Response of Water Quality Metrics to Foliar Herbicide Applications and Subsequent Plant Breakdown

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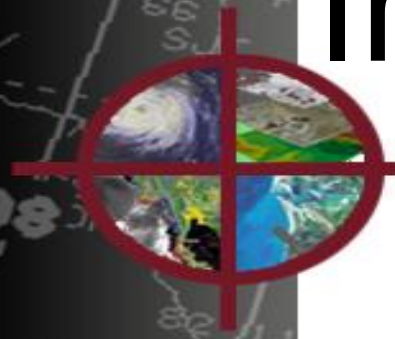
Introduction

- Aquatic plants can be beneficial to our ecosystem

Introduction

- Nuisance plant growth can negatively impact water quality
  - Decrease DO, reduce light penetration, Habitat loss, Increase sedimentation, Flooding, Etc.

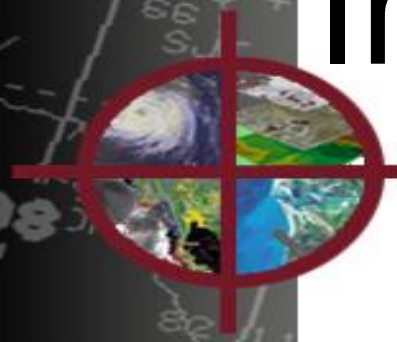
Introduction



- Herbicides are commonly used to control nuisance aquatic plants because of their efficiency

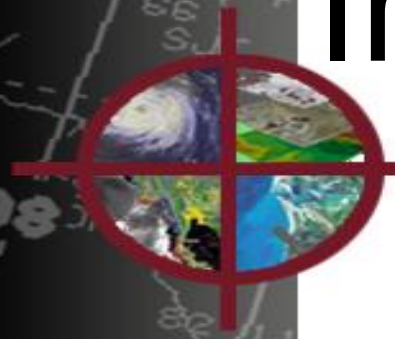
- 2,4-D, glyphosate, triclopyr, imazamox, imazapyr, flourpyrauxifen-benzyl, & flumioxazin investigated in this work.
  - These represent 4 MOA's: Auxin, ALS, EPSPS, PPO

Introduction



- Water chemistry/stability & aquatic plant relationship
  - DO inversely related to water temperature
  - Low pH affects fish ability to absorb DO
  - Excess organic material can cause eutrophic conditions
  - Thick, dense growth contribute to low oxygen levels at night
  - Oxygen consuming bacteria feed on decaying algae and plants

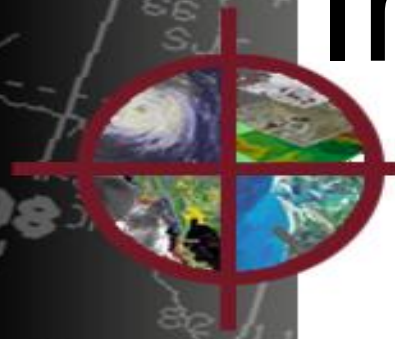
Introduction



- When plants die or start to decay, nutrients released back into the water column.

- Little is known about water quality after plant death
  - DO – can drop after plant death due to microbial activity.
  - pH - diurnal shift attenuated.
  - Conductivity – little is known, possibly rise over short-term.
  - Temperature equilibrium across the lake after plant death.

Introduction



- Little is known about water quality after plant death
  - Nitrate, Ammonium – nutrient metrics
    - Toxic nutrient levels for aquatic organisms such as fish.
    - Nitrate is relatively nontoxic to fish except at exceedingly high levels (above 90 mg/l NO3-N).

Introduction

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$$NH_3 + H_2O \leftrightarrow NH_4^+ + OH^-$$

Ph & Temp

- 2 - 5 mg/l of total ammonia nitrogen common in the spring and fall.
- Toxicity varies with fish species and time to adjust to elevated levels.
  - Lethal concentrations for fish species range from 0.2 to 2.0 mg/L.

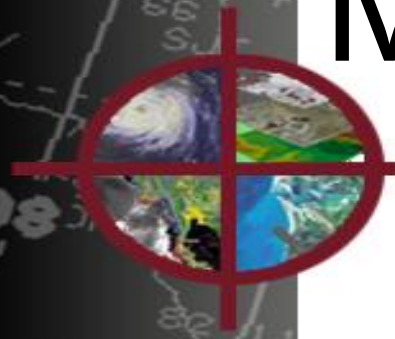
Introduction

- What happens to water quality after plant death?
- Does plant breakdown cause a change in water quality metrics and nitrogen levels?
- If changed observed, is it harmful to aquatic organisms?

Materials & Methods

- Community of 3 rooted native aquatic spp used – these can be problematic in SE U.S.
  - American lotus
  - White waterlily
  - Watershield

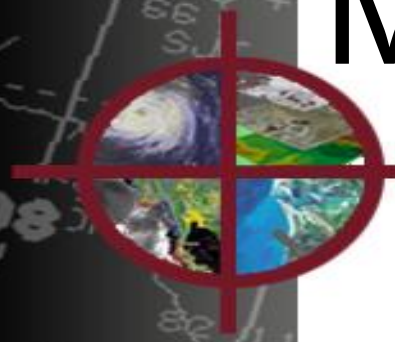
Materials & Methods



- Community of 3 rooted native aquatic spp used – these can be problematic in SE U.S.

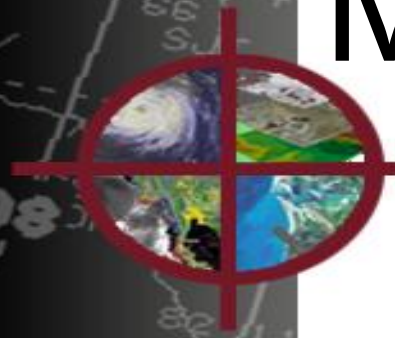
- These are problematic at Noxubee Wildlife Refuge
  - Inhibits navigation and recreational activity
  - Negatively affect ecosystem processes
    - Can disrupt temp, DO, pH

Materials & Methods



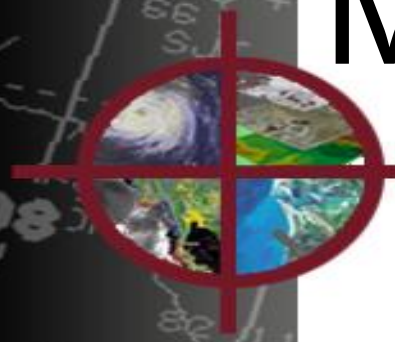
- Plants were grown in outdoor mesocosms (1136 L; 45 total)
  - 6 pots Lotus & Water lily per mesocosm
  - 4 pots Watershield per mesocosm
- Treated with: 7 herbicides at 2 rates (max and half max) each + non-treated ref (15 treatments)
  - Effective: glyphosate, imazamox, imazapyr, florpyrauxifen-benzyl

Materials & Methods



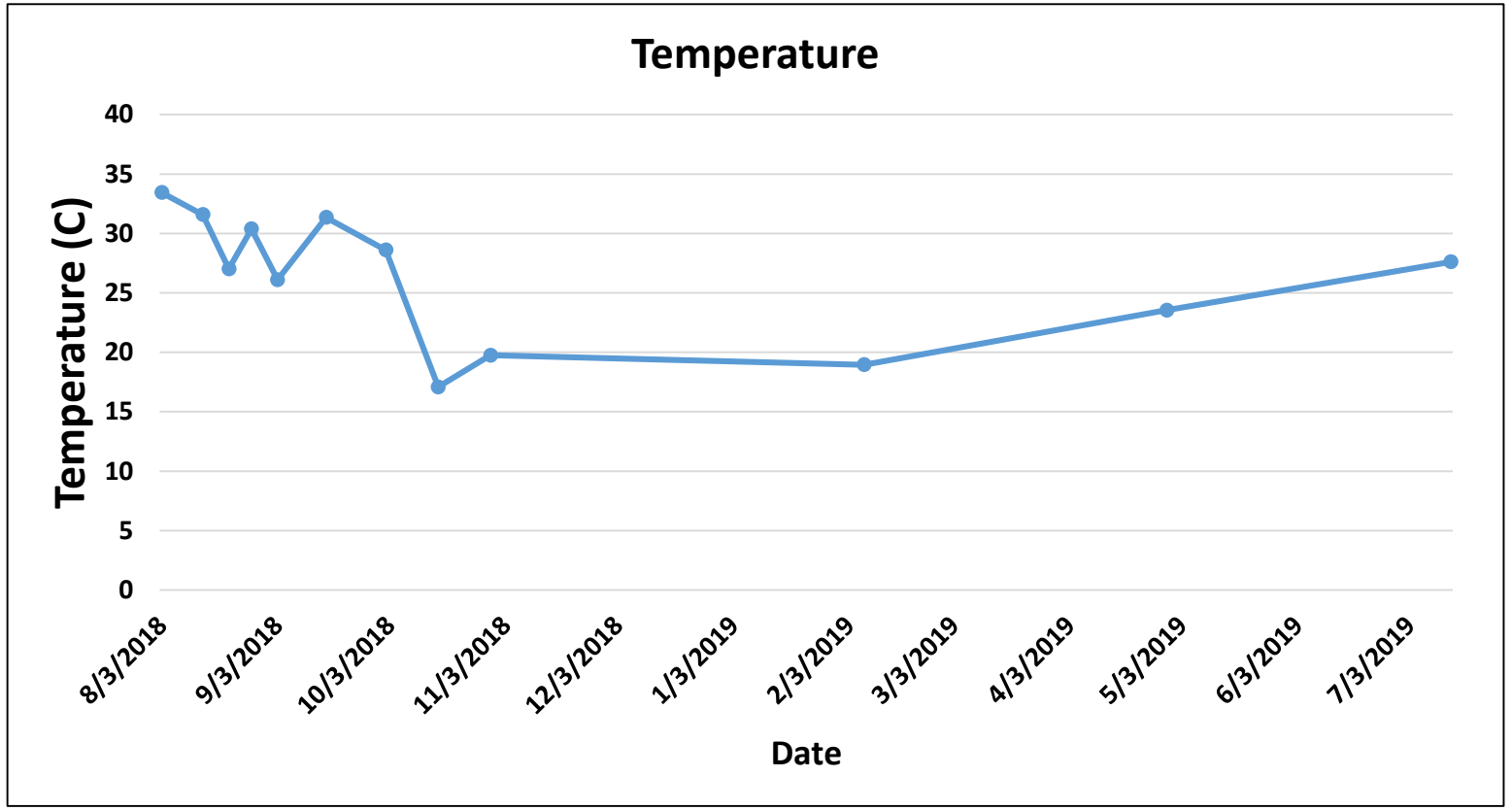
Treatments		
TREATMENT #	**TREATMENT**	**RATE**
1	Reference	NA
2	2,4-D	4.67 L/ha
3	2,4-D	9.35 L/ha
4	Glyphosate	4.38 L/ha
5	Glyphosate	8.76 L/ha
6	Triclopyr	9.35 L/ha
7	Triclopyr	18.70 L/ha
8	Imazamox	4.67 L/ha
9	Imazamox	9.35 L/ha
10	Imazapyr	1.75 L/ha
11	Imazapyr	3.51 L/ha
12	Flourpyrauxifen-benzyl	1 PDU
13	Flourpyrauxifen-benzyl	2 PDU
14	Flumioxazin	0.44 L/ha
15	Flumioxazin	0.88 L/ha

Materials & Methods



- Water quality metrics measured weekly, bi-monthly, and quarterly
- Nitrate & ammonium measured:
  - 0WAT, 2DAF, 2WAF, 4WAF, 8WAF, 26WAT, 52WAT
- ANOVA followed by Fisher's LSD when difference's detected

Results & Discussion



TRT	8/3/2018	8/14/2018	8/21/2018	8/27/2018	9/3/2018	9/16/2018	10/2/2018	10/16/2018	10/30/2018	2/7/2019	4/29/2019	7/14/2019
MEAN	33.44	31.58	27.02	30.38	26.1	31.35	28.6	17.08	19.75	18.95	23.54	27.61
p-value	0.9347	0.6743	0.6853	0.9862	0.8599	0.9593	0.4095	0.5359	0.4925	0.3811	0.5287	0.7373

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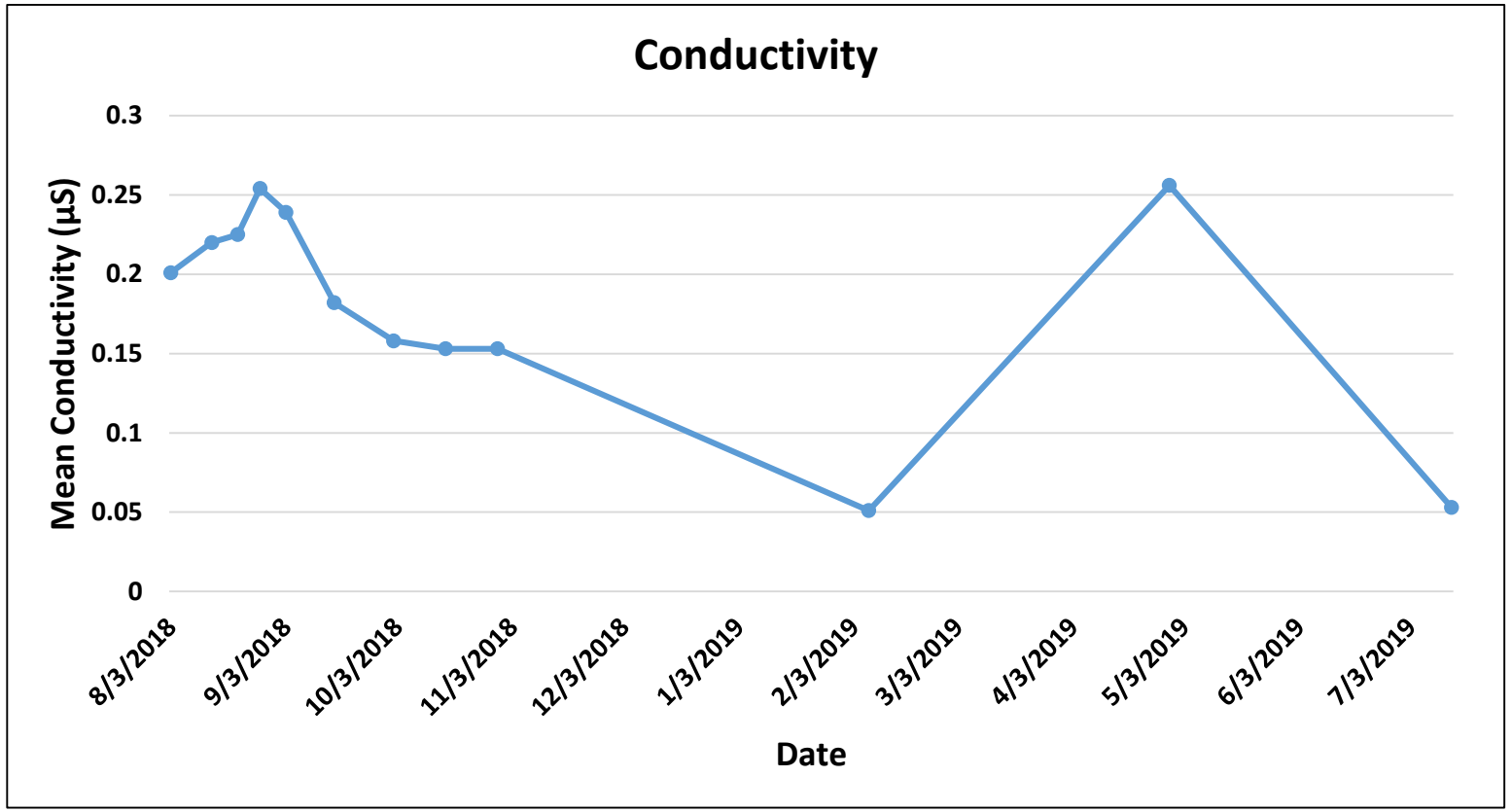
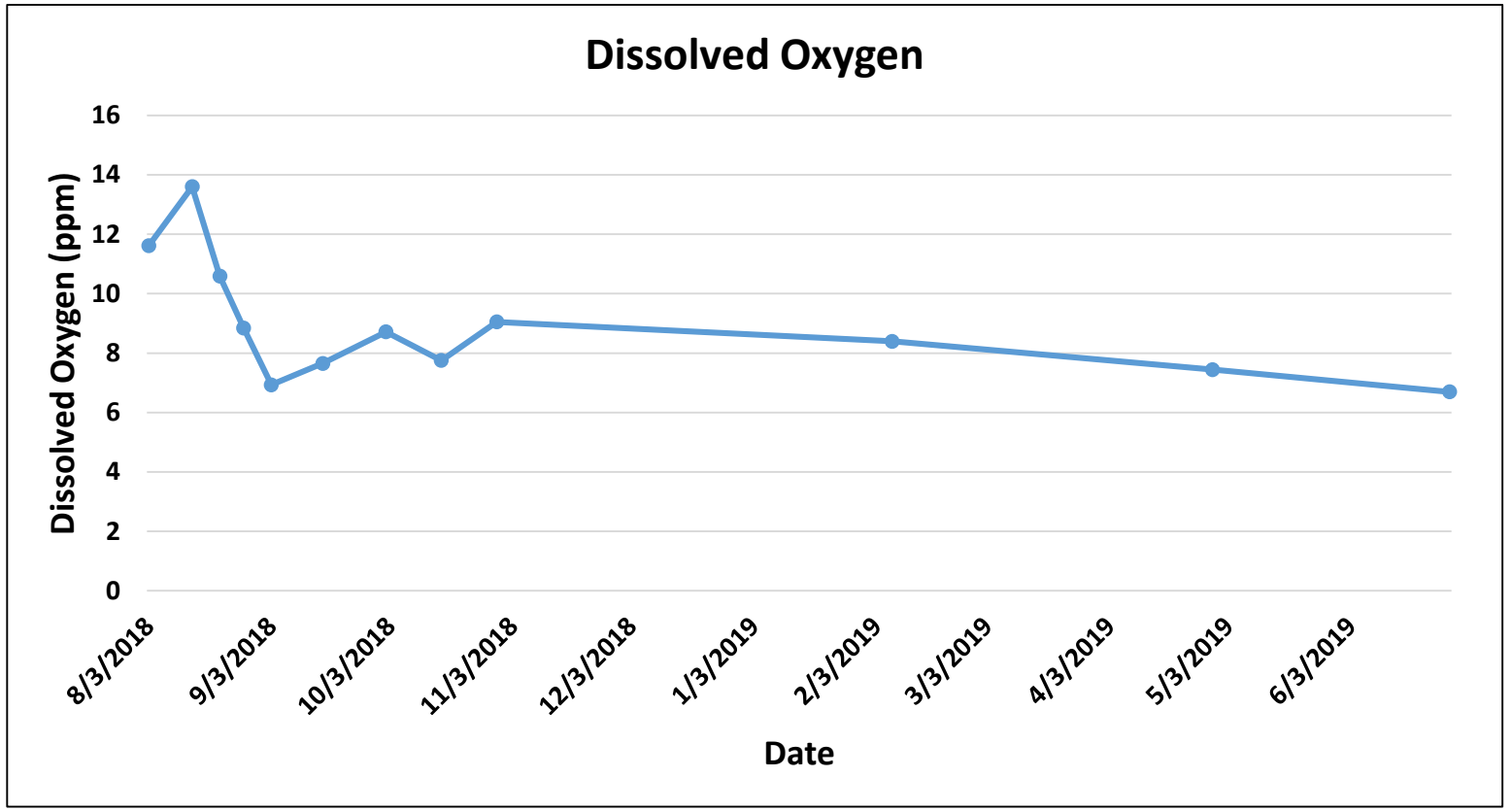


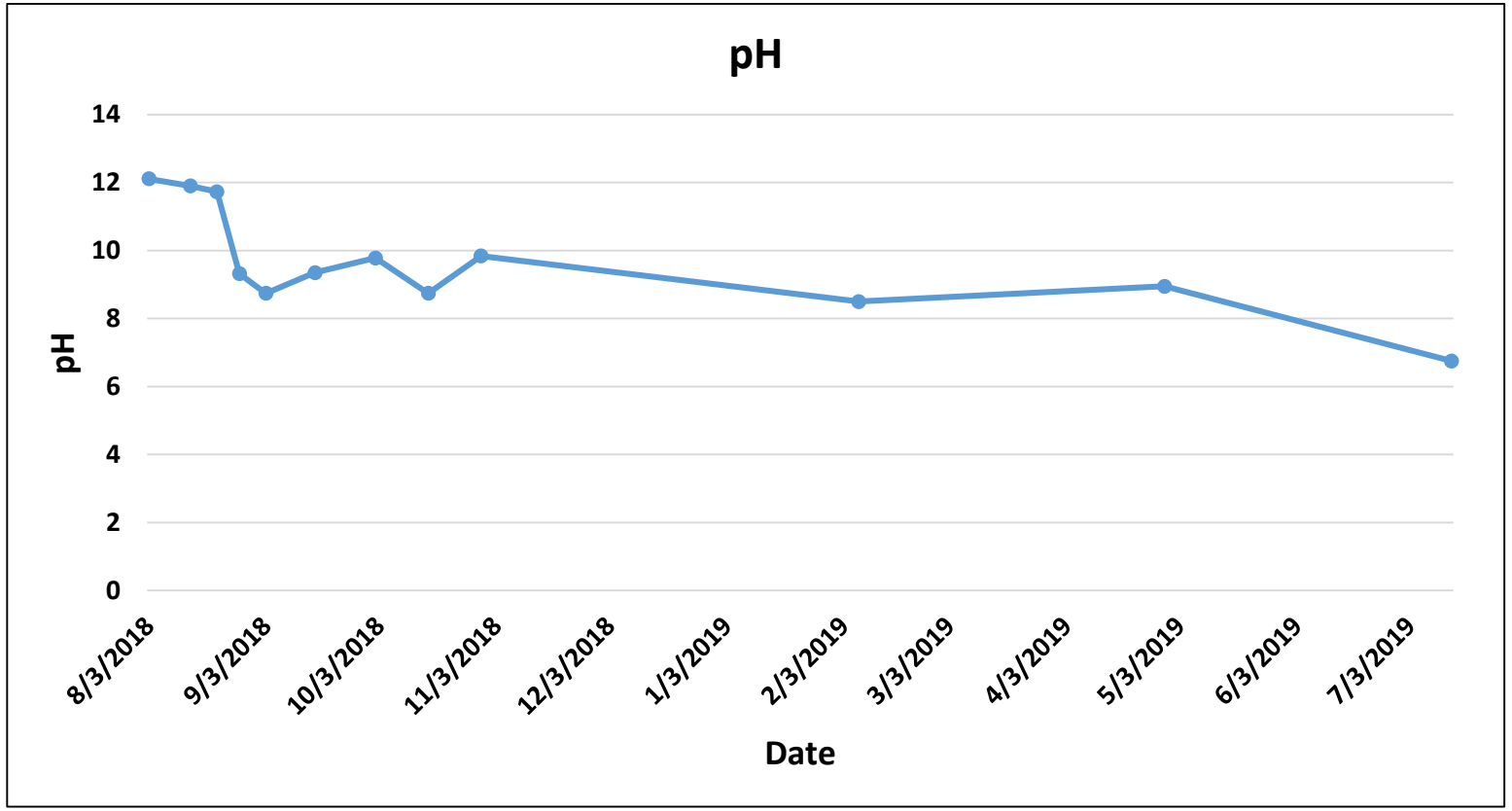
TRT	8/3/2018	8/14/2018	8/21/2018	8/27/2018	9/3/2018	9/16/2018	10/2/2018	10/16/2018	10/30/2018	2/7/2019	4/29/2019	7/14/2019
MEAN	0.201	0.22	0.225	0.254	0.239	0.182	0.158	0.153	0.153	0.051	0.256	0.053
p-value	0.8586	0.8286	0.6374	0.4259	0.3899	0.6546	0.5137	0.7845	0.8104	0.5175	0.7706	0.6265

Results & Discussion



TRT	8/3/2018	8/14/2018	8/21/2018	8/27/2018	9/3/2018	9/16/2018	10/2/2018	10/16/2018	10/30/2018	2/7/2019	4/29/2019	6/28/2019
MEAN	11.613	13.598	10.586	8.843	6.93	7.652	8.714	7.754	9.047	8.397	7.443	6.696
p-value	0.6835	0.8947	0.5819	0.838	0.8894	0.859	0.2398	0.35	0.3593	0.6412	0.8557	0.7307

Results & Discussion



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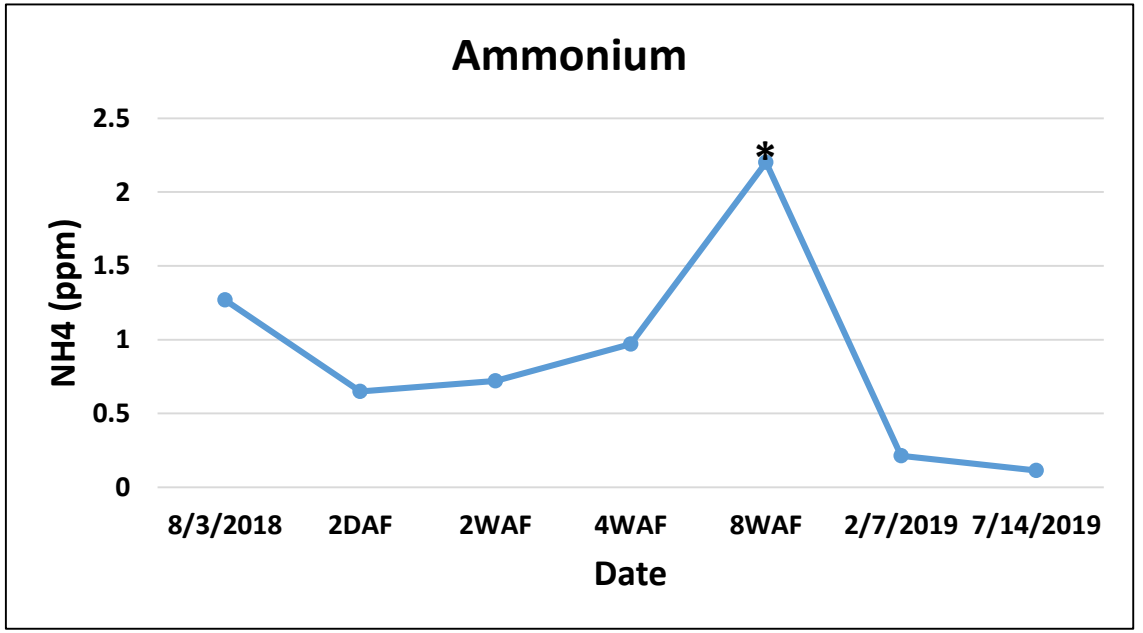
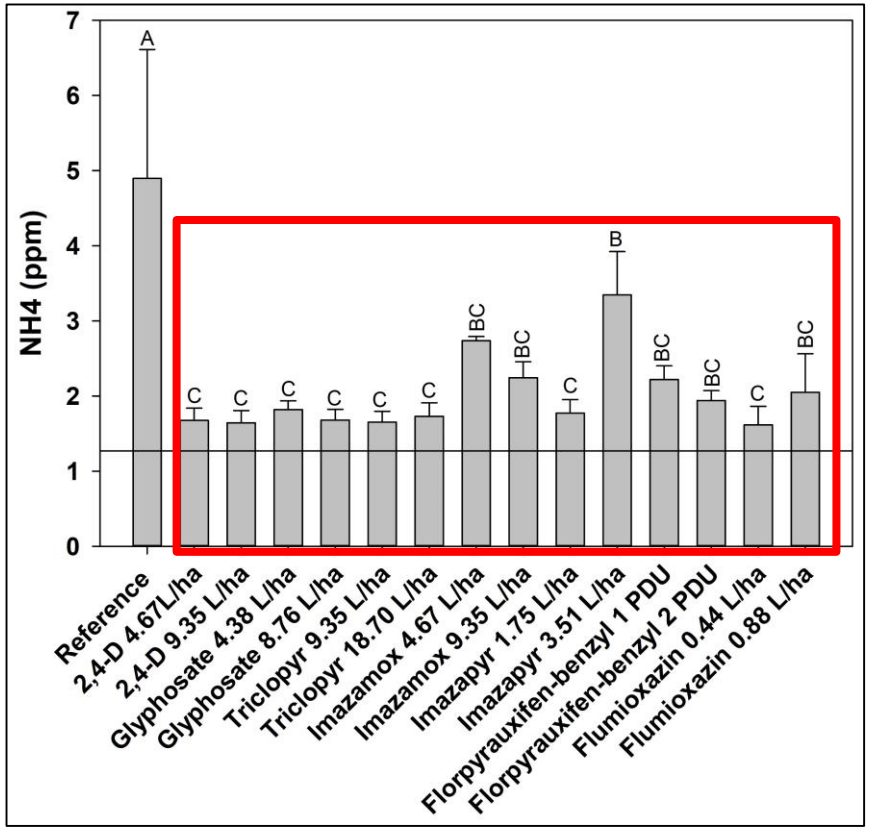
MEAN	12.11	11.9	11.73	9.32	8.74	9.35	9.78	8.74	9.84	8.5	8.95	6.75
p-value	0.1304	0.6401	0.7595	0.8835	0.9333	0.4979	0.2271	0.7329	0.5544	0.2438	0.9937	0.8395

Results & Discussion



TRT	8/3/2018	2DAF	2WAF	4WAF	8WAF	2/7/2019	7/14/2019
MEAN	1.27	0.65	0.721	0.97	2.202	0.214	0.114
p-value	0.3402	0.1368	0.5254	0.2869	0.0051	0.5214	0.2235



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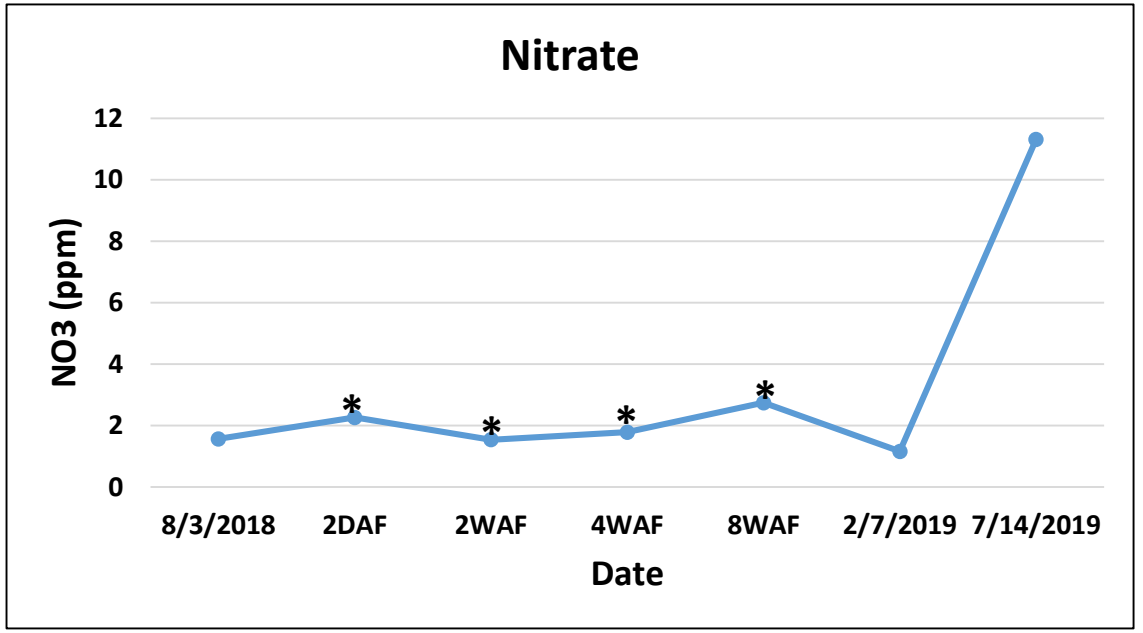
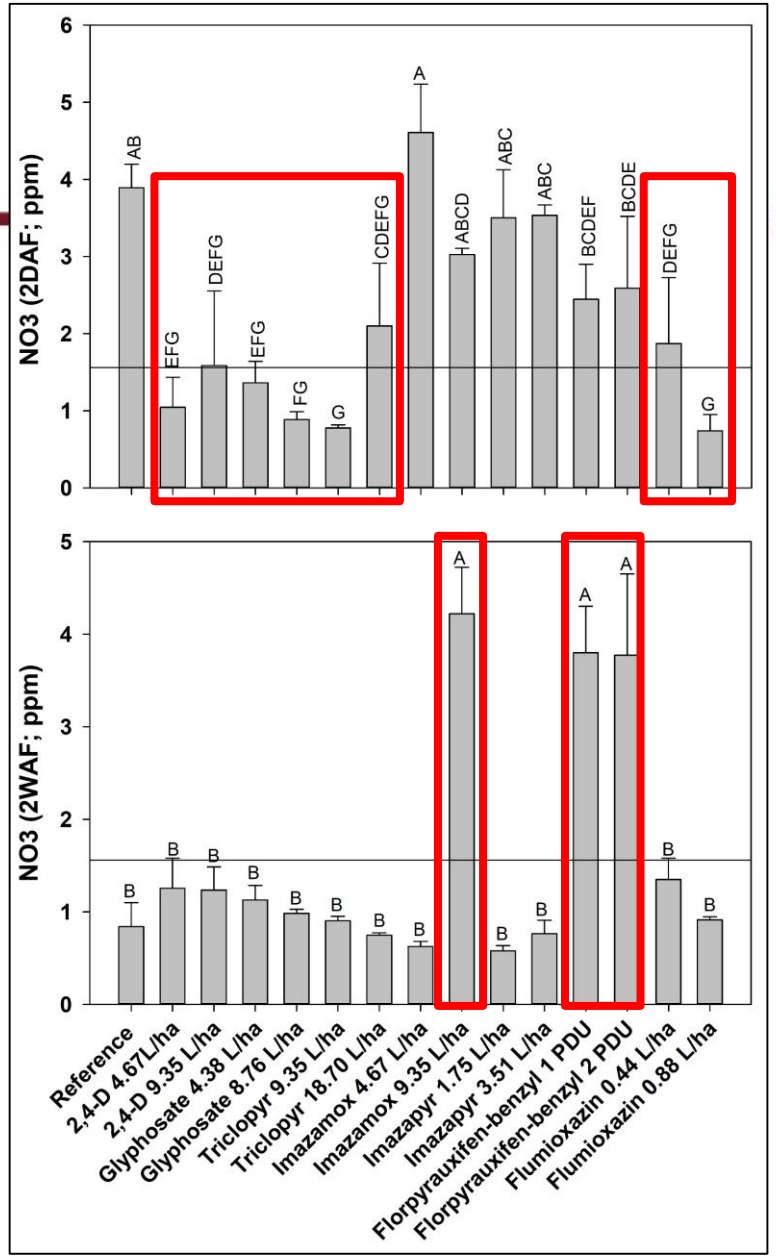


TRT	8/3/2018	2DAF	2WAF	4WAF	8WAF	2/7/2019	7/14/2019
MEAN	1.568	2.265	1.542	1.788	2.742	1.161	11.315
p-value	0.4055	0.0001	<0.0001	<0.0001	<0.0001	0.0817	0.611



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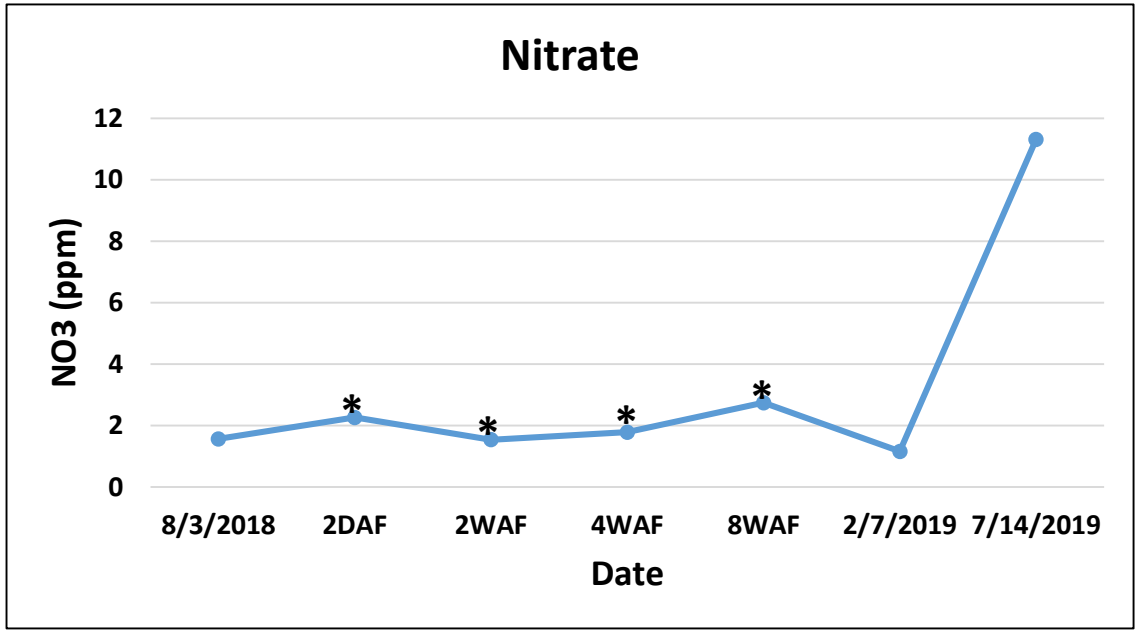

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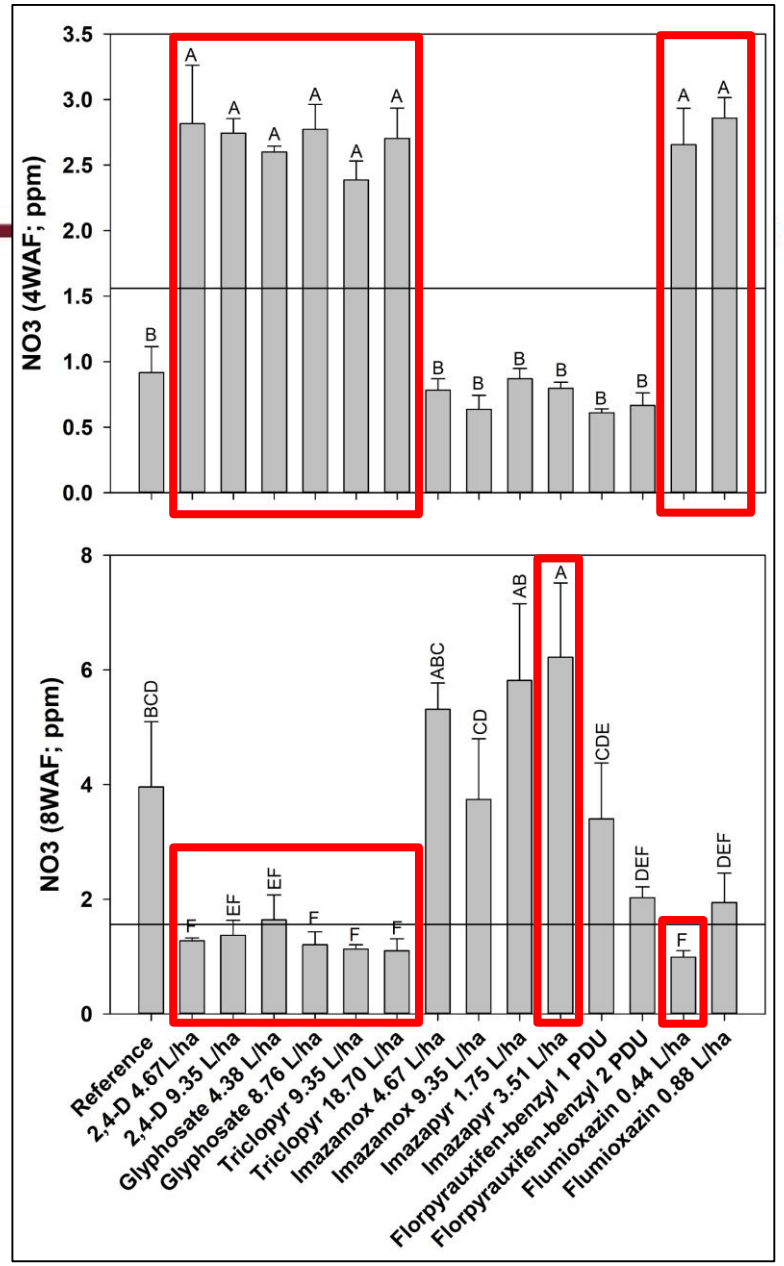
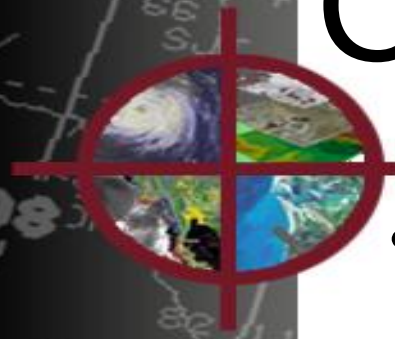
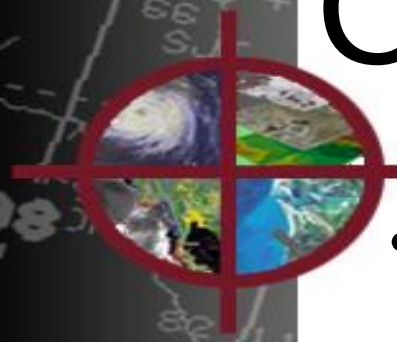


Conclusions



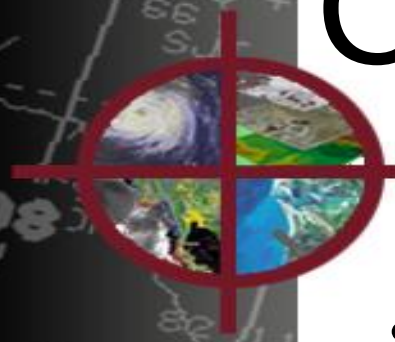
- DO, pH, conductivity, and temperature were not affected by plant breakdown when compared to reference.
- Ammonium shows a drop in all treatments at 8 WAF (9-12 WAT depending on treatment); otherwise no difference from reference
- Nitrate – variable results

Conclusions



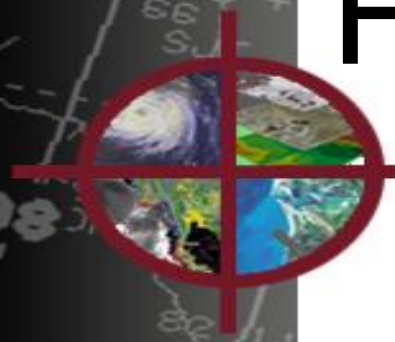
- Some treatments (2-7, 14, 15) lower at 2 DAF (1-4 WAT) compared to reference; others no difference
- Some treatments (9, 12, 13) higher at 2 WAF (3-6 WAT); others no difference from reference
- Some treatments (2-7, 14, 15) higher at 4 WAF (5-8 WAT); others no difference than reference
- Some treatments (2-7, 14) lower; one higher (11); while rest no difference from ref at 8 WAF (9-12 WAT)

Conclusions



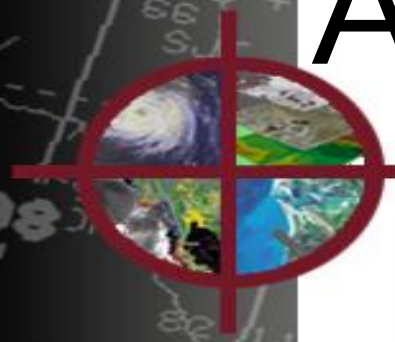
- Nitrate levels observed here are not abnormally high based on existing literature.
- Herbicide applications and subsequent plant breakdown did not negatively impact water quality metrics or nitrogen levels.

Future Work



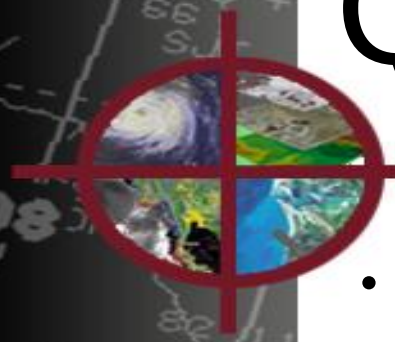
- Treatments moved from mesocosm scale to field sites
  - 35 plots on Loakfoma lake
- Carried out on Noxubee National Wildlife Refuge
- Determine ammonium to ammonia conversion calculation for instrument.
- Need to repeat on other spp.
  - Ex) Frogsbit

Acknowledgements



- Herbicide Companies
- Noxubee Wildlife Refuge
- Mason Thomas, Schulyer Cool, Colin McCloud, Hayden Hunter, Chandler Bryant, Ethan Cox, Kennedy Calhoun, Cory Shoemaker, & Sam Kirk

Questions



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