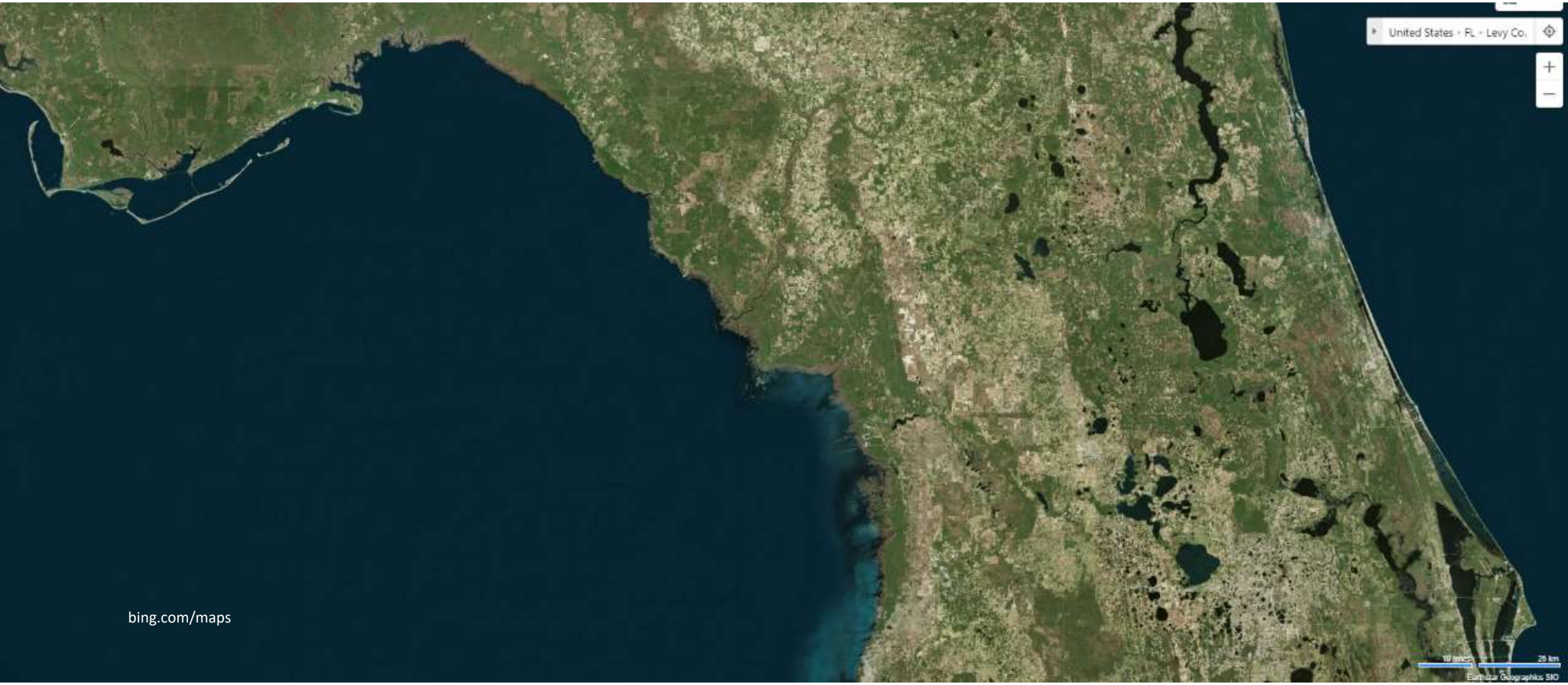
United States · FL · Levy Co.
bing.com/maps

- Low road and human population density for FL and coastal US
- 30% of land area and 100-km of coastline protected status
- 13% private sector employment and 25% of all economic activity tied to natural resources

bing.com/maps

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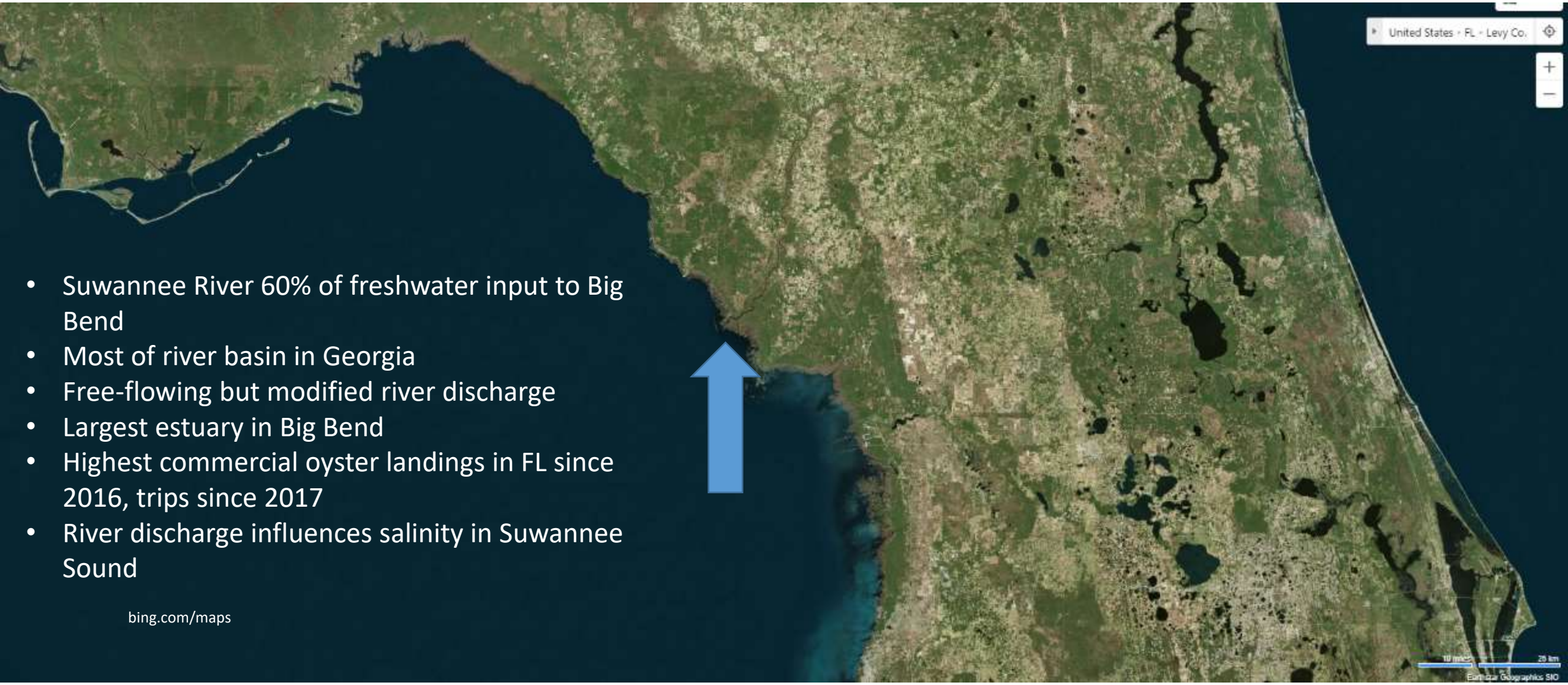
bing.com/maps

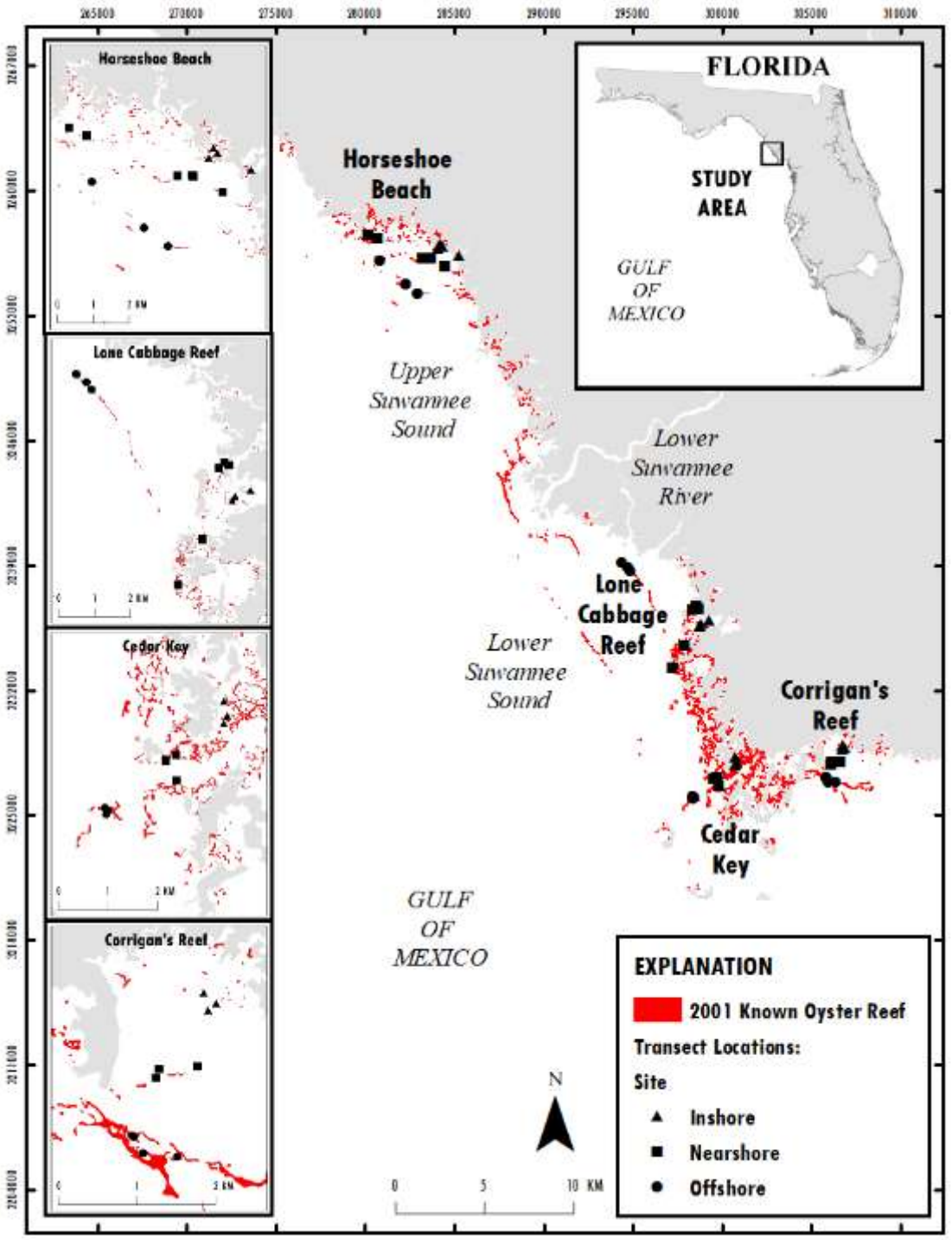


- Suwannee River 60% of freshwater input to Big Bend
- Most of river basin in Georgia
- Free-flowing but modified river discharge
- Largest estuary in Big Bend
- Highest commercial oyster landings in FL since 2016, trips since 2017
- River discharge influences salinity in Suwannee Sound

bing.com/maps

Suwannee Sound

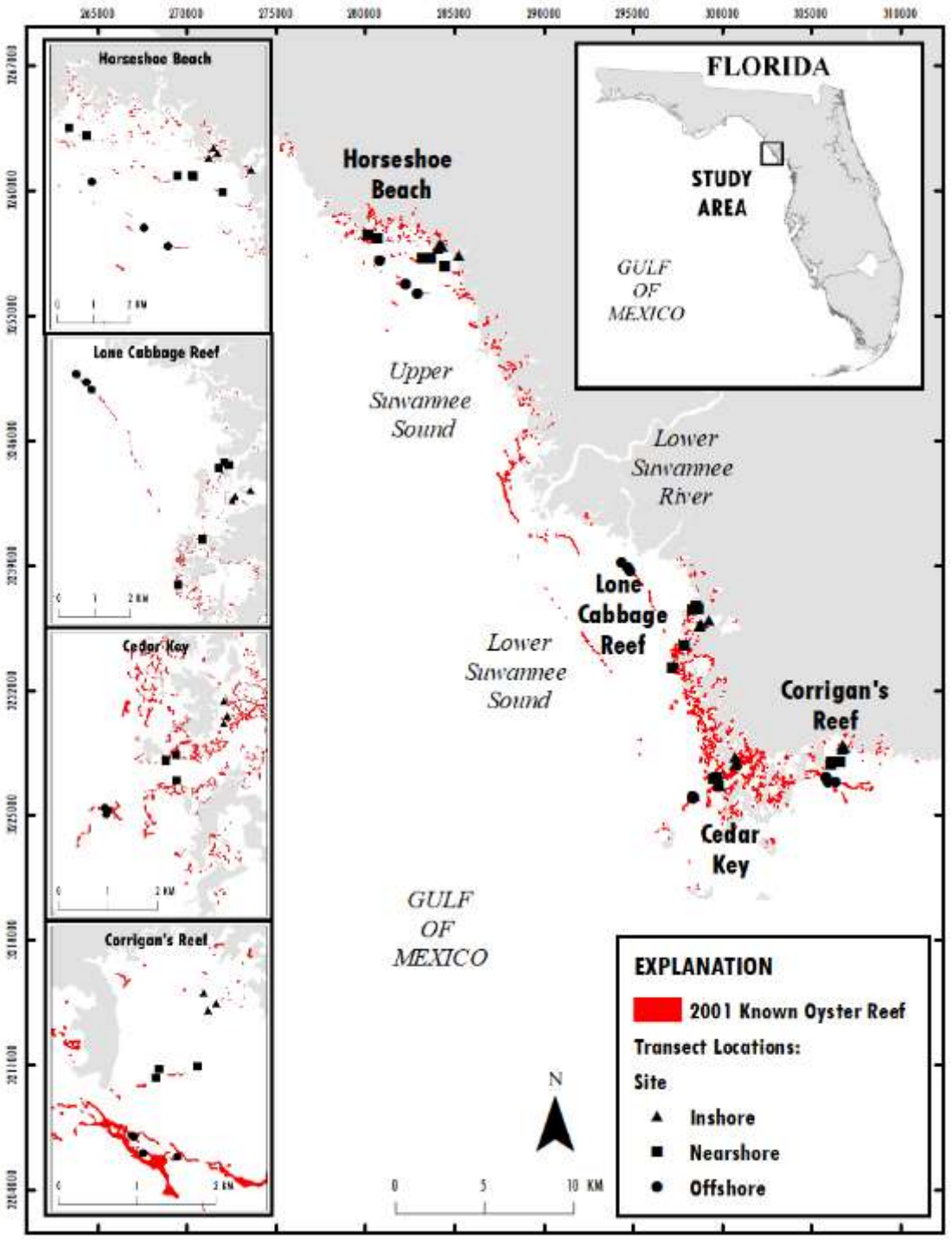
- Stakeholder observed changes in oyster reef distribution and abundance
- Seavey et al. 2011 changes in intertidal oysters 1982-2011
  - Imagery and field assessments
  - Offshore = -88%
  - Nearshore = -61%
  - Inshore = -50%



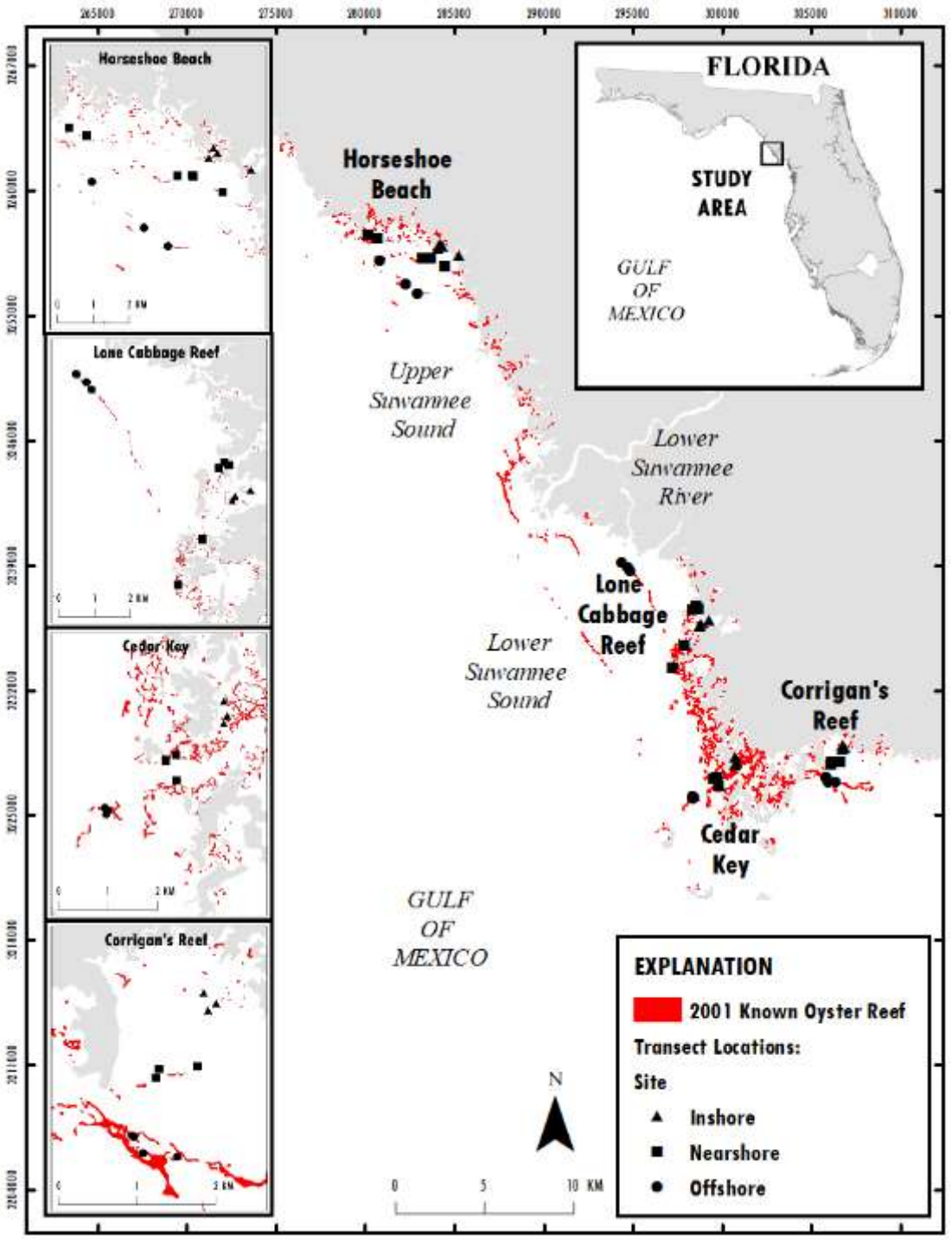
Suwannee Sound

- Key questions:
  - Are there temporal trends in intertidal oyster counts at these localities and sites?
  - If so, is there a relationship with freshwater discharge from Suwannee River?
  - Can we detect an effect of fishing between areas open and closed to seasonal harvest?

  - Irregular monitoring since 2010
  - Each year 2 periods = 18 total periods

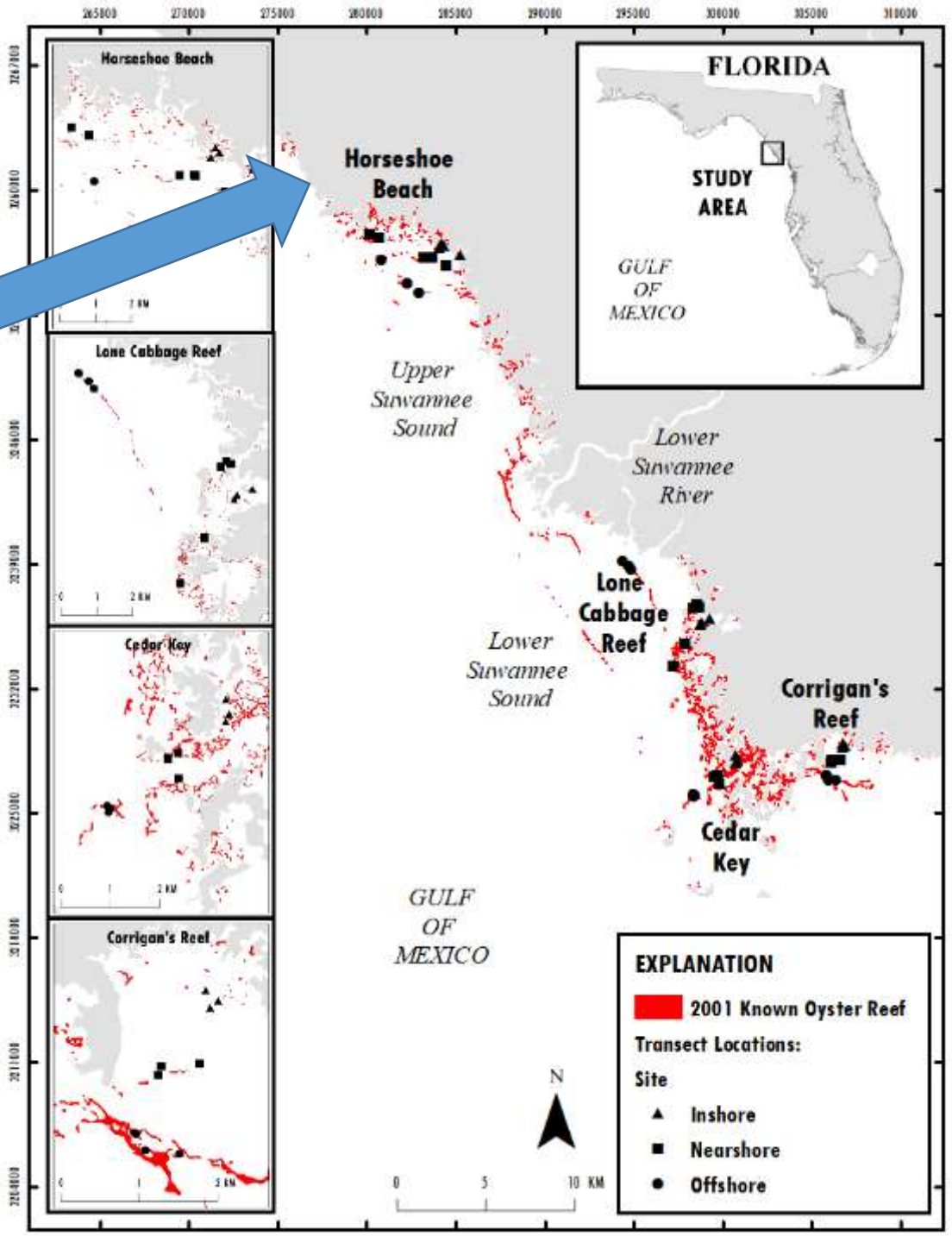


Suwannee Sound



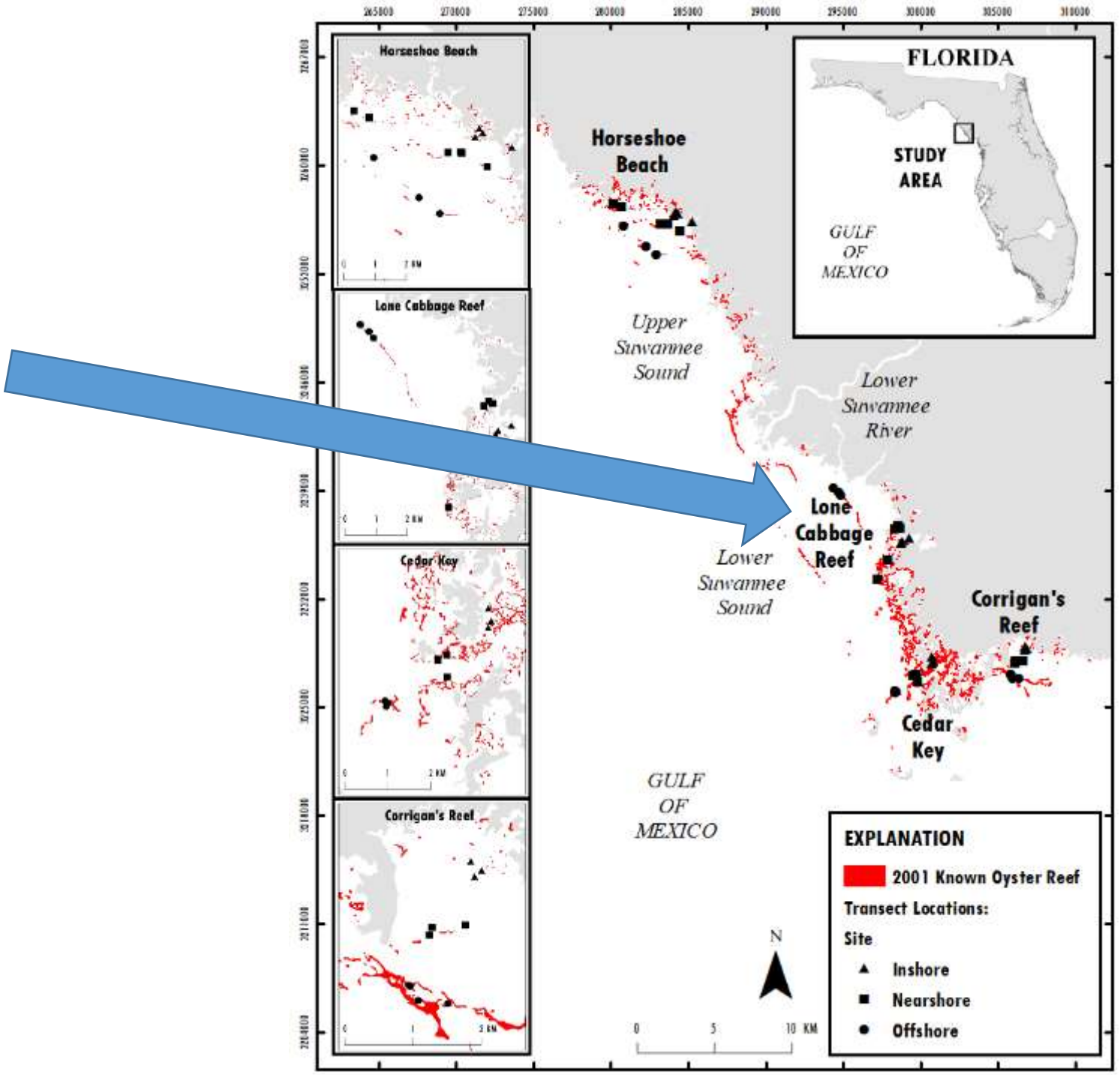
Intertidal surveys

- Four localities



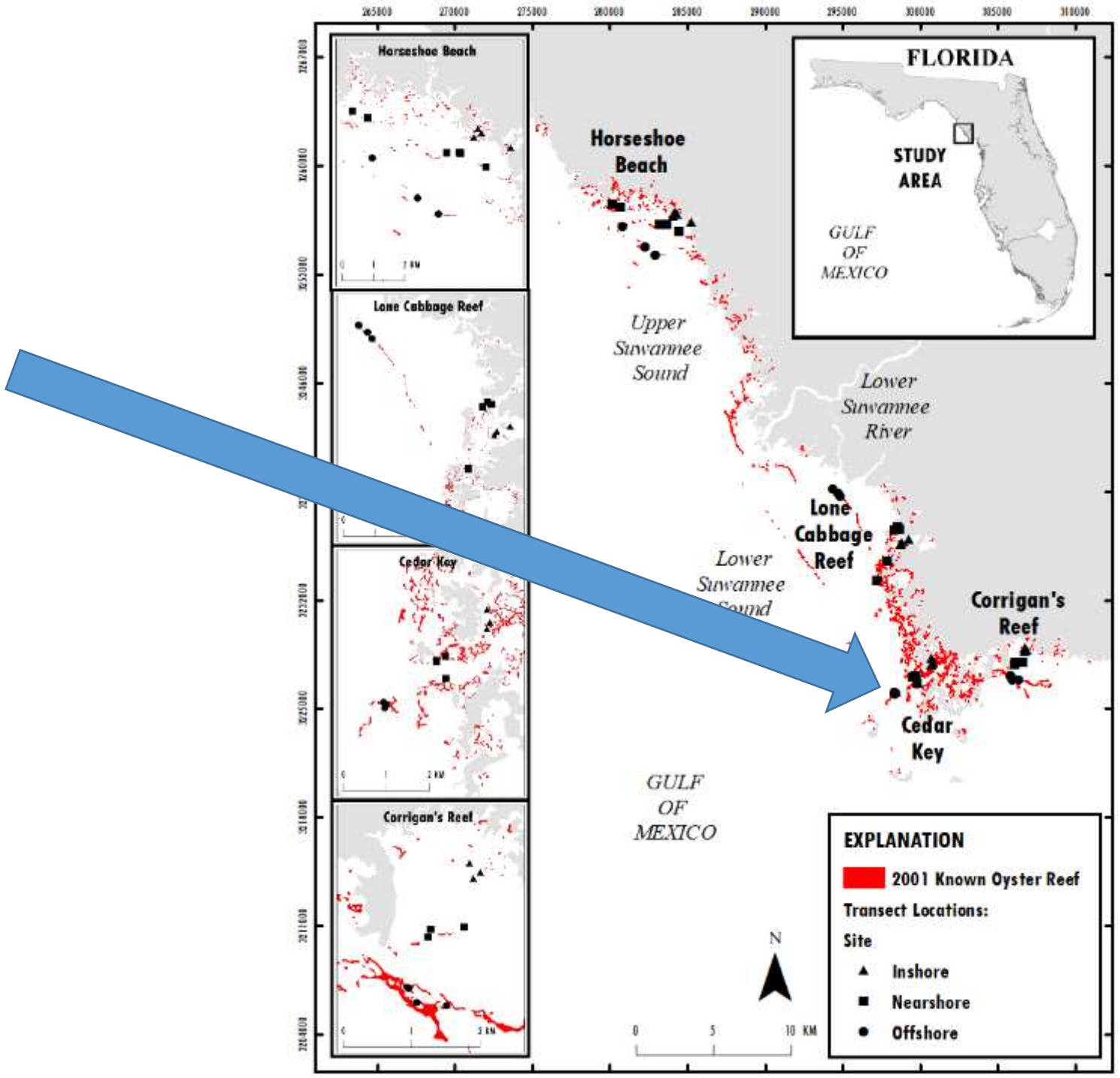
Intertidal surveys

- Four localities



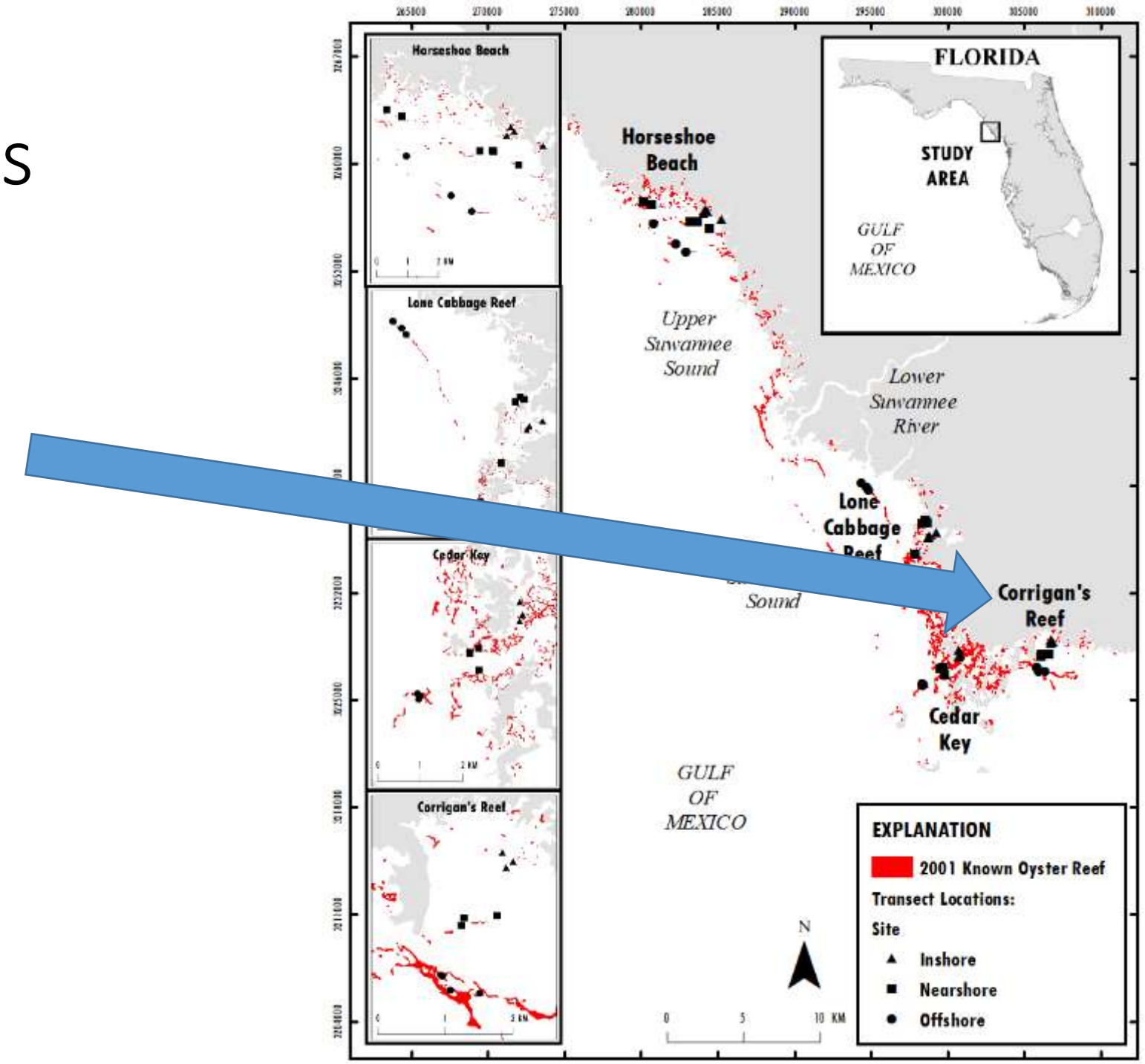
Intertidal surveys

- Four localities



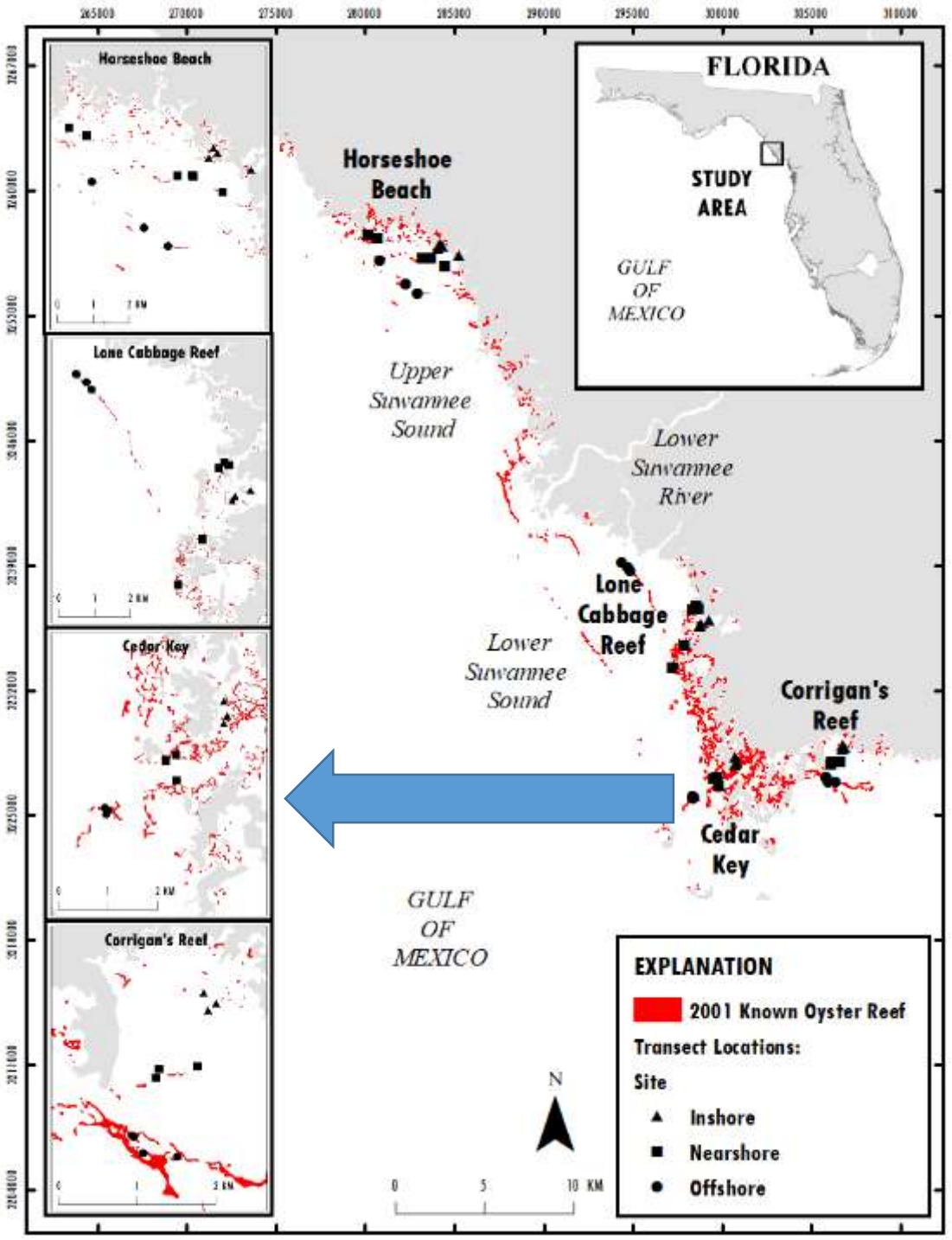
Intertidal surveys

- Four localities

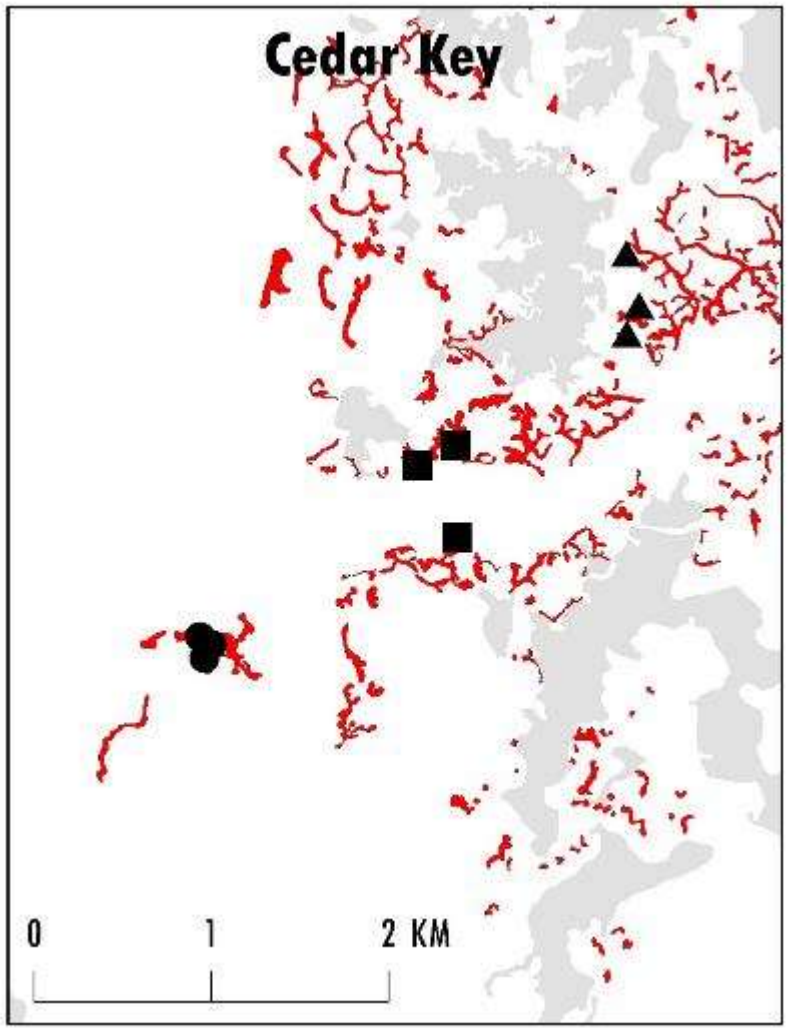


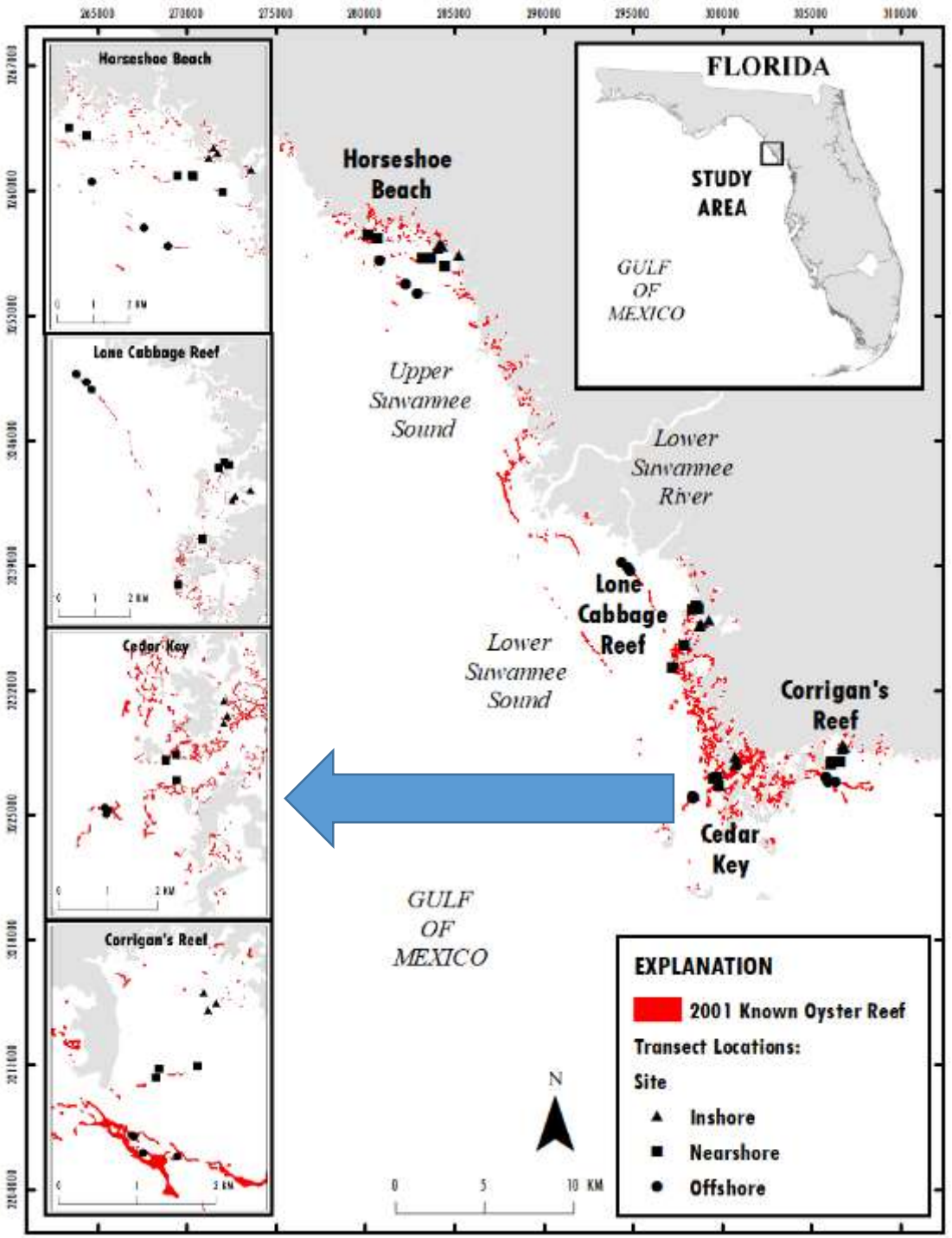
Intertidal surveys

- Linear chains of reefs at each locality
  - Inshore
  - Nearshore
  - Offshore



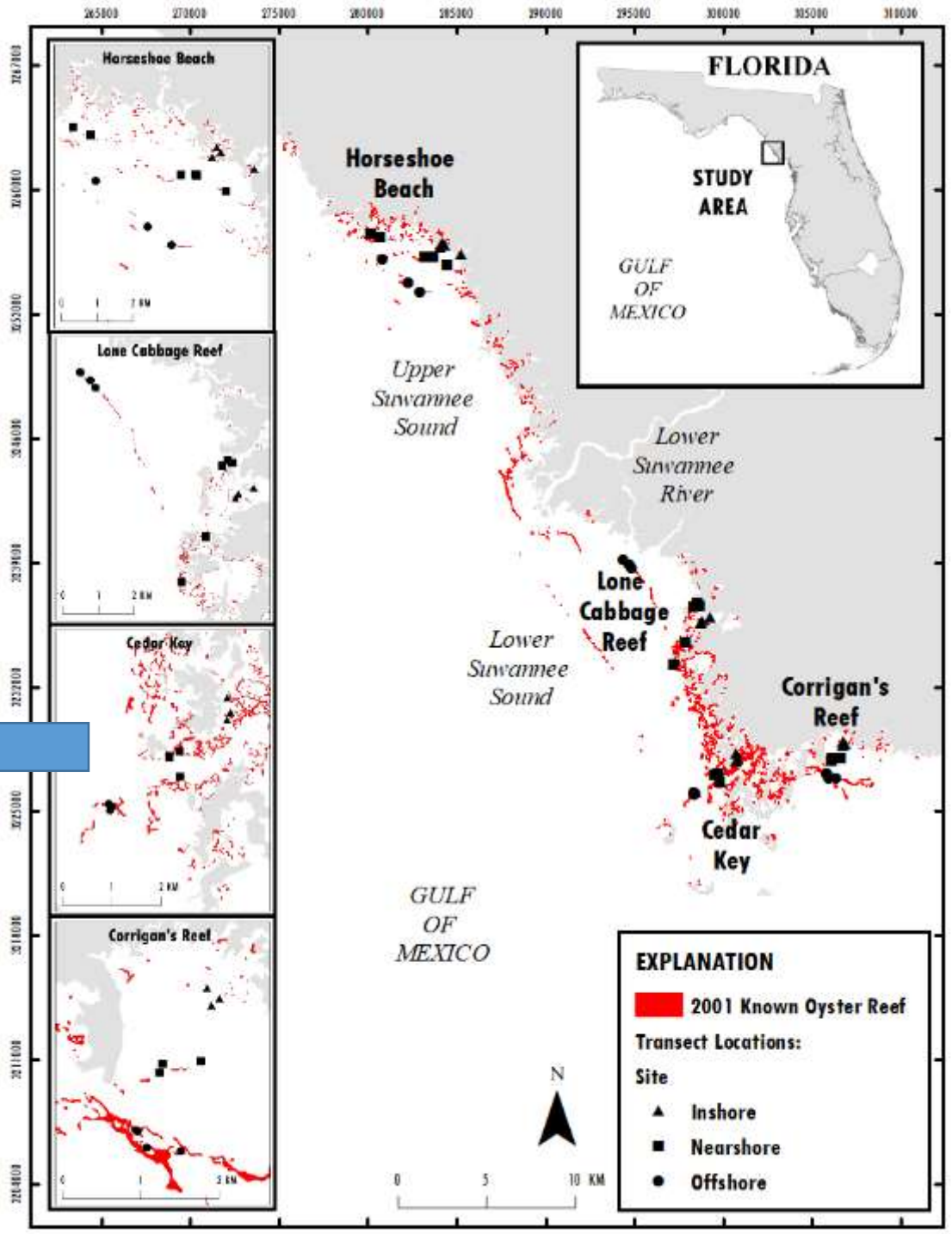
Intertidal surveys





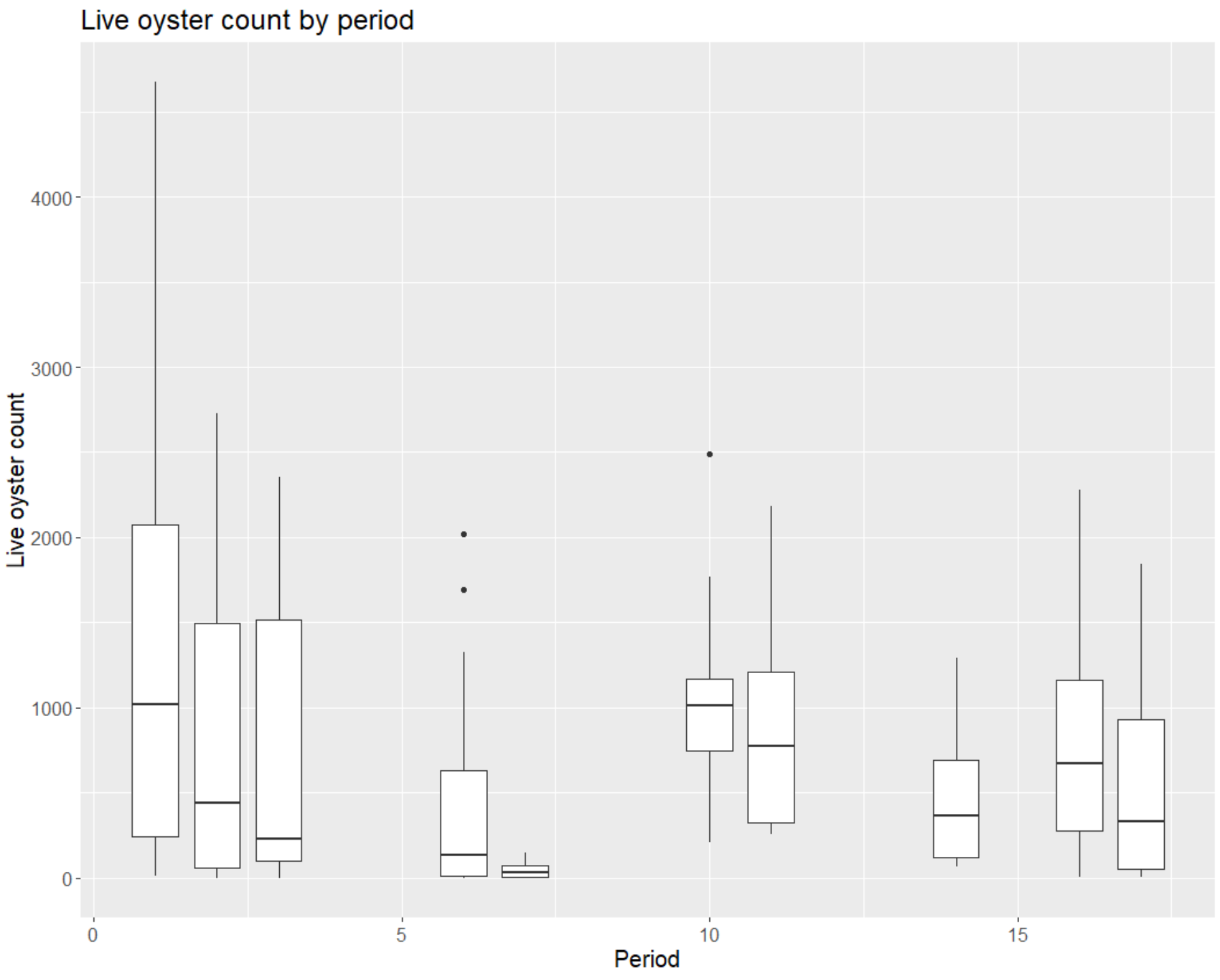
Intertidal surveys

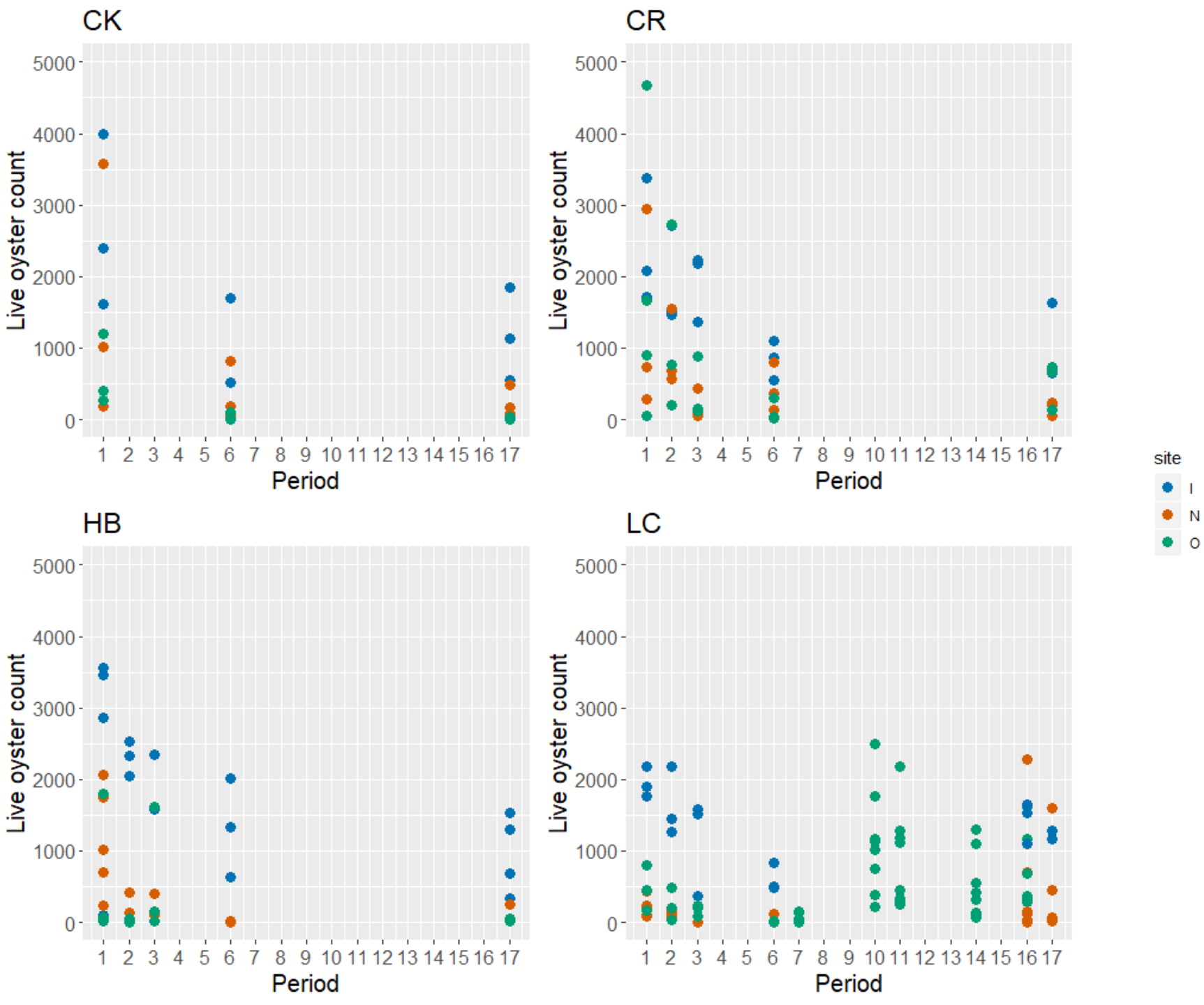
- Survey >3 intertidal reefs at each site using line transect



Data

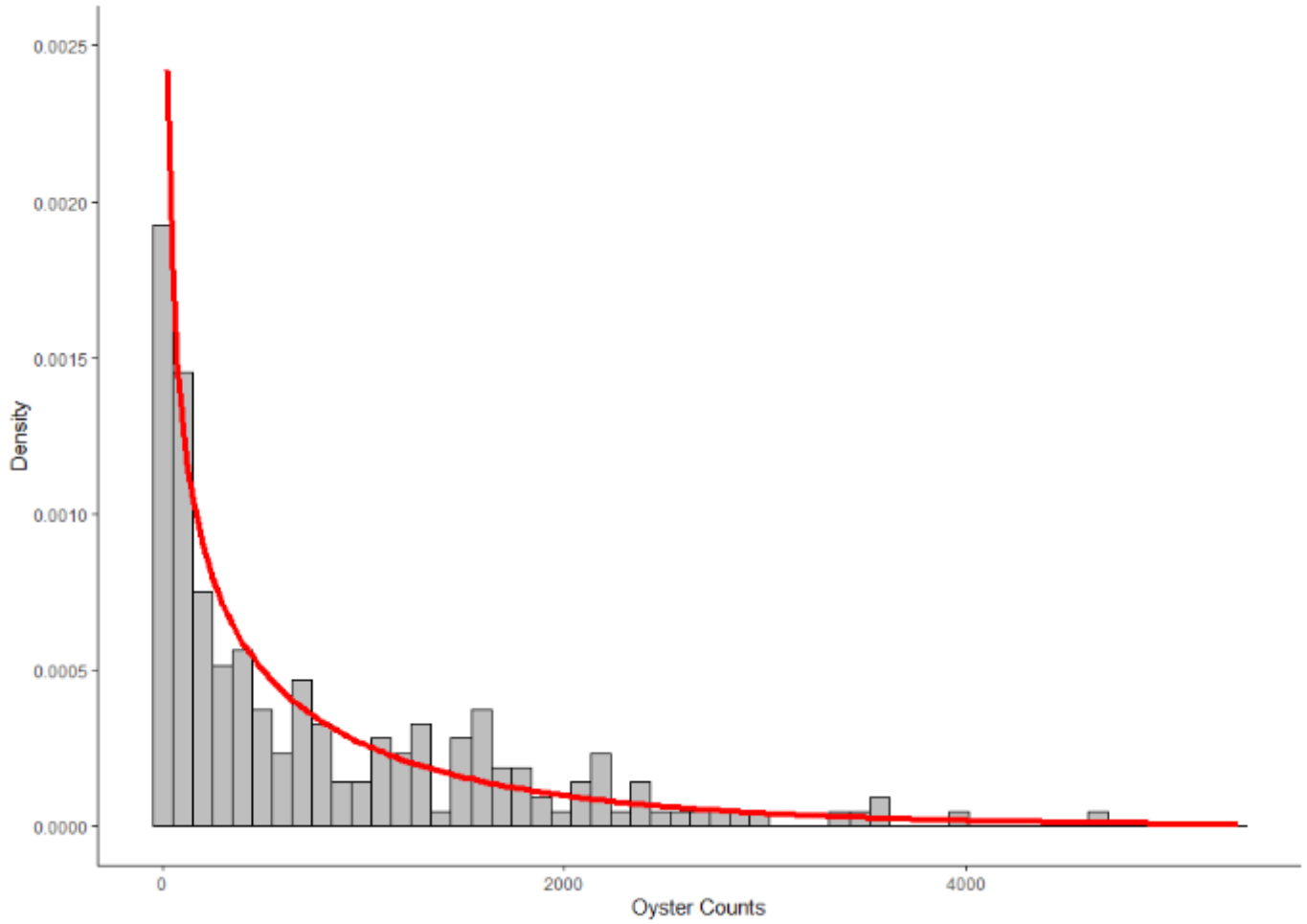
- Average individual transect length ~30-m
- Counts of live and dead oysters > 5-mm
- Summed counts from individual reef transects within site (i.e., sum 3 inshore reefs)


Live oyster count by period
Live oyster count
4000
3000
2000
1000
0
0
5
10
15
Period


CK
CR
HB
LC
Live oyster count
Period
0
1000
2000
3000
4000
5000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
site
I
N
O

Data

- Count data
- High variation in counts
- variance > mean
- Negative binomial good fit
- Transect length as effort offset (log link function)

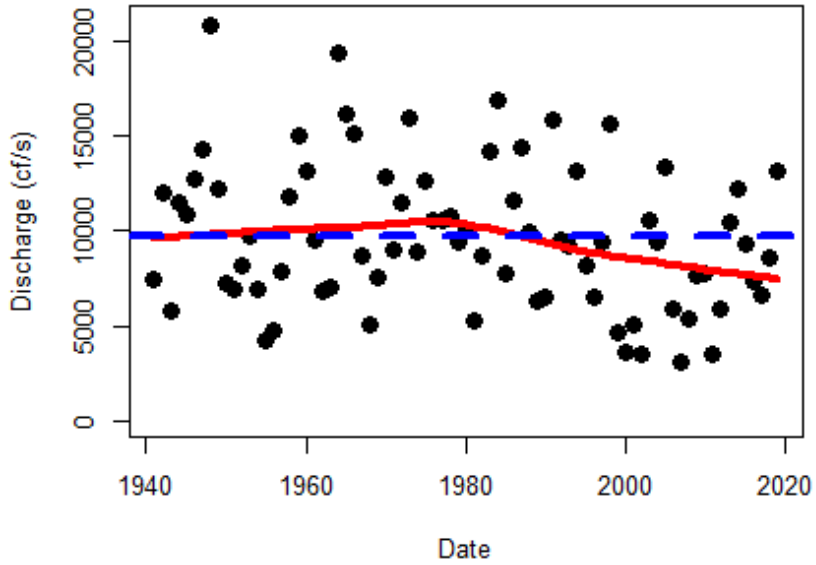


Candidate Models

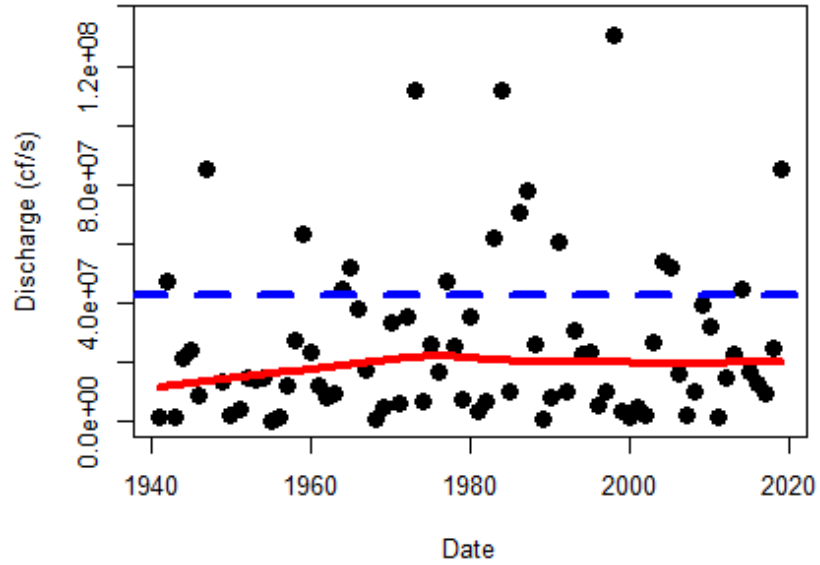
- Fit GLM models using glmmTMB in R assuming negative binomial
- Live oyster counts by period
- “Biological” covariates
  - River discharge with 0, 1, 2-year lags
  - Oyster landings or trips with 0, 1, 2-year lags
  - Assessed model performance with simulation

SUWANNEE RIVER NEAR WILCOX, FLA.

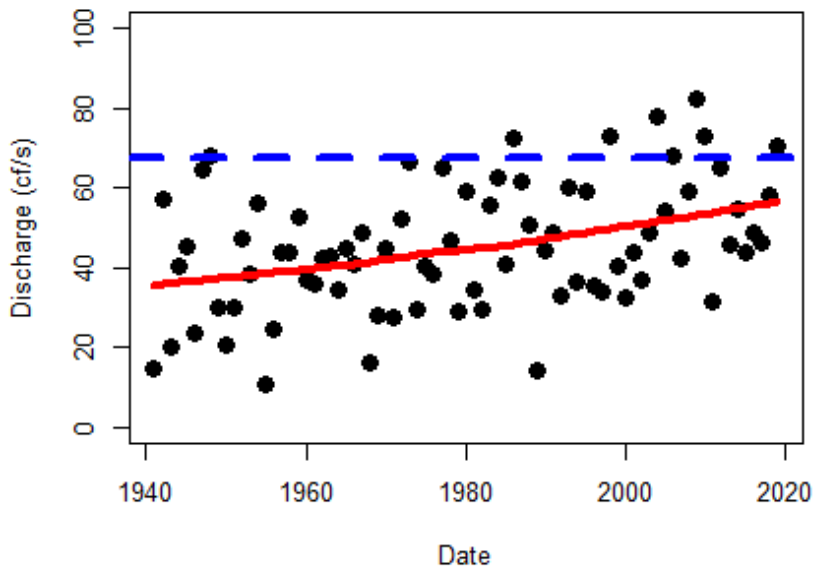
Mean daily discharge by year



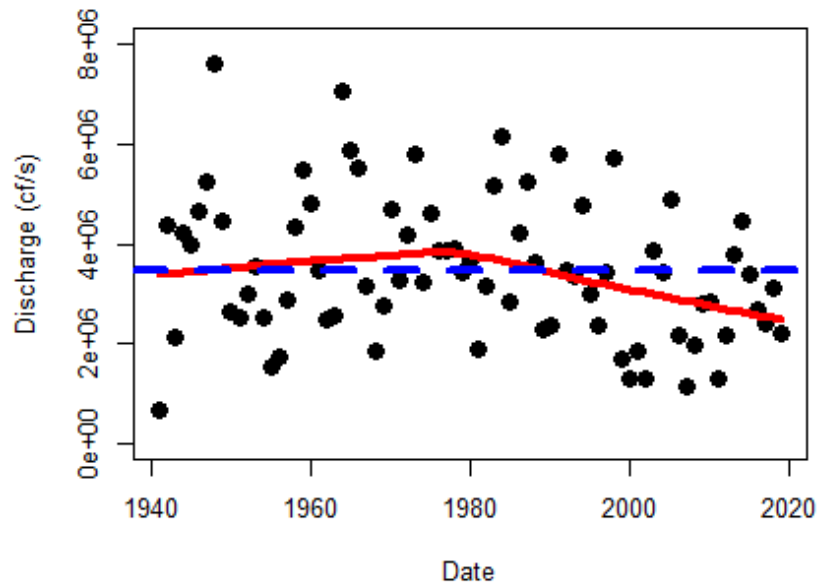
Daily discharge variance by year



Daily discharge CV by year

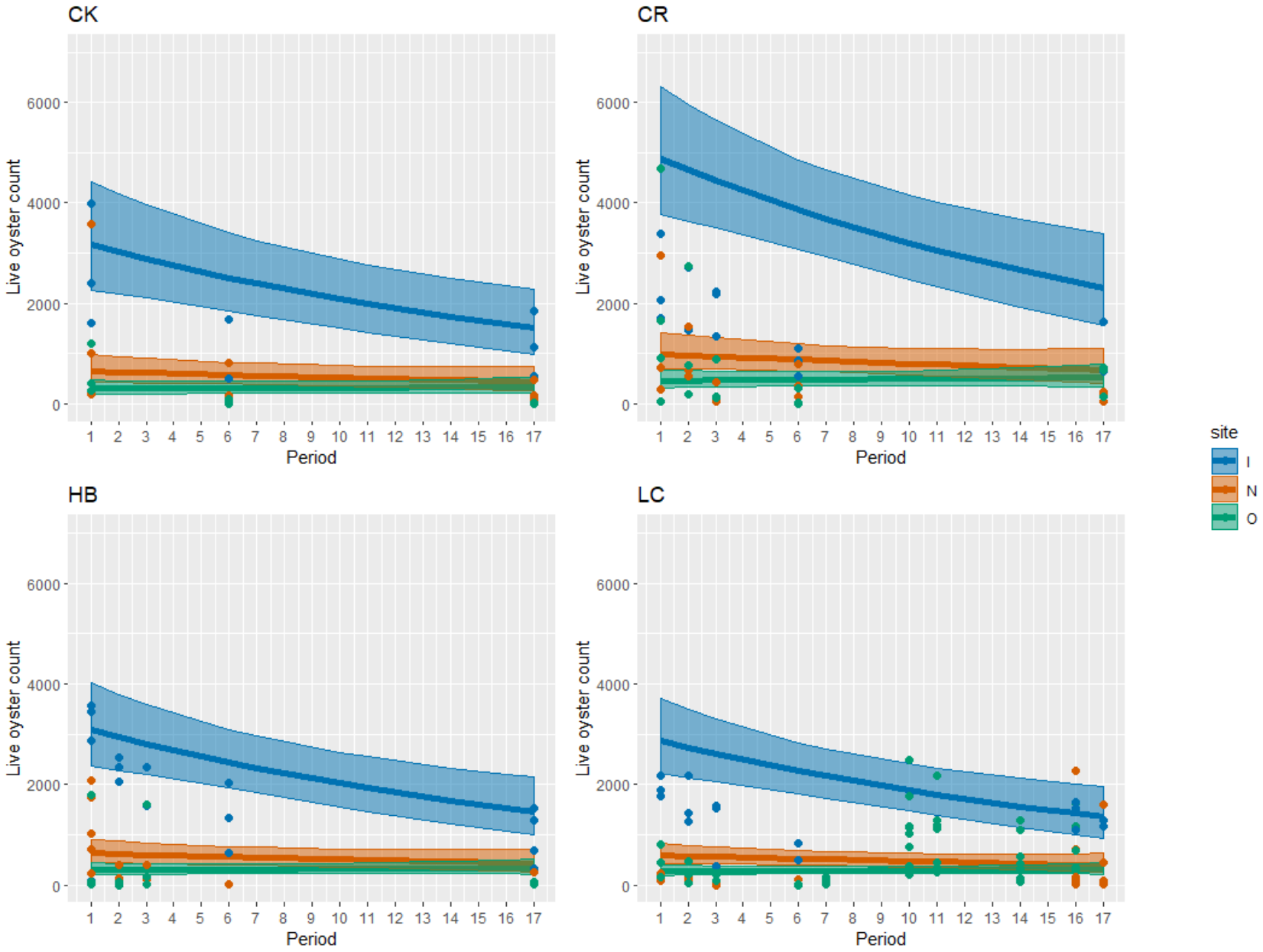


Total annual discharge by year



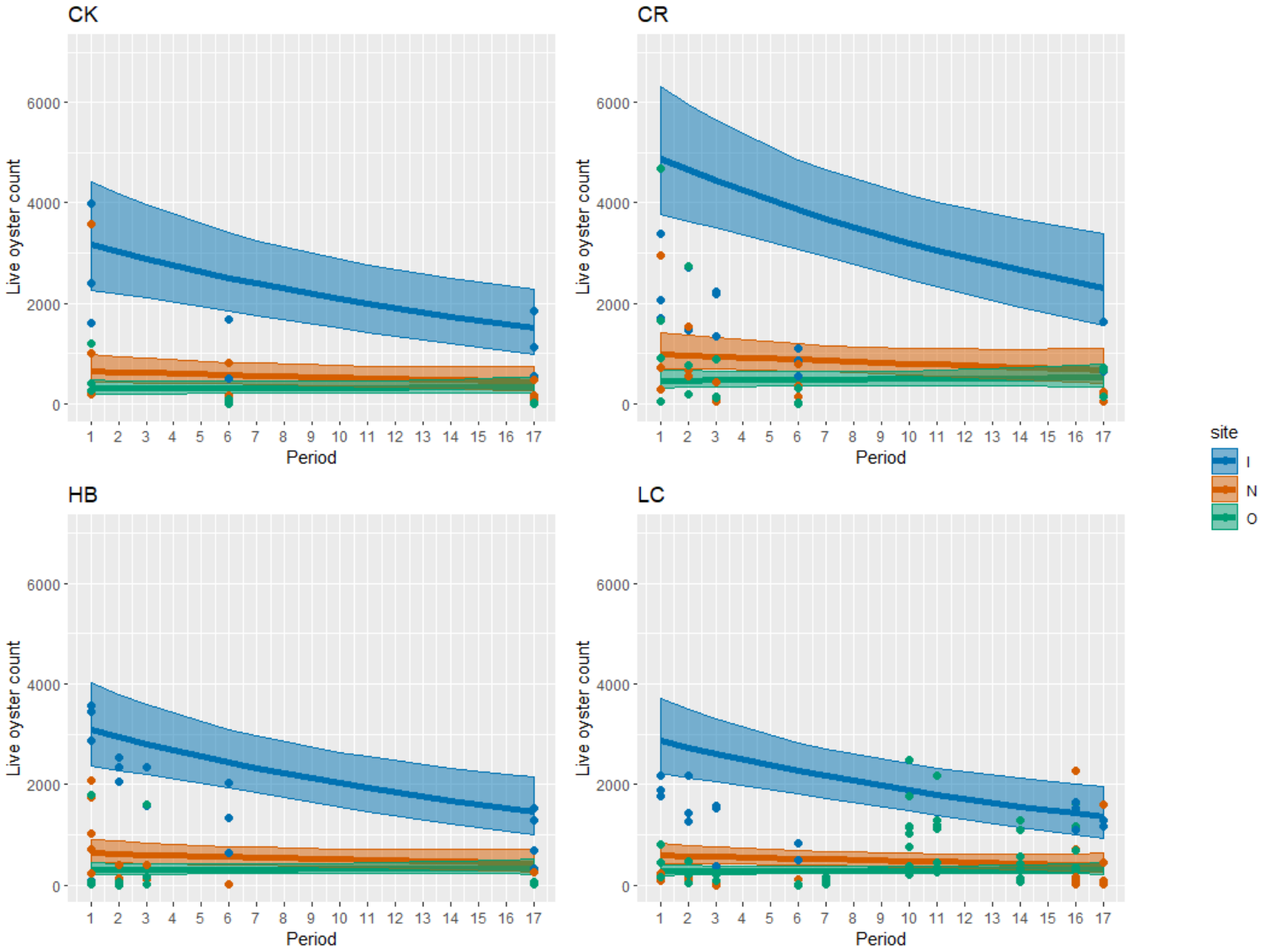
Results

- Oyster counts declined significantly at each location and site
- Largest changes found in inshore reefs
- Inshore becoming like offshore and nearshore



Results

- Best fit
  - Period*site+locality+ offset(log(tran_length)
- With covariates
  - Included one-year lag on either total annual or mean annual discharge
  - Including landings, trips or area open/closed did not improve model fit



River discharge oyster count relationship?

- Yes, but its complicated
- Don’t assume that more water = more oysters
- One aspect of resilient oyster reefs

Fishing effects?

- No, but its complicated
- Intertidal bars have few legal oysters due to growth
- Fishing effort effects unclear
- Complicated source-sink dynamics and feedbacks

What do we do?

What do we do? Restoration?

What do we do? But what about SLR?

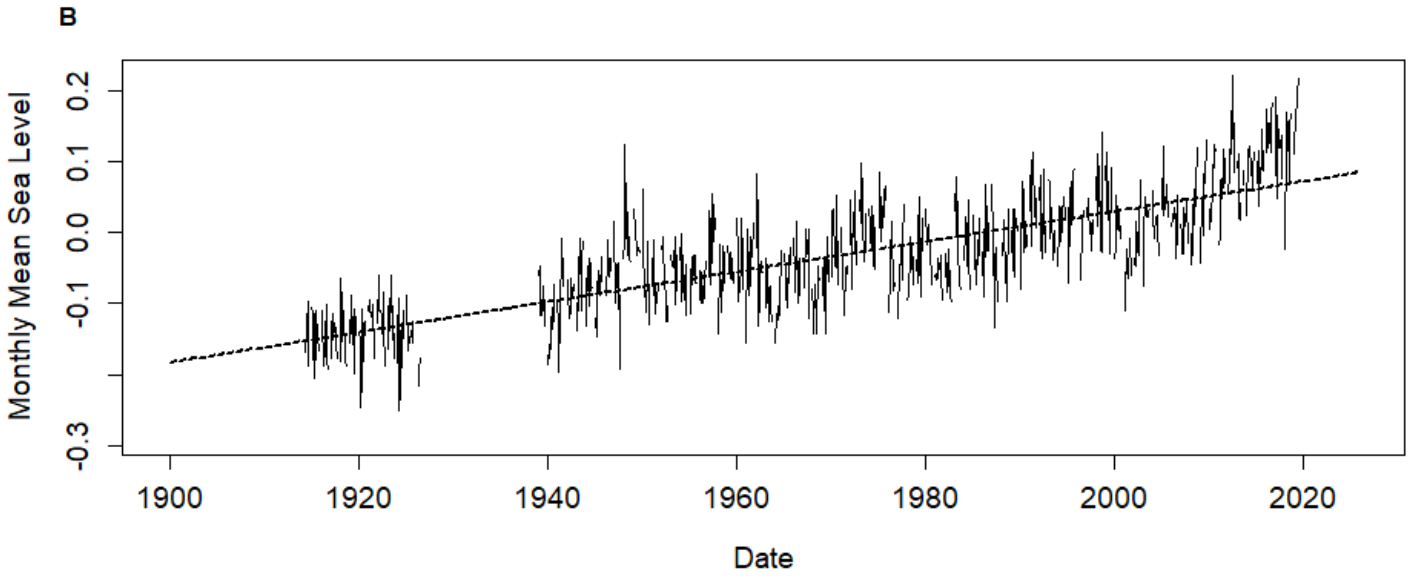
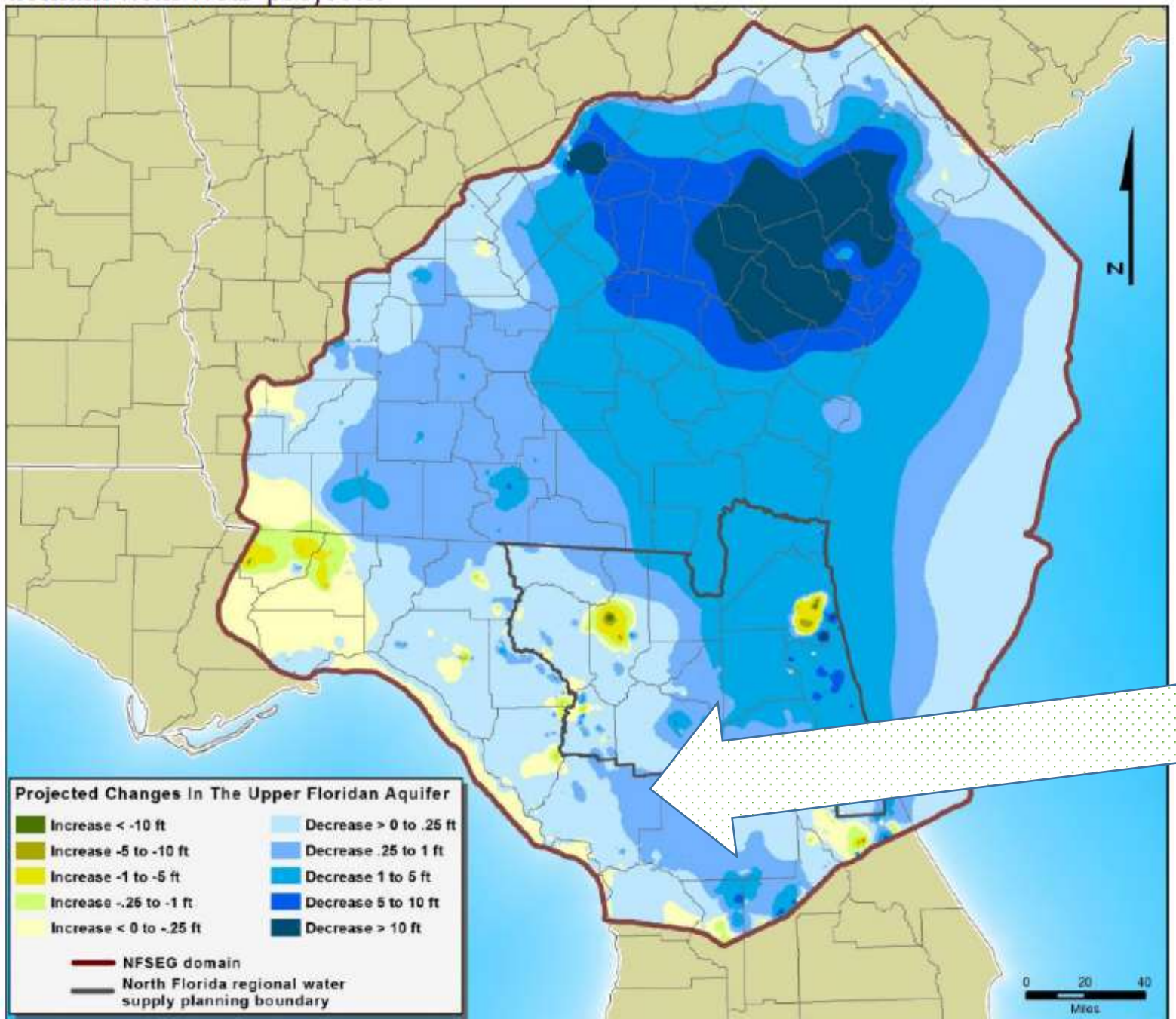


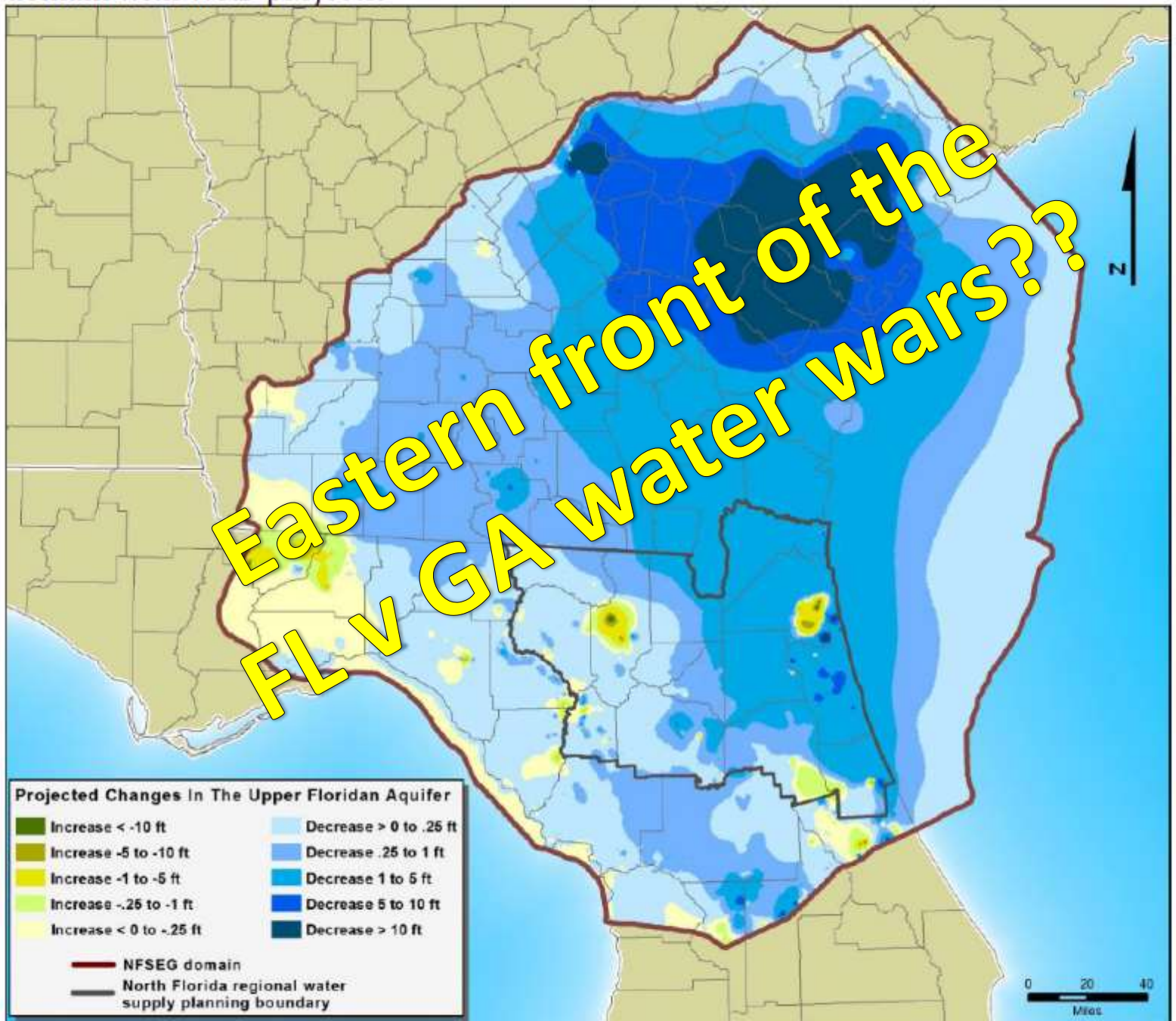
Figure C4: Change in Upper Floridan aquifer from 2035 withdrawals within the NFSE domain with WRD projects.



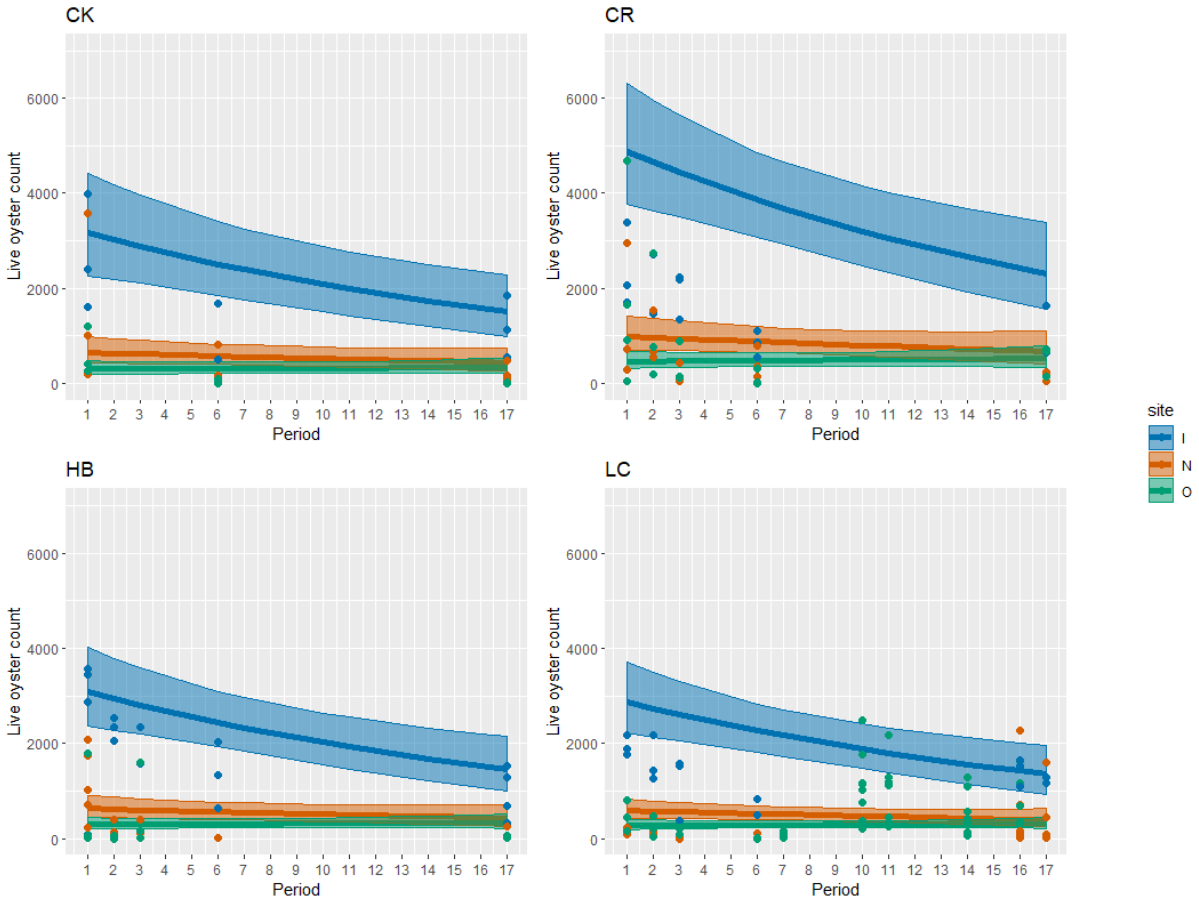
Latest groundwater models forecast declines for nearly all of Suwannee Basin by 2035 BEST CASE SCENARIO

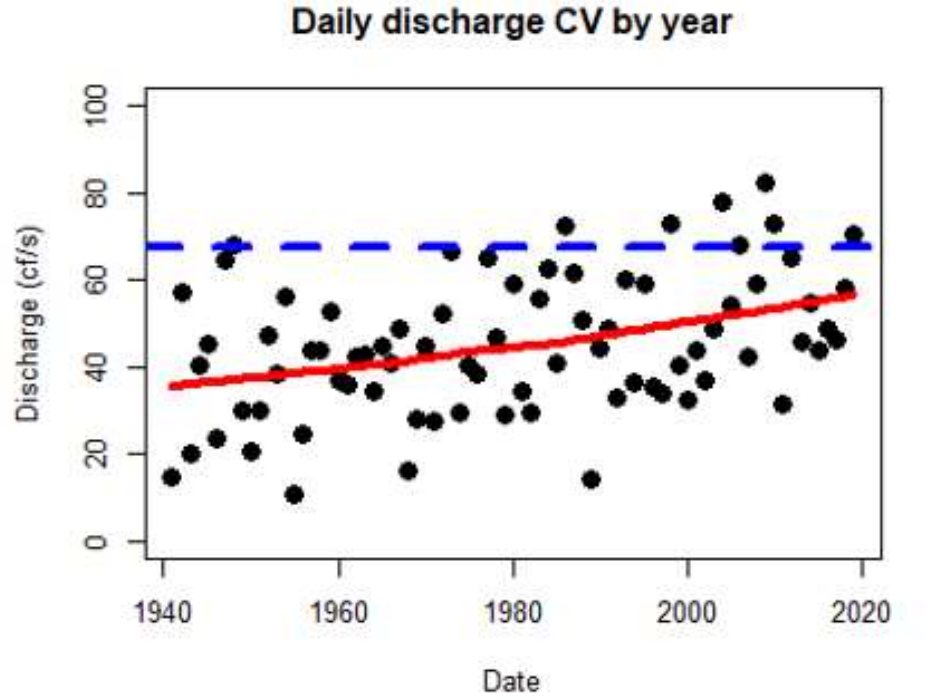
http://northfloridawater.com/

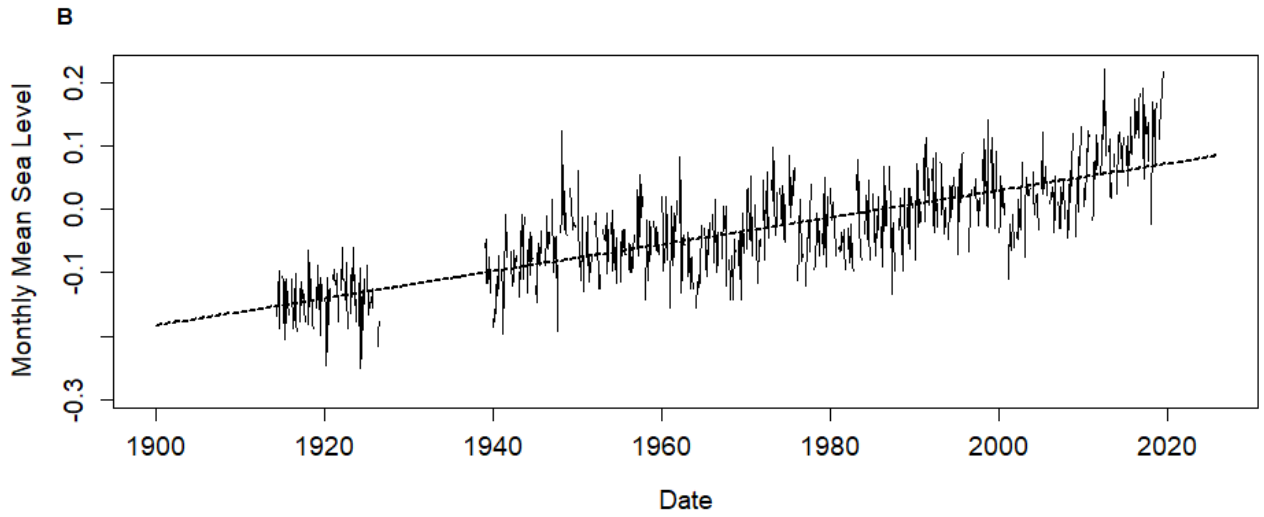
Figure C4: Change in Upper Floridan aquifer from 2035 withdrawals within the NFSE domain with WRD projects.

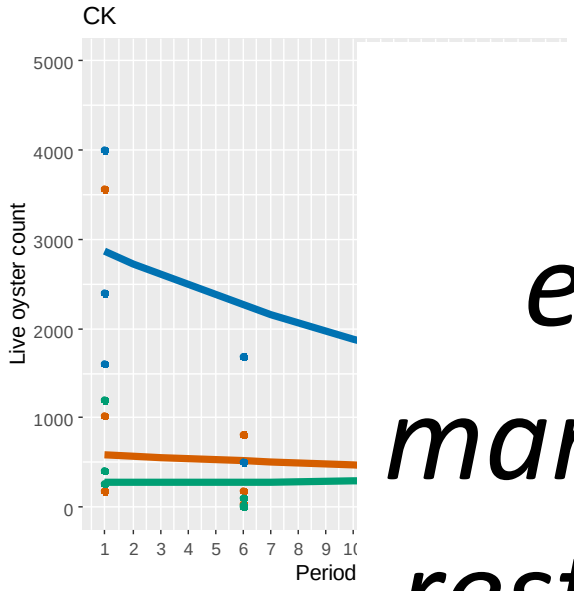


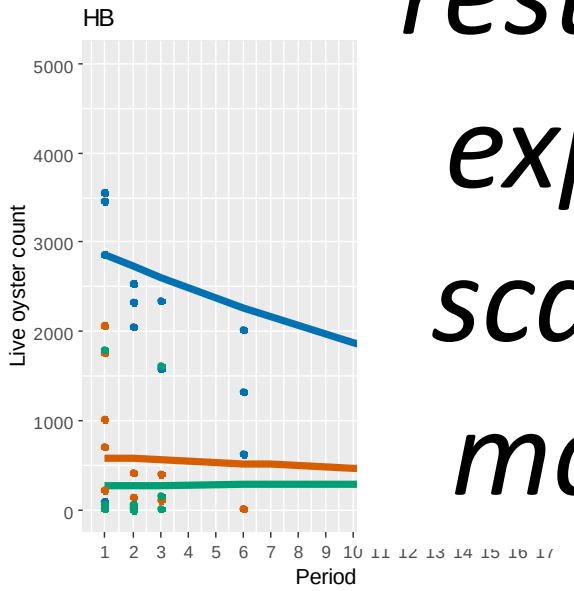
http://northfloridawater.com/


CK
CR
HB
LC
Live oyster count
Period
site
I
N
O


Daily discharge CV by year
Discharge (cf/s)
Date


B
Monthly Mean Sea Level
Date

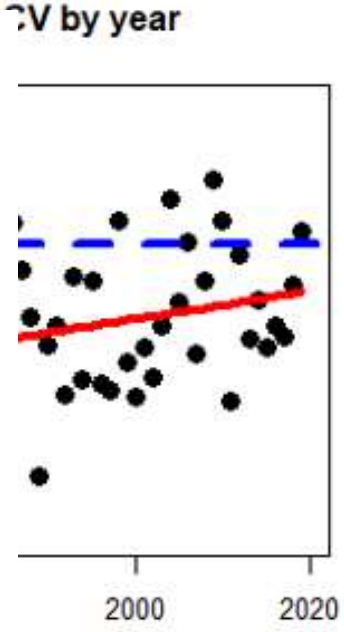


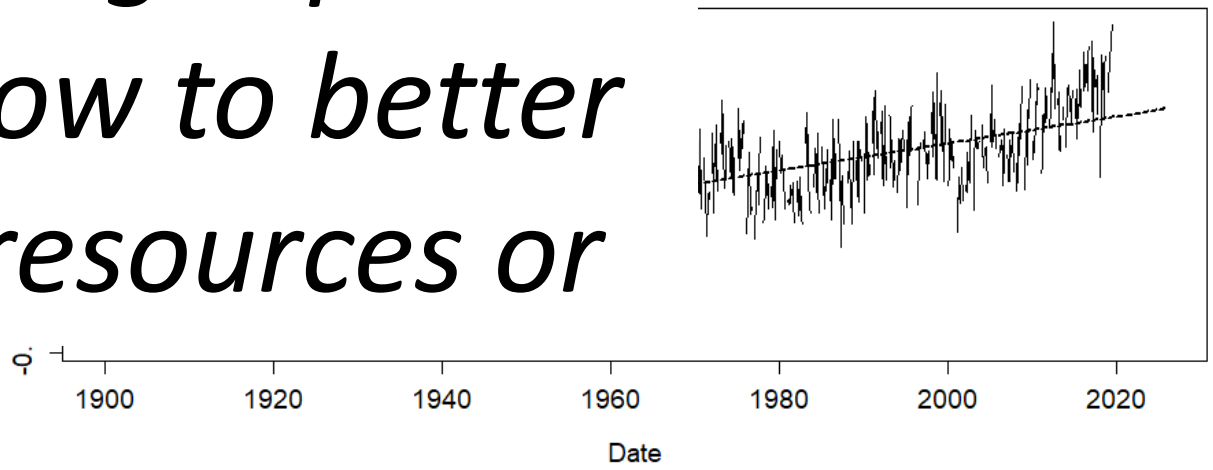


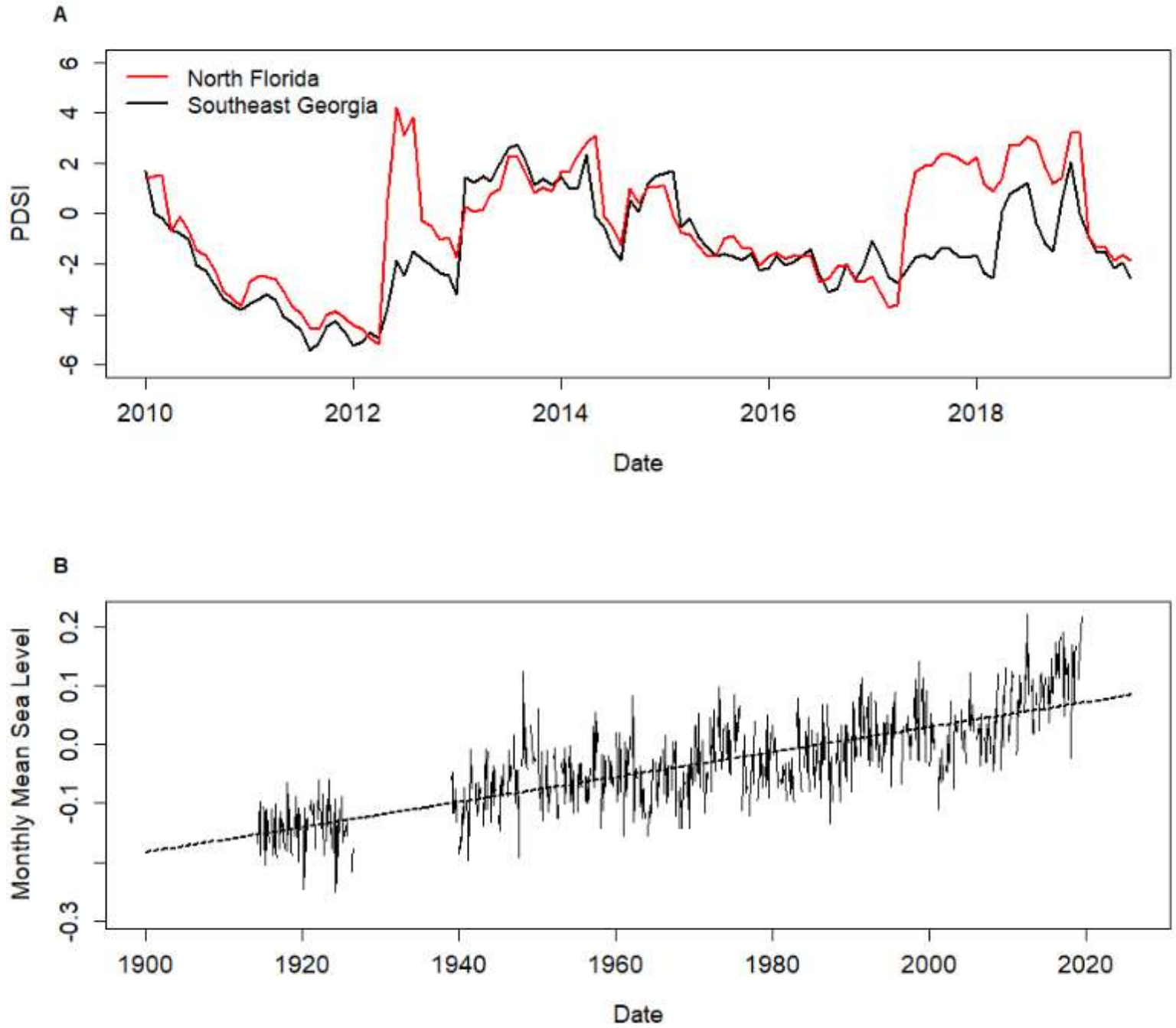
CR

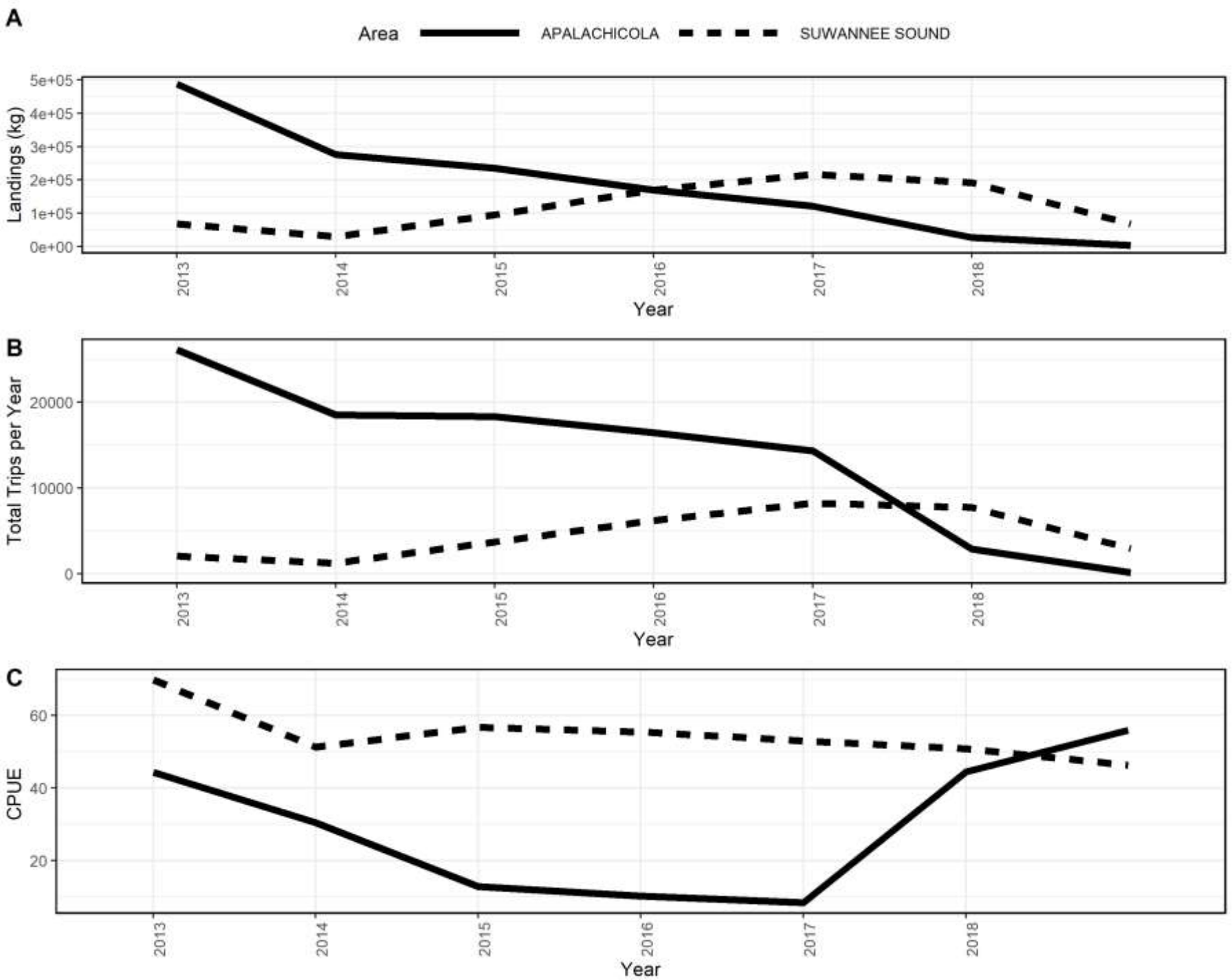
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Period

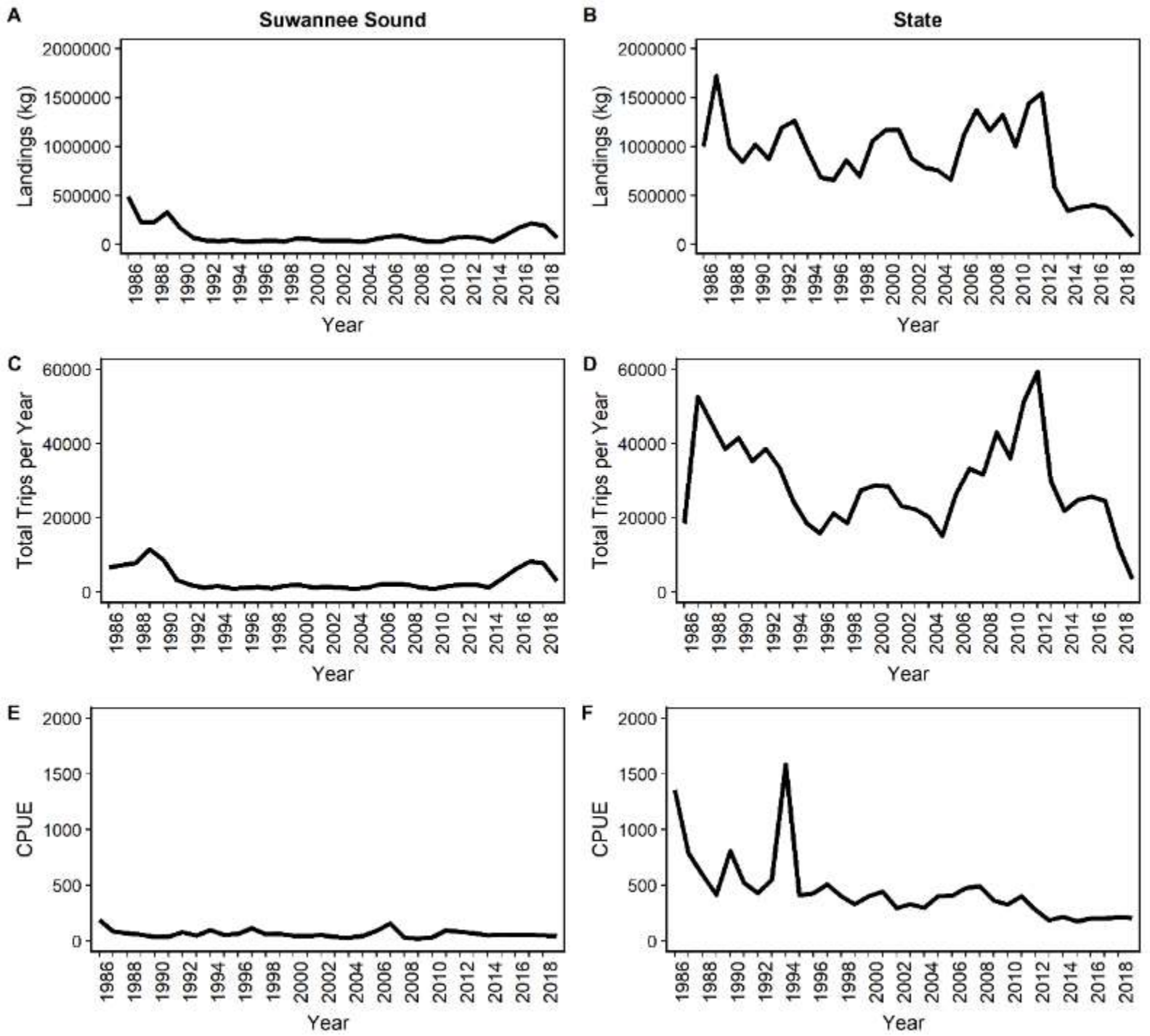
Way forward: Use environmental contrasts, management regulations, and restoration efforts as planned experiments at large spatial scales to learn how to better manage oyster resources or

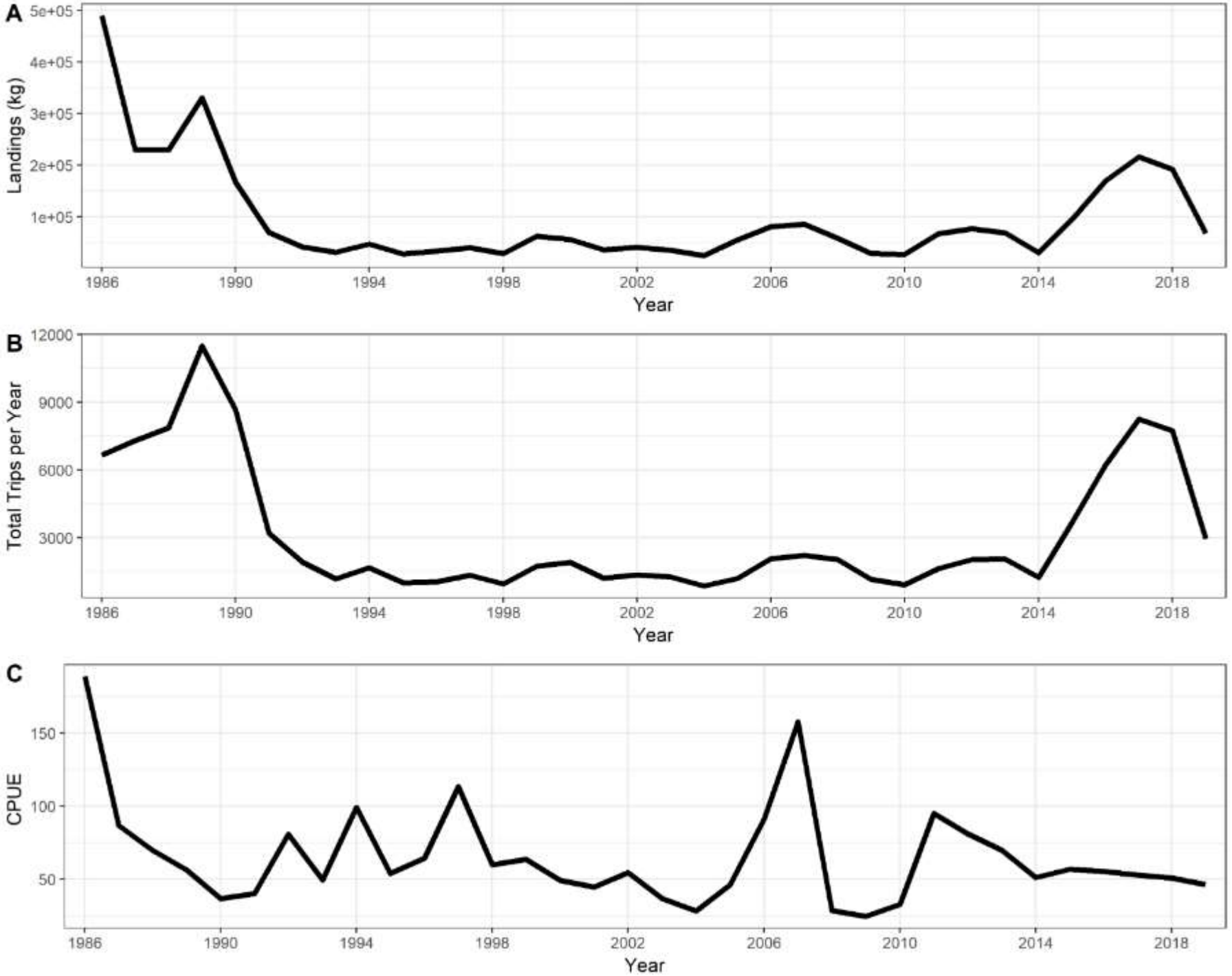


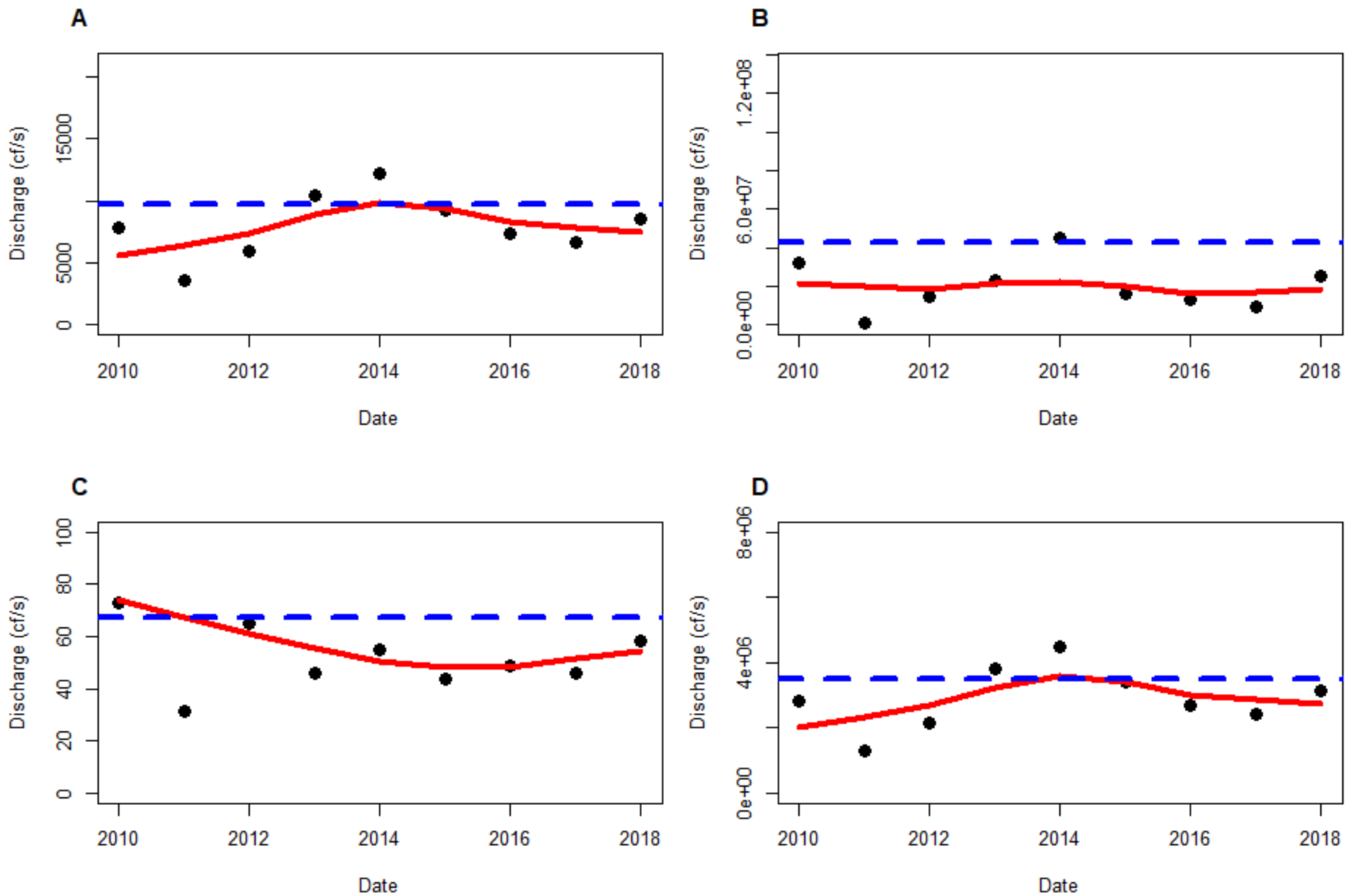


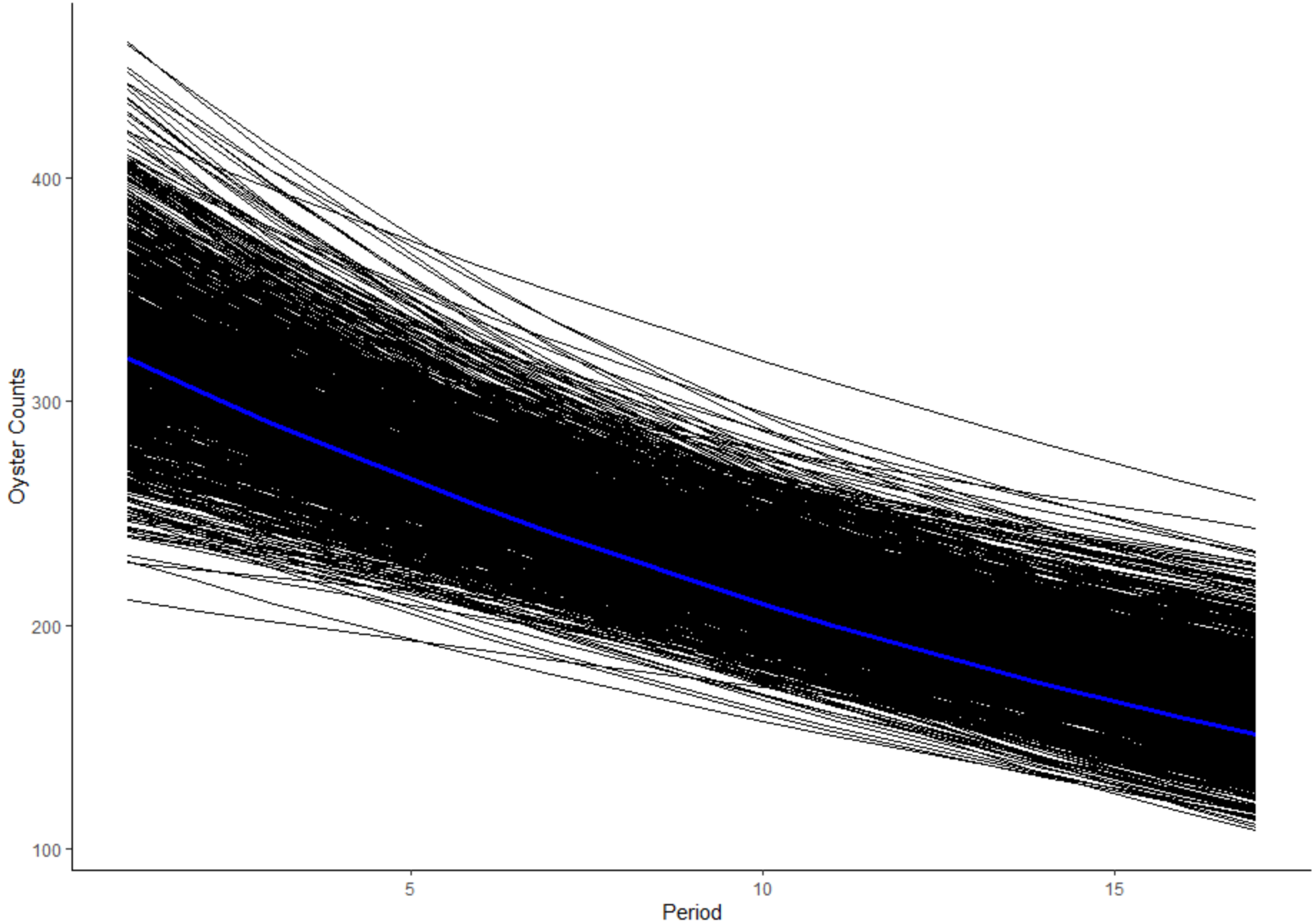

A
North Florida
Southeast Georgia
PDSI
6
4
2
0
-2
-4
-6
2010
2012
2014
2016
2018
Date
B
Monthly Mean Sea Level
0.2
0.1
0.0
-0.1
-0.3
1900
1920
1940
1960
1980
2000
2020
Date

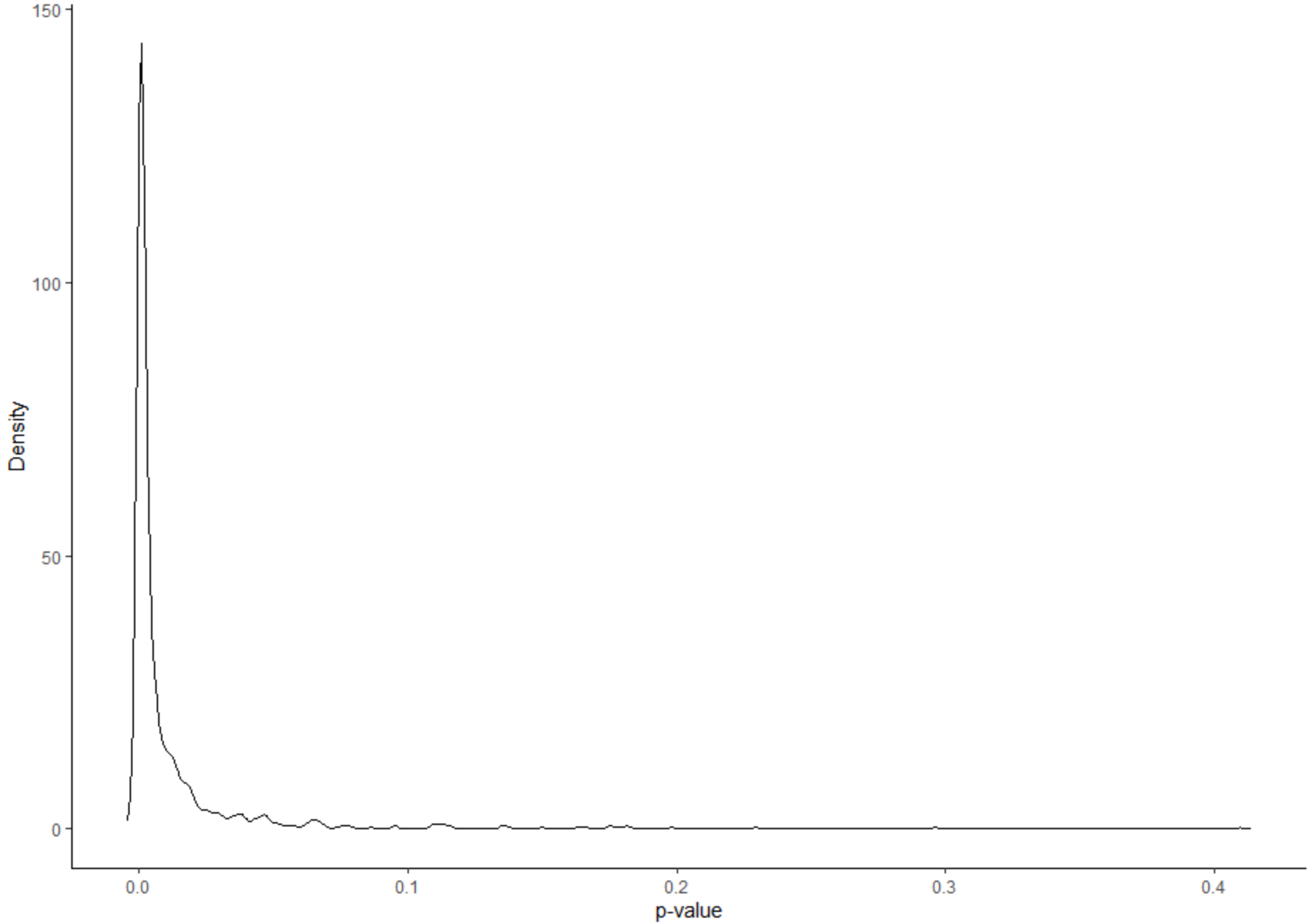

A
Area
APALACHICOLA
SUWANNEE SOUND
Landings (kg)
5e+05
4e+05
3e+05
2e+05
1e+05
0e+00
2013
2014
2015
2016
2017
2018
Year
B
Total Trips per Year
20000
10000
0
Year
C
CPUE
60
40
20
Year


A
Suwannee Sound
B
State
Landings (kg)
2000000
1500000
1000000
500000
0
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Year
C
D
Total Trips per Year
60000
40000
20000
E
F
CPUE
2000
1500
1000
500


A
Landings (kg)
5e+05
4e+05
3e+05
2e+05
1e+05
1986
1990
1994
1998
2002
2006
2010
2014
2018
Year
B
Total Trips per Year
12000
9000
6000
3000
1986
1990
1994
1998
2002
2006
2010
2014
2018
Year
C
CPUE
150
100
50
1986
1990
1994
1998
2002
2006
2010
2014
2018
Year


A
Discharge (cf/s)
0
5000
15000
2010
2012
2014
2016
2018
Date
B
Discharge (cf/s)
0.0e+00
6.0e+07
1.2e+08
2010
2012
2014
2016
2018
Date
C
Discharge (cf/s)
0
20
40
60
80
100
2010
2012
2014
2016
2018
Date
D
Discharge (cf/s)
0e+00
4e+06
8e+06
2010
2012
2014
2016
2018
Date


Oyster Counts
400
300
200
100
5
10
15
Period


150
100
50
0
Density
0.0
0.1
0.2
0.3
0.4
p-value

Suwannee River and Estuary

- Suwannee River 60% of freshwater input to Big Bend
- River discharge modified by surface and subsurface withdrawals
- Largest estuary in region
- River discharge influences salinity in Suwannee Sound

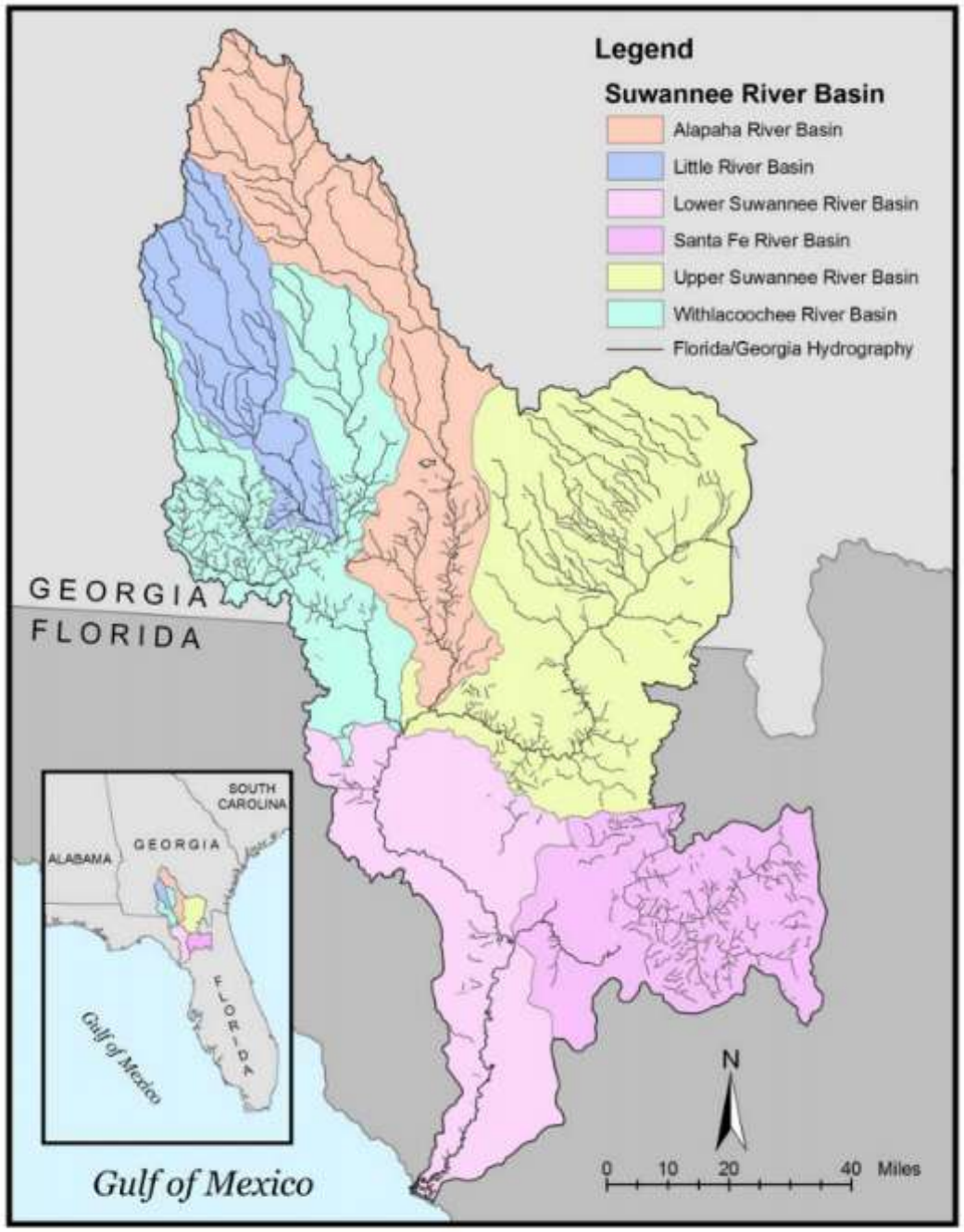


Figure 2-1. Suwannee River Basin in Florida and Georgia. Basins shown are USGS hydrologic units (Kenner et al., 1967).

http://www.dep.state.fl.us/DocumentCenter/View/72/Suwannee-River-Basin-Florida-Georgia-Map---PDF?bidId=