Aquatic Resources of the Pee Dee Basin

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- Florence SC 29506

Drainage	Stream Run(miles)	Lake Area(acres)	Native fish species	Introduced fish species
Pee Dee	8,075	15,984	102	10
Santee	11,699	139,504	110	18
Edisto	2,775	0	87	3
Savannah	4,857	105,516	113	16

*Pee Dee drainage includes the Pee Dee, Lynches, Waccamaw, and Black River systems

Freshwater Fishes of South Carolina

- 159 Freshwater fish species
- 137 Native Species
- 22 Introduced Species
- 25 SWAP Species
- 112 Species in the Pee Dee
- 6 Diadromous species
- 2 Endangered

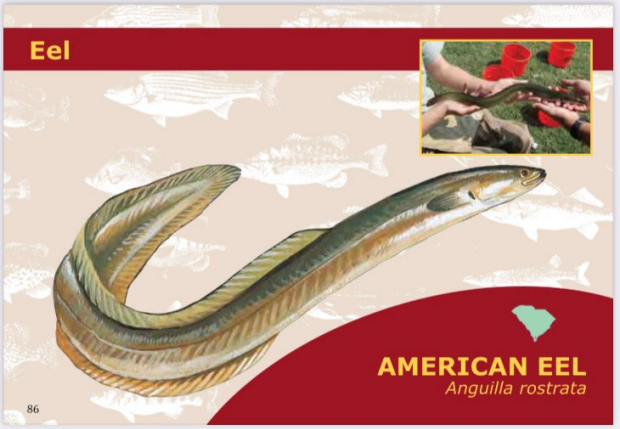
Pee Dee River Fish Community Study 2008/2009

Jason Marsik

- Boat electrofishing
- Sampled 23 sites
- 30-minute run time on each bank
- All fish were collected, identified to species, weighed and measured

PD Fish Community Study 2008/2009

- 23 Hours of pedal time
- Collected 4,936 total fish
- 214 fish/per hour
- 51 Species



Number	Species
1	Dollar sunfish
1	Notchlip redhorse
1	Redfin pickerel
1	White perch
2	Atlantic needlefish
2	Pirate perch
2	Striped bass
2	Yellow perch
3	Bigmouth buffalo
3	Chain pickerel
3	Freshwater goby
4	Flier
7	Blueback herring
9	Coastal shiner
9	Grass carp
10	Shorthead redhorse
10	Tesselated darter
10	Warmouth
11	Southern flounder
11	Spotted sucker
12	Spotfin mojarra
15	Inland silverside
18	Bowfin
18	Mosquitofish
19	Flathead catfish
24	Black crappie
25	Golden shiner
29	Channel catfish
31	Fiery Black shiner
32	Common carp
34	Hogchcoker
34	Spottail shiner
38	Brook silverside
39	Spotted sunfish
40	Redbreasr sunfish
68	Pumpkinseed
82	Bay Anchovy
93	American eel
123	American shad
138	Largemouth bass
140	Smallmouth buffalo
141	Redear
188	Threadfin shad
242	Longnose gar
297	Eastern silvery minnow
325	Blue catfish
363	Striped mullet
369	Gizzard shad
506	Satinfin shiner
645	Bluegill
705	Whitefin shiner

Striped bass study

Jason Marsik

Evaluate the current population

Describe the genetics

Understand movements(telemetry)

Stocking assessment

Striped bass study

Evaluate the current population

Started in 2017

Boat electrofished 3 standardized sites
From February-May

Site	2017	2018	2019
1	2.6	0.6	2.3
2	0.5	0.4	2.5
4	0	0.3	0.2

*number of fish per site per day

Striped bass study

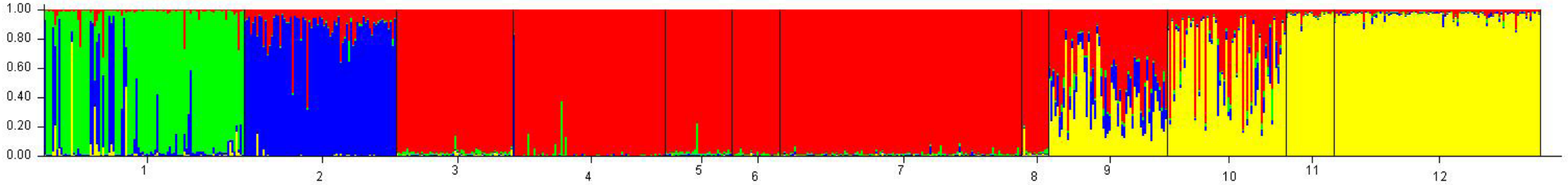


Figure 2. Results from STRUCTURE displaying the fractional ancestry to *K*=4 genetic clusters of striped bass from South and North Carolina rivers: Savannah River (1); ACE Basin (2); Congaree River (3); Cooper River (4); Lake Marion (5); Lake Moultrie (6); Santee River (7); Lake Wateree (8); Lower Pee Dee River (9); Upper Pee Dee River (10); Cape Fear (11); and Roanoke River (12) Each individual bar represents the ancestry of a single striped bass, with the colors corresponding to the proportion of population assignments.

Genetic Evaluation

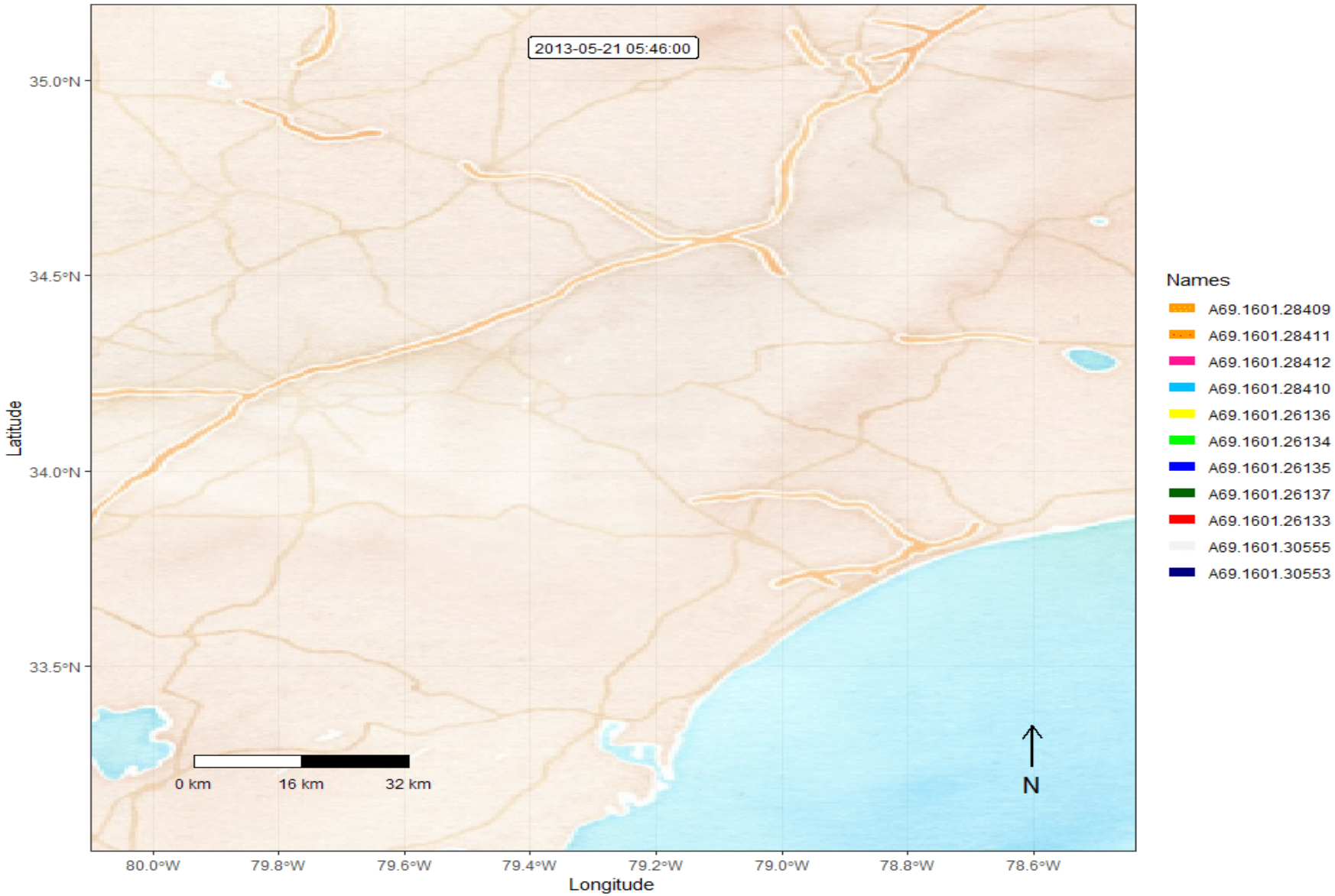
- No unique Pee Dee strain
- Mixed ancestry- Cape Fear, Roanoke, and Santee Cooper
- 20-40% of the fish are cultured and have immigrated into the Pee Dee River

Striped bass study

Telemetry project

Tagged 11 adult striped bass with acoustic tags

Approx 75 receivers in the Pee Dee


2013-05-21 05:46:00
35.0°N
34.5°N
34.0°N
33.5°N
Latitude
0 km
16 km
32 km
N
80.0°W
79.8°W
79.6°W
79.4°W
79.2°W
79.0°W
78.8°W
78.6°W
Longitude
Names
A69.1601.28409
A69.1601.28411
A69.1601.28412
A69.1601.28410
A69.1601.26136
A69.1601.26134
A69.1601.26135
A69.1601.26137
A69.1601.26133
A69.1601.30555
A69.1601.30553

Striped bass project

Stocking:

Used Santee Cooper genetic strain
Used unique genetic families

2019- stocked 32,206 phase II
2020- stocked 54,018 phase II
2021- stocked 10,206 phase II

=96,430 fish

Striped bass project

Stocking:

Used Santee Cooper genetic strain
Used unique genetic families

2019- stocked 32,206 phase II
2020- stocked 54,018 phase II
2021- stocked 10,206 phase II

=96,430 fish

Stocking Assessment:

2020 Results

Collected 65 fish
-40 Cultured
-28 2019 YC

-23 Wild

2021 Results

Collected 100 fish
-62 Cultured
-8, 2019 YC
-23 2020 YC
-35 Wild

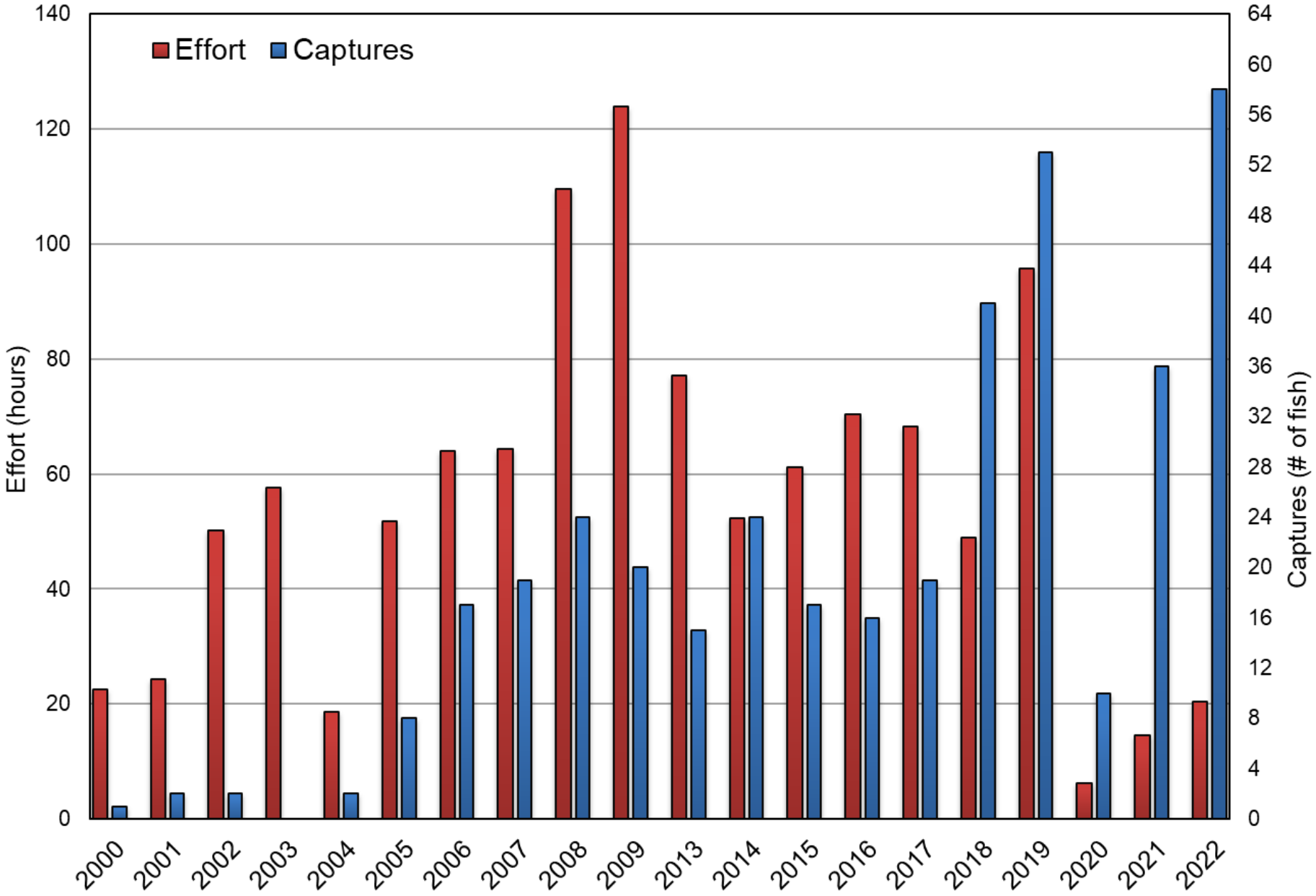
Site	2017	2018	2019	2020	2021	2022
1	2.6	0.6	2.3	2.9	3.4	3.3
2	0.5	0.4	2.5	4.7	4	1.9
4	0	0.3	0.2	1.1	0.2	0.1
total	1	0.4	1.7	2.9	2.5	1.8

*number of fish per site per day

Robust Redhorse Restoration

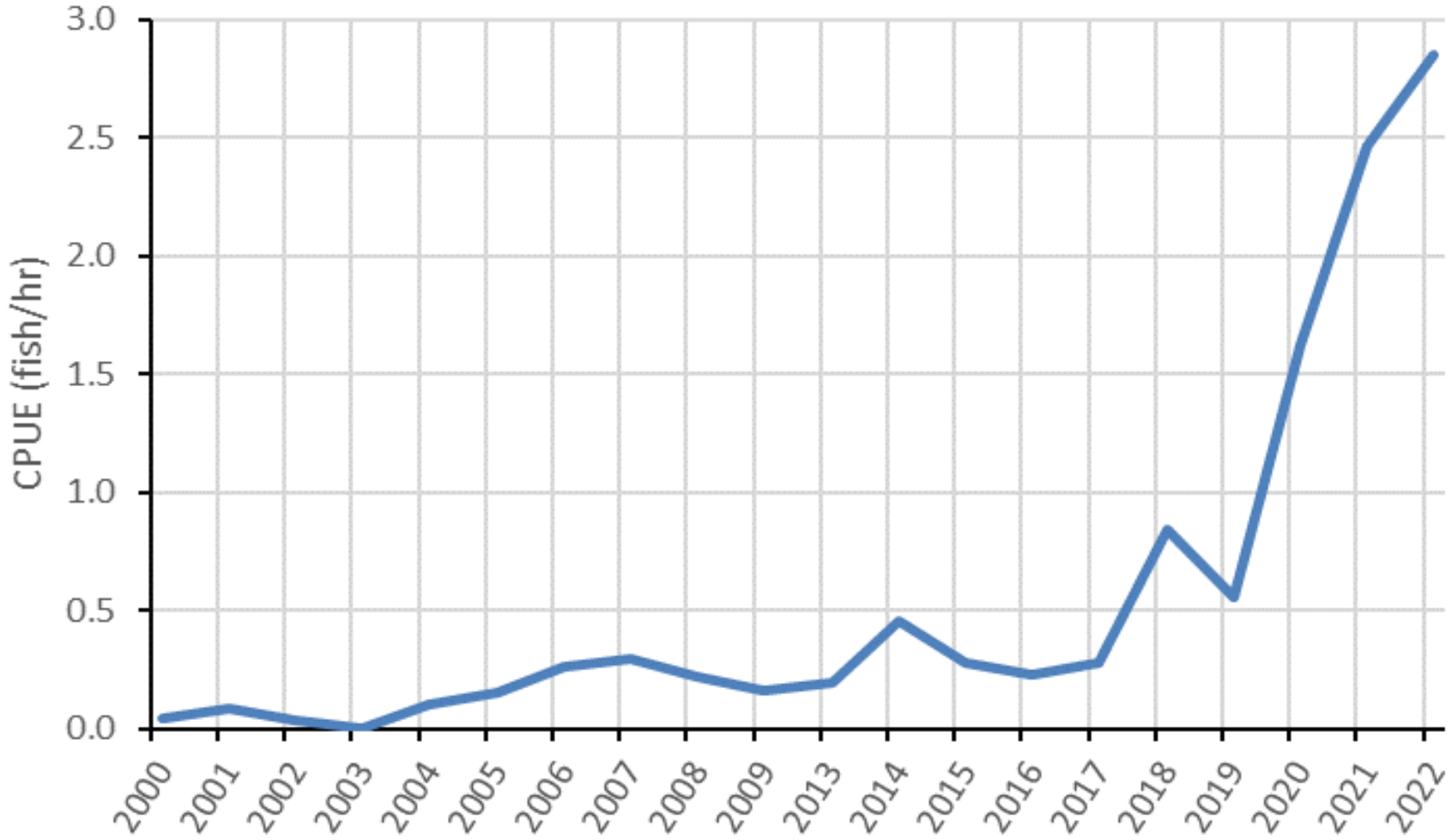
Brena Jones NCWRC

- Large (up to 18 pounds), long lived (~30 years) sucker species
- Species was lost to science for over 100 years and rediscovered in GA in 1991
- Pee Dee sampling began in the late 1990's and a concerted targeting effort began in 2000.



During Targeted Sampling Only

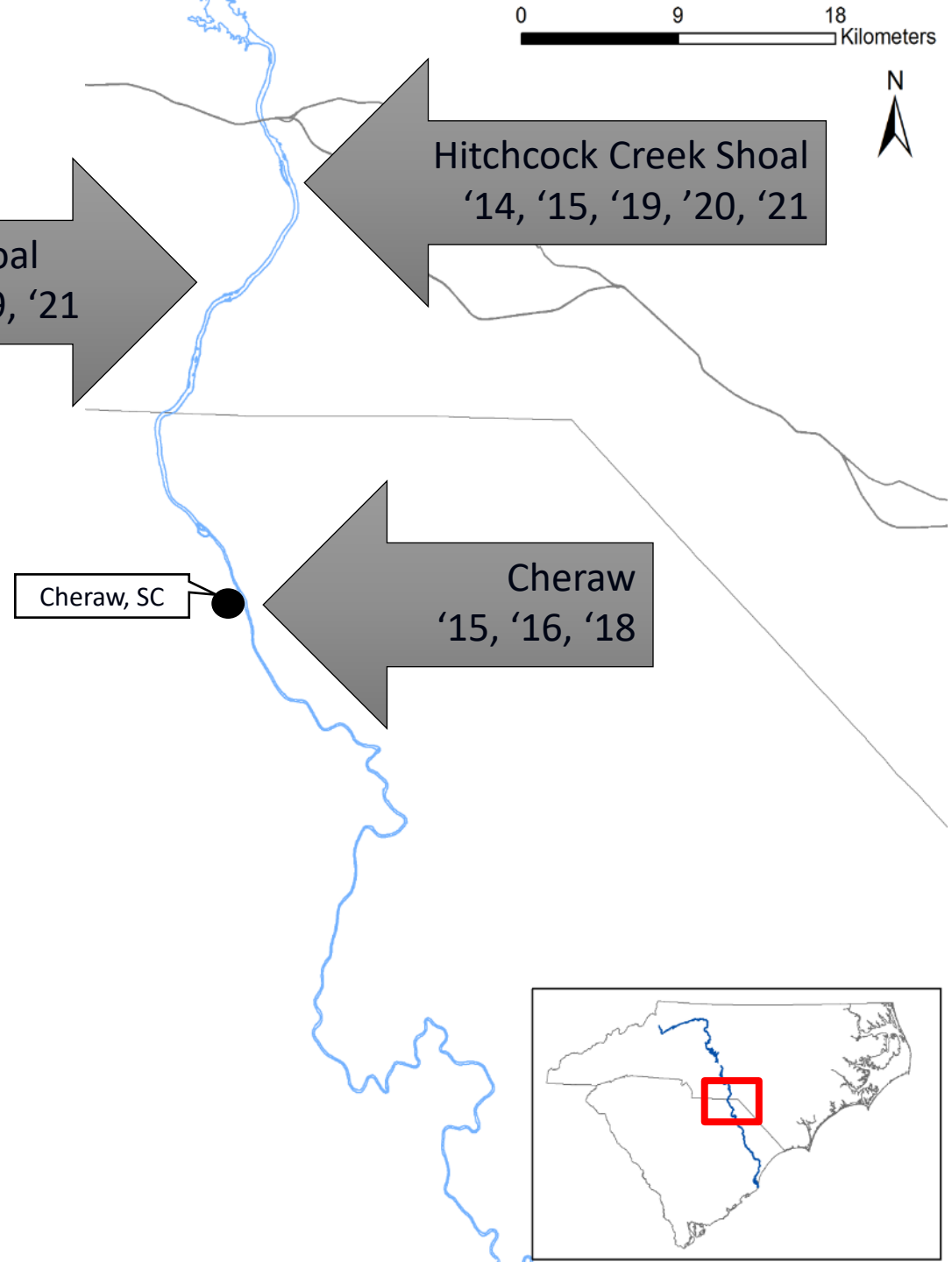
Fish Captured Per Pedal-Hour



During Targeted Sampling Only

Pee Dee River Stocking

- Hitchcock Creek Shoal
  - 23,475 Phase I
  - 739 Phase II
  - 51 Phase III (5 y.o.)
- Jones Creek Shoal
  - 12,472 Phase I
  - 1,311 Phase II
- Cheraw
  - 11,695 Phase I
  - 634 Phase II



Summary

- Successfully stocking 2-3,000 fingerlings/yr 2018-2021
- Capture numbers continue to rise
  - Many new females tagged in spring 2022
- Fish are observed, looking healthy, in active spawning condition on their natural shoals
- Successful recruitment documented from most stocked crosses at all stocking sizes
- There is some level of take in SC gill net fisheries
- Wild recruitment still critically low
  - Fish produce gametes, find each other, but unclear after that

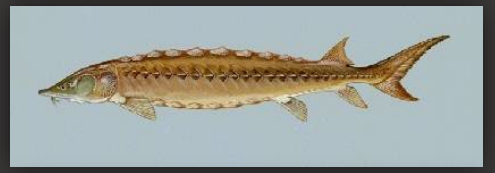
Unanswered questions:

- Why is recruitment of wild-spawned fish so low? How regularly do females spawn?
- What is the survival rate during the first 2-3 years of life? What aspects of this period differ from adulthood?
- Why do we see elevated hatchling mortality in hatcheries? Does this also happen in the wild?
- How are contaminants impacting RRH, which are most critical, & where can we make a difference?
- What is the scale of mortality due to invasive species? Due to take by humans?

Diadromous fishes

Bill Post

Anadromous - migrating from the sea to fresh water for the purpose of spawning.



Catadromous - migrating from fresh water to the sea for the purpose of spawning.

Atlantic Sturgeon
Acipenser oxyrinchus

Shortnose Sturgeon
Acipenser brevirostrum

Multi-state sturgeon study

- Federally-funded (NMFS) 3 year telemetry study (NCE) (2010-2014)

- State collaborators: NCSU, NCDMF, and UGA

Objectives:

1. Better address the distribution/migration range of both species of sturgeon

2. Identify critical habitat (foraging, spawning, potential impacted sites, etc.) for both species of sturgeon

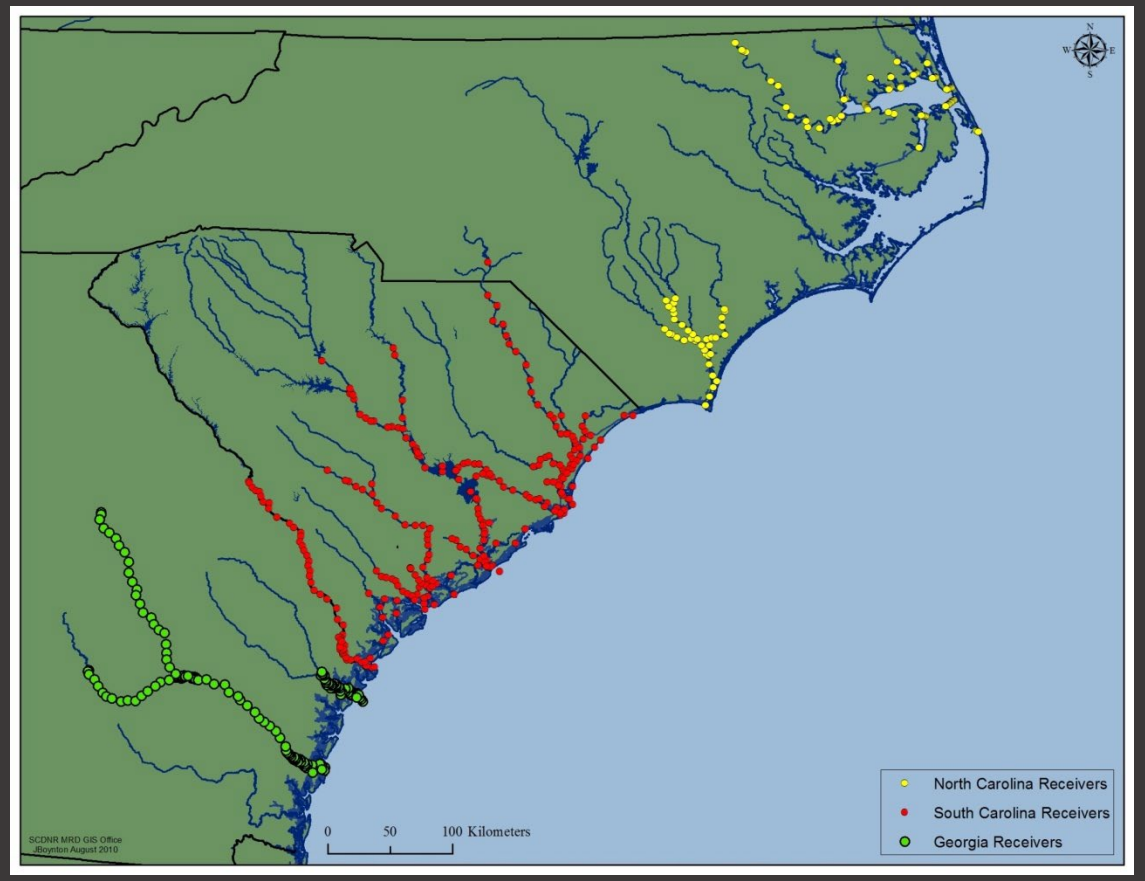
3. Document the degree of inter-basin transfer occurring for both species

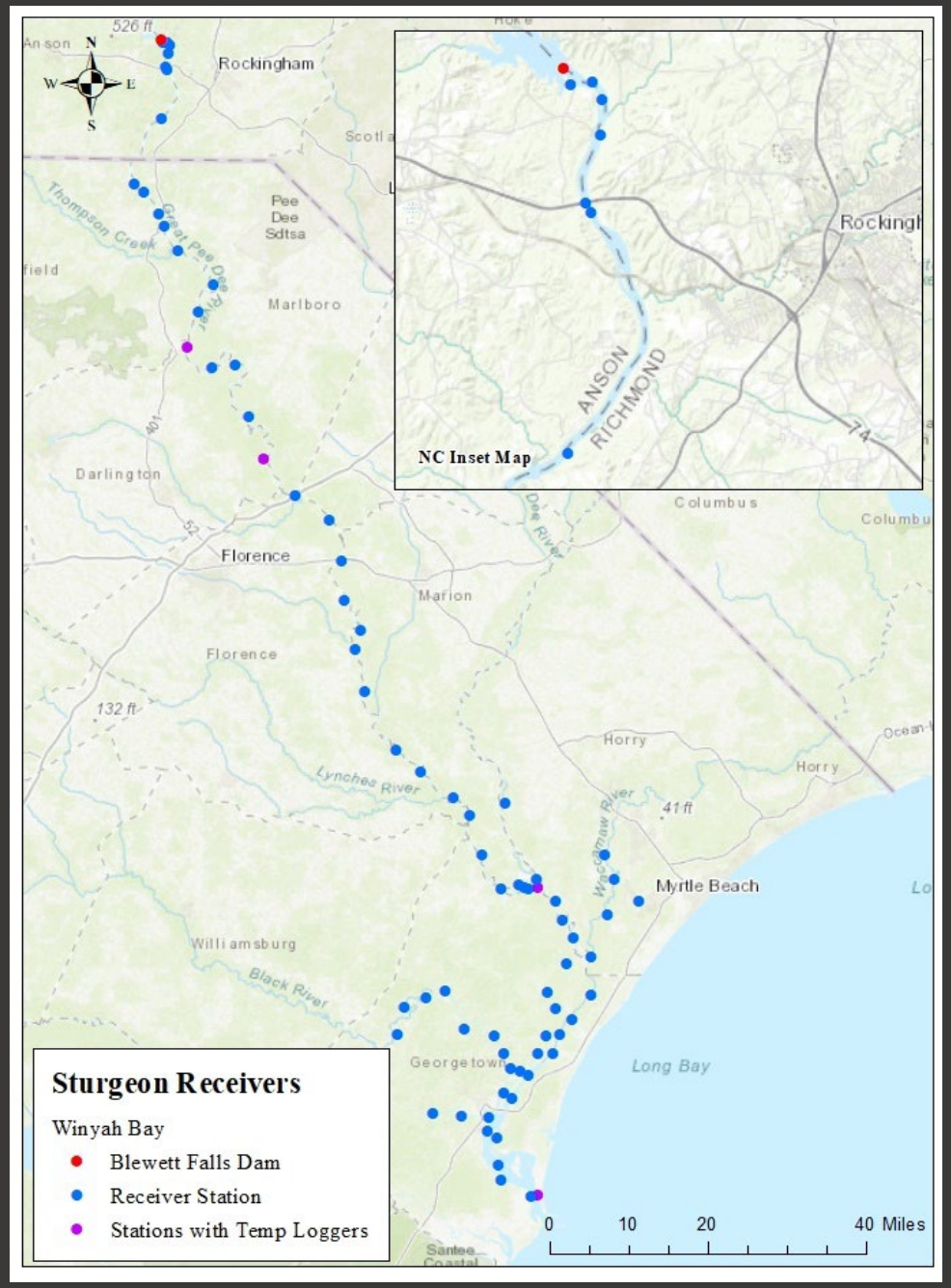
All work performed under ESA Permits 16442 and 20528-02

Receivers

- Deploy array of ~300 receivers in SC.
- In SC most major river systems, ICW, and sounds.

VR2W Receiver





2011-2022

- Great Pee Dee River and Winyah Bay System
- 76 receivers deployed over 325 rkm

2015-2022

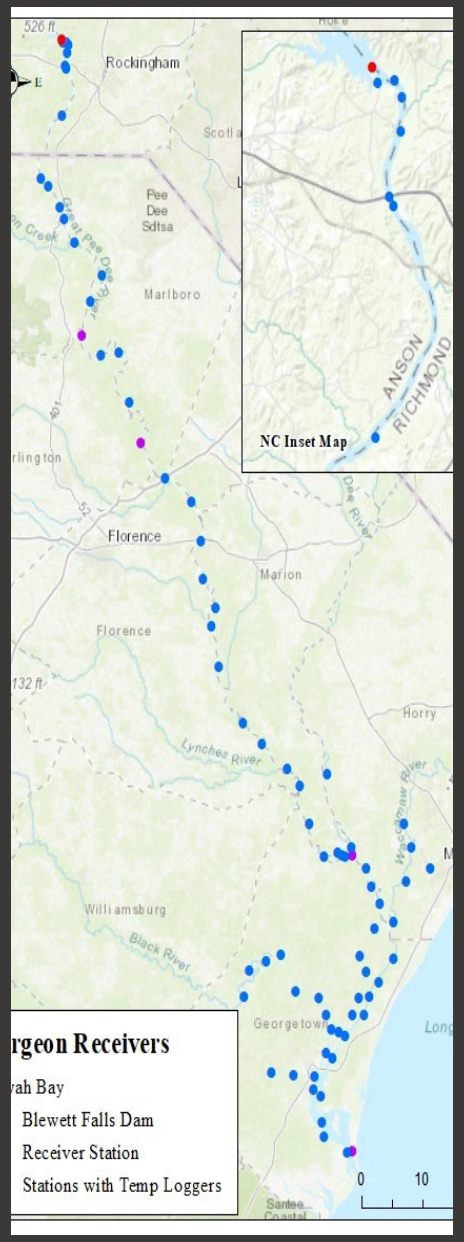
- Low level NMFS funding (purchase and maintain receivers)
- Funding through Duke Energy FERC license requirements

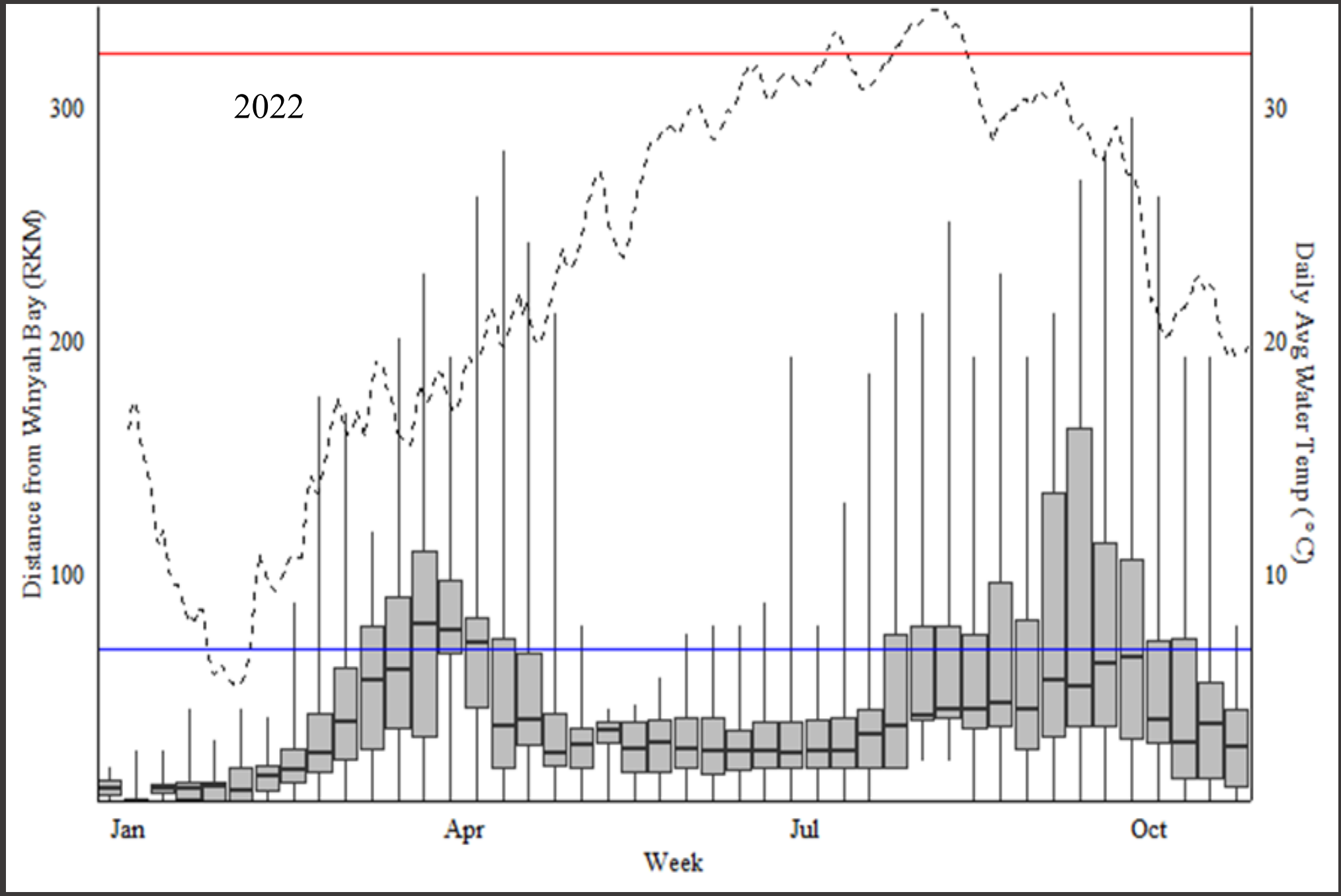
Tagged adult sturgeon

SNS	ATS
66	145

- Each transmitter has a 10-year life span

All work performed under ESA Permit 20528-04


Rockingham
Pee Dee Sdtsa
Marlboro
ANSON
RICHMOND
NC Inset Map
Florence
Marion
Florence
Horry
Williamsburg
Georgetown
rgeon Receivers
yah Bay
Blewett Falls Dam
Receiver Station
Stations with Temp Loggers
0
10


2022
Distance from Winyah Bay (RKM)
300
200
100
Daily Avg Water Temp (°C)
30
20
10
Jan
Apr
Jul
Oct
Week


45
46
47
48
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SC Stream Assessment and Small Rivers

Kevin Kubach

- Need for statewide, data-driven, proactive conservation framework

- Current status
- Relationships with aquatic habitat, watershed
- Response to changes in the landscape (e.g. development)

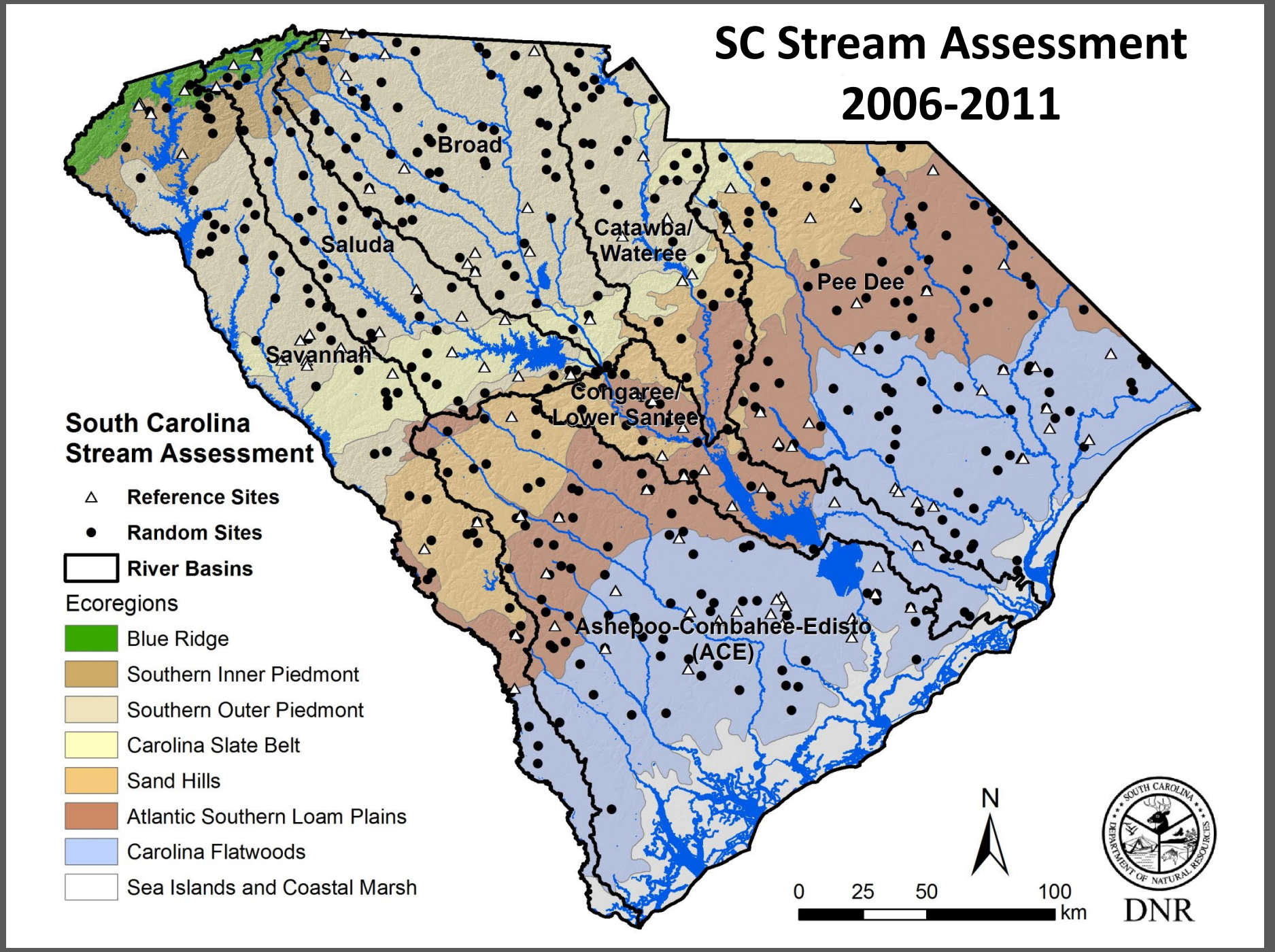
Wadeable streams (watersheds 4 – 150 km²)

Reference Sites (90) sampled annually by regional fisheries management staff

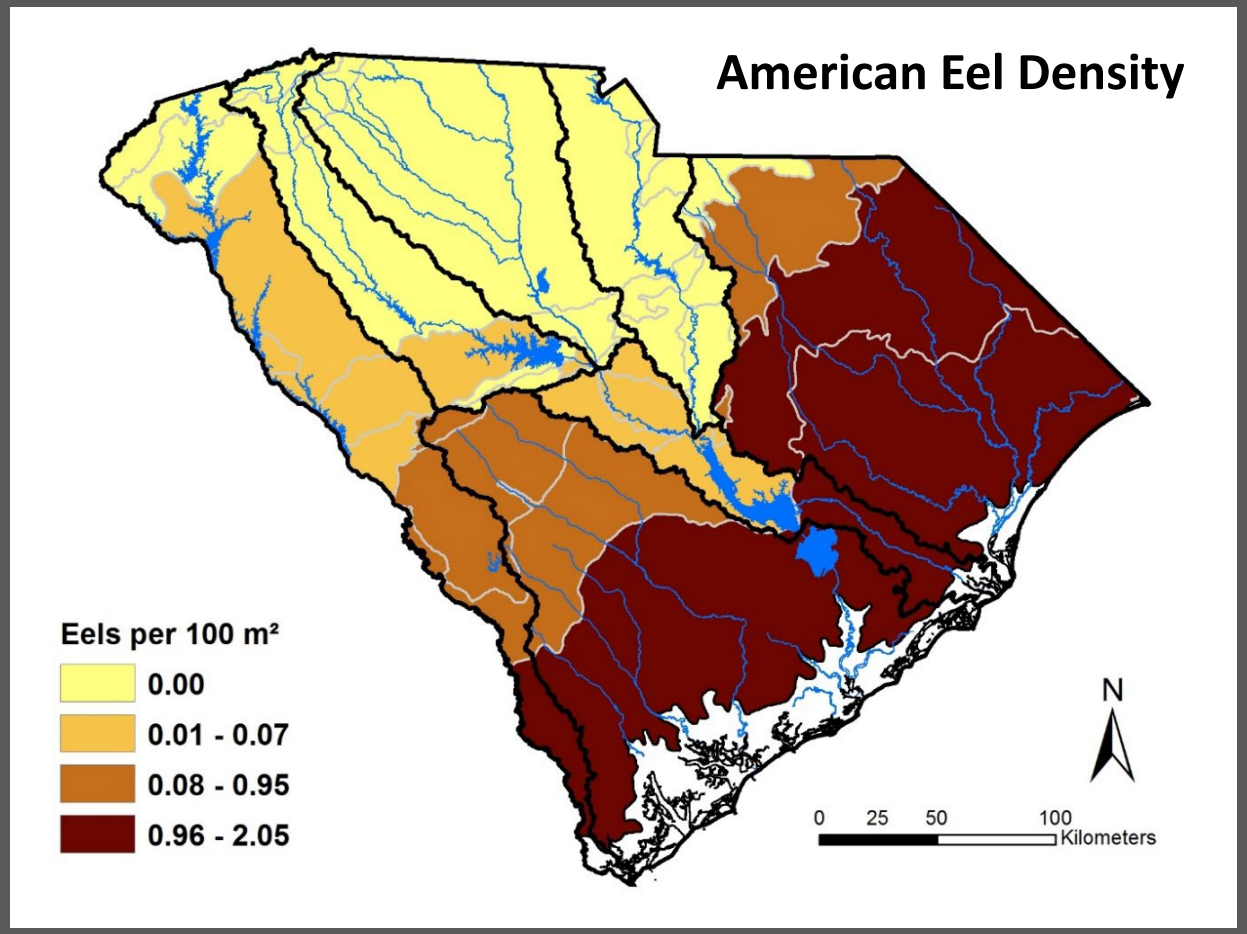
Random Sites (400) sampled by dedicated "Stream Team"

Standardized sampling

- Biota
- Habitat
- Water quality



Resource Estimates



American Eel Density (individuals per 100 m²)

STRATUM	Mean	95% CI
STATEWIDE	**0.73**	**0.33 - 1.13**
Watershed Area 75-150 km²	1.44	0.20 - 2.68
Watershed Area 25-75 km²	0.86	0.00 - 2.70
Watershed Area 4-25 km²	0.60	0.00 - 2.78
RIVER BASIN		
ACE	1.59	0.00 - 3.18
Pee Dee	1.04	0.44 - 1.64
Congaree /Lower Santee	0.62	0.08 - 1.16
Savannah	0.26	0.11 - 0.41
Saluda	0.004	0.00 - 0.01
Broad	0.00	0.00 - 0.00
Catawba/Wateree	0.00	0.00 - 0.00
ECOREGION		
Carolina Flatwoods	1.69	0.42 - 2.96
Atlantic S. Loam Plains	0.87	0.57 - 1.18
Sand Hills	0.14	0.05 - 0.22
Outer Piedmont	0.02	0.00 - 0.05
Slate Belt	0.01	0.00 - 0.01
Blue Ridge	0.00	0.00 - 0.00
Inner Piedmont	0.00	0.00 - 0.00

State Wildlife Action Plan
Freshwater Fishes

2005 Plan

- Professional judgement
- Limited by patchy data

DATA

- Stream Assessment species abundance, occurrence data

2015 Plan

- Quantitative Conservation Priority index employing standardized, statewide data

Sandhills Chub
Semotilus lumbee

- 9 species added
- 4 species removed

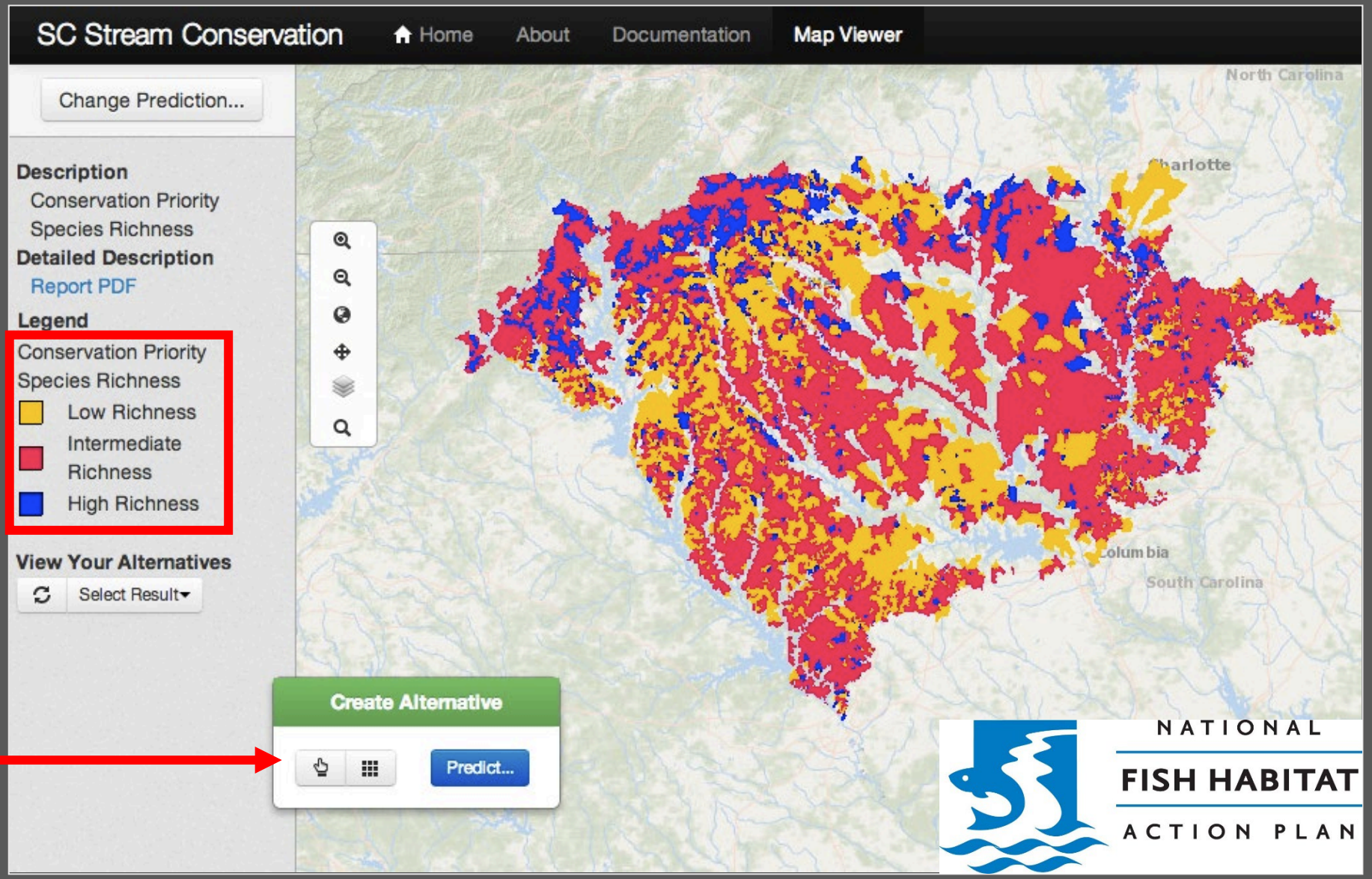
Stream Conservation Planning Tool

1) Model biological condition across watershed population

- NFHAP predictor data
  - Natural variables
  - Human disturbance
  - Land cover

2) Forecast response to human impacts

- User can adjust predictors and visualize effects (e.g. land use change)



Small River Assessment 2016-2020

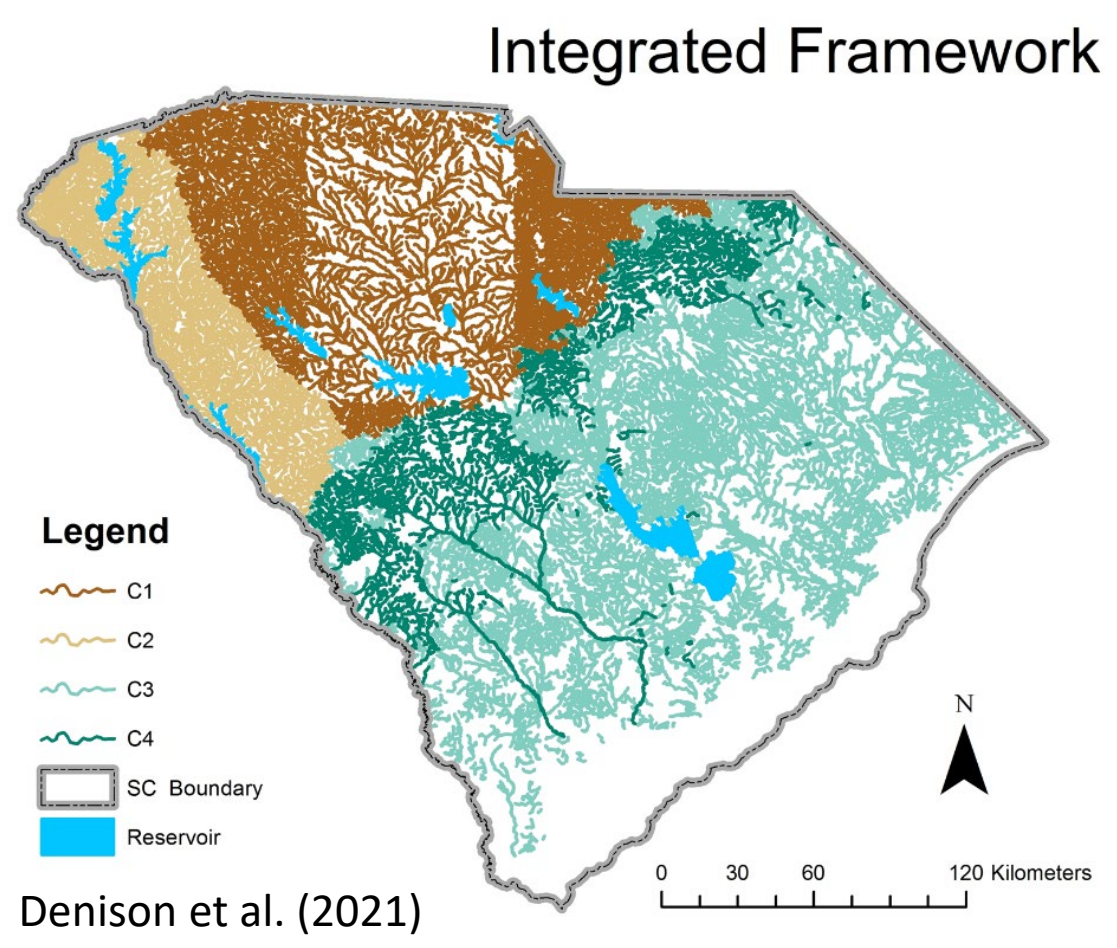
Watershed range: 150 km_2 to 2,000 km_2

Standardized sampling

- Biota
- Habitat
- Water quality

Black Mingo Creek

Development of a Biotic Index for Assessing Stream Integrity



Denison et al. (2021)

- Score determines whether stream meets, partially meets or does not meet the biological expectation for least-disturbed (reference) condition

	Meets Expectation	Partially Meets Expectation	Does Not Meet Expectation
Class 1	≥ 0.050	<0.050 to > -0.180	≤ -0.180
Class 2	≥ 0.002	<0.002 to > -0.300	≤ -0.300
Class 3	≥ 0.005	<0.005 to > -0.295	≤ -0.295
Class 4	≥ 0.299	<0.299 to > -0.046	≤ -0.046

Recreational Fisheries

Mid 90's creel survey:

- Catch was dominated by catfish, mostly blue catfish, but also flatheads and channel catfish
- Second main target was bream species, bluegill and shellcracker
- Recently there have been numerous bass tournaments out of Bucksport, Georgetown, and Yauhannah.

Commercial Fisheries

Mid 90's creel survey

- American shad and blueback herring-gillnetting season
- Catfish- mostly blues and some flatheads
- American eels- one of two states that allows a commercial harvest
- Carp and buffaloes-sell to pay ponds

Freshwater Mussels

Morgan Kern-SCDNR

29 Species occur in South Carolina

-20 Species in the Pee Dee Drainage are listed in the SWAP, species of greatest conservation need
- -Carolina heelsplitter- federal endangered
- -Atlantic pigtoe –state endangered

-1 Introduced species Asian clam

Serve as indicators of a healthy ecosystem
Filter large volumes of water, removing algae, bacteria, diatoms, and fine particulate organic matter

Major Threats:
Increased sediment
Runoff pollution such as household wastes, fertilizers, animal fecal material
Heavy metals and ammonia
Altered water flows

Freshwater crayfish

37 Native species found in South Carolina

-5 Species in the Pee Dee Drainage are listed on the SWAP

Genetic assessment of invasive crayfish dispersal in the coastal plain of the Pee Dee River Basin, U.S.A.

Michael R. Kendrick*, Matt J. Walker, Tanya L. Darden, Elizabeth B. Underwood, Peter R. Kingsley-Smith

South Carolina Dept. of Natural Resources
Marine Resources Research Institute

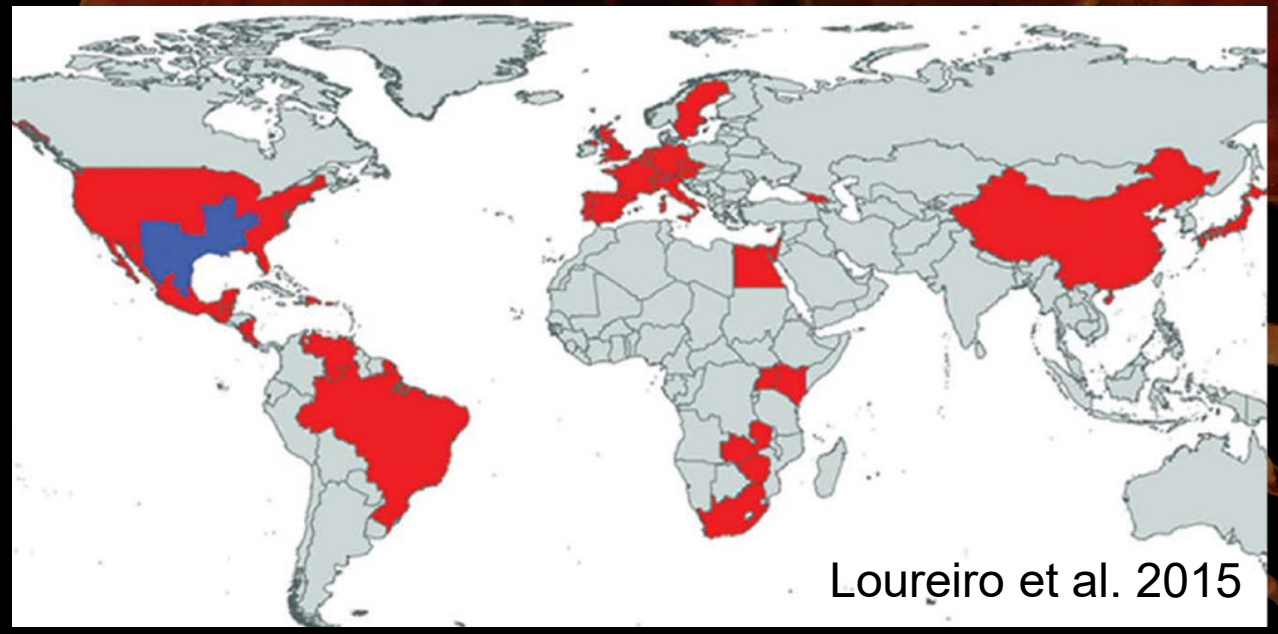
kendrickm@dnr.sc.gov

Invasive species spread globally (and locally)

- Non-native species that harm natural resources
- Cost $26.8 billion per year
  - Losses of goods/services/production
  - Costs of management
- Understanding their ecology is important for developing effective management strategies

Red Swamp Crayfish *(Procambarus clarkii)*: A global invader

Red Swamp Crayfish *(Procambarus clarkii)*: A global invader



Movement

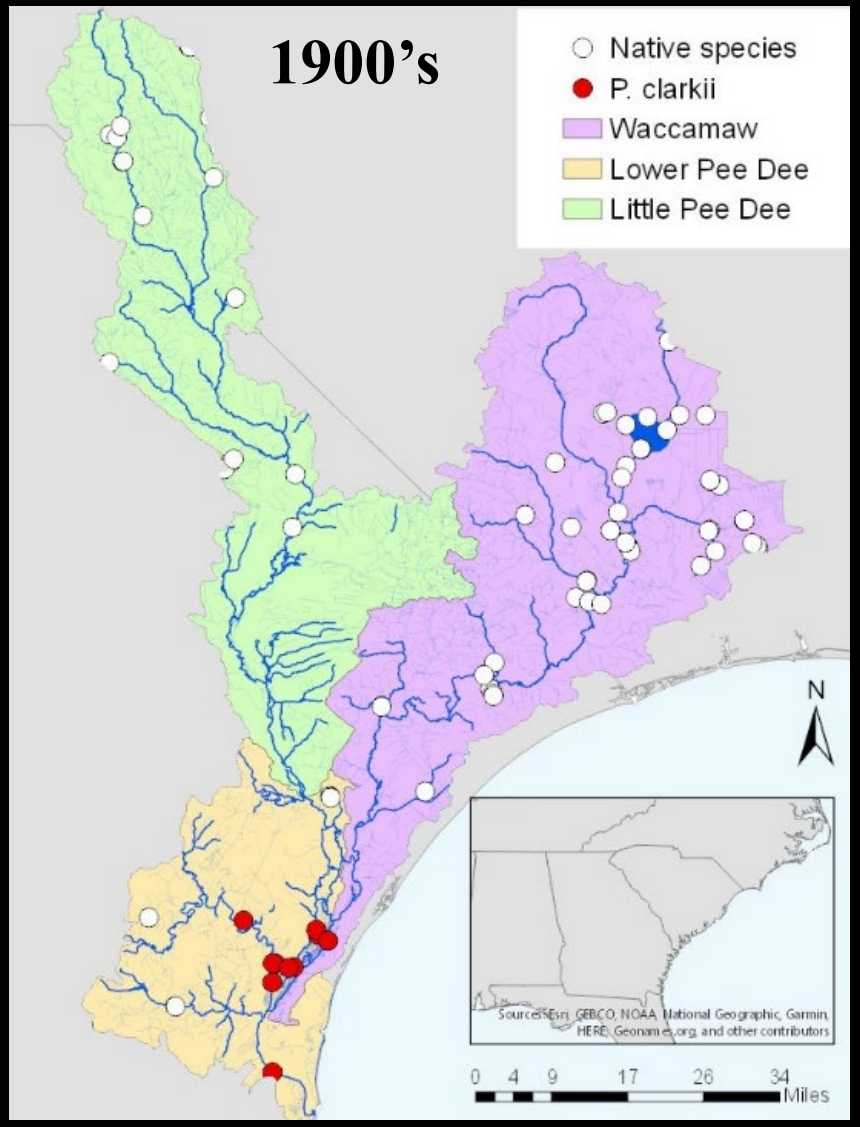
- Aquaculture, bait, aquarium trade
- Natural dispersal (in-water and overland)

Impacts

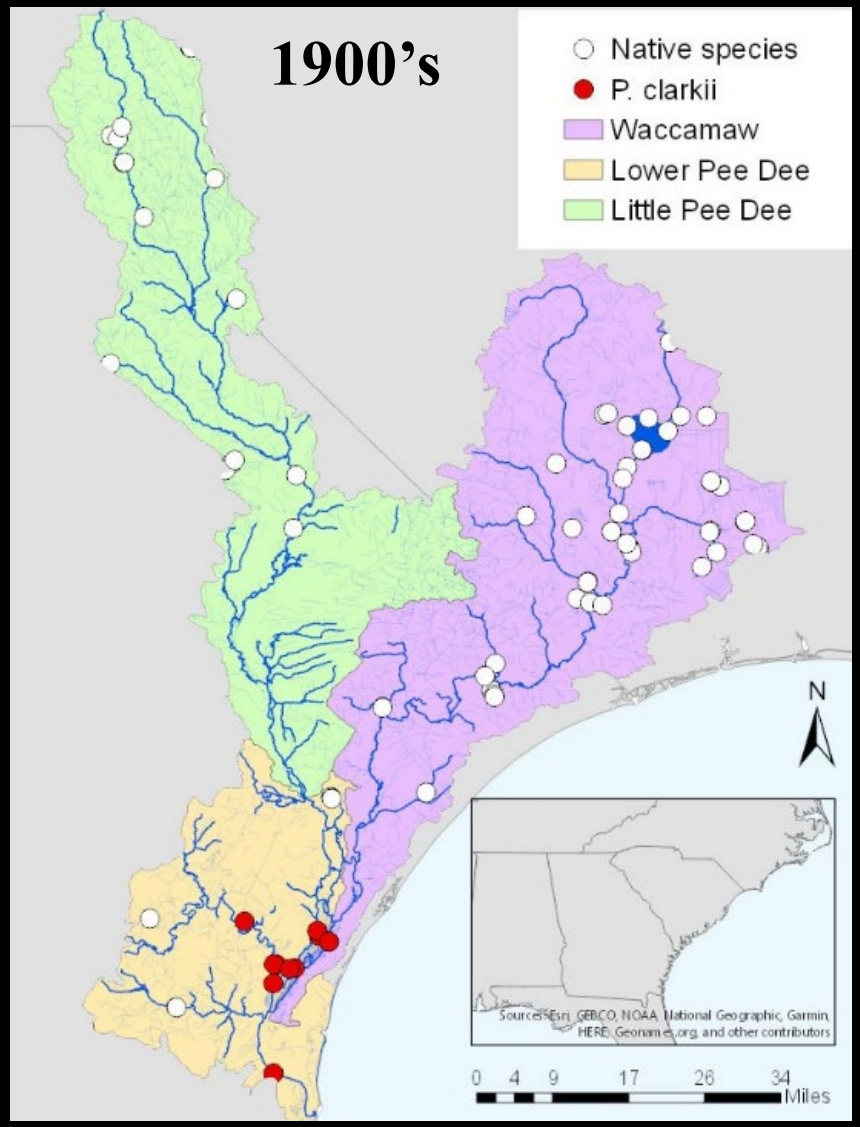
- Displaces native species
- Reduces macrophyte density
- Vector for parasites and disease

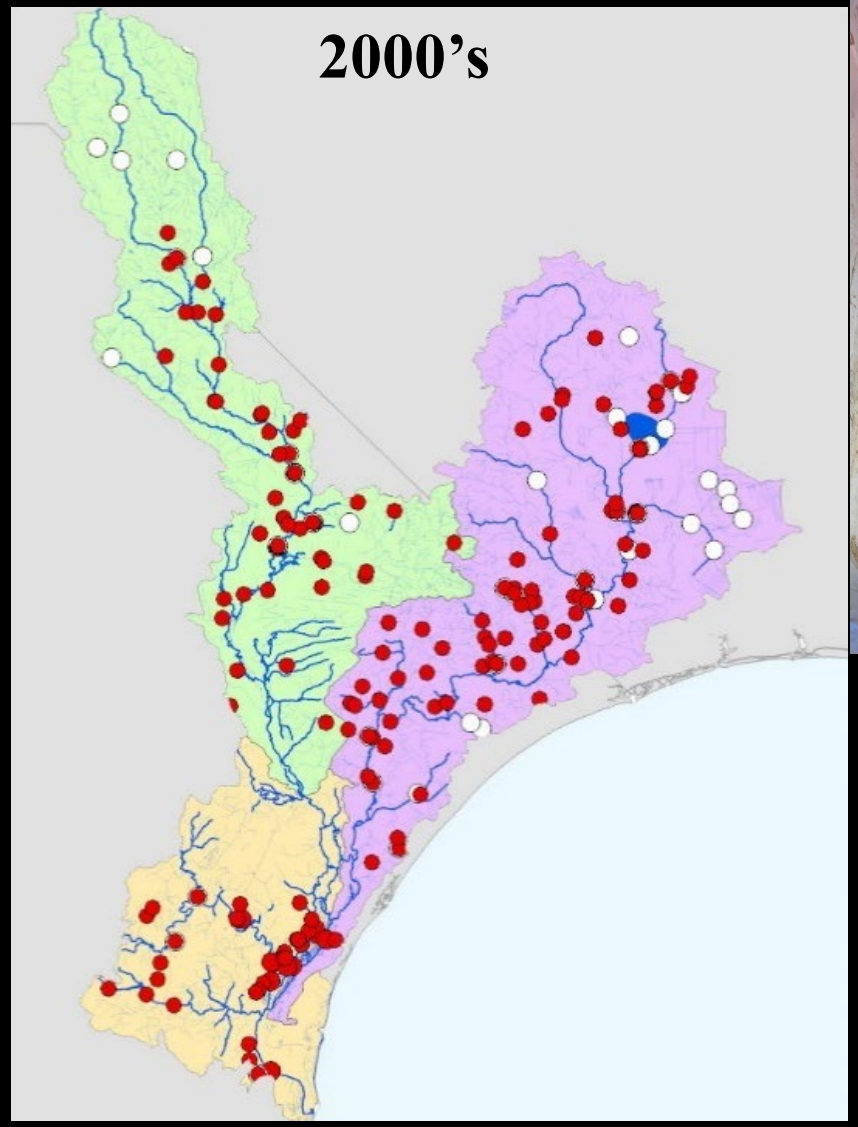
1. Document the spread
2. Infer dispersal patterns
3. Assess impacts on native crayfishes

Compile historical crayfish data

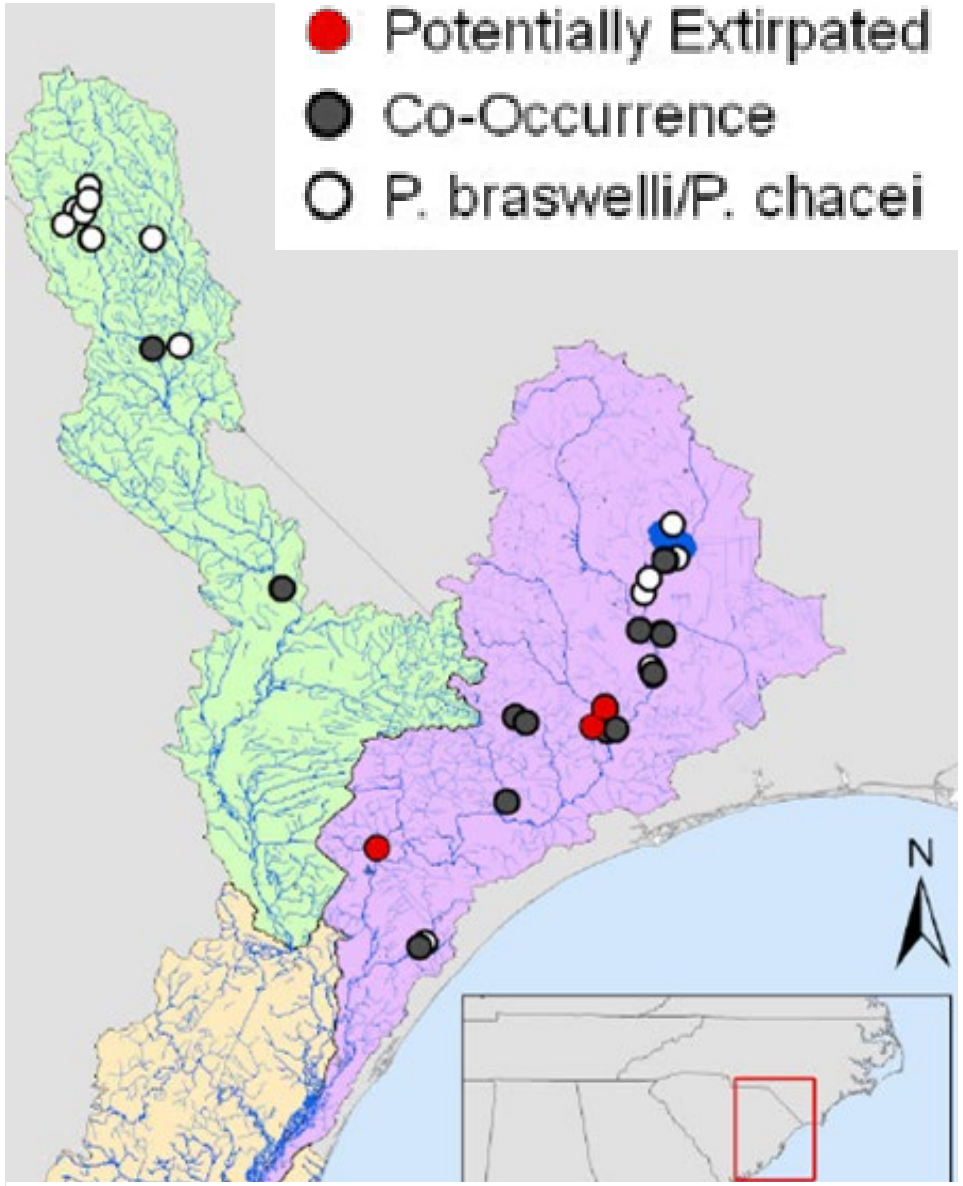


Document the spread

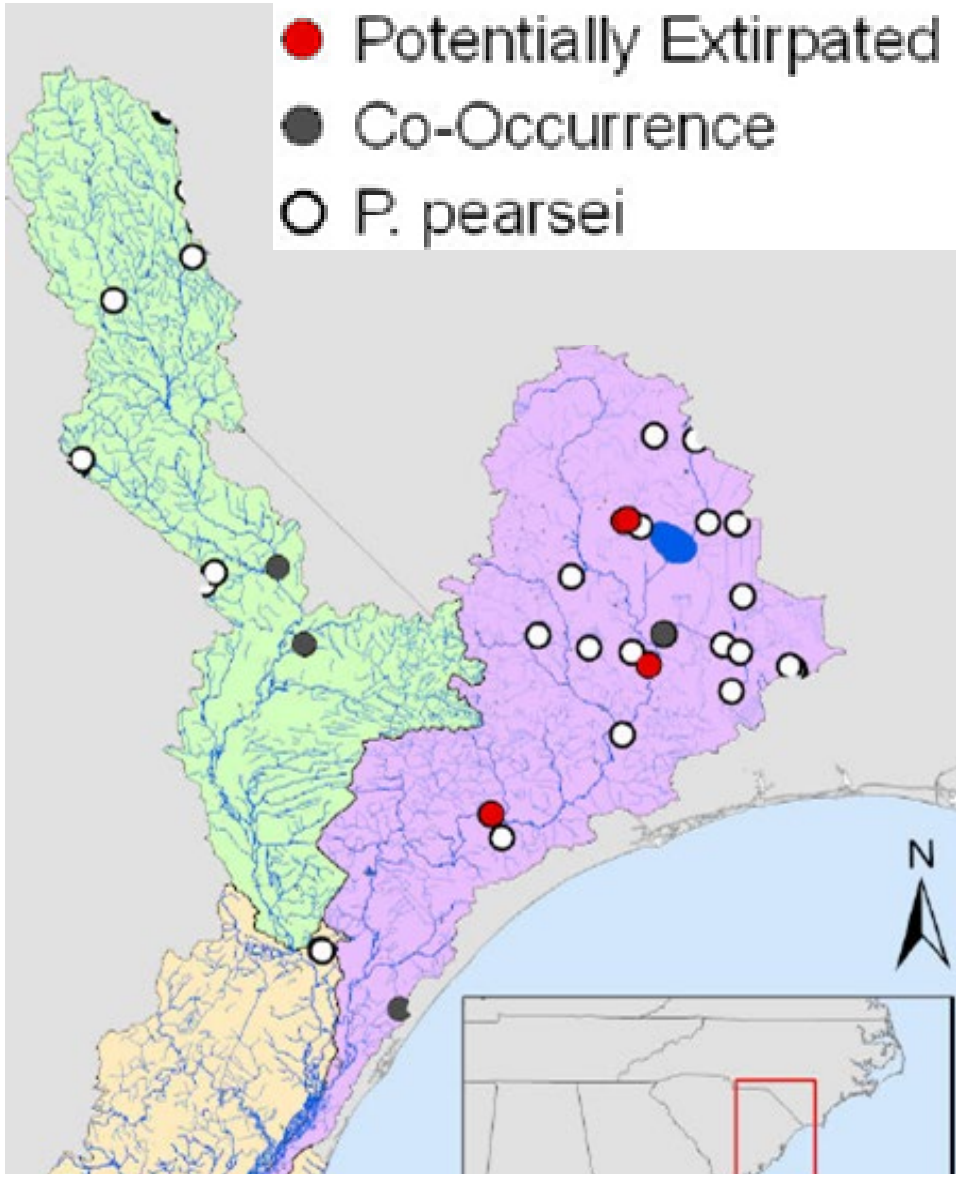




Impacts on native species



P. braswelli/chacei



P. pearsei

Help reduce the spread of invasive species

- Minimize moving animals
- Prevent escape artists

SCDNR Instream Flow Policy – Biological Justification

- Fish and other aquatic life need water
- Riverine aquatic life require sufficient flows to sustain biotic integrity
  - Reduced flows impact spawning migrations and success, decrease habitat availability, negatively effect water quality and increase silt deposition

Instream Flows Yadkin-Pee Dee Hydroelectric Project

Elizabeth Miller

2007 Comprehensive Relicensing Settlement Agreement
-NC Division of Water Quality 2008 Certificate
-Duke Energy's FERC license- Article 403

Blewett Falls

Time Period	Minimum Flow Requirement
Feb 1 to May 15	2,400 cfs
May 16 to May 31	1,800 cfs
June 1 to Jan 31	1,200 cfs

*cfs as measured on an average daily basis

Additional Projects

Little Pee Dee River- 2022-2024- Fish Community Study
- ongoing Redbreast stocking events

Waccamaw River- 2015-2017 Fish Community Study
2018 Hurricane Florence fish kill
2019-2021 Fish Kill recovery study
-ongoing Largemouth bass stocking events

Black River- 2018-2019- Fish Community Study

Thank you!