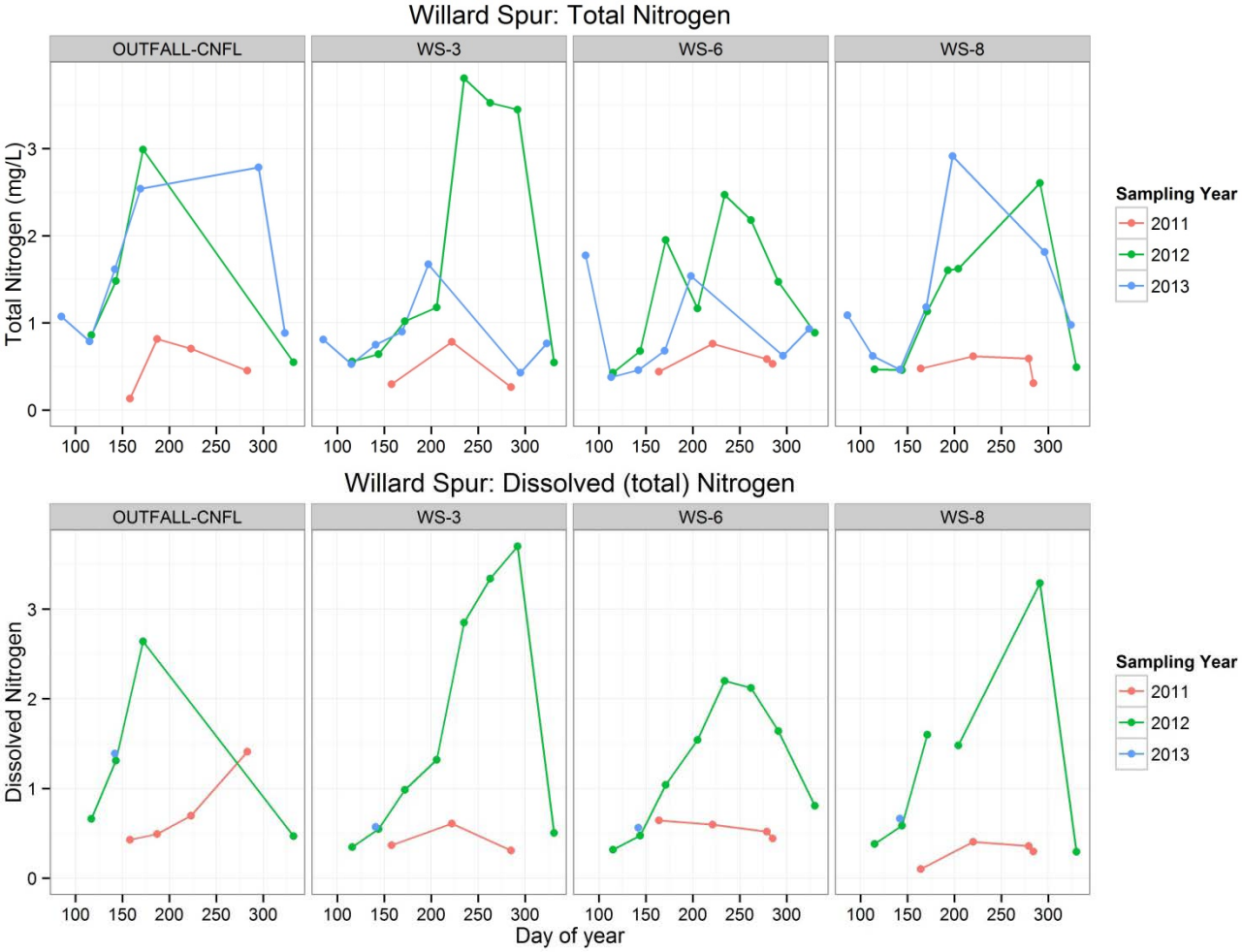

Willard Spur: Water Column pH
OUTFALL-CNFL
WS-3
WS-6
WS-8
Water Column pH
10.0
9.5
9.0
8.5
8.0
Sampling Year
2011
2012
2013


Willard Spur: Water Column pH
OUTFALL-CNFL
WS-3
WS-6
WS-8
Water Column pH
10.0
9.5
9.0
8.5
8.0
Sampling Year
2011
2012
2013

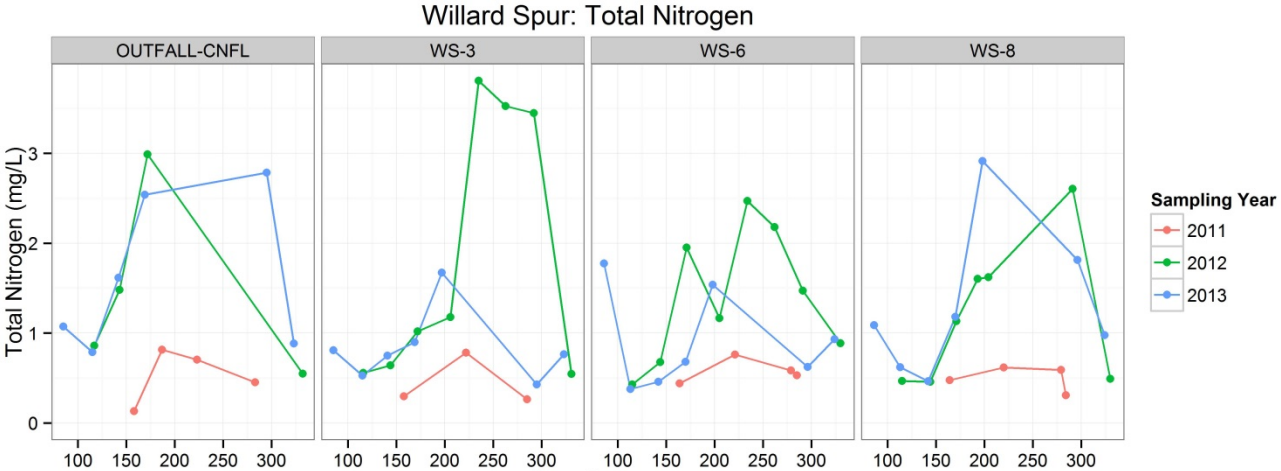

Willard Spur: Chlorophyll-a
OUTFALL-CNFL
WS-3
WS-6
WS-8
Chlorophyll-a (µg/L)
125
100
75
50
25
0
Sampling Year
2011
2012
2013

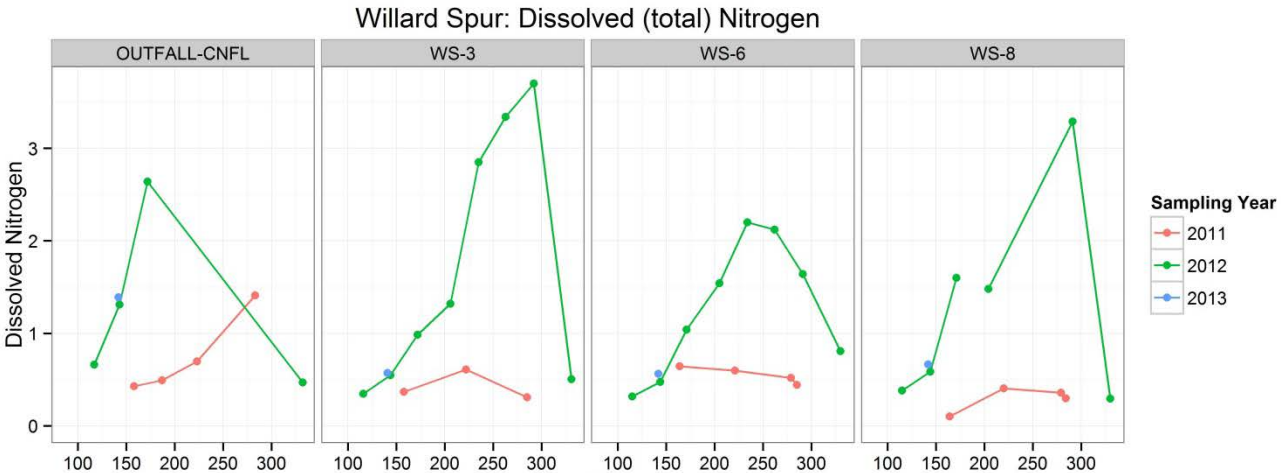

Willard Spur: Water Column pH
OUTFALL-CNFL
WS-3
WS-6
WS-8
Water Column pH
10.0
9.5
9.0
8.5
8.0
Sampling Year
2011
2012
2013
Willard Spur: Chlorophyll-a
Chlorophyll-a (µg/L)
125
100
75
50
25
0
Willard Spur: Average SAV cover
Average SAV cover
100
75
50
25
0
100 150 200 250 300
Day of year

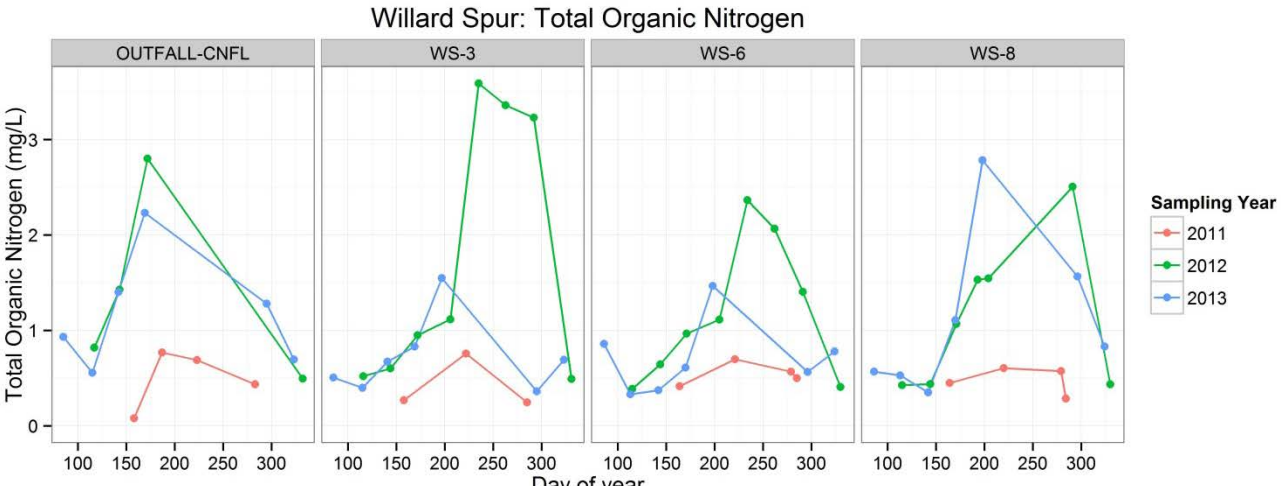

Willard Spur: Total Nitrogen
OUTFALL-CNFL
WS-3
WS-6
WS-8
Total Nitrogen (mg/L)
0
1
2
3
100
150
200
250
300
Day of year
Sampling Year
2011
2012
2013



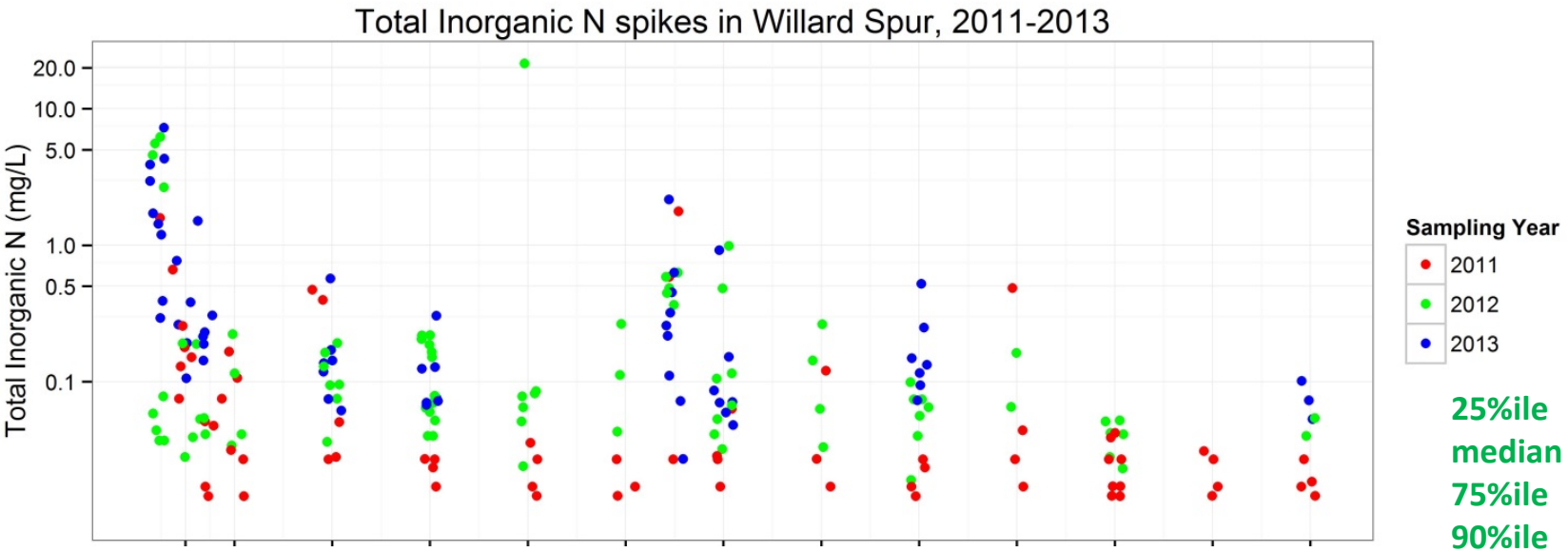
Most of TN is dissolved.





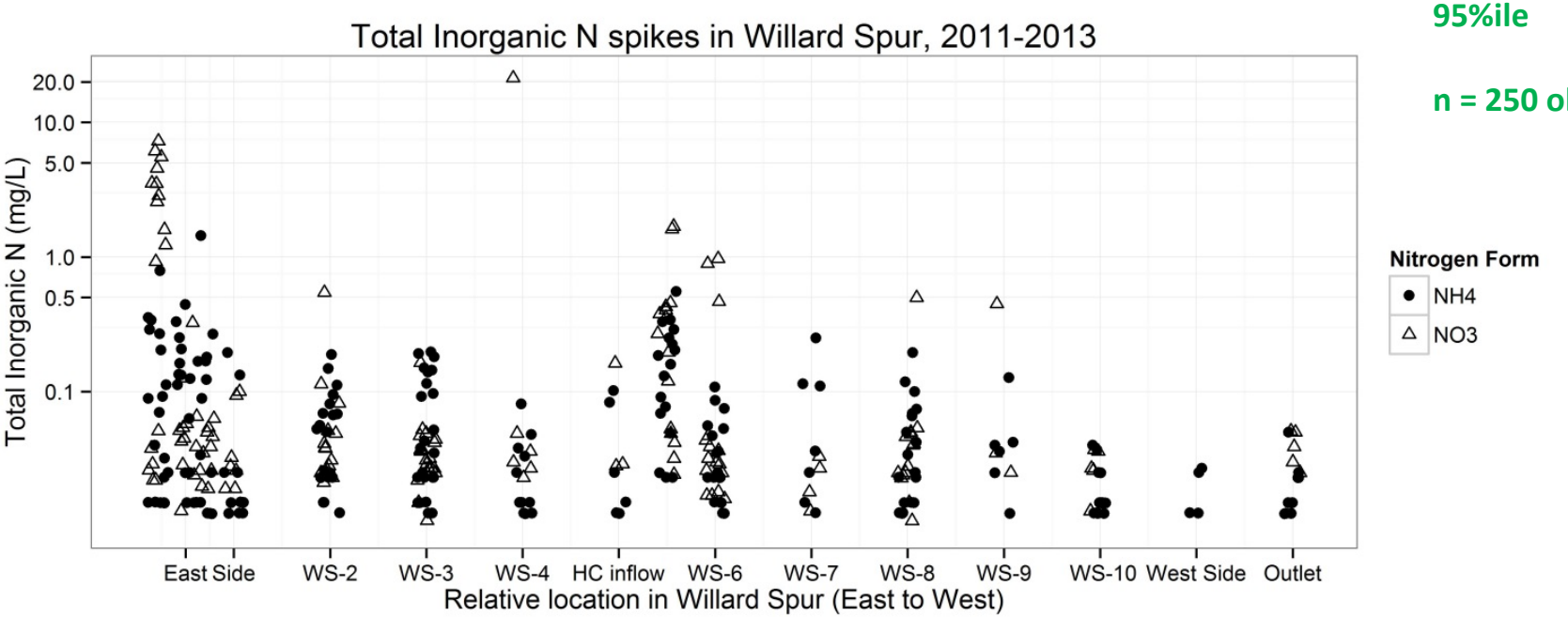


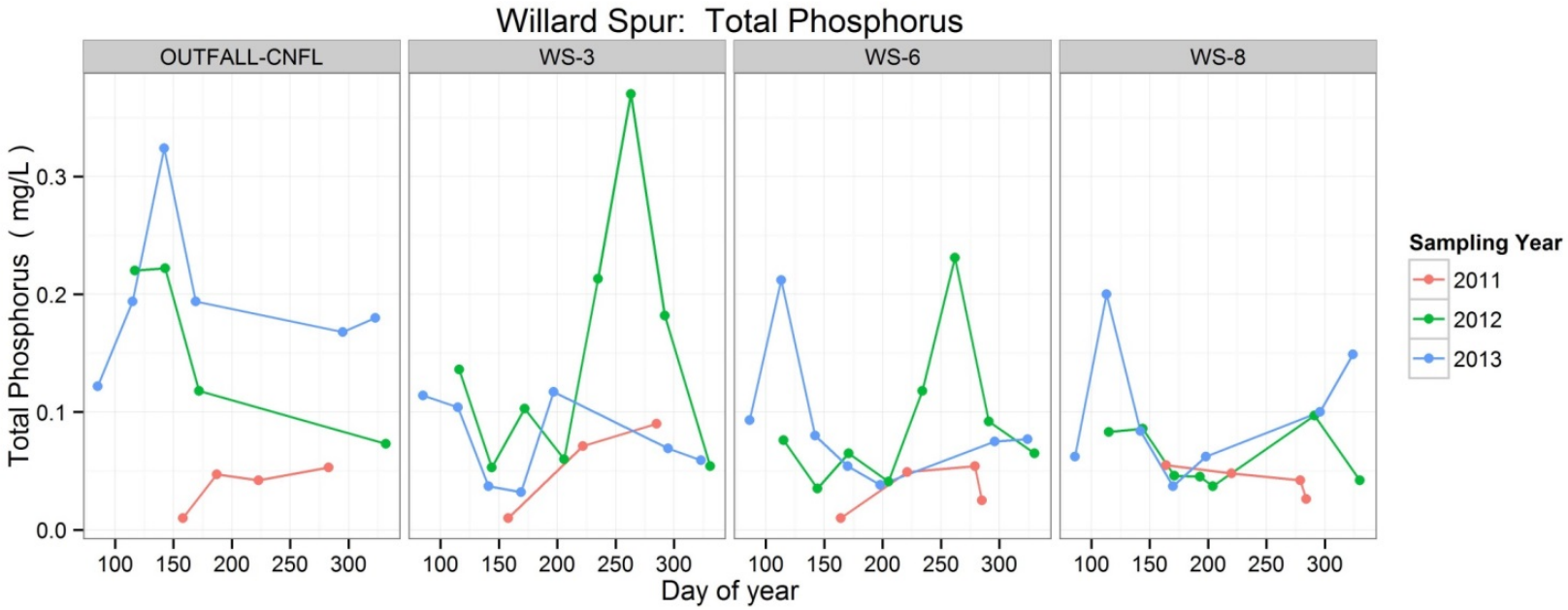
Most of TN is dissolved, organic N.

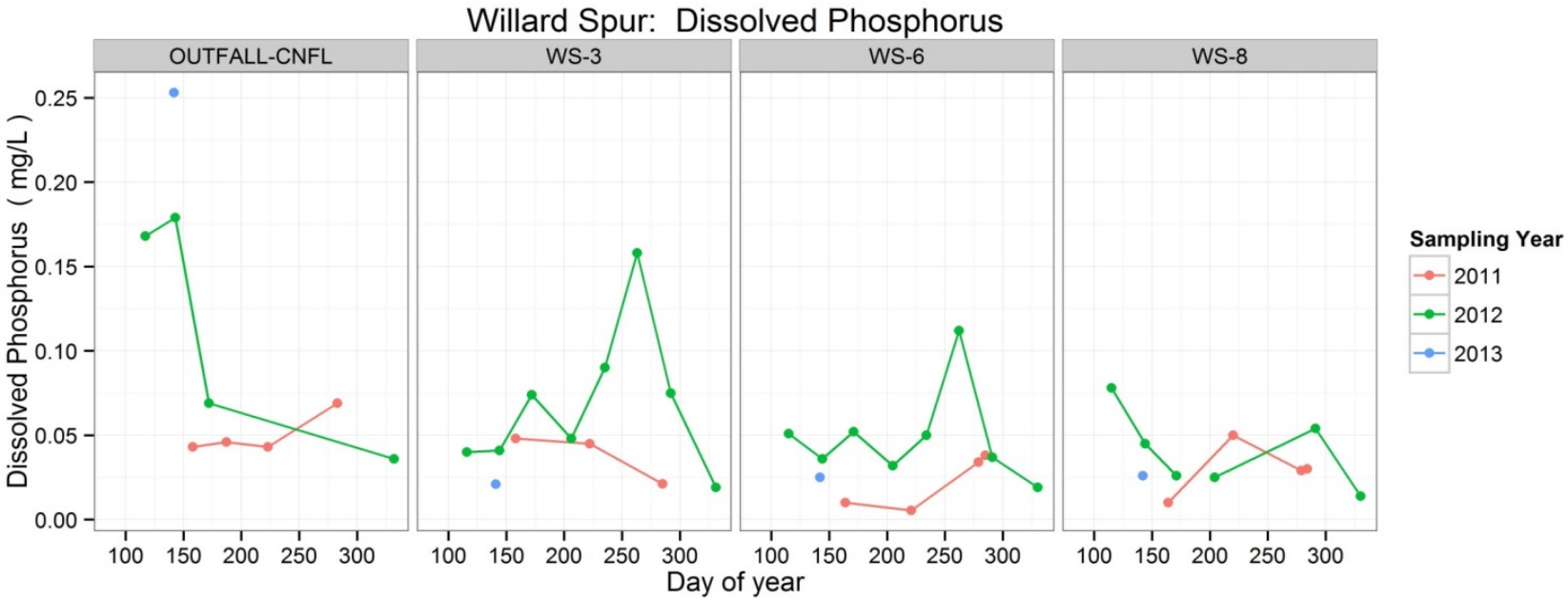


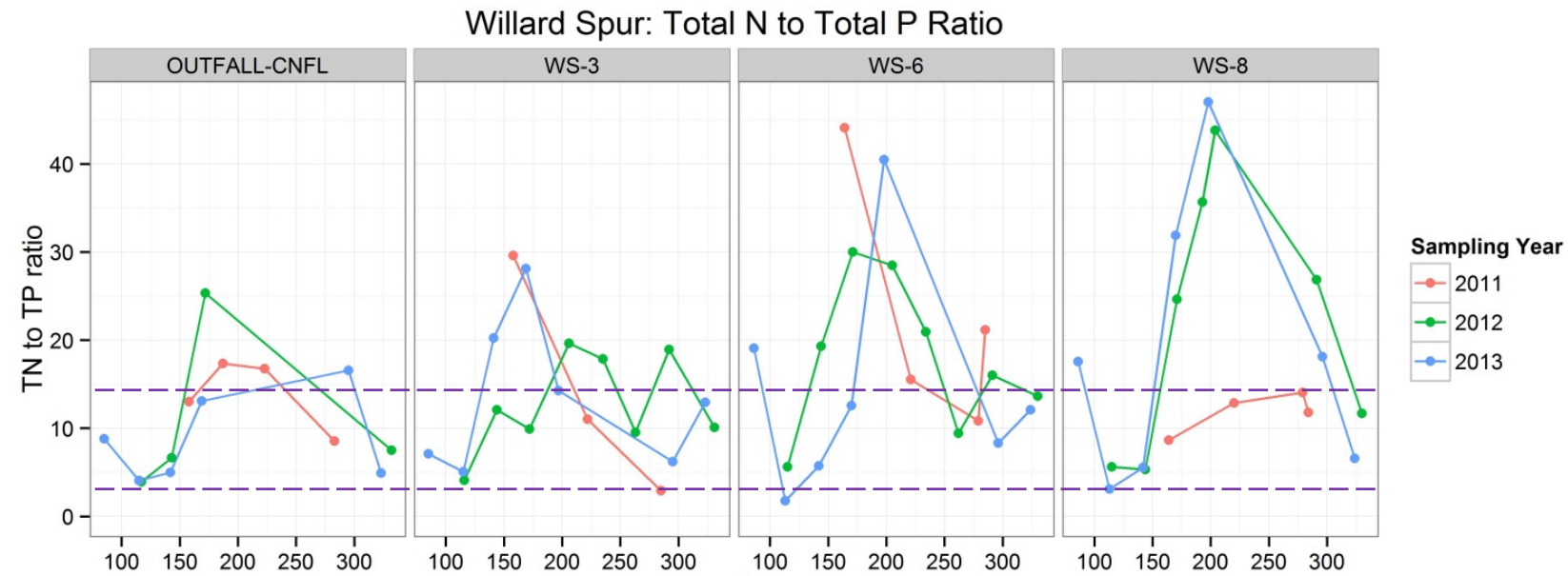
25%ile	0.036
median	0.072
75%ile	0.184
90%ile	0.571
95%ile	1.655

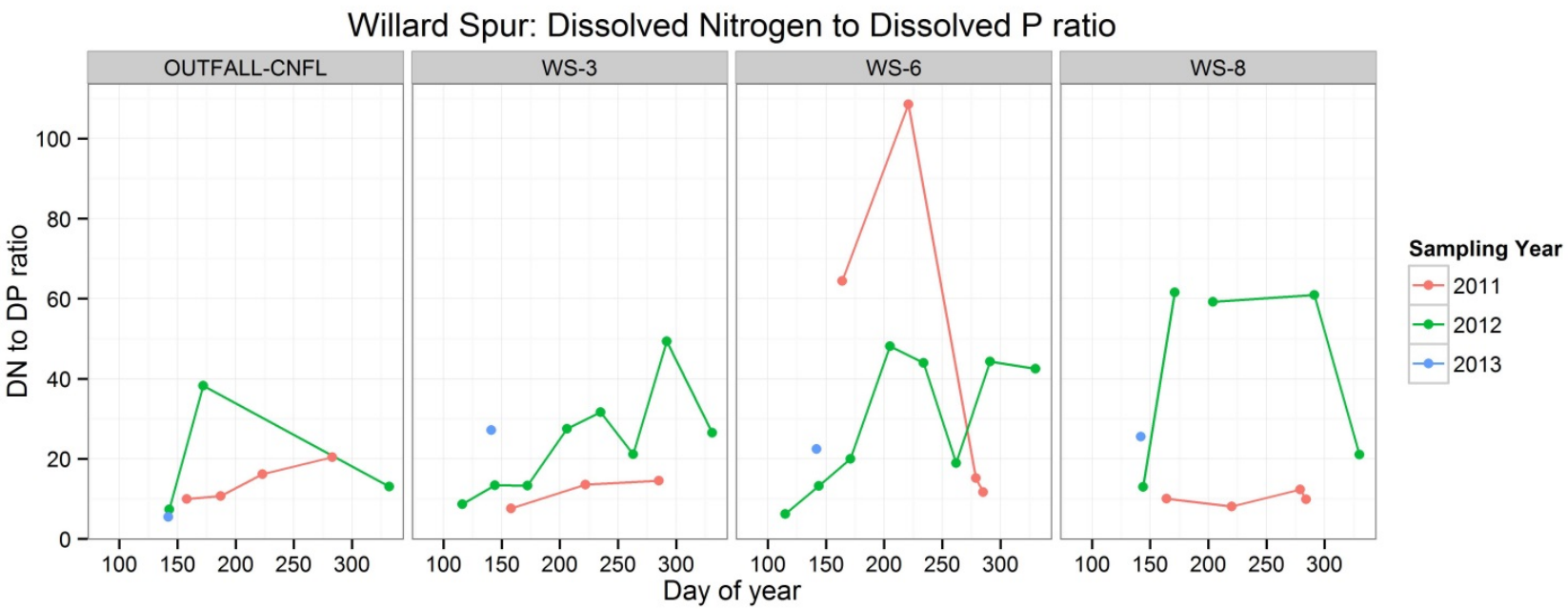
n = 250 obs



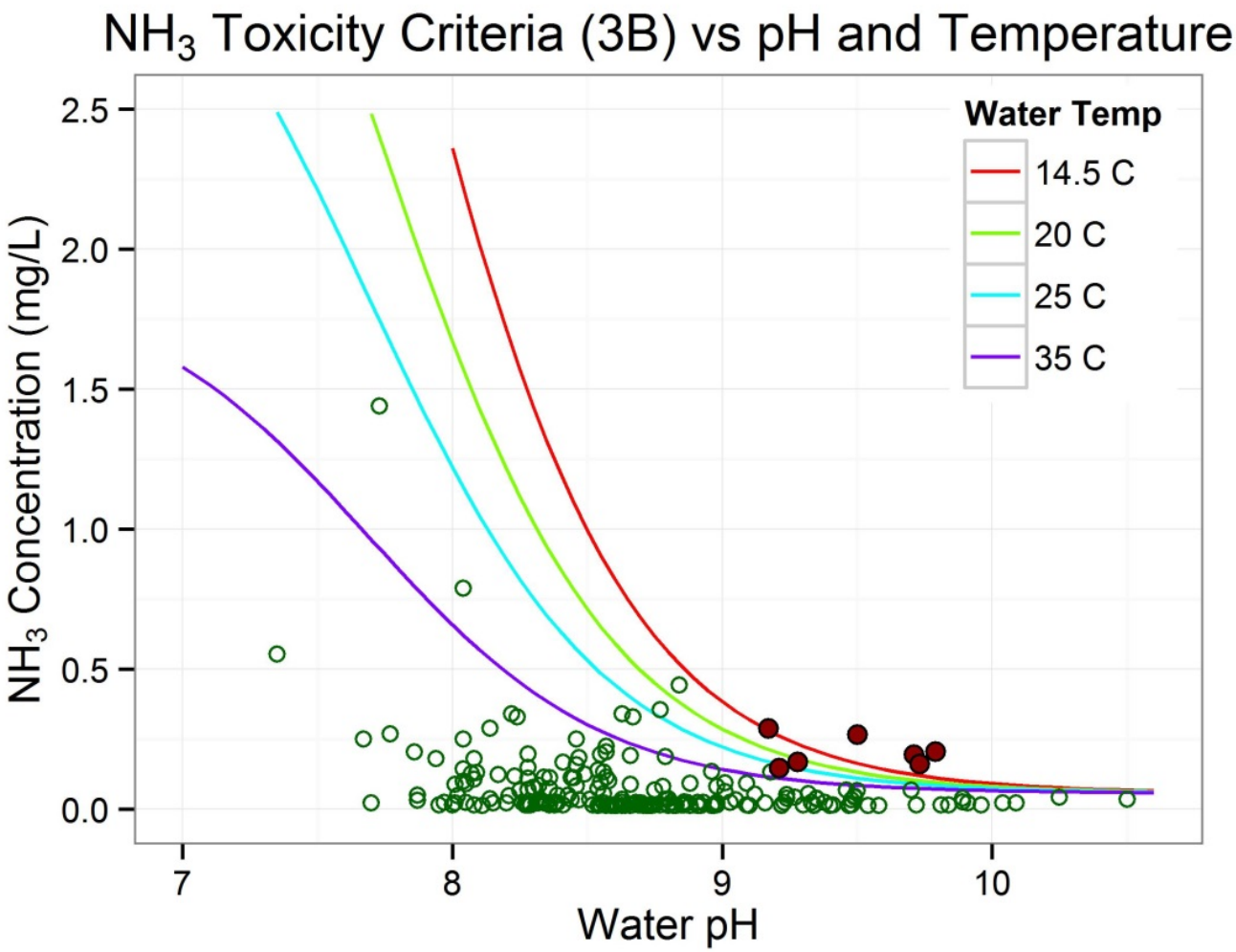

Willard Spur: Total Phosphorus
OUTFALL-CNFL
WS-3
WS-6
WS-8
Total Phosphorus (mg/L)
0.0
0.1
0.2
0.3
100
150
200
250
300
Day of year
Sampling Year
2011
2012
2013


Willard Spur: Dissolved Phosphorus
OUTFALL-CNFL
WS-3
WS-6
WS-8
Dissolved Phosphorus (mg/L)
0.00
0.05
0.10
0.15
0.20
0.25
100
150
200
250
300
Day of year
Sampling Year
2011
2012
2013


Willard Spur: Total N to Total P Ratio
OUTFALL-CNFL
WS-3
WS-6
WS-8
TN to TP ratio
0
10
20
30
40
100
150
200
250
300
Sampling Year
2011
2012
2013


Willard Spur: Dissolved Nitrogen to Dissolved P ratio
OUTFALL-CNFL
WS-3
WS-6
WS-8
DN to DP ratio
0
20
40
60
80
100
100
150
200
250
300
Day of year
Sampling Year
2011
2012
2013

Any Observed Water Quality Standards Violations ?

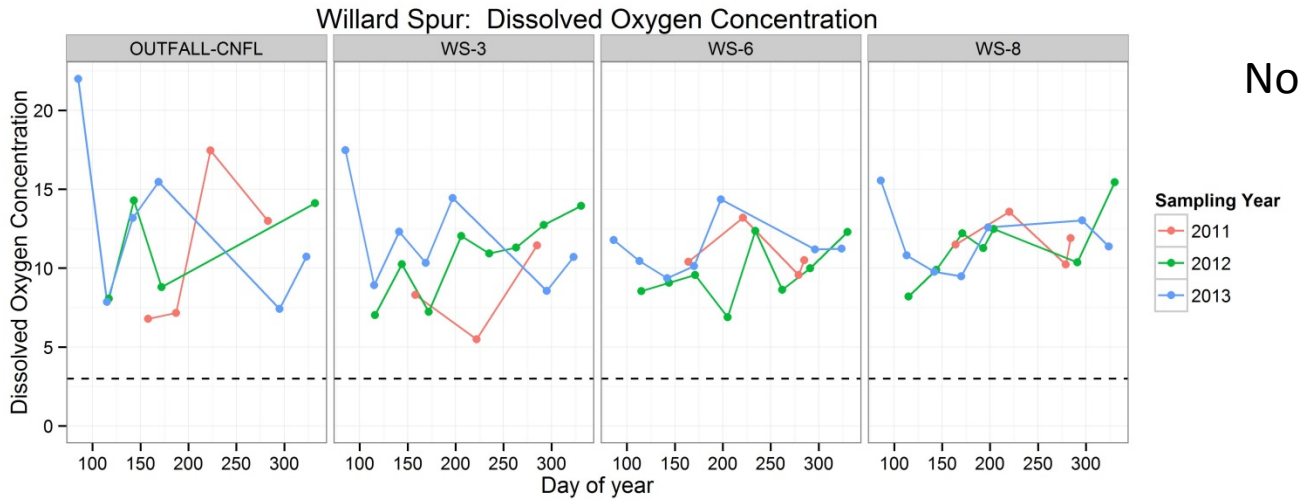


7 exceedances for NH3

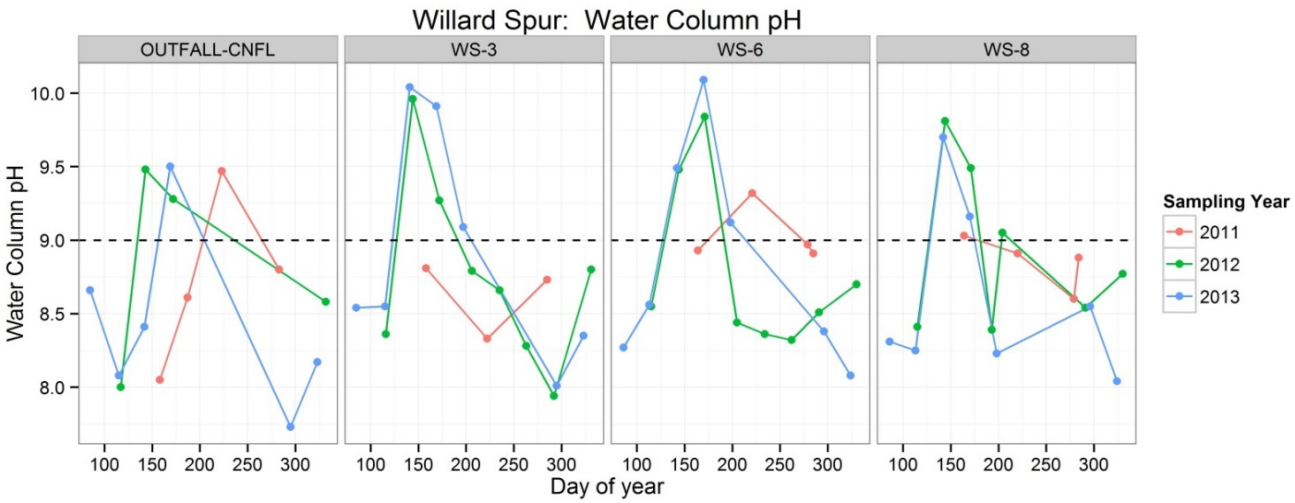
Driven by:

- Warm Temps (> 28.5 C)
- High pH (> 9.17)
- Elevated NH_4^+ (> 80th percentile)

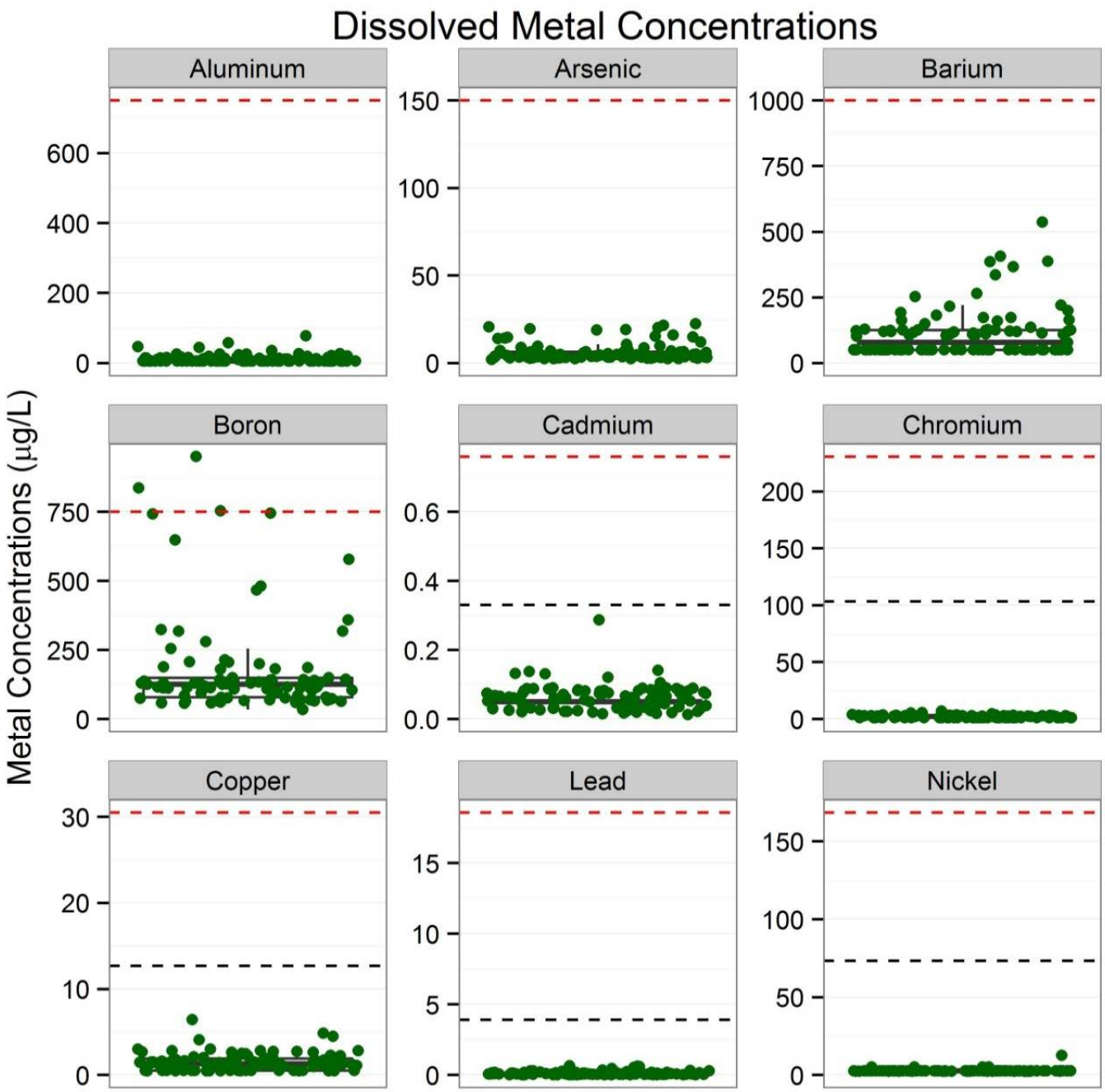
All within the eastern portion of the Spur

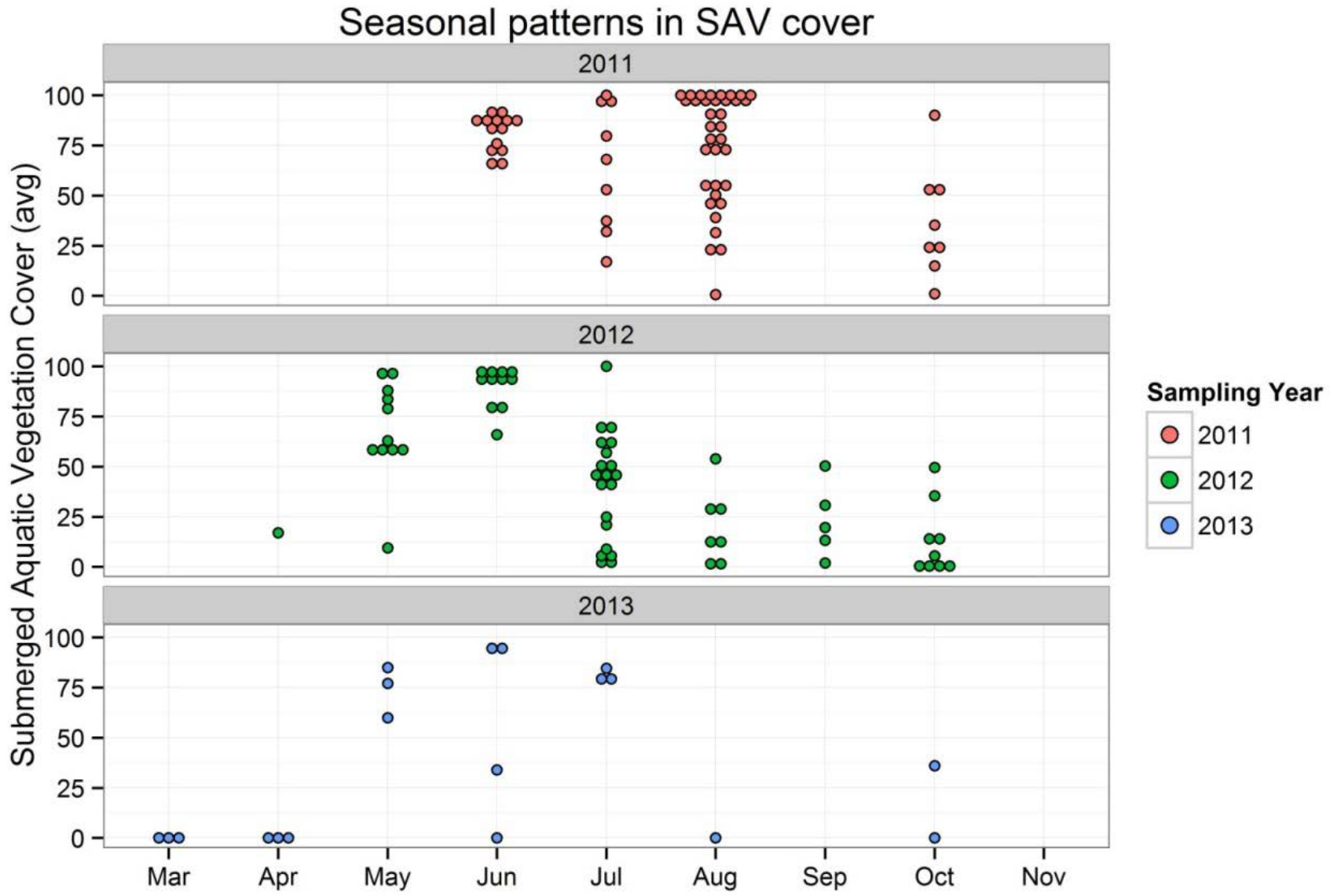


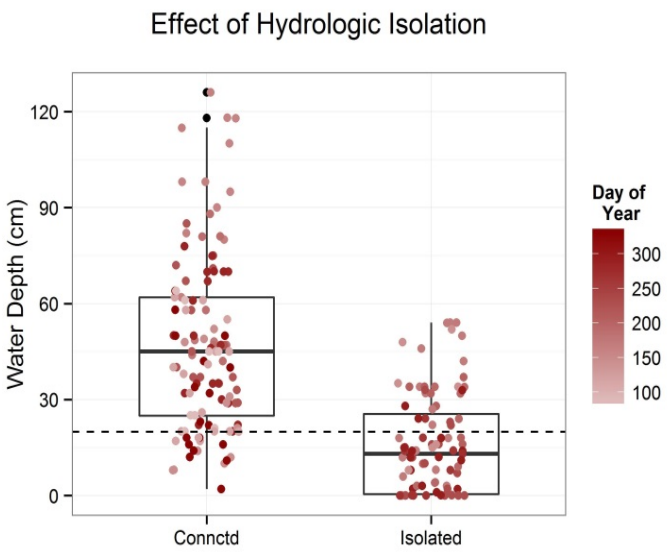
No exceedances for Minimum DO (3 mg/L)

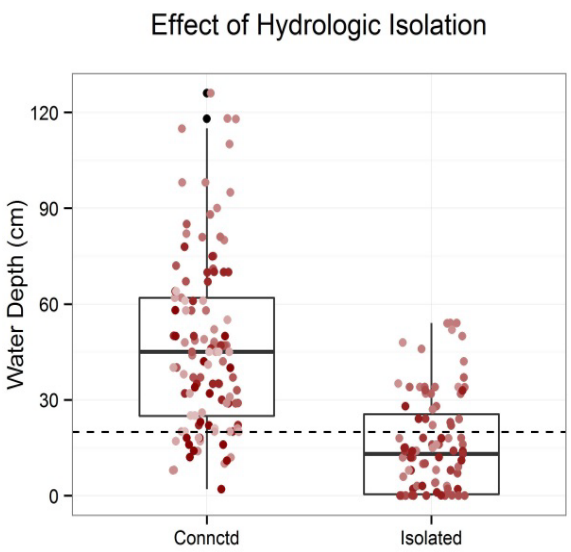


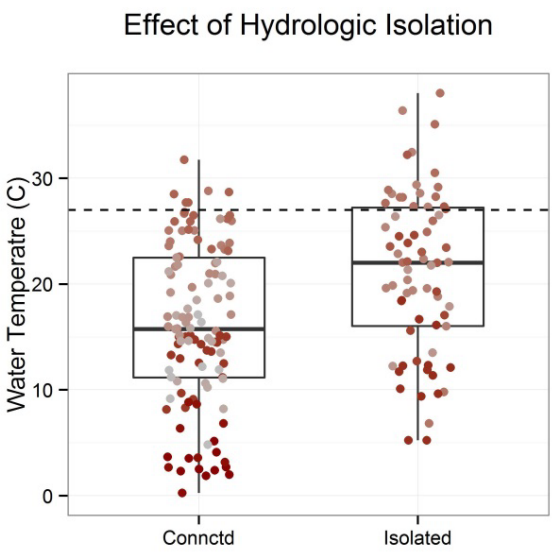
56 Samples with pH > 9.0

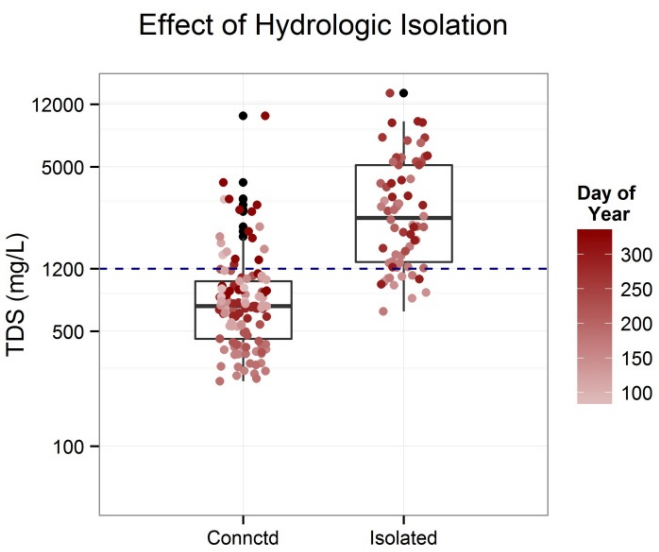

Dissolved Metal Concentrations
Aluminum
Arsenic
Barium
Boron
Cadmium
Chromium
Copper
Lead
Nickel
Metal Concentrations (µg/L)
0
200
400
600
50
100
150
250
500
750
1000
0.0
0.2
0.4
0.6
10
20
30
5
15

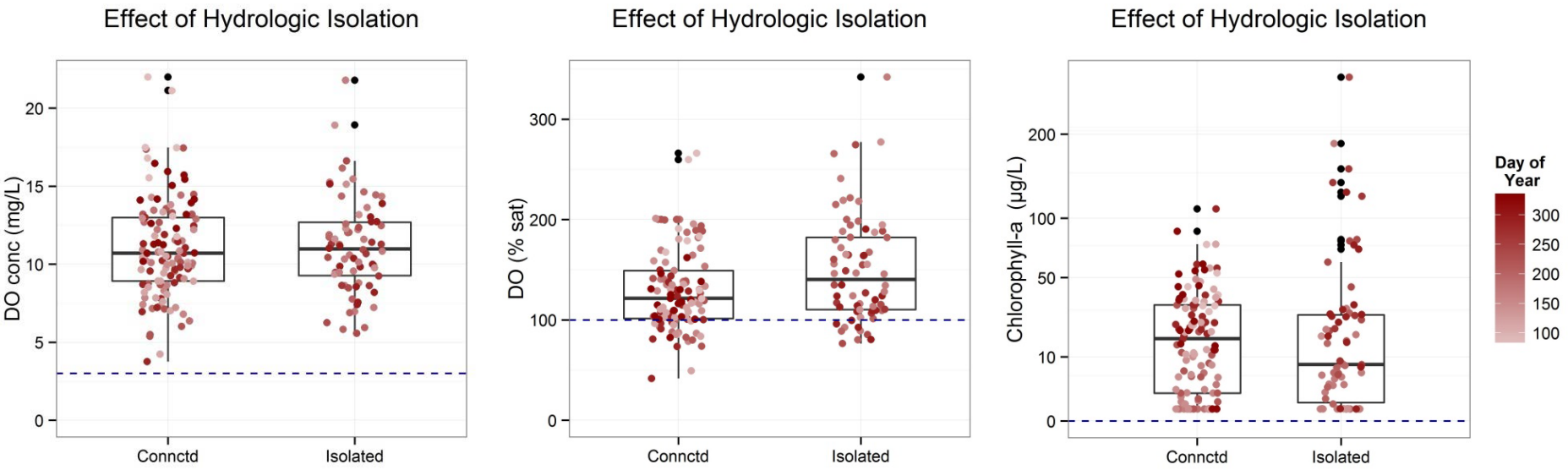

Seasonal patterns in SAV cover
2011
2012
2013
Submerged Aquatic Vegetation Cover (avg)
100
75
50
25
0
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Sampling Year
2011
2012
2013

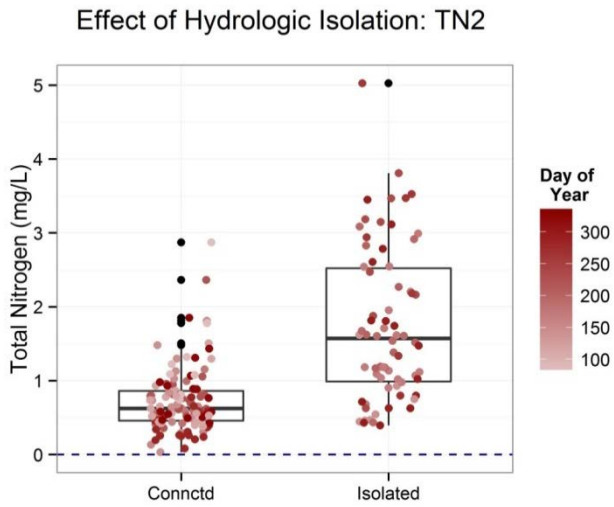

Effect of Hydrologic Isolation
Water Depth (cm)
120
90
60
30
0
Connctd
Isolated
Day of Year
300
250
200
150
100

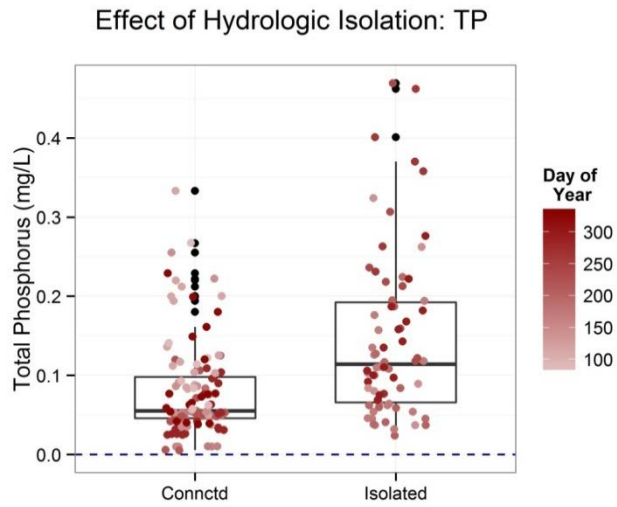

Effect of Hydrologic Isolation
Water Depth (cm)
120
90
60
30
0
Connctd
Isolated

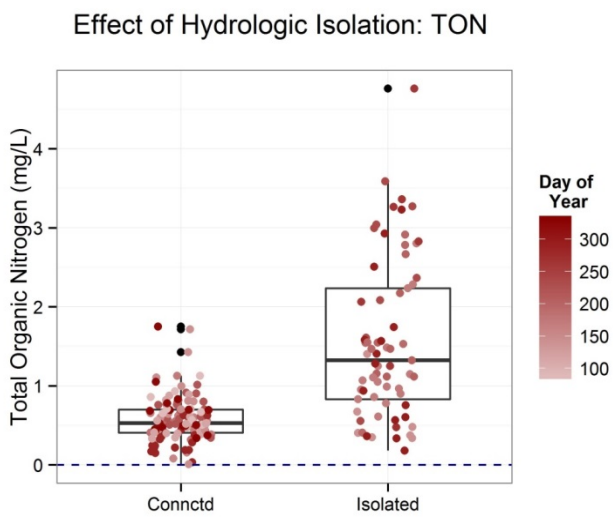

Effect of Hydrologic Isolation
Water Temperatre (C)
30
20
10
0
Connctd
Isolated

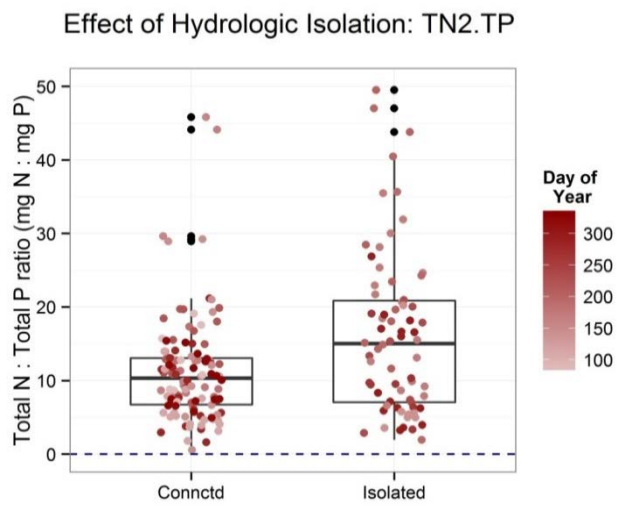

Effect of Hydrologic Isolation
TDS (mg/L)
12000
5000
1200
500
100
Connctd
Isolated
Day of Year
300
250
200
150
100

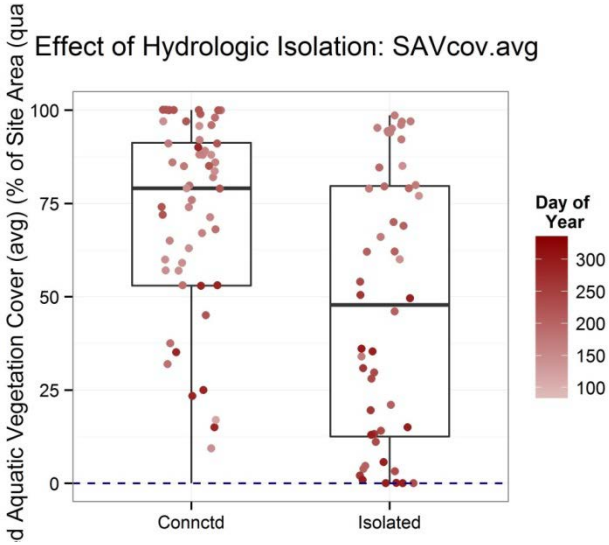

Effect of Hydrologic Isolation
DO conc (mg/L)
0
5
10
15
20
Connctd
Isolated
Effect of Hydrologic Isolation
DO (% sat)
0
100
200
300
Connctd
Isolated
Effect of Hydrologic Isolation
Chlorophyll-a (µg/L)
0
10
50
100
200
Connctd
Isolated
Day of Year
100
150
200
250
300

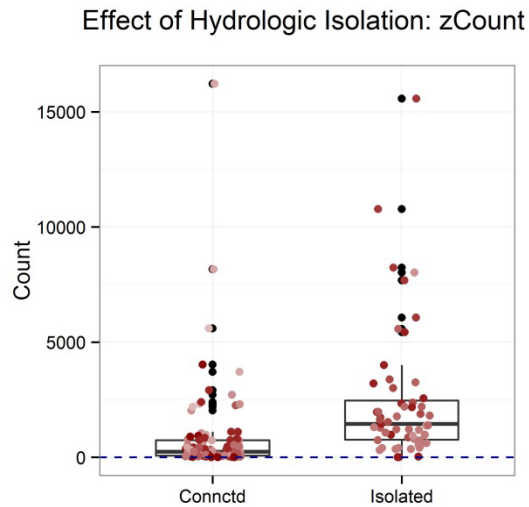

Effect of Hydrologic Isolation: TN2
Total Nitrogen (mg/L)
0
1
2
3
4
5
Connctd
Isolated
Day of Year
300
250
200
150
100

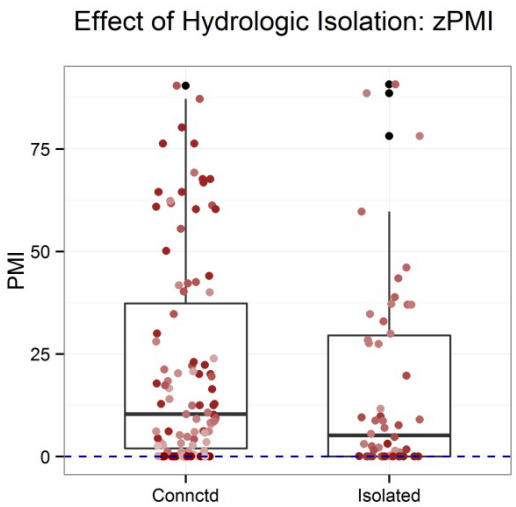

Effect of Hydrologic Isolation: TP
Total Phosphorus (mg/L)
0.0
0.1
0.2
0.3
0.4
Connctd
Isolated
Day of Year
300
250
200
150
100

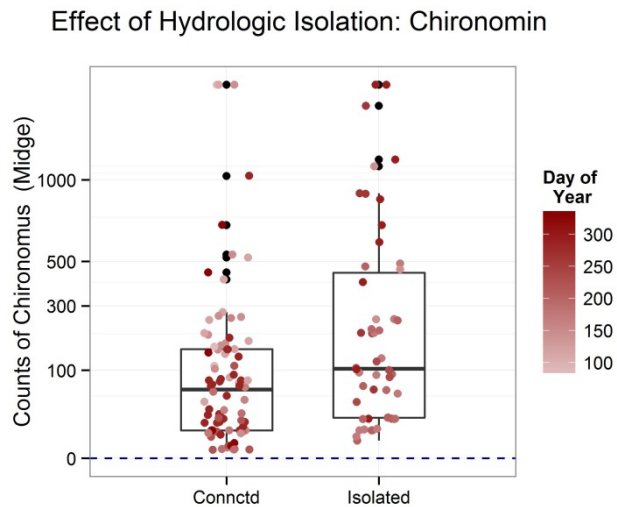

Effect of Hydrologic Isolation: TON
Total Organic Nitrogen (mg/L)
0
1
2
3
4
Connctd
Isolated
Day of Year
300
250
200
150
100

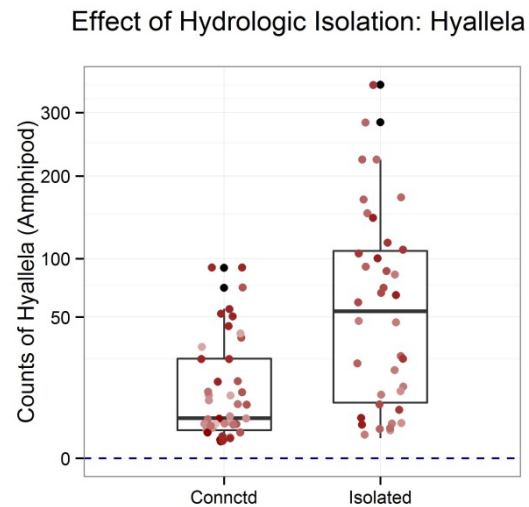

Effect of Hydrologic Isolation: TN2.TP
Total N : Total P ratio (mg N : mg P)
0
10
20
30
40
50
Connctd
Isolated
Day of Year
300
250
200
150
100

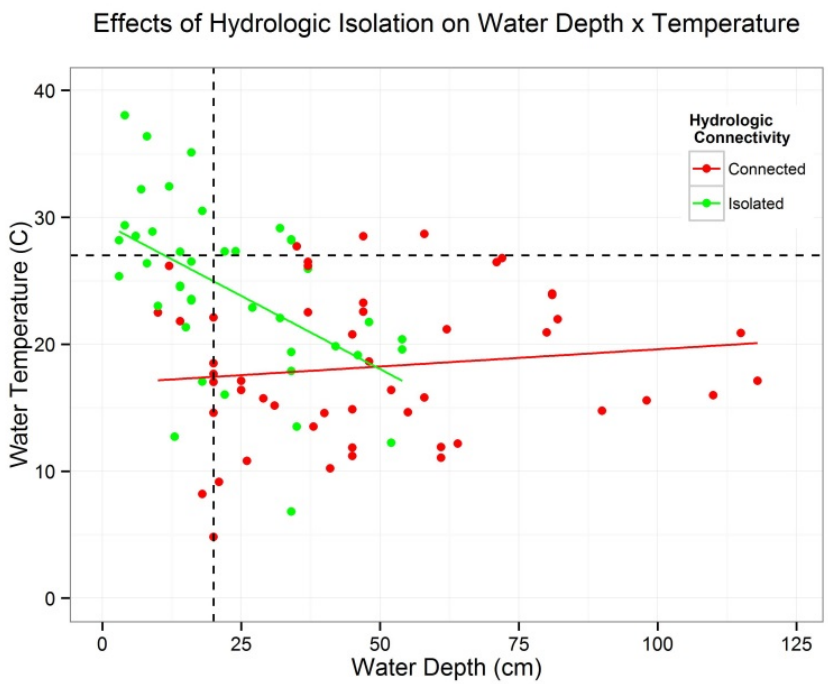

Effect of Hydrologic Isolation: SAVcov.avg
d Aquatic Vegetation Cover (avg) (% of Site Area (qua
100
75
50
25
0
Connctd
Isolated
Day of Year
300
250
200
150
100

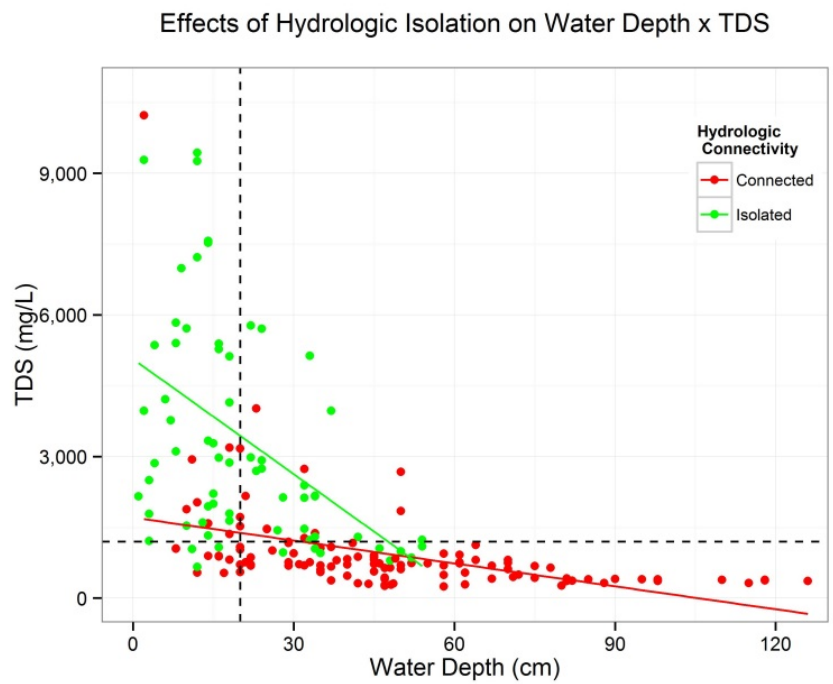

Effect of Hydrologic Isolation: zCount
Count
15000
10000
5000
0
Connctd
Isolated

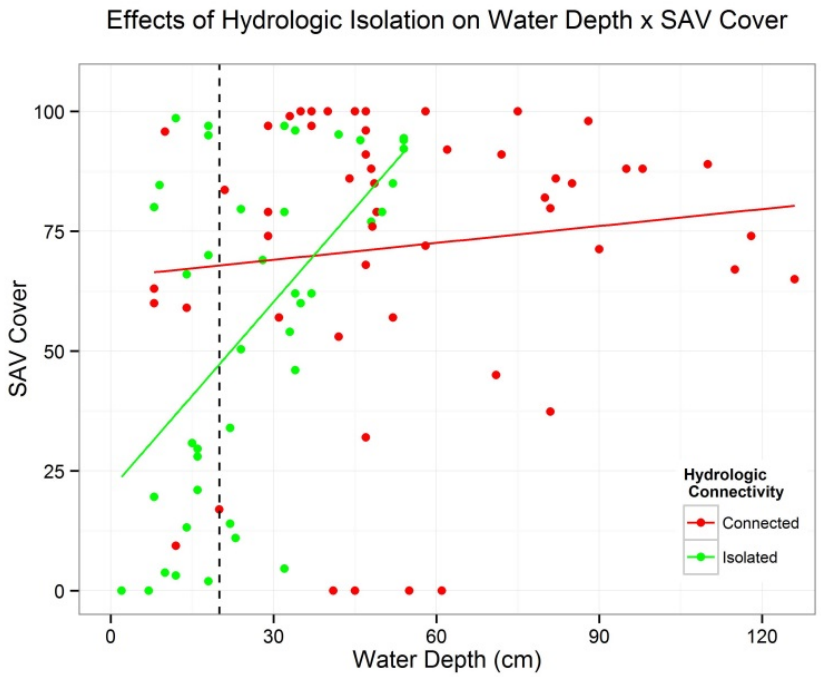

Effect of Hydrologic Isolation: zPMI
PMI
75
50
25
0
Connctd
Isolated

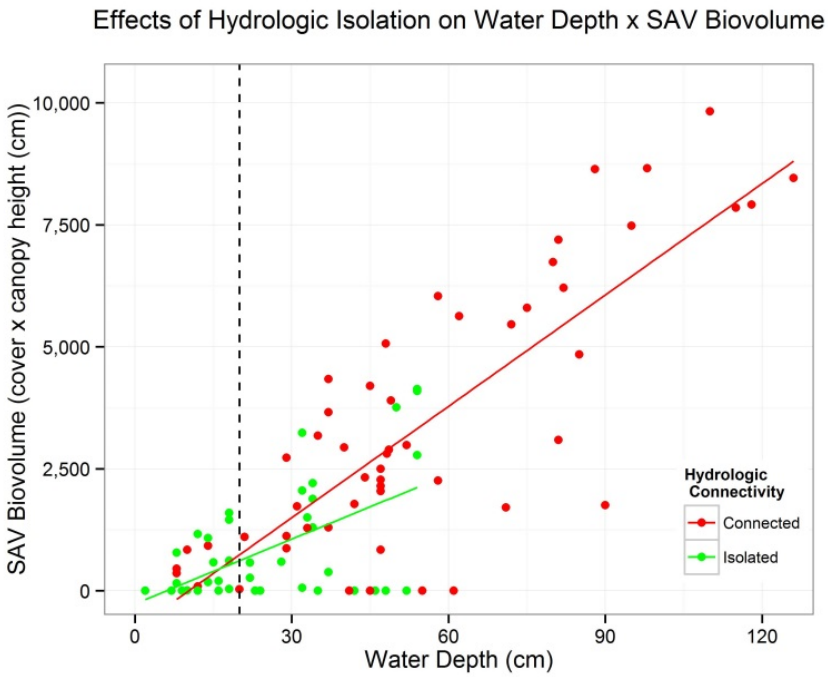

Effect of Hydrologic Isolation: Chironomin
Counts of Chironomus (Midge)
1000
500
300
100
0
Connctd
Isolated
Day of Year
300
250
200
150
100


Effect of Hydrologic Isolation: Hyallela
Counts of Hyallela (Amphipod)
300
200
100
50
0
Connctd
Isolated

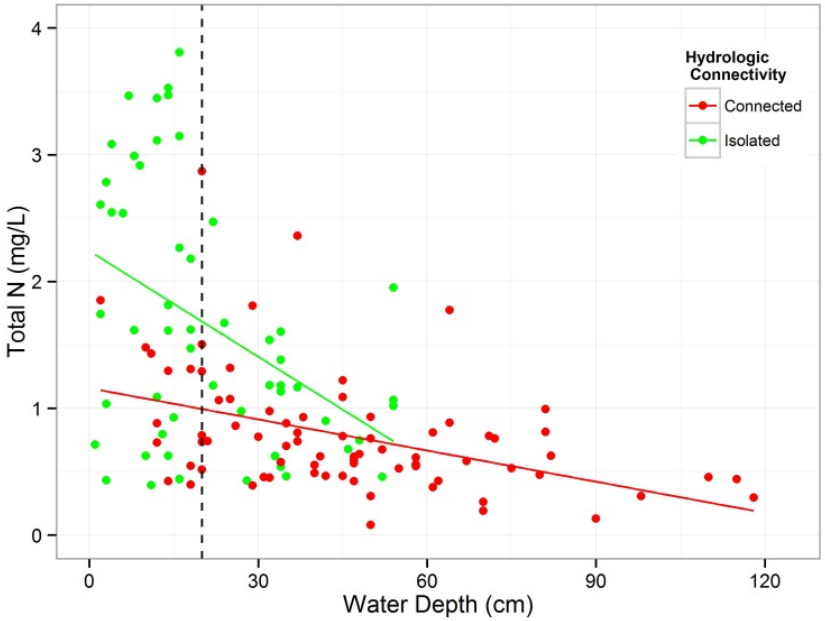

Effects of Hydrologic Isolation on Water Depth x Temperature
Water Temperature (C)
Water Depth (cm)
Hydrologic Connectivity
Connected
Isolated
0
10
20
30
40
0
25
50
75
100
125


Effects of Hydrologic Isolation on Water Depth x TDS
TDS (mg/L)
Water Depth (cm)
Hydrologic Connectivity
Connected
Isolated
0
3,000
6,000
9,000
0
30
60
90
120

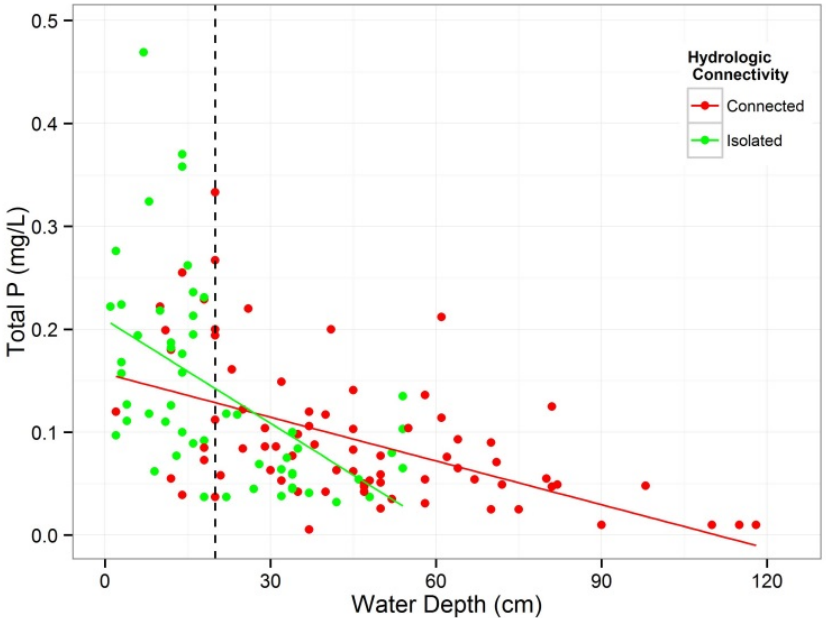

Effects of Hydrologic Isolation on Water Depth x SAV Cover
SAV Cover
Water Depth (cm)
0
25
50
75
100
0
30
60
90
120
Hydrologic Connectivity
Connected
Isolated


Effects of Hydrologic Isolation on Water Depth x SAV Biovolume
SAV Biovolume (cover x canopy height (cm))
Water Depth (cm)
0
2,500
5,000
7,500
10,000
0
30
60
90
120
Hydrologic Connectivity
Connected
Isolated

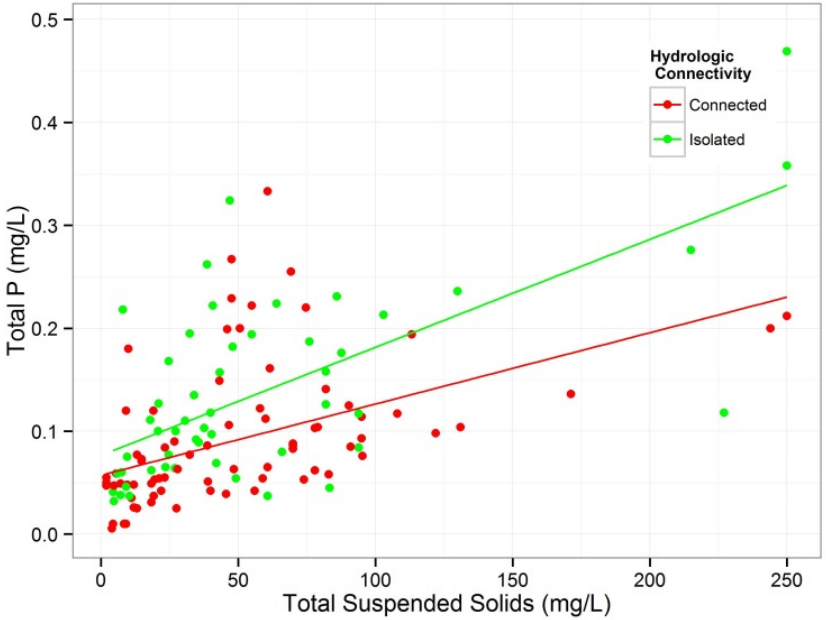
Effects of Hydrologic Isolation on Water Depth x Total N

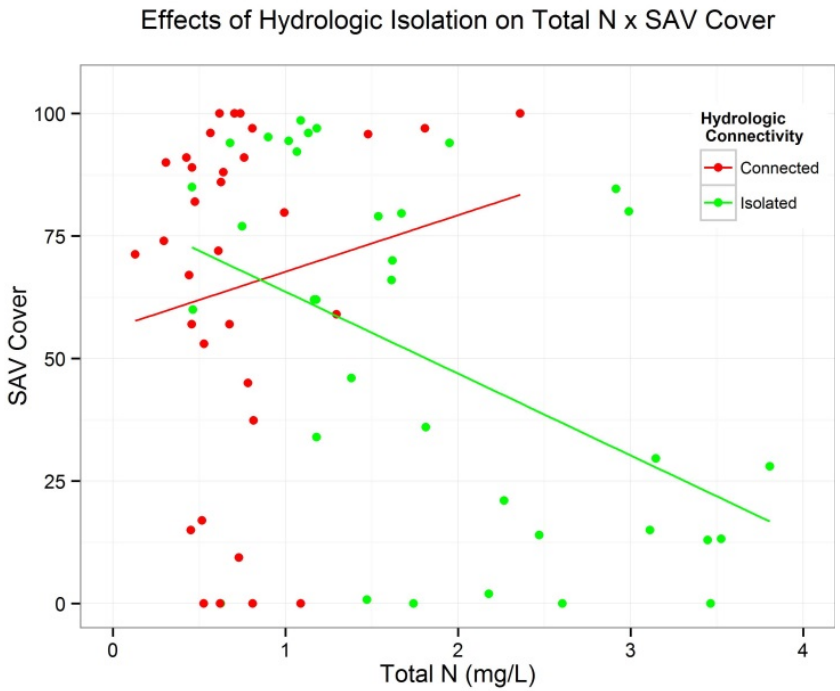


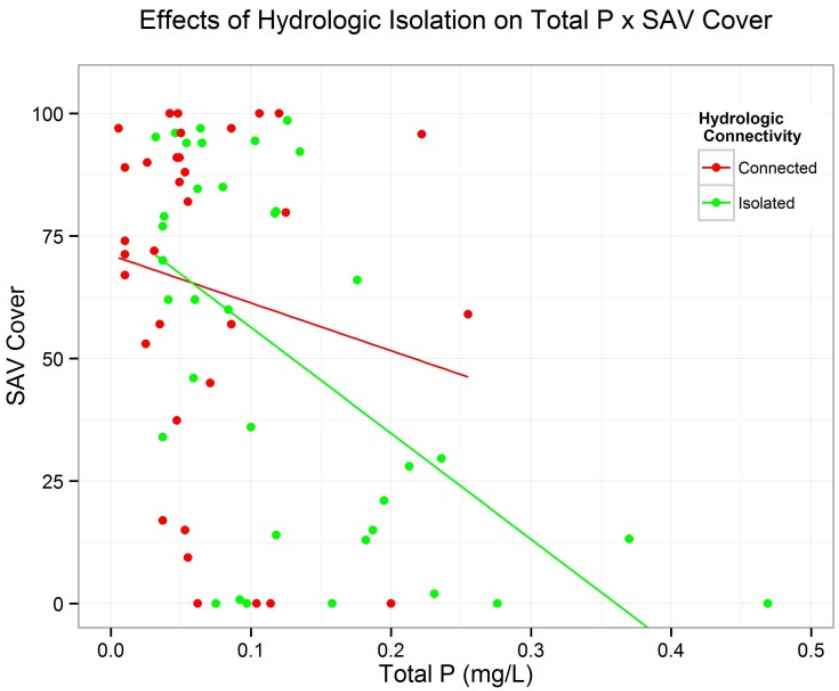
Effects of Hydrologic Isolation on Water Depth x Total P

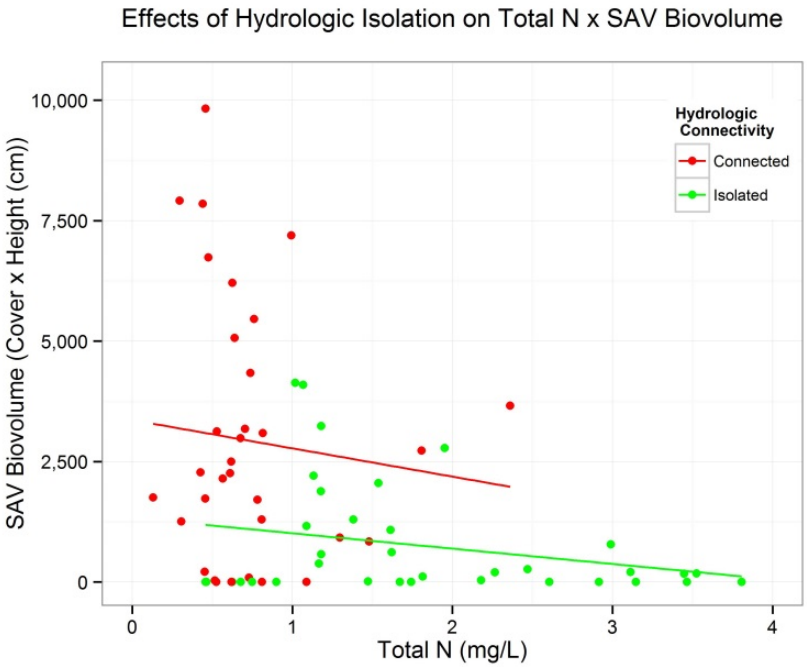


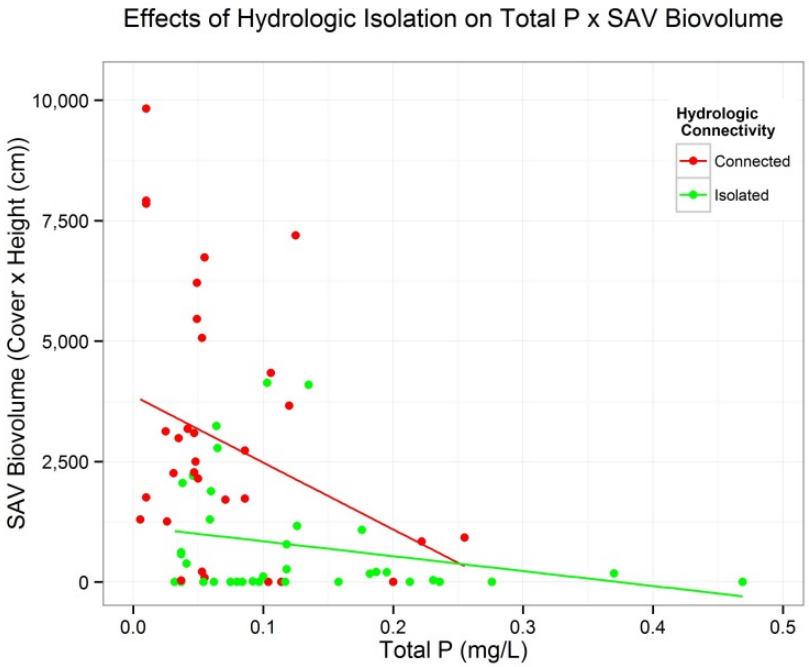
Effects of Hydrologic Isolation on Water TSS x Total P




Effects of Hydrologic Isolation on Total N x SAV Cover
SAV Cover
Total N (mg/L)
Hydrologic Connectivity
Connected
Isolated
0
25
50
75
100
0
1
2
3
4


Effects of Hydrologic Isolation on Total P x SAV Cover
SAV Cover
Total P (mg/L)
Hydrologic Connectivity
Connected
Isolated
0
25
50
75
100
0.0
0.1
0.2
0.3
0.4
0.5


Effects of Hydrologic Isolation on Total N x SAV Biovolume
SAV Biovolume (Cover x Height (cm))
10,000
7,500
5,000
2,500
0
0
1
2
3
4
Total N (mg/L)
Hydrologic Connectivity
Connected
Isolated


Effects of Hydrologic Isolation on Total P x SAV Biovolume
SAV Biovolume (Cover x Height (cm))
10,000
7,500
5,000
2,500
0
0.0
0.1
0.2
0.3
0.4
0.5
Total P (mg/L)
Hydrologic Connectivity
Connected
Isolated