



Florida Department of Environmental Protection

Loxahatchee River Reasonable Assurance Plan

March 27, 2017





Variability in Estuarine Systems

- Tidal flow
- Salinity
- Precipitation event dynamics
- Seasonal variability
- Water color & light penetration
- Land use characteristics

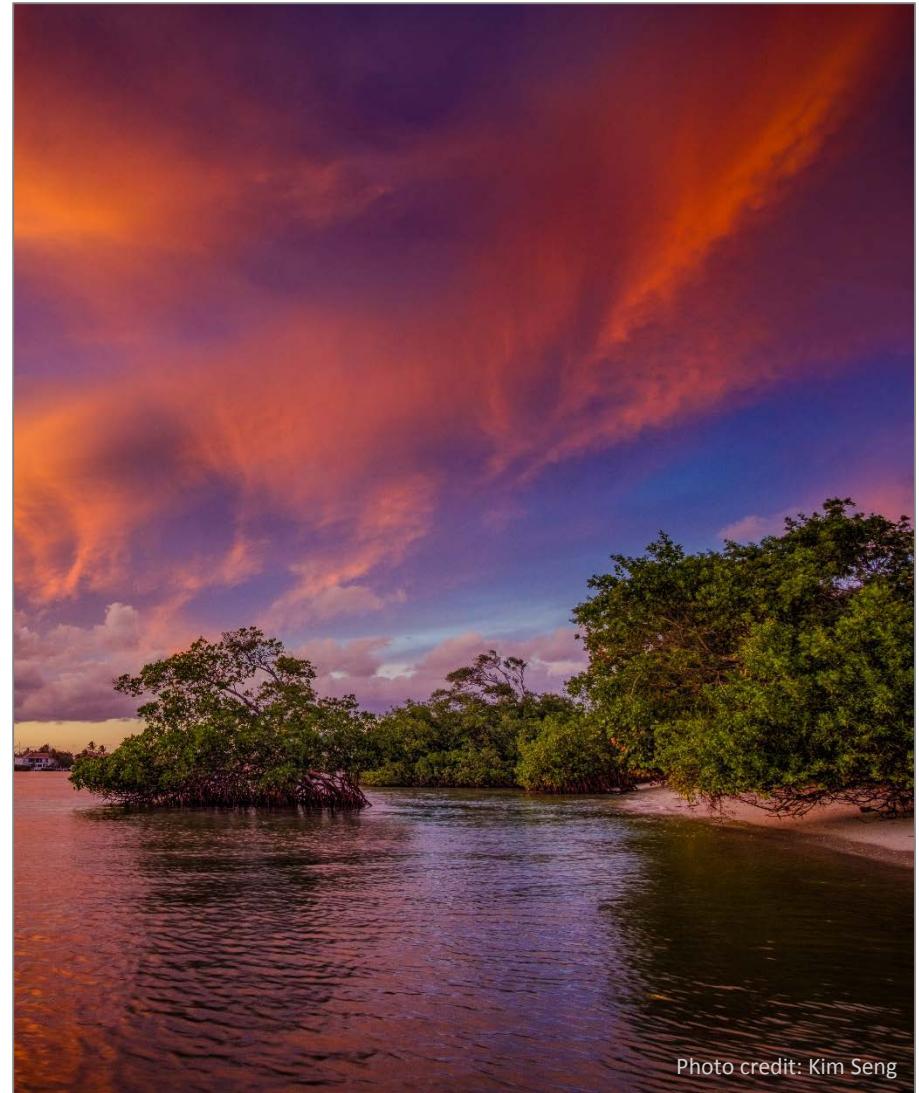


Photo credit: Kim Seng

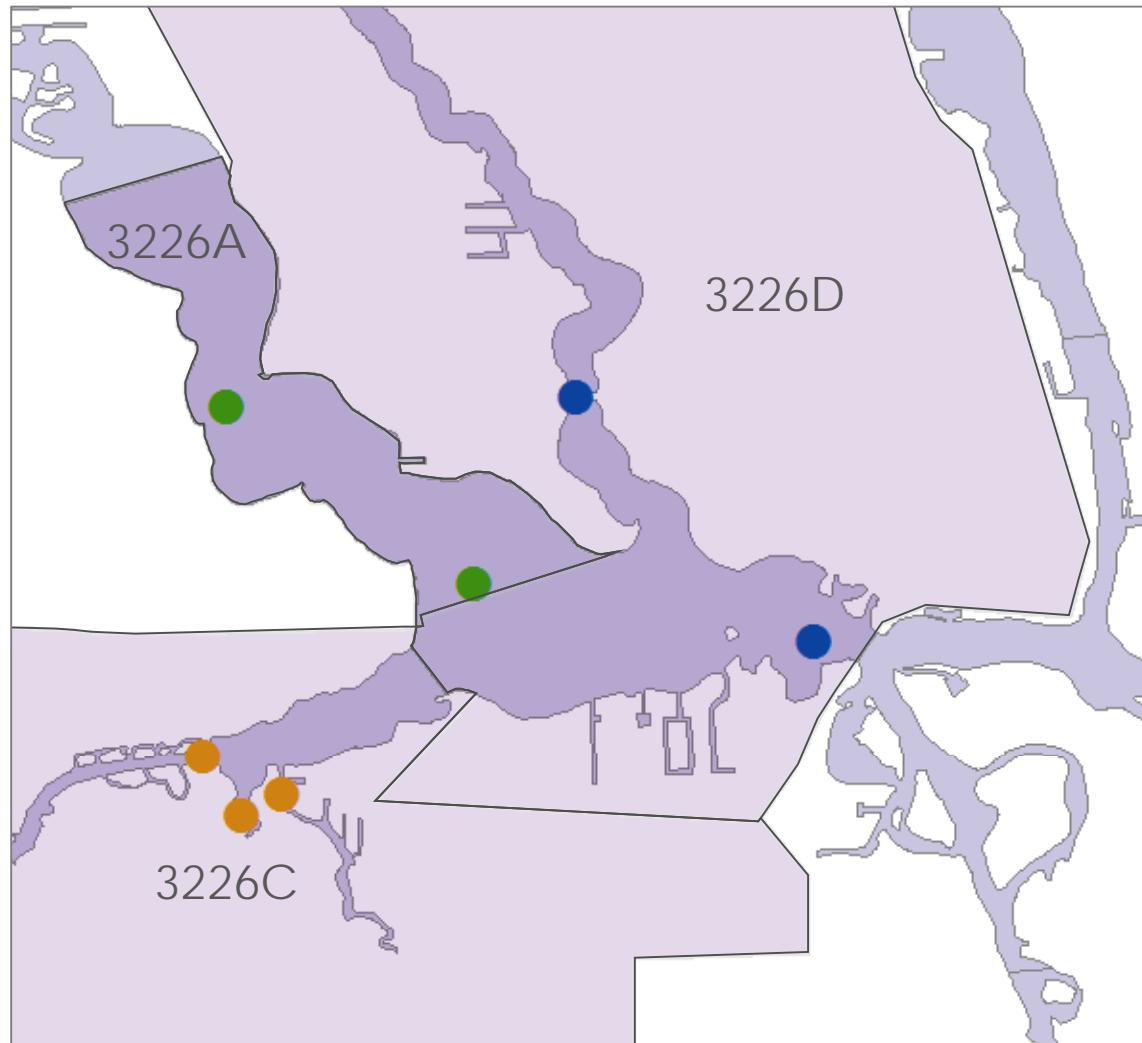


Area Summary

Loxahatchee Watershed



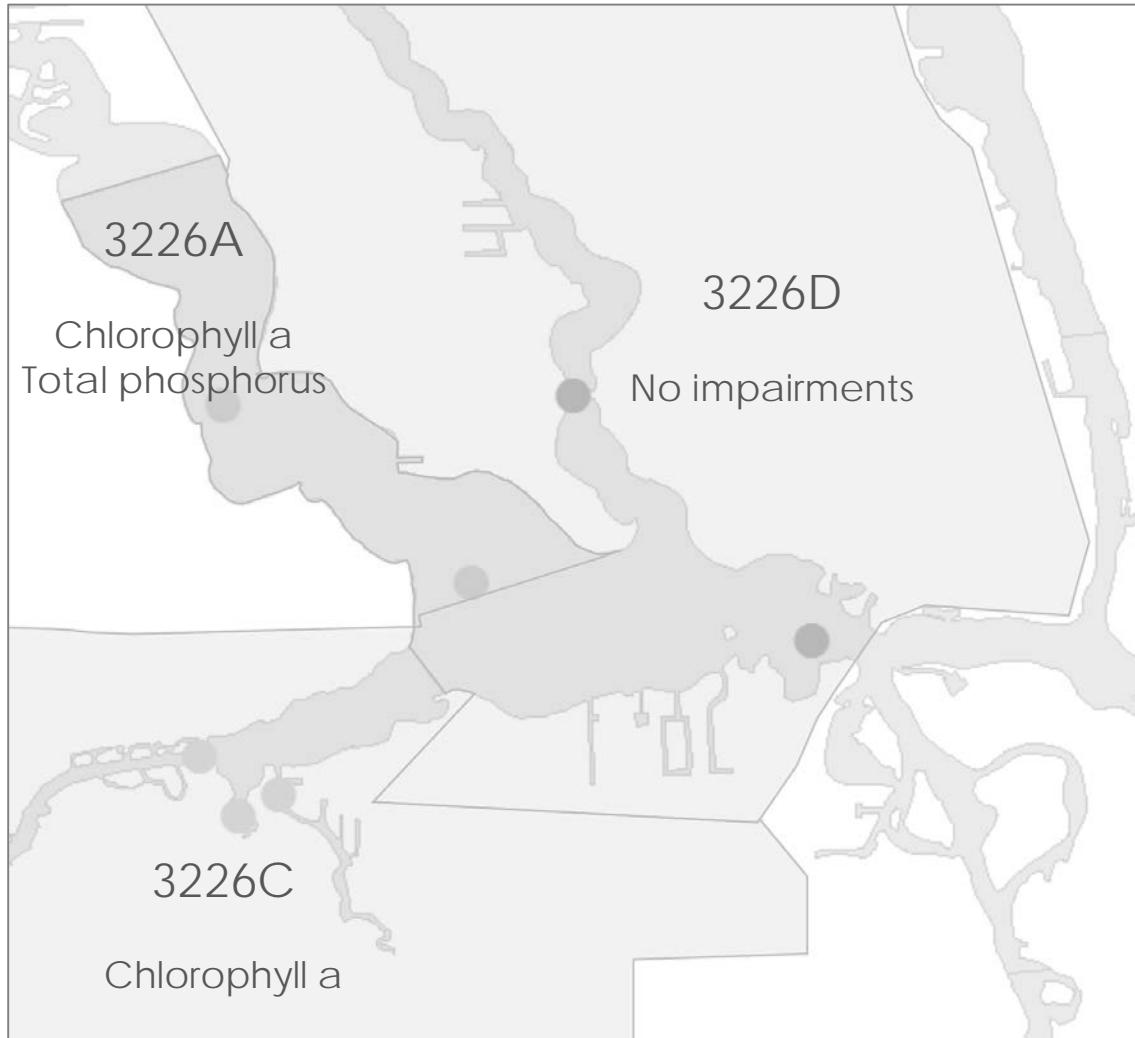
Area Summary



Loxahatchee Watershed



Impairments



Numeric Nutrient Criteria

3226A & 3226D

Chlorophyll a **4.0 µg/L**

Total nitrogen **0.80 mg/L**

Total phosphorus **0.030 mg/L**

3226C

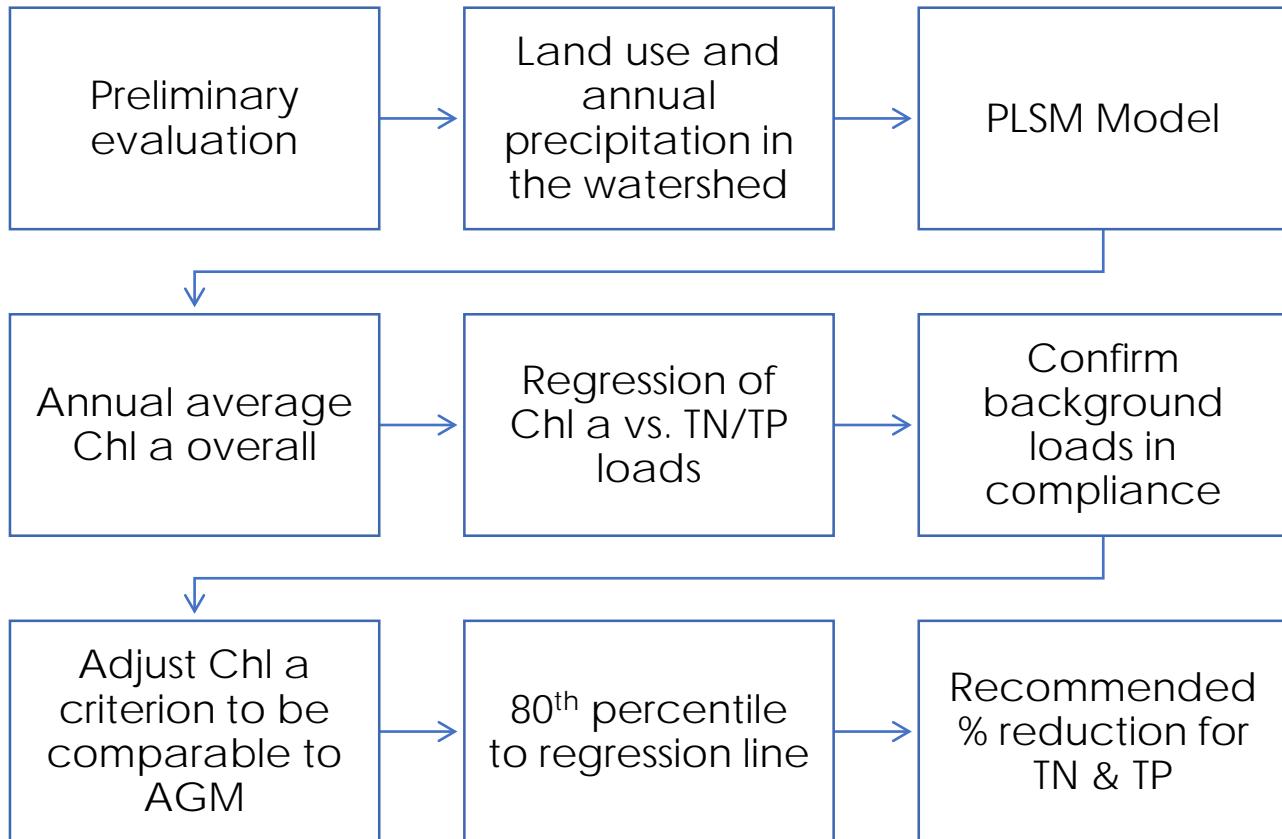
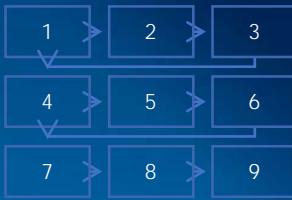
Chlorophyll a **5.5 µg/L**

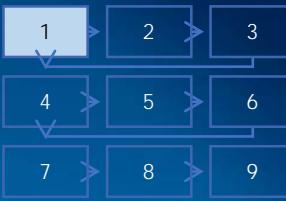
Total nitrogen **1.26 mg/L**

Total phosphorus **0.075 mg/L**



Process





Preliminary Evaluation

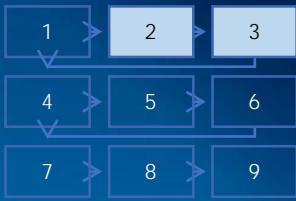
Regression relationships for measured data 2006-2014 at all stations within 3226A, 3226C, & 3226D

| Relationship* | r ² | n |
|---------------------|----------------|-----|
| Chl vs. TP | 0.36 | 557 |
| Chl vs. TN | 0.25 | 560 |
| Chl vs. color | 0.30 | 537 |
| Chl vs. salinity | 0.34 | 559 |
| Chl vs. temperature | 0.08 | 558 |

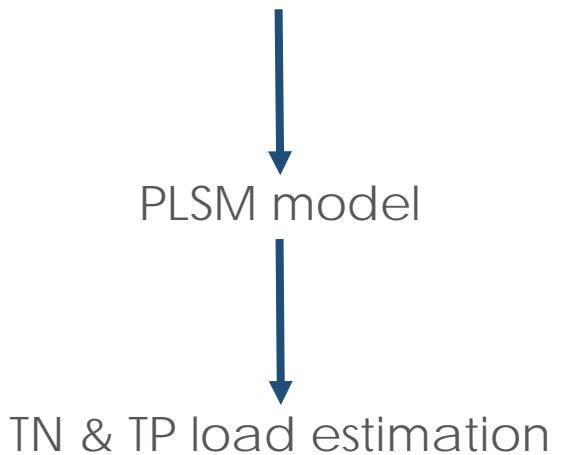
*Values were log-transformed to account for typical lognormal distribution



PLSM Model

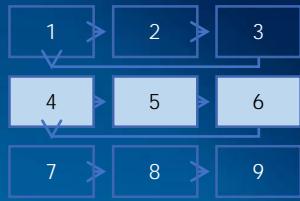


Annual precipitation
+
Watershed land use

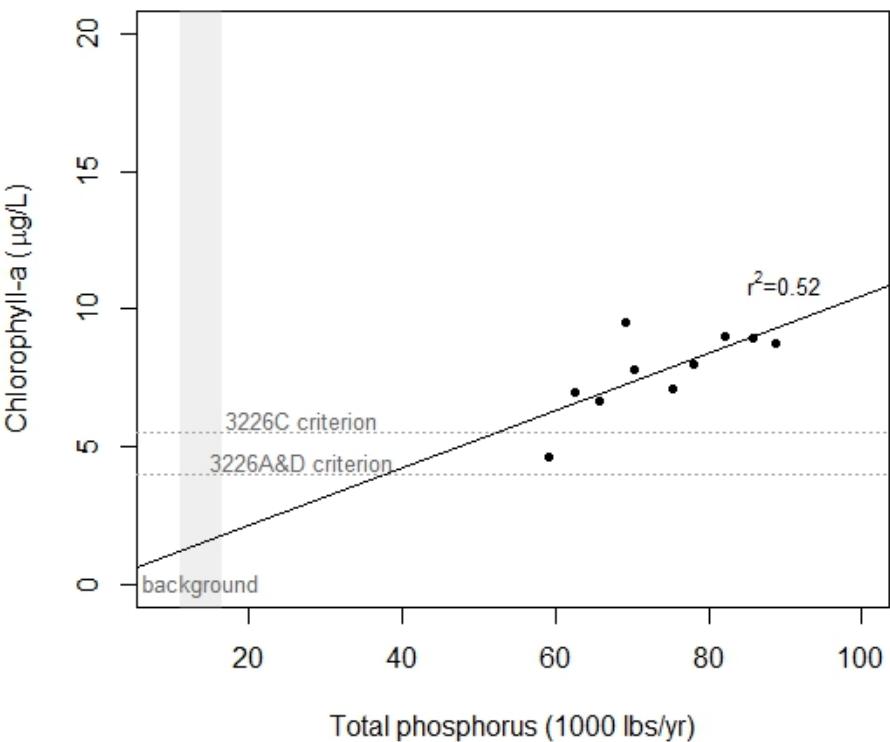
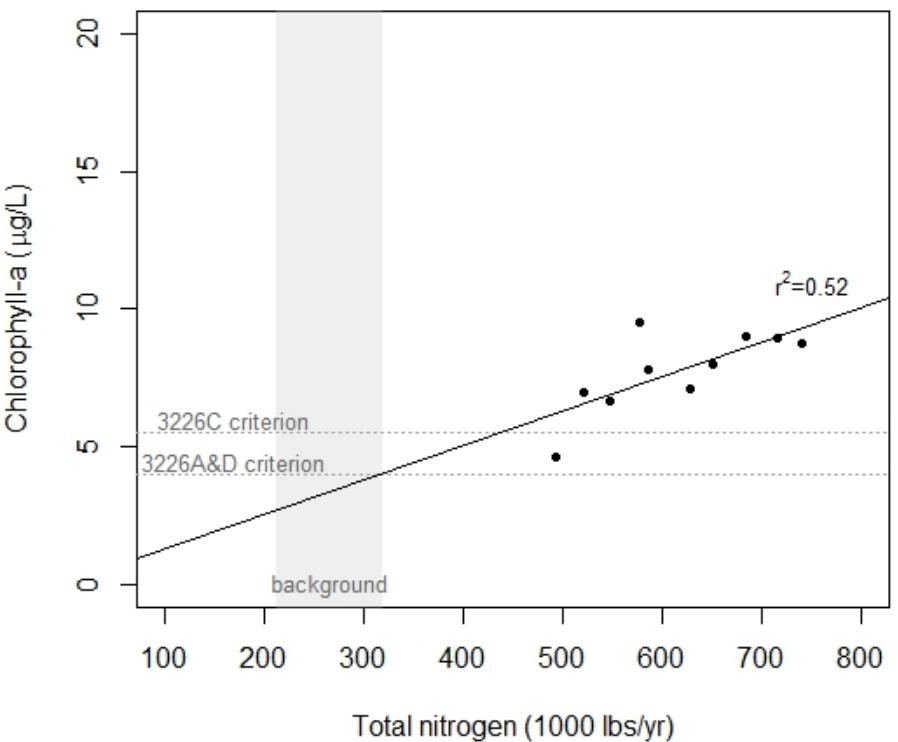




Process



Annual mean chlorophyll a concentrations vs. Simulated nutrient loads

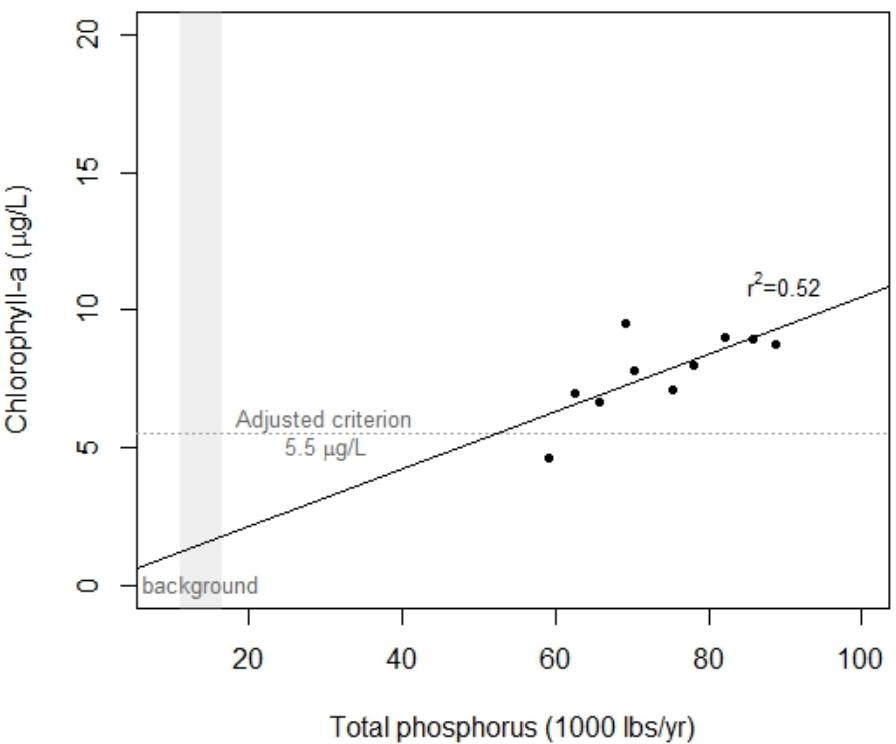
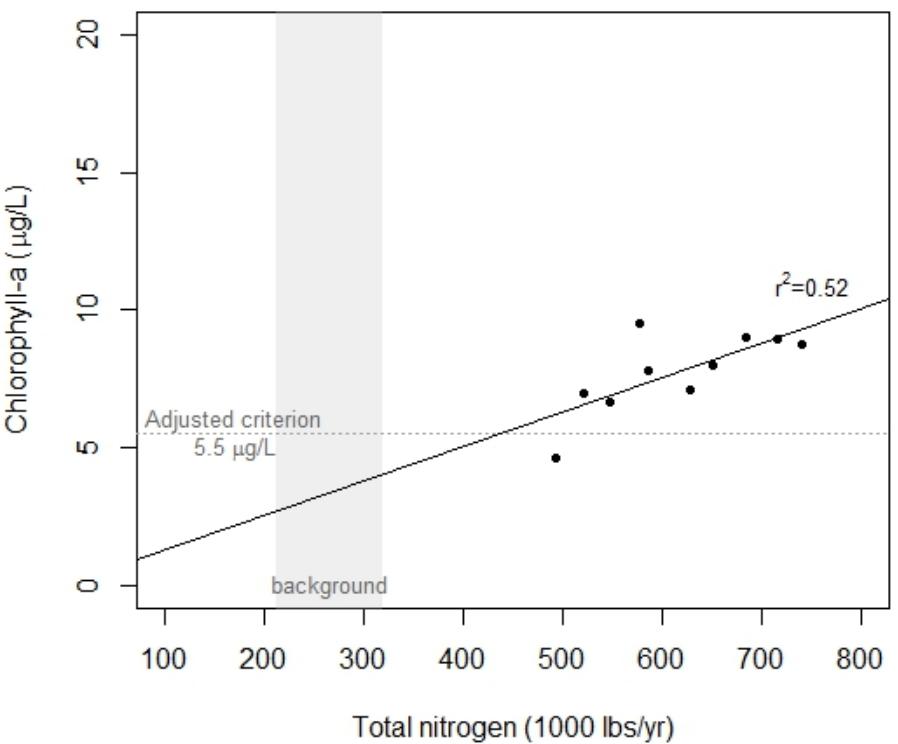




Process

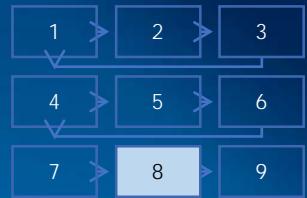


Annual mean chlorophyll a concentrations vs. Simulated nutrient loads

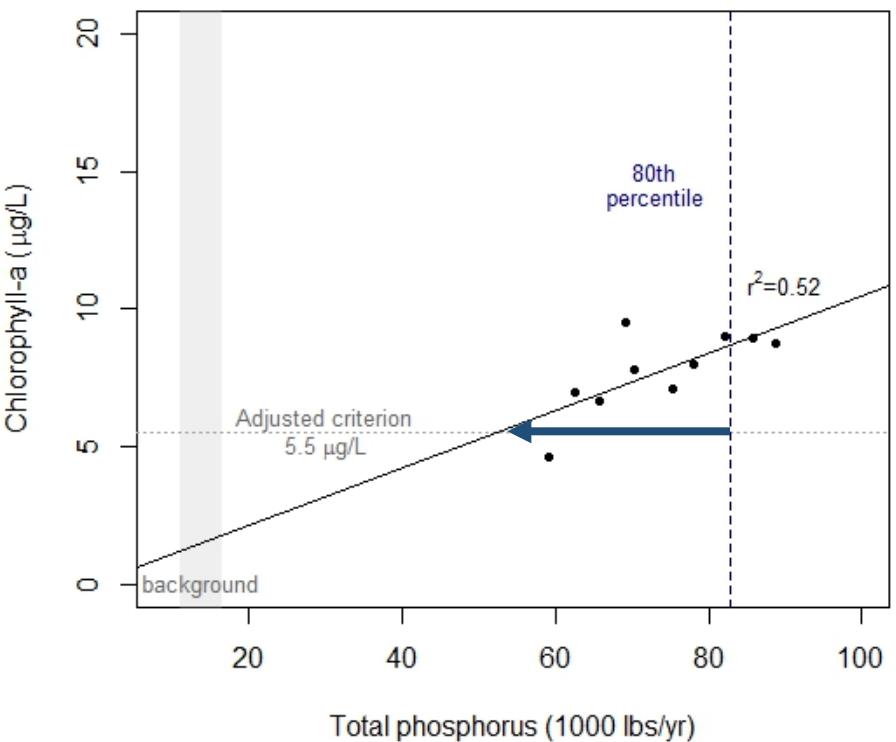
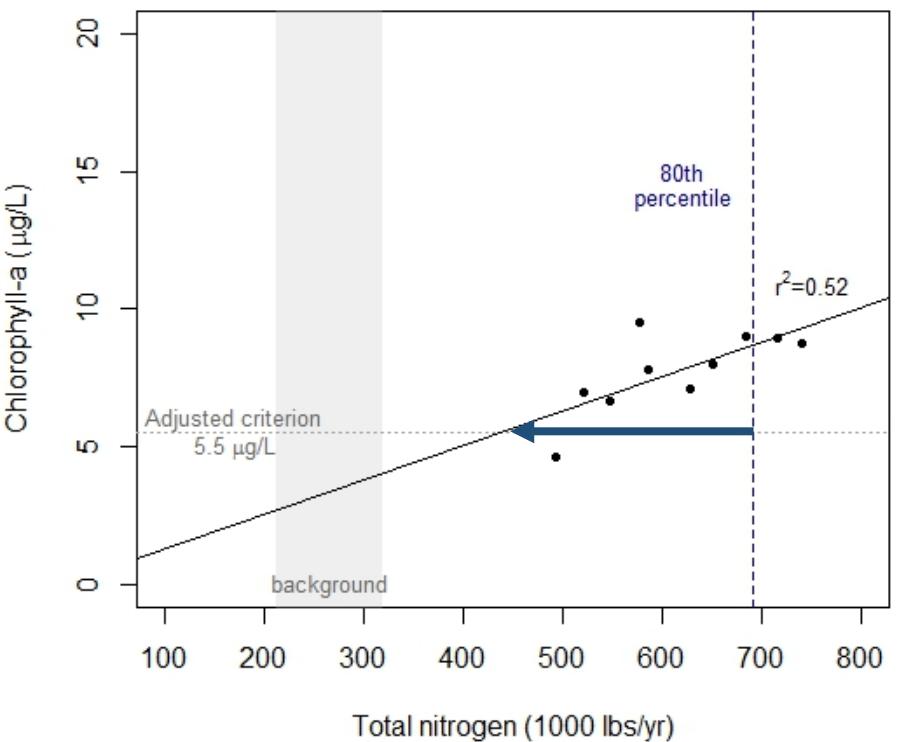




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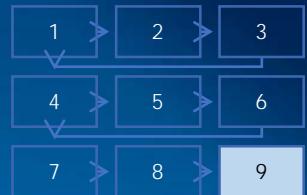


Annual mean chlorophyll a concentrations vs. Simulated nutrient loads

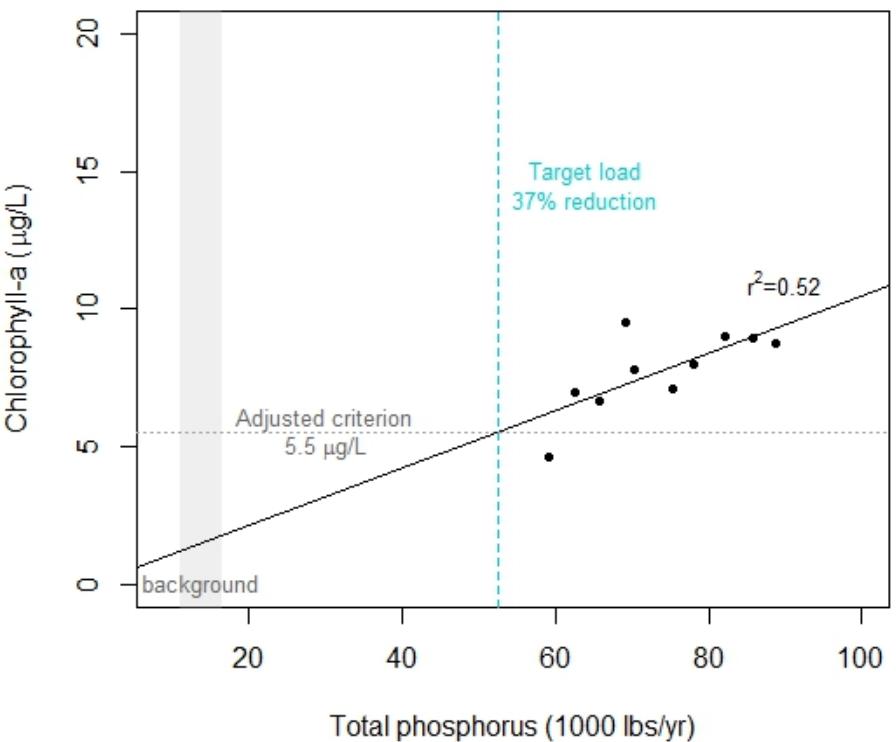
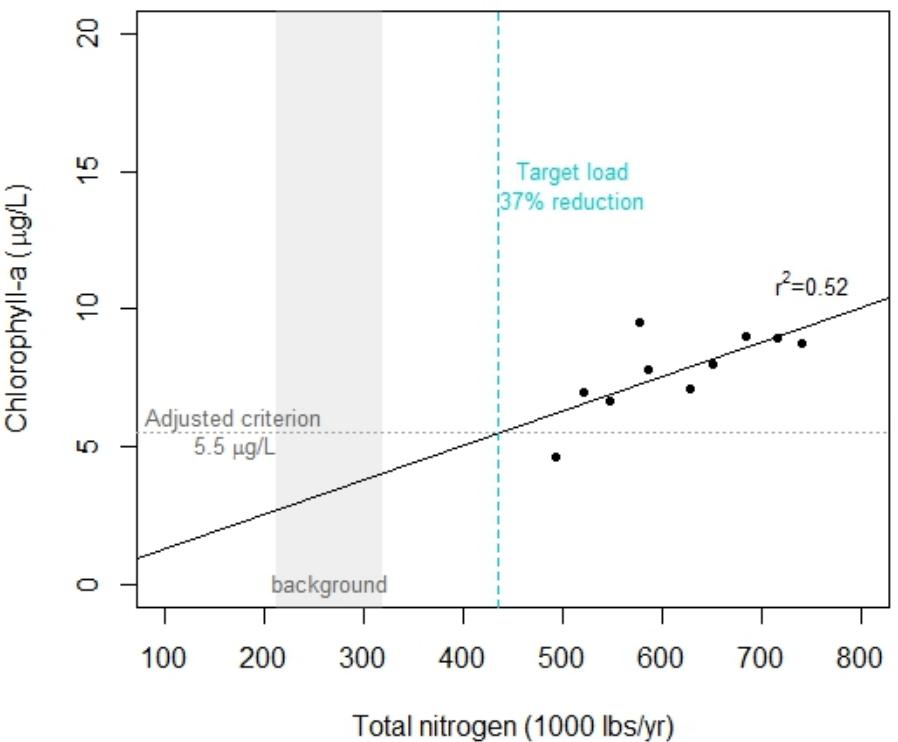




Process



Annual mean chlorophyll a concentrations vs. Simulated nutrient loads





Criteria Comparisons

| Location | Chl Criterion ($\mu\text{g/L}$ AGM) | |
|---------------------|--------------------------------------|---------------------------------------|
| St. Lucie River | 4.7 - 7.4 | Loxahatchee Chlorophyll a Criteria |
| Biscayne Bay | 1.7 | 3226A & 3226D 4.0 $\mu\text{g/L}$ |
| Caloosahatchee | 5.6 | 3226C 5.5 $\mu\text{g/L}$ |
| San Carlos Bay | 3.7 | |
| Indian River Lagoon | 5.9 | |
| Lower Suwanee | 5.7 | |



Reduction Comparisons

| Location | TMDL Reductions |
|---------------------|------------------------------|
| St. Lucie River | TN 21% - 51% TP 41% - 78% |
| Biscayne Bay | N/A |
| Caloosahatchee | TN 23% |
| San Carlos Bay | N/A |
| Indian River Lagoon | TN 21% - 51% TP 41% - 48% |
| Lower Suwanee | TN 58% |

Loxahatchee RA
Proposed
Reduction
TN & TP 37%



Recommendations

1. Proposed reduction is 37% for the watershed, but should be targeted to anthropogenic land uses
2. No expected reduction from natural land use areas
3. Targeted data collection to be more representative of open water estuary
4. Adaptive management, standards, and reductions



Questions?



Photo credit: Kim Seng



Supplemental Material



Assessment

| WBID | Year | TN | TP | Chla |
|-------|------|-------------|--------------|-------------|
| 3226A | 2007 | (0.5 mg/L) | (0.03 mg/L) | (2.7 µg/L) |
| | 2008 | (0.5 mg/L) | (0.03 mg/L) | (3.7 µg/L) |
| | 2009 | (0.3 mg/L) | (0.03 mg/L) | (4.7 µg/L) |
| | 2010 | (0.4 mg/L) | (0.03 mg/L) | (6.0 µg/L) |
| | 2011 | (0.4 mg/L) | (0.04 mg/L) | (5.1 µg/L) |
| | 2012 | (0.3 mg/L) | (0.03 mg/L) | (4.2 µg/L) |
| | 2013 | (0.4 mg/L) | (0.03 mg/L) | (6.8 µg/L) |
| 3226C | 2007 | (0.72 mg/L) | (0.031 mg/L) | (8.0 µg/L) |
| | 2008 | (0.54 mg/L) | (0.041 mg/L) | (12.3 µg/L) |
| | 2009 | (0.45 mg/L) | (0.033 mg/L) | (8.5 µg/L) |
| | 2010 | (0.48 mg/L) | (0.041 mg/L) | (12.9 µg/L) |
| | 2011 | (0.58 mg/L) | (0.039 mg/L) | (8.0 µg/L) |
| | 2012 | (0.48 mg/L) | (0.040 mg/L) | (9.6 µg/L) |
| | 2013 | (0.48 mg/L) | (0.043 mg/L) | (9.2 µg/L) |
| 3226D | 2007 | (0.4 mg/L) | (0.02 mg/L) | (2.3 µg/L) |
| | 2008 | (0.2 mg/L) | (0.02 mg/L) | (2.6 µg/L) |
| | 2009 | (0.1 mg/L) | (0.01 mg/L) | (2.3 µg/L) |
| | 2010 | (0.2 mg/L) | (0.02 mg/L) | (2.8 µg/L) |
| | 2011 | (0.2 mg/L) | (0.02 mg/L) | (2.9 µg/L) |
| | 2012 | (0.3 mg/L) | (0.02 mg/L) | (3.4 µg/L) |
| | 2013 | (0.2 mg/L) | (0.02 mg/L) | (1.8 µg/L) |



Evaluation

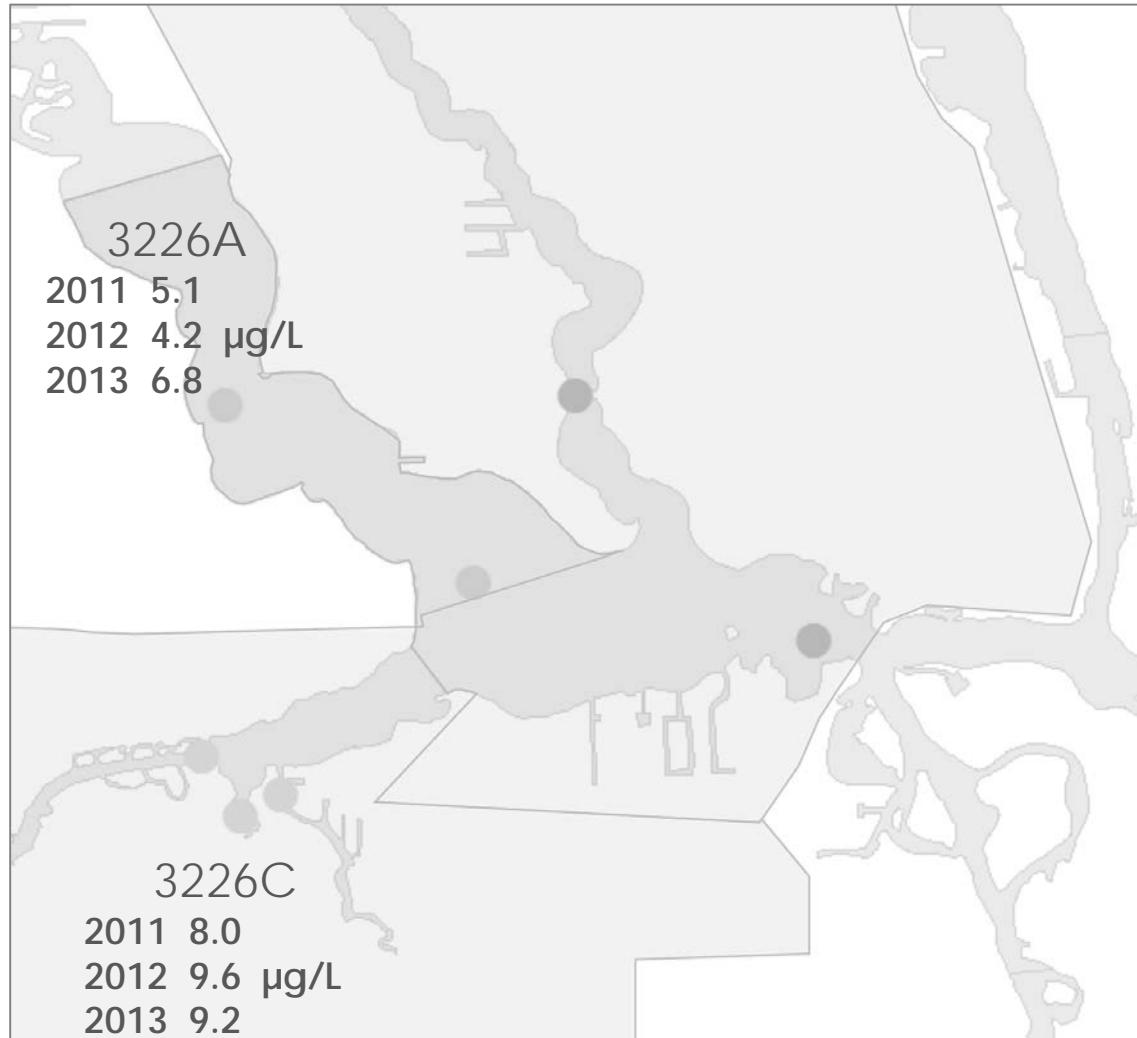
Regression relationships for measured data 2006-2015 in each of the primary WBIDs

| Relationship* | WBID | r ² | n |
|---------------------|-------|----------------|-----|
| Chl vs. TP | 3226A | 0.13 | 134 |
| | 3226C | 0.10 | 283 |
| | 3226D | 0.33 | 140 |
| Chl vs. TN | 3226A | 0.13 | 134 |
| | 3226C | 0.04 | 286 |
| | 3226D | 0.10 | 140 |
| Chl vs. color | 3226A | 0.24 | 134 |
| | 3226C | 0.03 | 263 |
| | 3226D | 0.38 | 140 |
| Chl vs. salinity | 3226A | 0.22 | 134 |
| | 3226C | 0.05 | 285 |
| | 3226D | 0.56 | 140 |
| Chl vs. temperature | 3226A | 0.19 | 134 |
| | 3226C | 0.14 | 284 |
| | 3226D | 0.06 | 140 |

*Values were log-transformed to account for typical lognormal distribution (except temperature)



Chlorophyll a Impairments



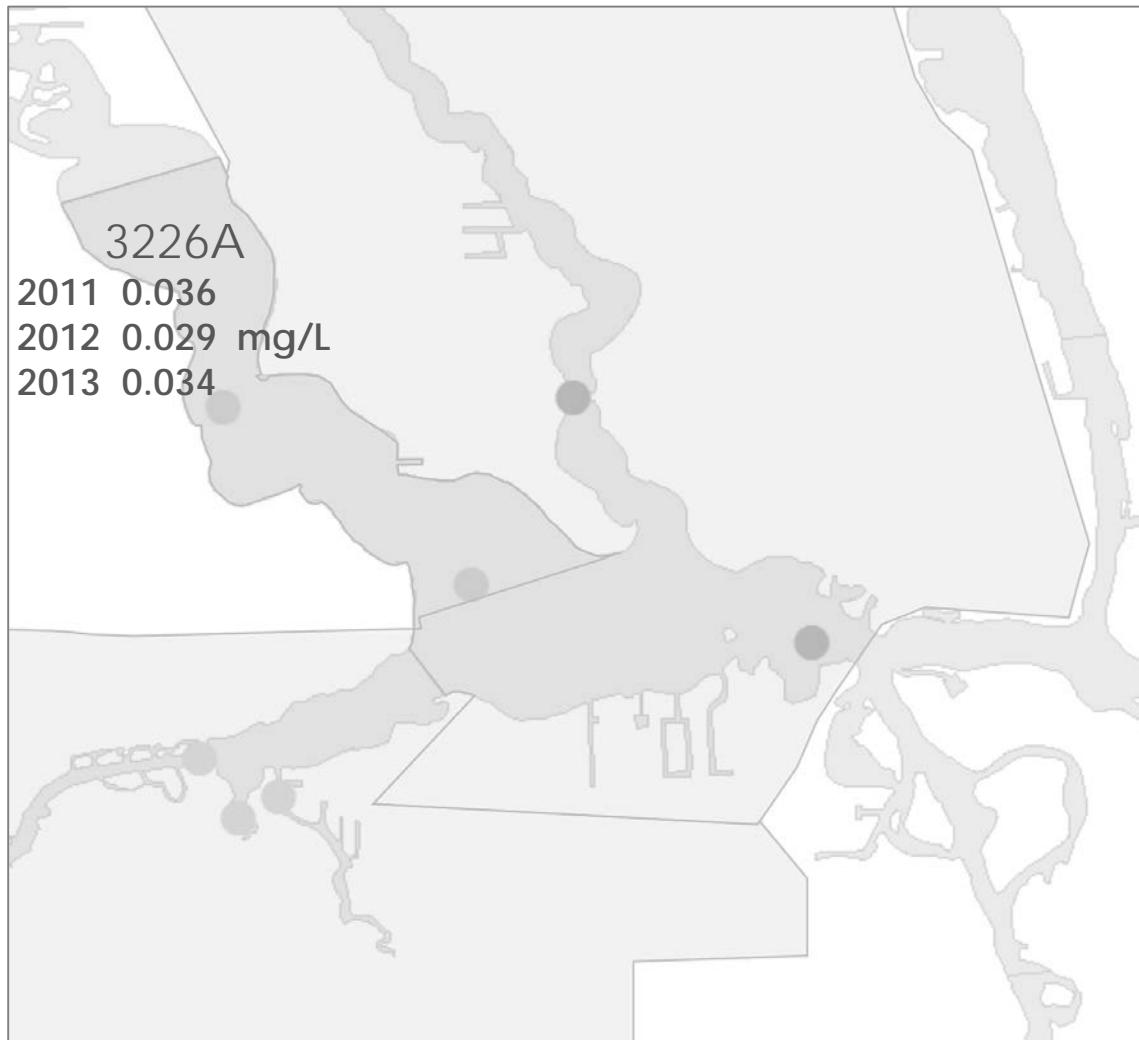
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Total phosphorus **0.030 mg/L**

3226C
Chlorophyll a **5.5 µg/L**
Total nitrogen **1.26 mg/L**
Total phosphorus **0.075 mg/L**



Phosphorus Impairments



Numeric Nutrient Criteria

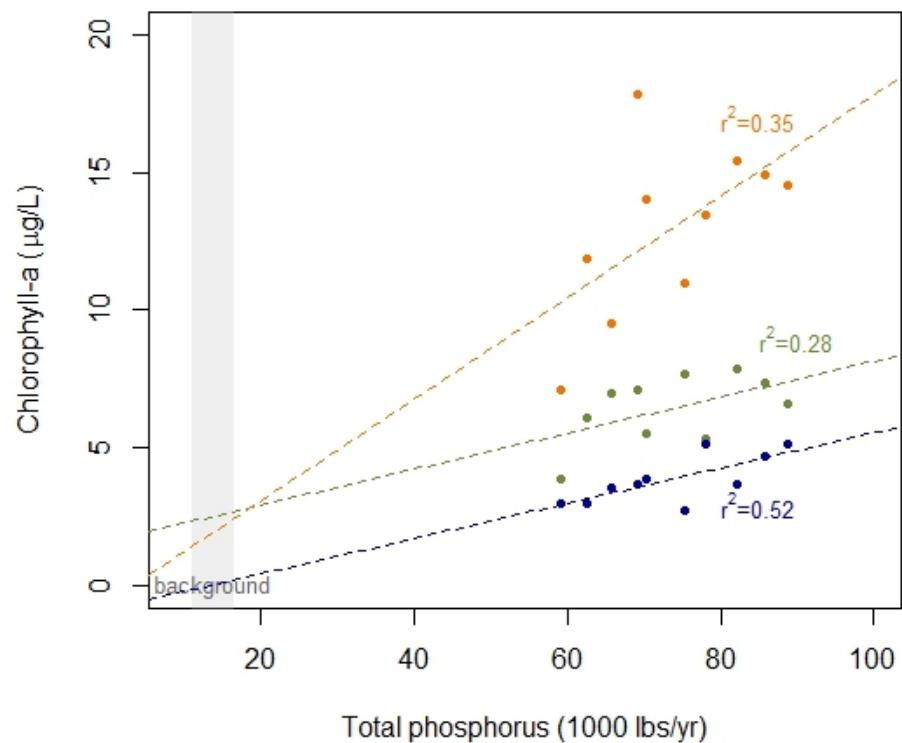
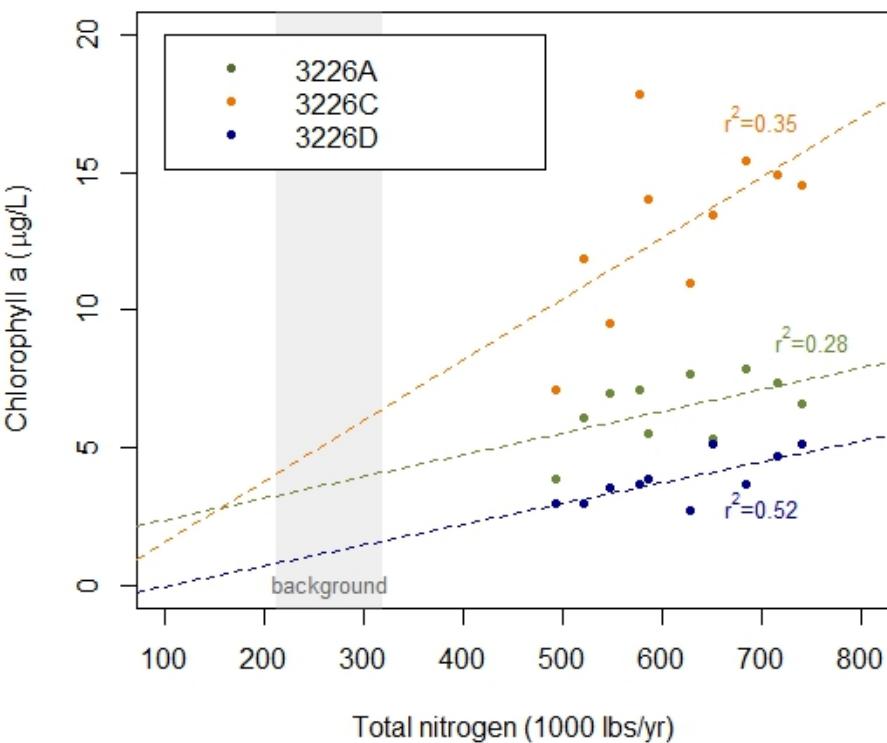
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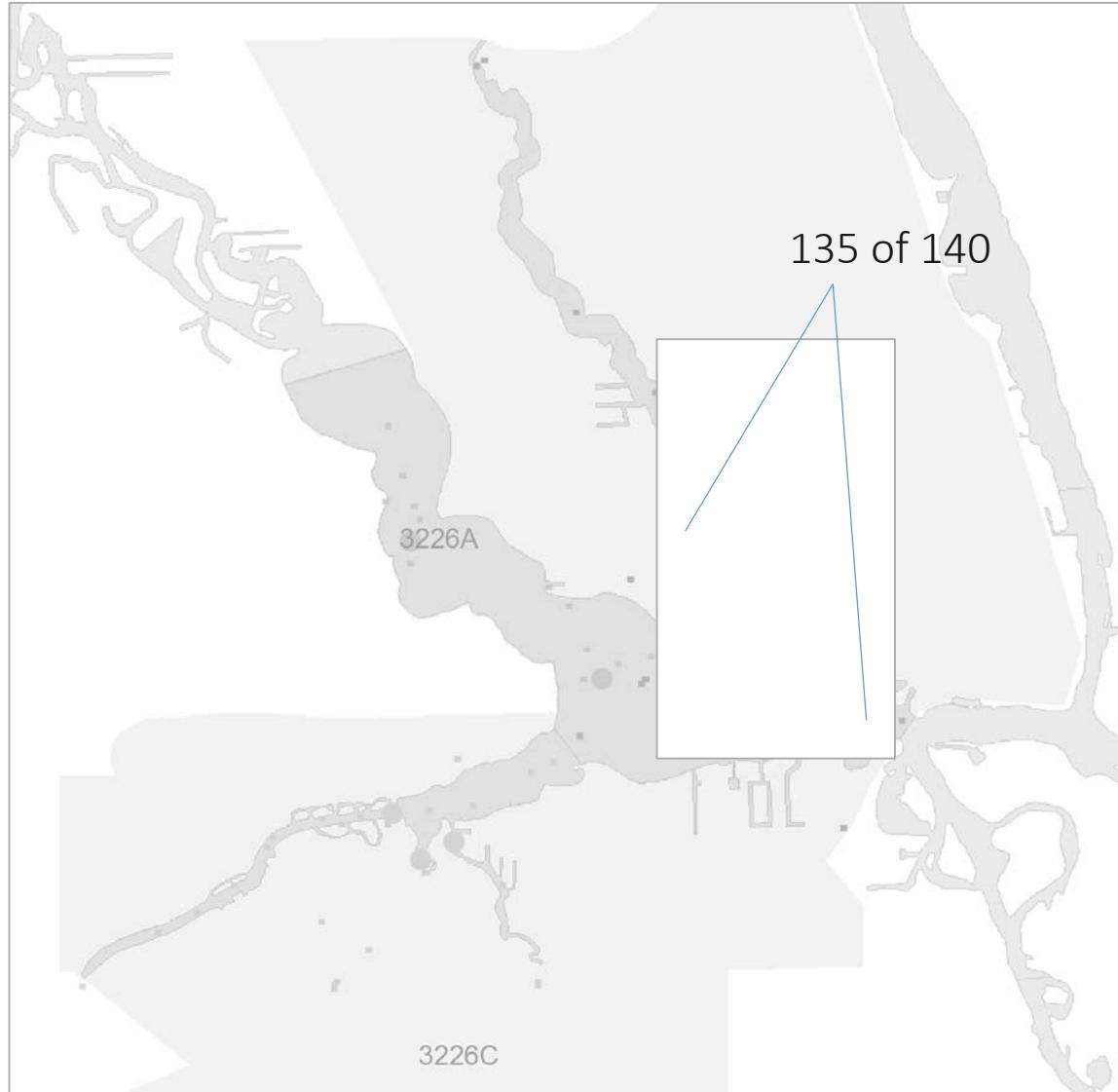
Evaluation

Annual mean chlorophyll a concentrations for select WBIDs
vs. Simulated basin-wide nutrient loads





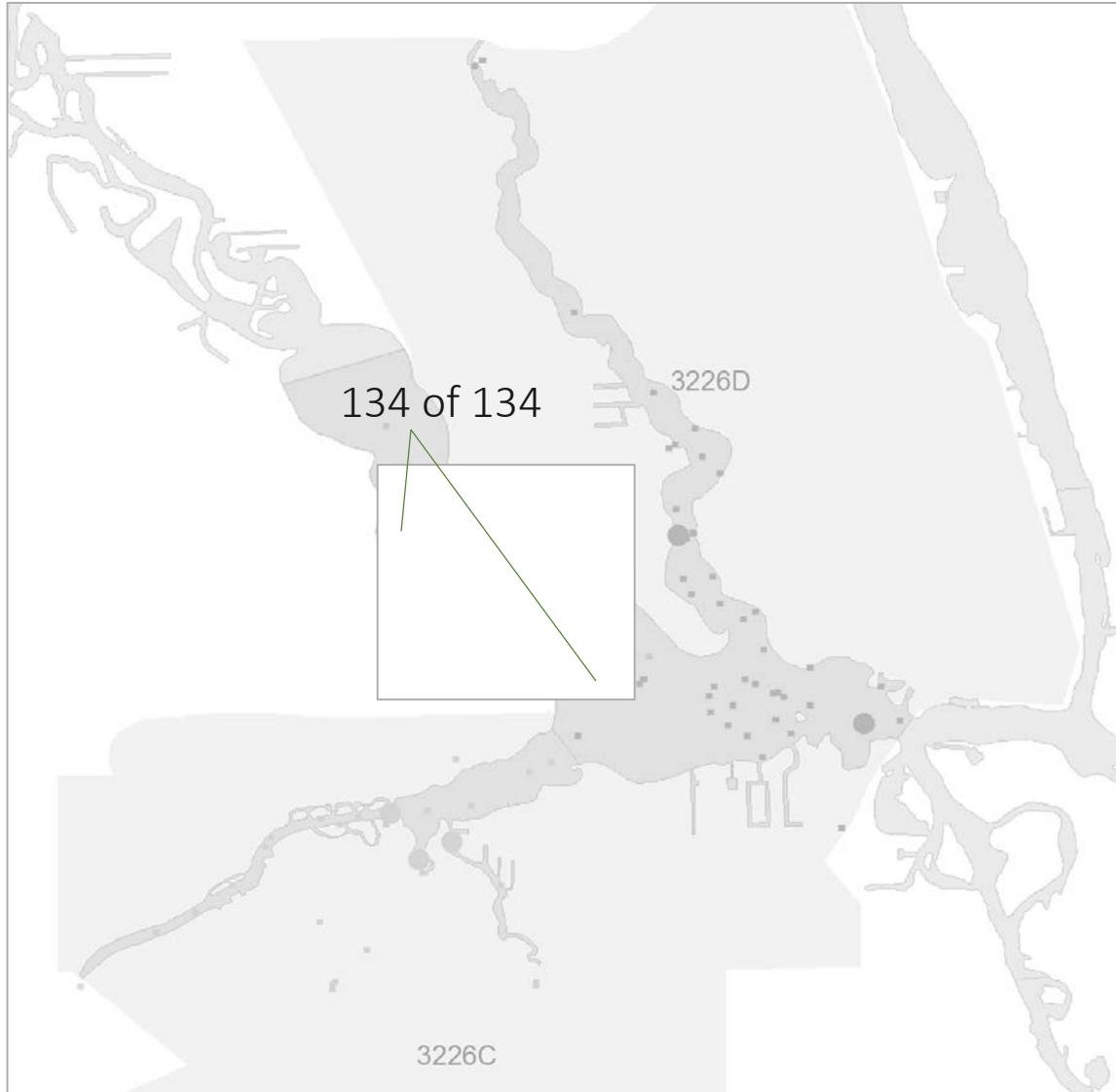
2006-2015 Data Summary



Loxahatchee Watershed



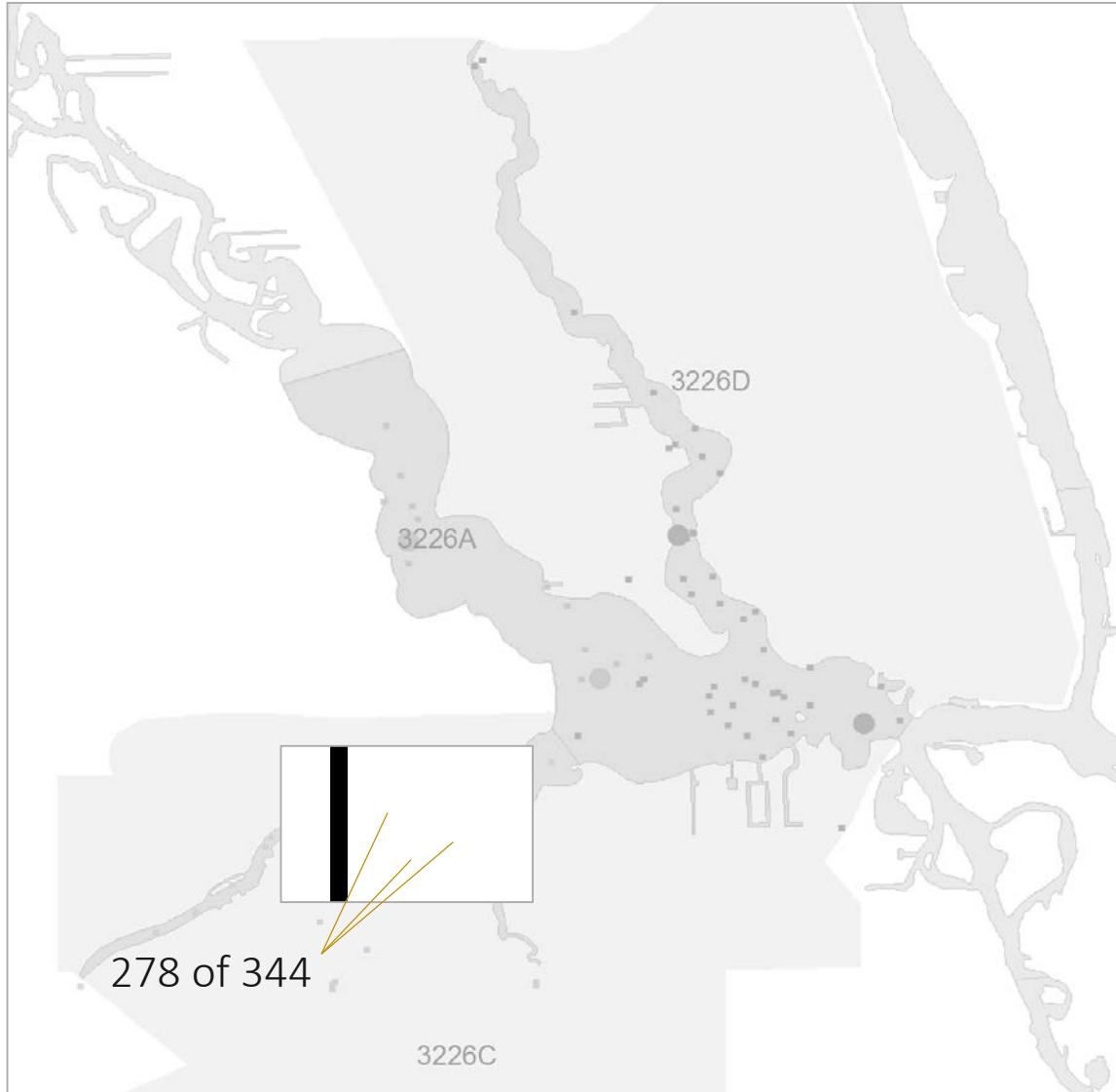
2006-2015 Data Summary



Loxahatchee Watershed



2006-2015 Data Summary



Loxahatchee Watershed