Distribution, Demographics, and Impacts of the Island Applesnail (*Pomacea maculata*) in South Carolina: Past, Present and Future Research Efforts

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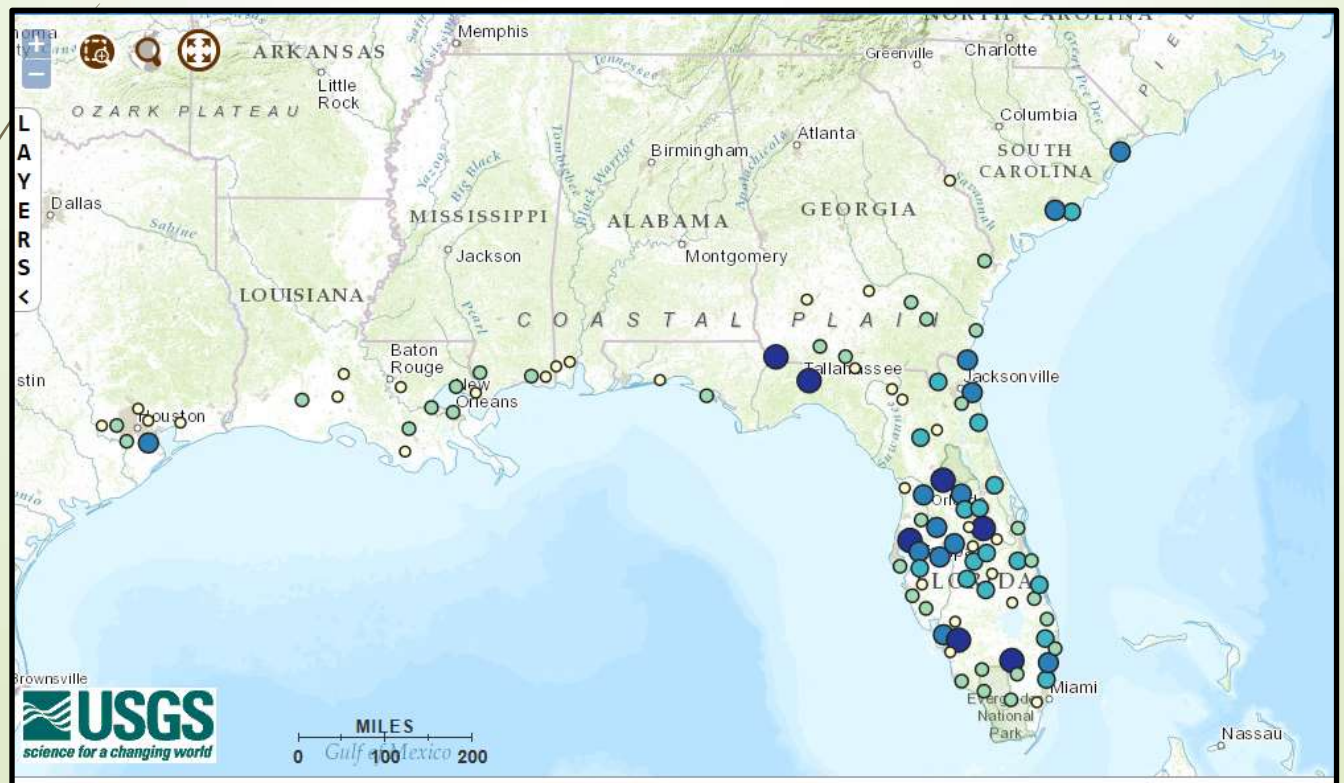
Origins and Distribution

- *Pomacea maculata* was formerly known as *P. insularum*
- Still some debate over the taxonomy of *Pomacea* spp.
- *P. maculata* is native to parts of South America
- First reported in the U.S. in Florida in 2002
- Now distributed throughout much of South Atlantic



Origins and Distribution

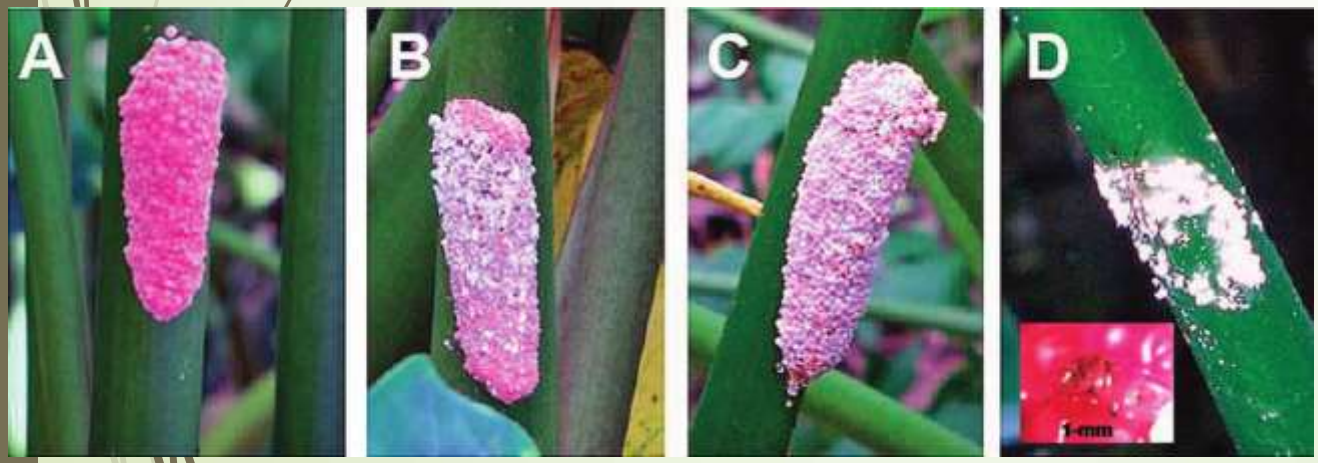
- In SC, *P. maculata* first reported in Socastee (Myrtle Beach) in 2008. Currently 3 populations in SC.

Diet / herbivory

- Higher rates of feeding and growth than most native freshwater snails (Baker *et al*., 2010)
- Consume a wide variety of aquatic vegetation; compete with native spp. (Morrison & Hay, 2011)
- Introduced to consume unwanted plants
- Agricultural pests

Early maturity / High fecundity

- Reach maturity as early as 3 months old
- Females each deposit at least one egg mass per week from April – September (Barnes *et al.*, 2008)
- Each egg mass contains ~2000 eggs, each yielding 10-140 snails

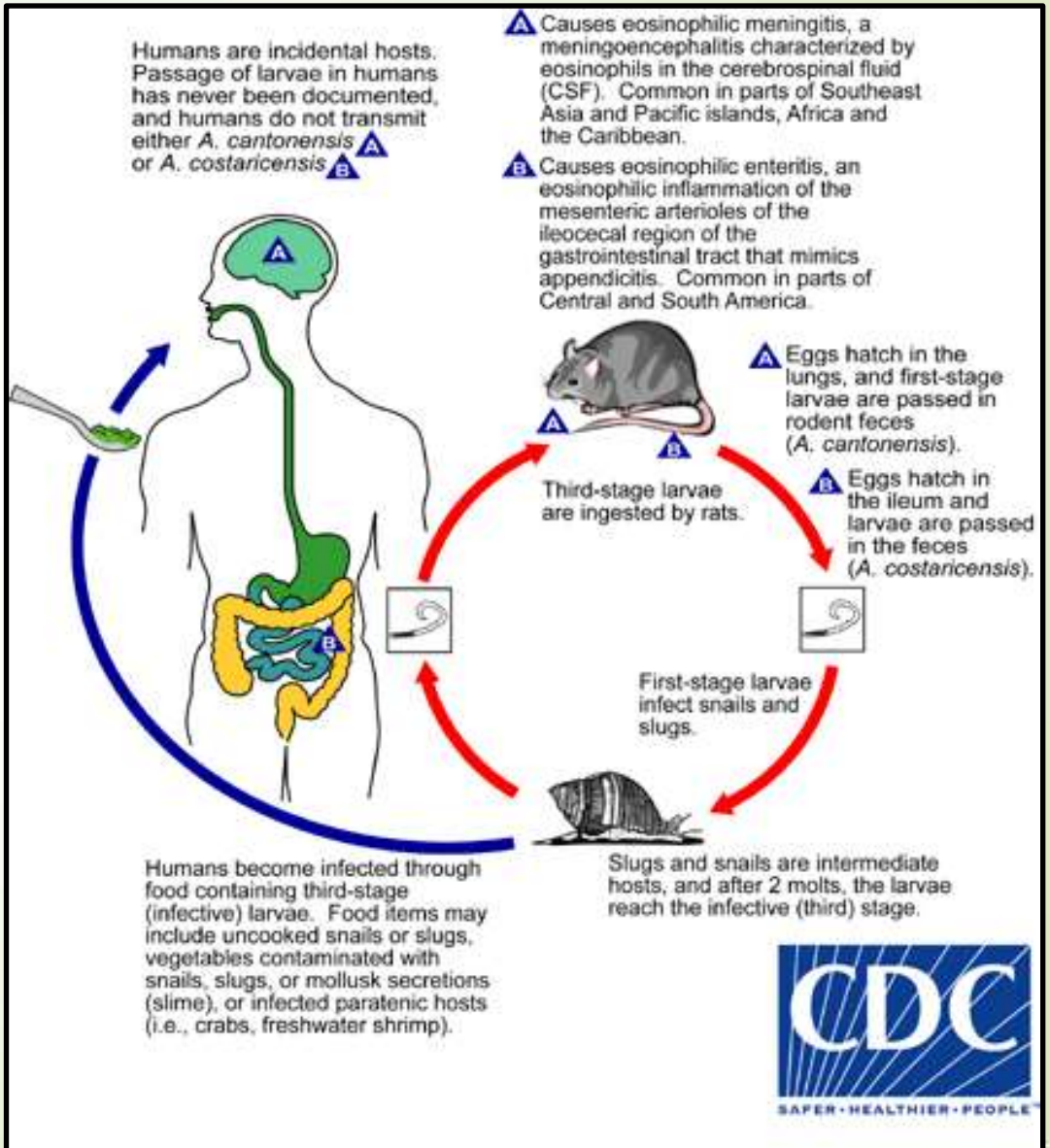


From Barnes *et al.* (2008)

Human health concern

Pomacea maculata can serve as an intermediate host for the rat lung worm parasite, *Angiostrongylus cantonensis*.

Teem *et al*. (2013)



Recent Research Questions:

Are there additional populations of *Pomacea maculata* in *other* stormwater ponds in South Carolina, outside of the three known areas?

- Distribution Survey in 2015

What is the seasonality of snail capture and reproductive activity (egg-laying) of *P. maculata* in SC?

- Bi-weekly Survey, West Ashley Pond, 2015-2016

For the known populations of *P. maculata* in SC, is this invasive species present in additional ponds within those systems?

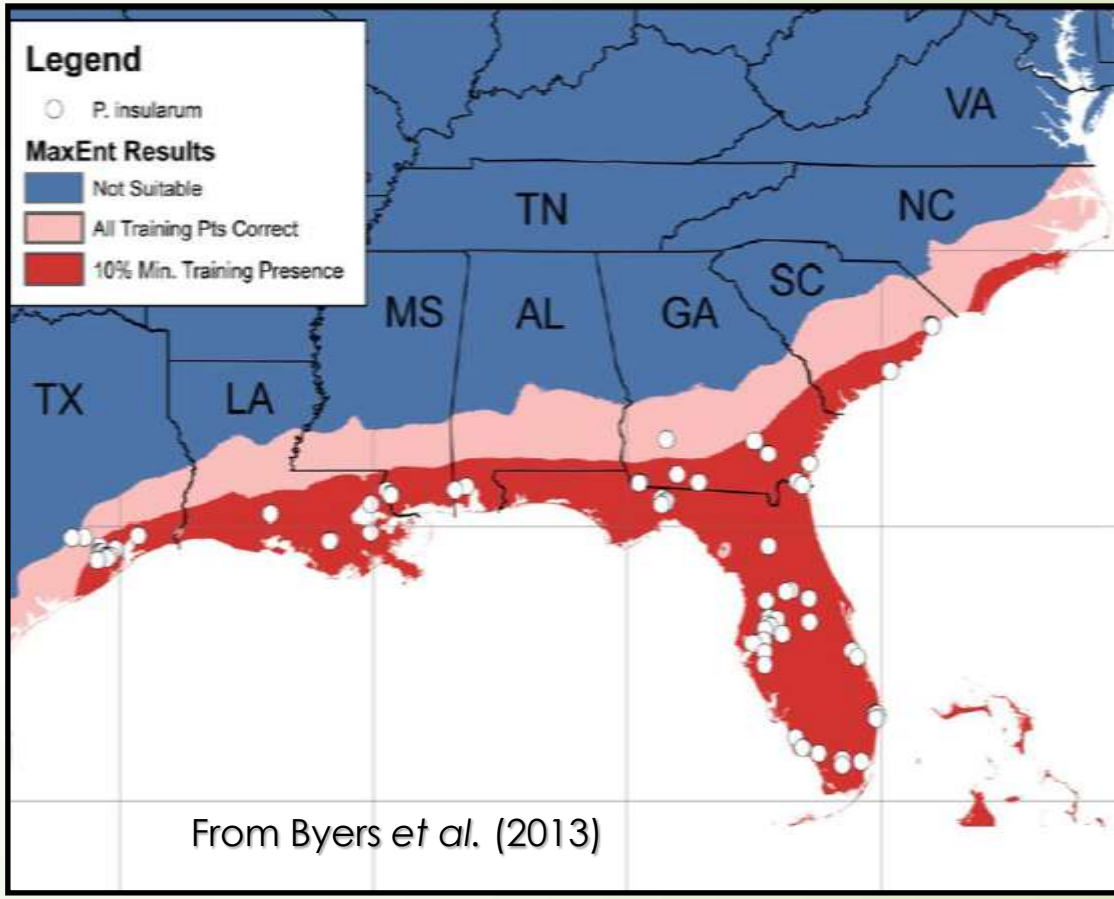
- Spread survey in 2015

Study Sites

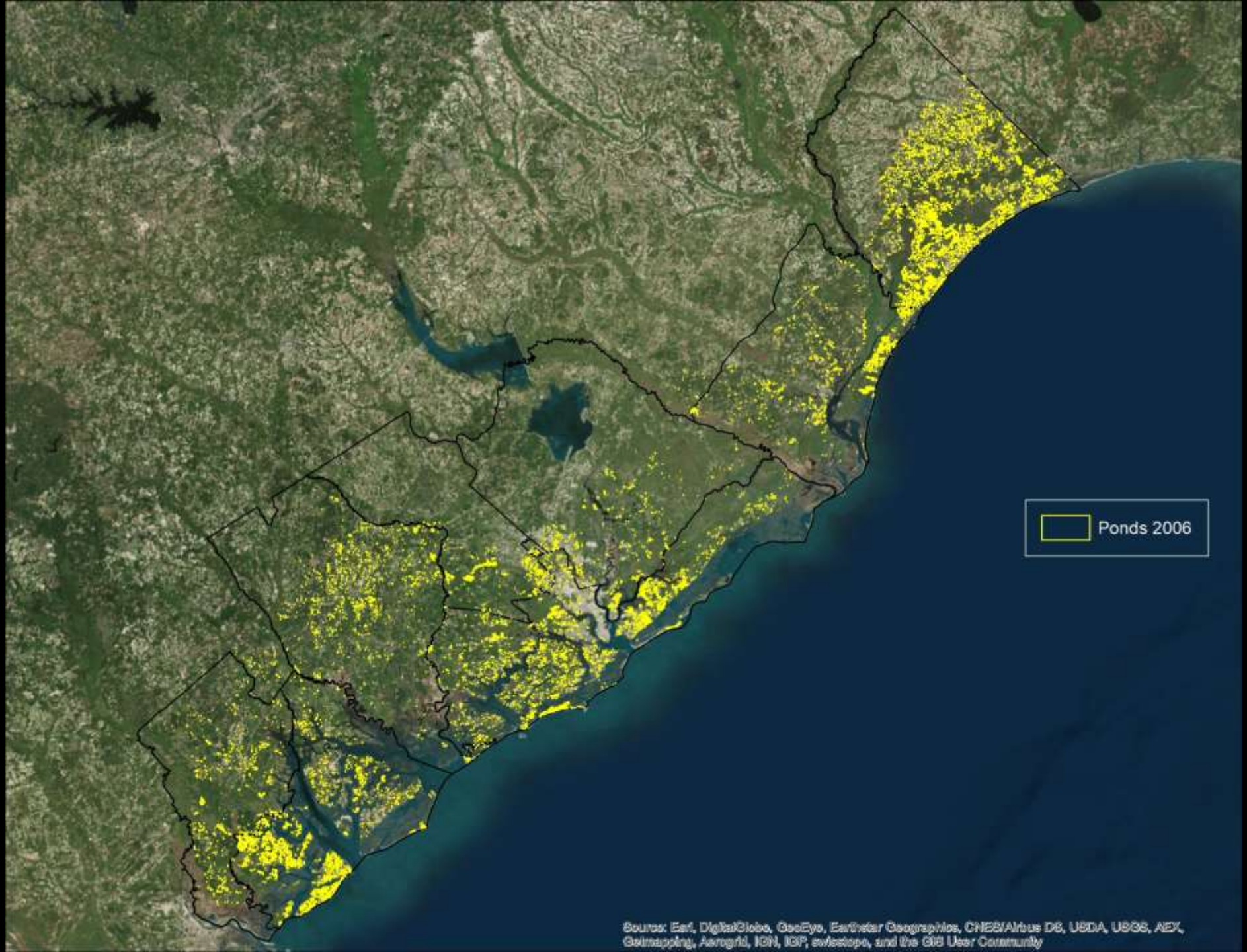
- Distribution Survey – coastal counties of SC
- Bi-weekly Survey – West Ashley, SC pond only
- Spread Survey – West Ashley and Myrtle Beach, SC

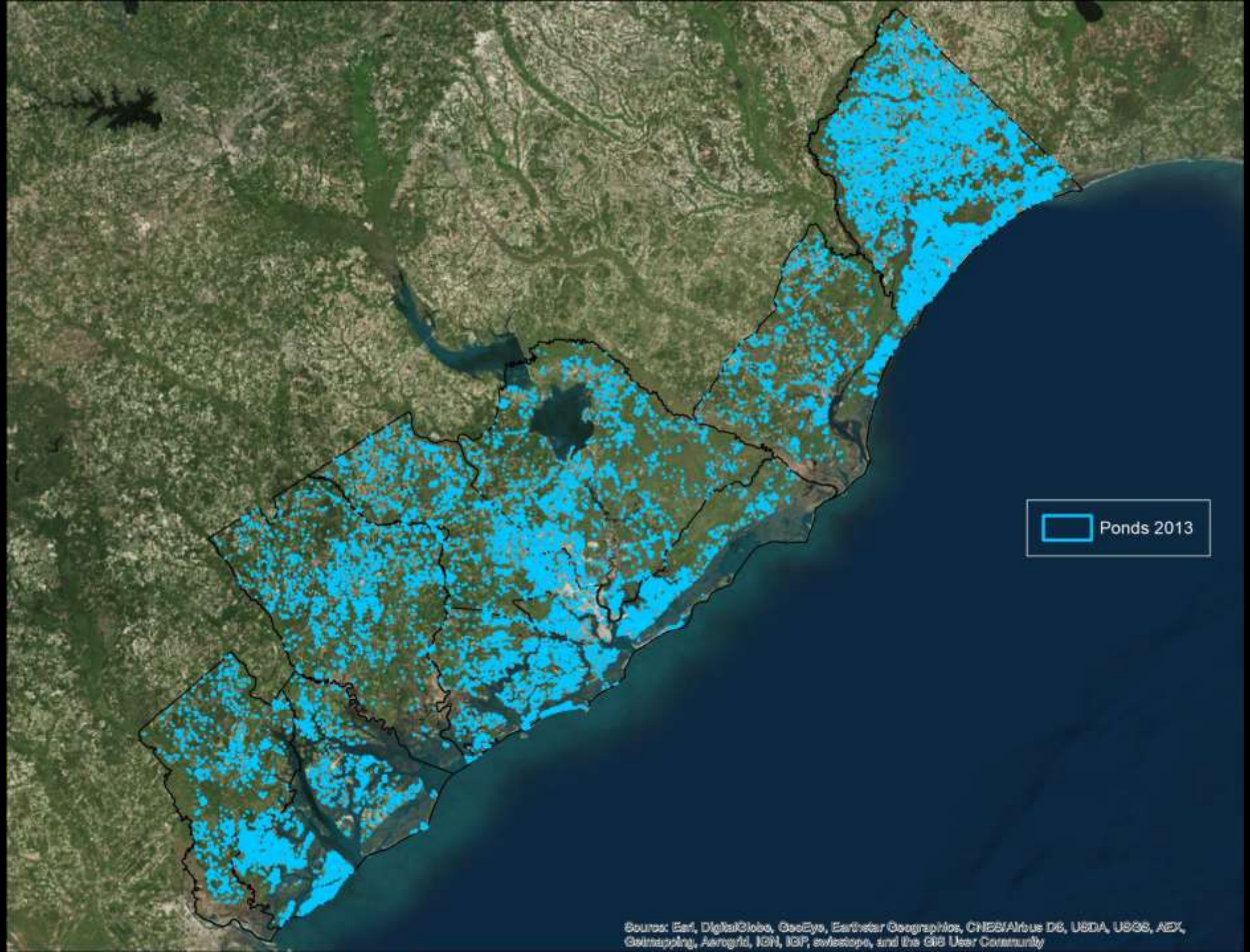
Distribution Survey

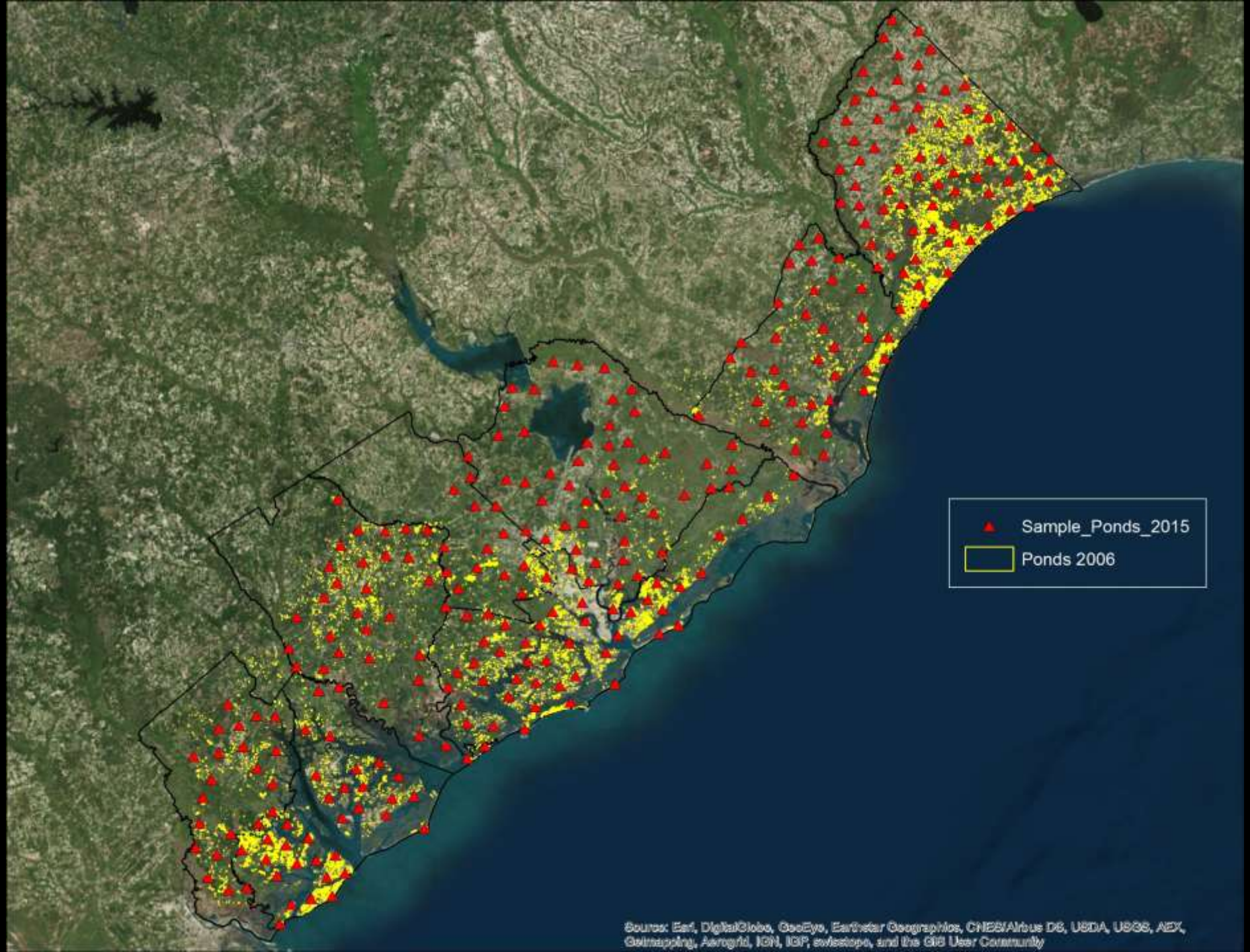
- Using Byers *et al.* (2013) model, we randomly selected 100 ponds throughout coastal SC
- Used stormwater retention pond GIS data layer to locate ponds. Surveyed ponds on residential, commercial, and agricultural lands



From Byers *et al.* (2013)


Ponds 2006
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


Ponds 2013
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


Sample_Ponds_2015
Ponds 2006
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Distribution Survey

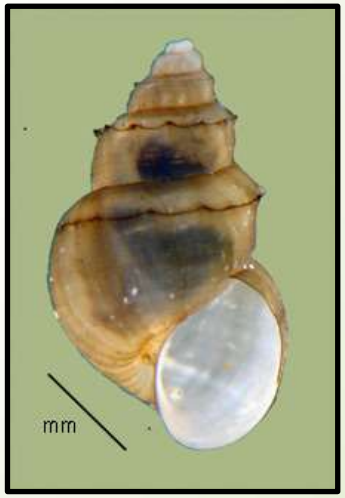
- Perimeter of pond determines the number of "rake sites" (i.e., site every 100m). A clam rake and a garden rake scrape the top 3 cm of the pond.
  - Pond perimeter surveyed for snails and egg masses
  - Record pond characteristics (vegetation, substrates) and pond water quality
  - Snails and egg masses are counted for each substrate type, and all accessible egg masses destroyed

Distribution Survey

- No new *P. maculata* populations were found among the 100 randomly selected ponds. Populations may be very localized.
- 4 other invasive freshwater snail species were found on Hilton Head Island.

Bellamya japonica

Biomphalaria havanensis



Pyrgophorus parvulus

Melanoides tuberculata

Bi-weekly survey, West Ashley

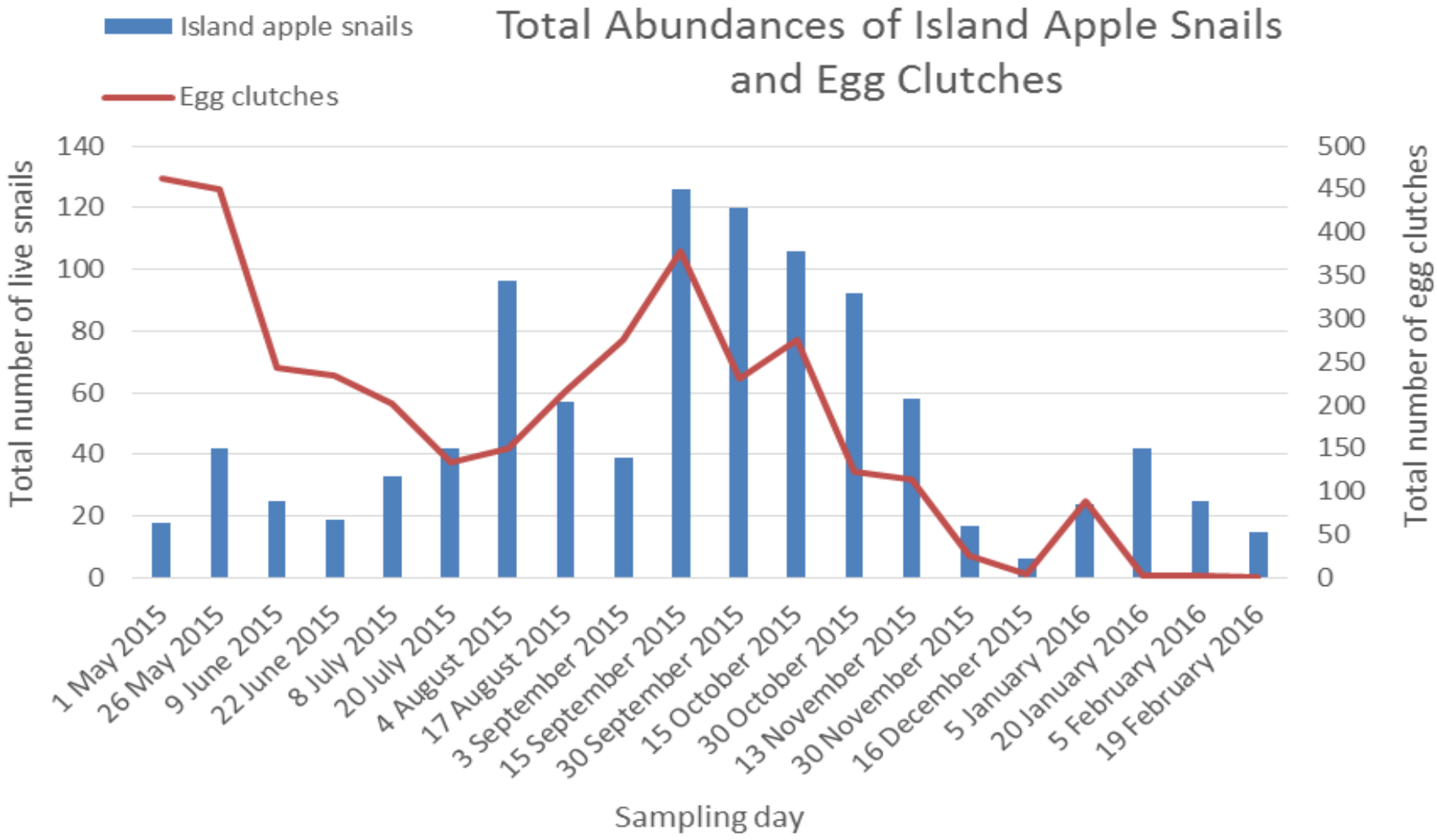
Bi-weekly survey, West Ashley

- Sampling pond in West Ashley bi-weekly (May 2015 – May 2016)
  - Visual surveys and rakings
  - Collect water quality data (temperature and conductivity)
  - Collect all snails found
  - Destroy all egg masses (and making notes on those that are not accessible)

Bi-weekly survey, West Ashley

- On the first day of this survey, we collected 60+ snails and collected dozens of egg casings

Bi-weekly survey, West Ashley



Bi-weekly survey, West Ashley

log(# snails) = -0.035 + (0.886 * log(air temp.))

Adj. R^2=0.0372 F=1.734 dF=1 p=0.204

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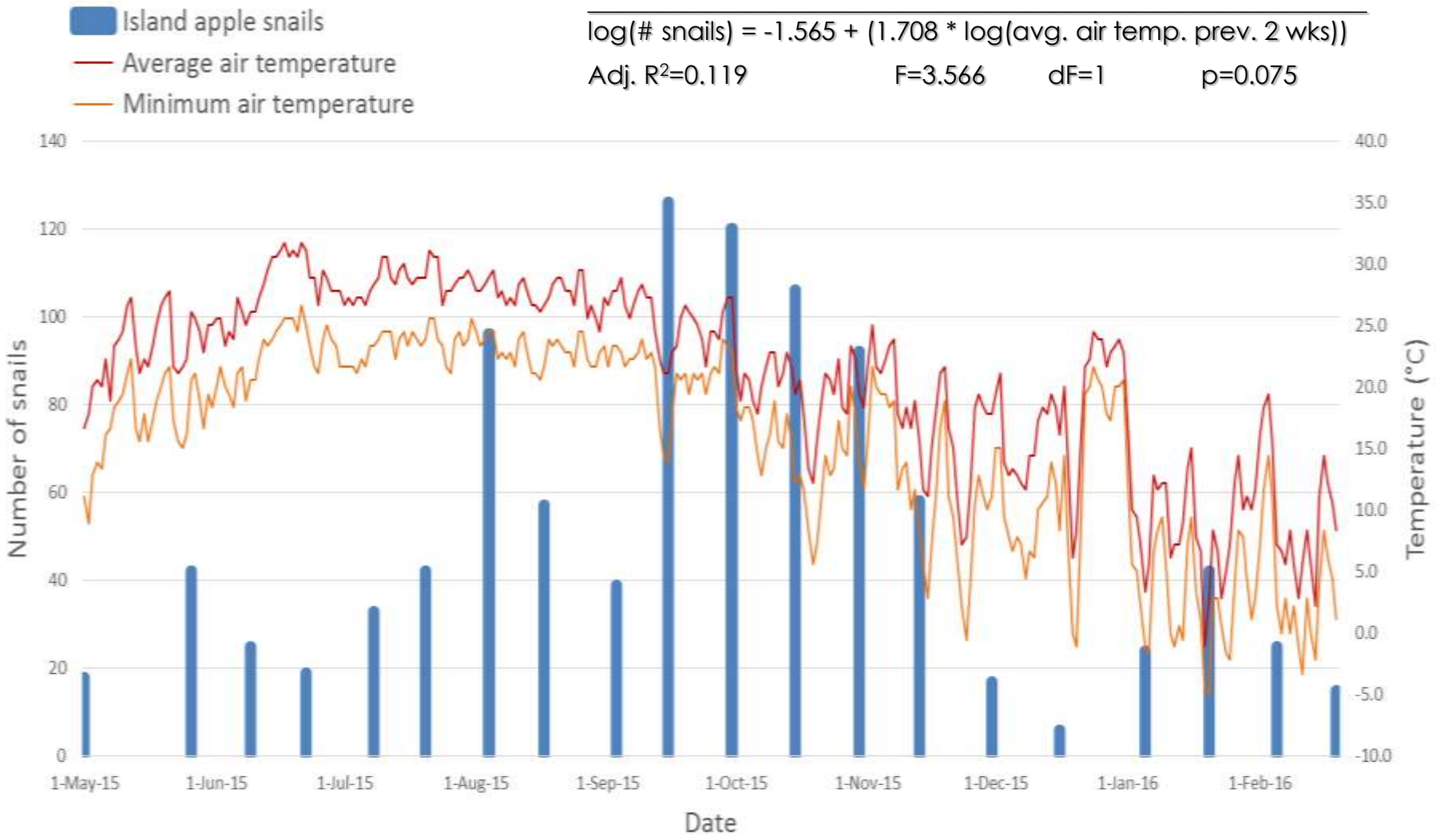
log(# snails) = -1.565 + (1.708 * log(avg. air temp. prev. 2 wks))

Adj. R^2=0.119 F=3.566 dF=1 p=0.075



Bi-weekly survey, West Ashley

log(# egg clutches) = -7.323 + (5.064 * log(air temp.))

Adj. R^2=0.476 F=18.26 dF=1 p<0.001

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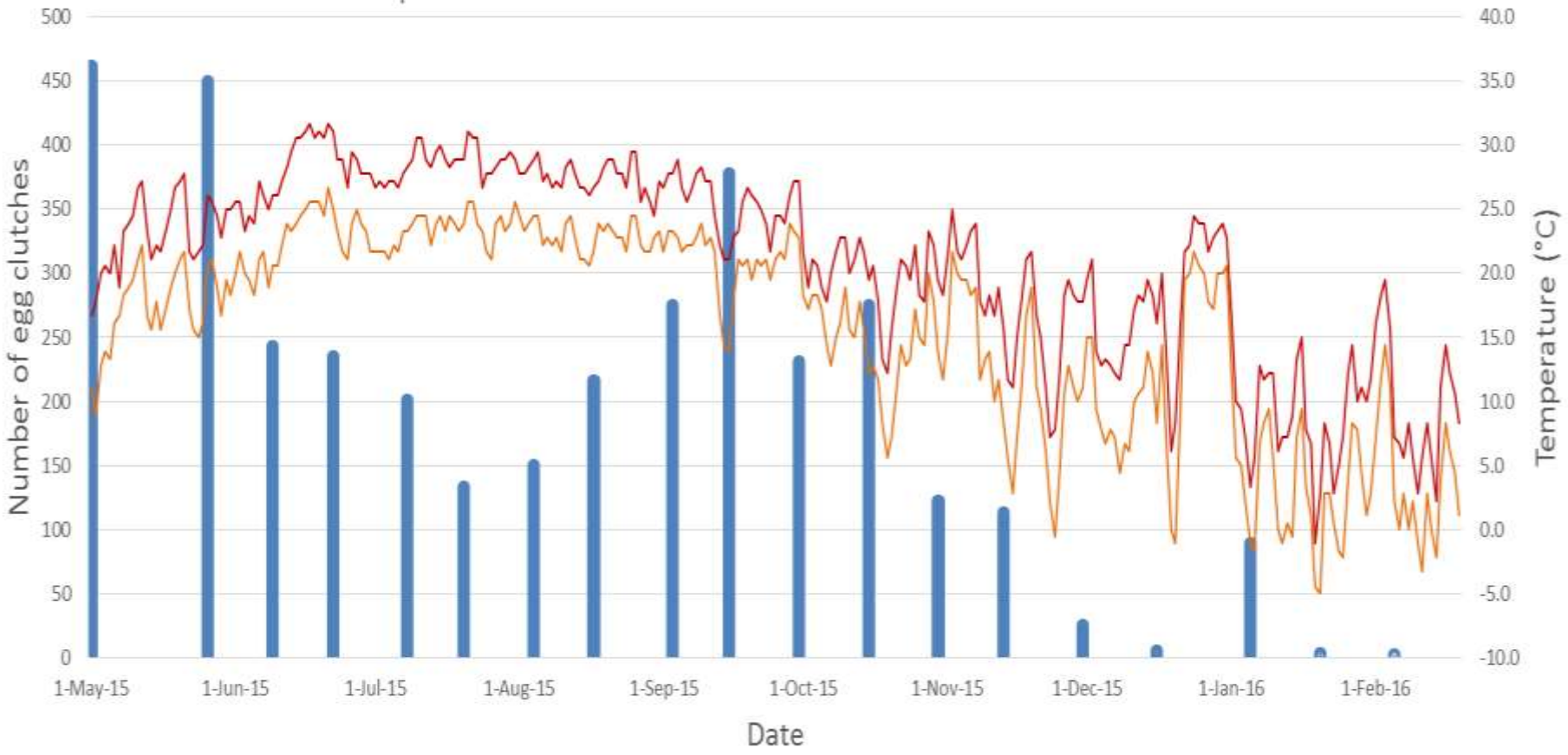
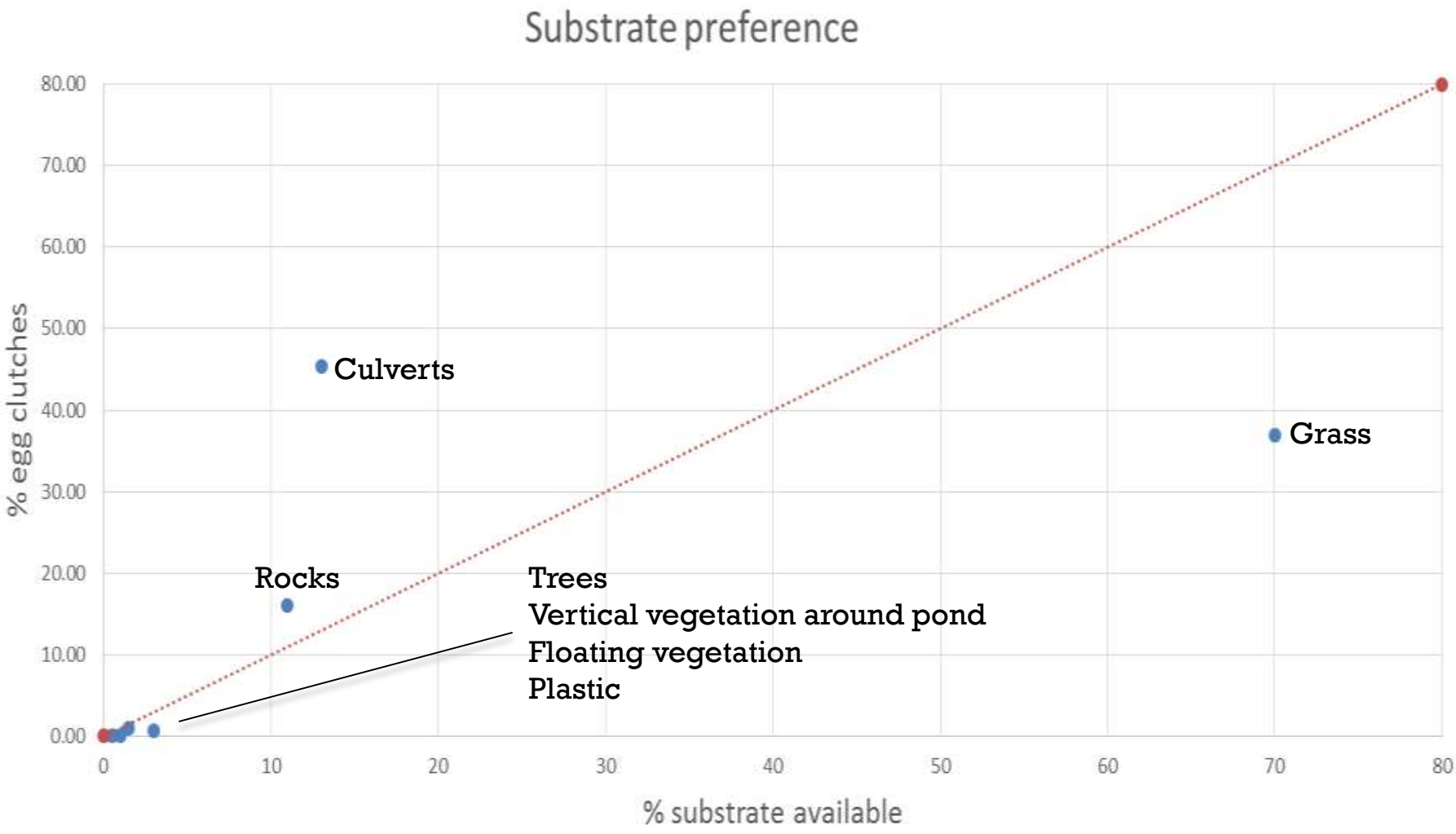
log(# egg clutches) = -14.223 + (8.761 * log(avg. air temp. prev. 2 wks))

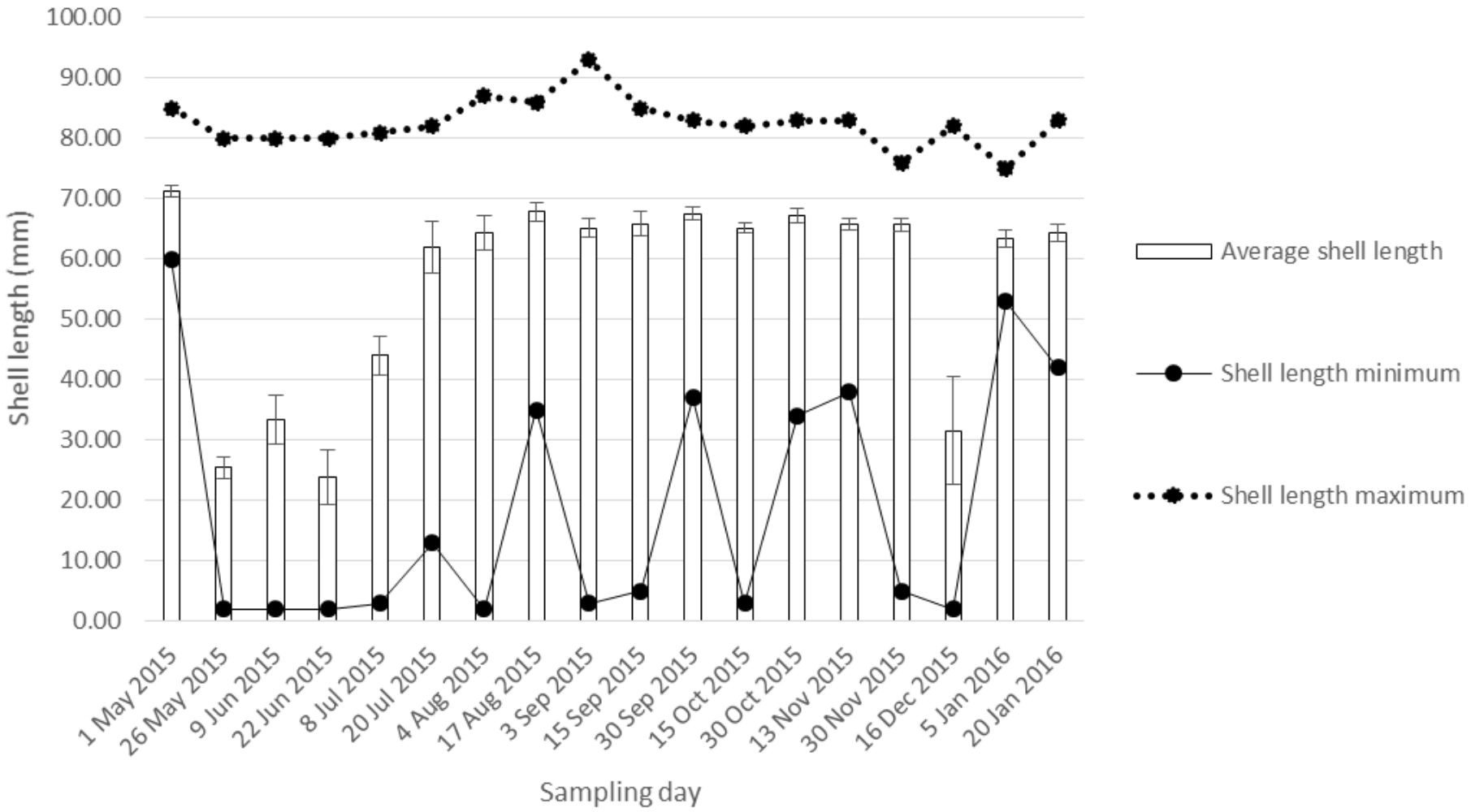
Adj. R^2=0.750 F=57.996 dF=1 p<0.001



Bi-weekly survey, West Ashley



Bi-weekly survey, West Ashley

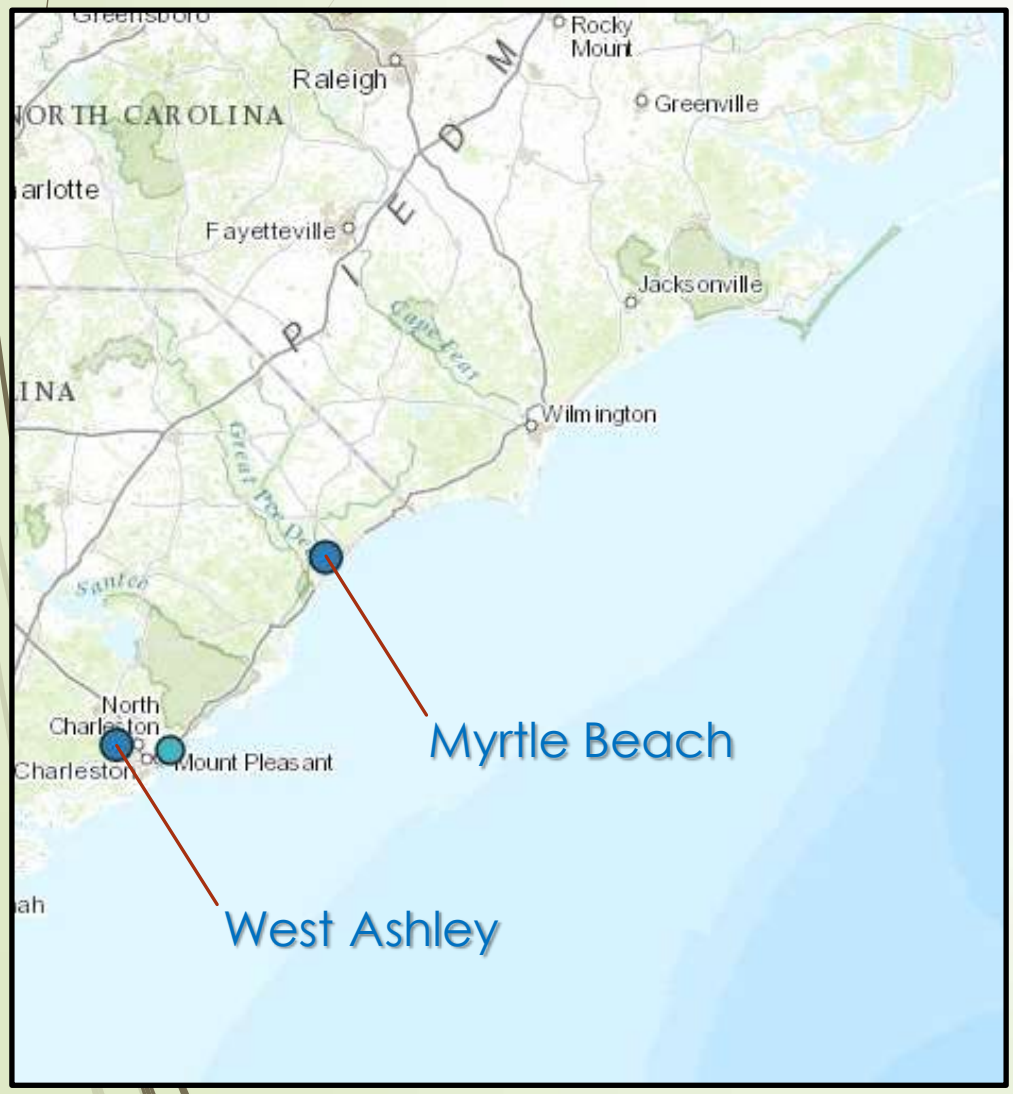


Spread Survey

Potential mechanisms for spread

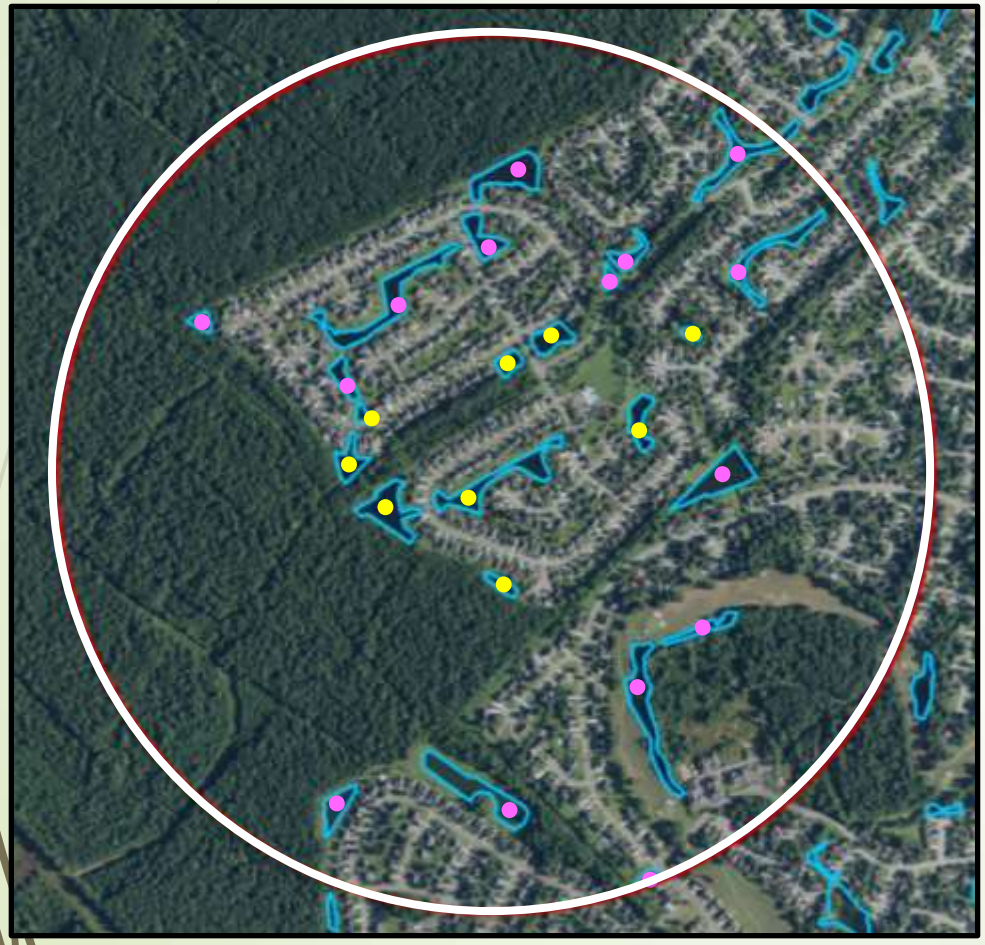
- Stormwater pond connectivity
- Predators
- New human introductions
- Flooding, large rain events

Spread Survey



- Surveyed all ponds within 0.5-mile radius of known established *P. maculata* population
- Conducted visual surveys of pond perimeters and rake site sampling
- Surveyed 1 area in West Ashley and 3 areas in Myrtle Beach

Spread Survey

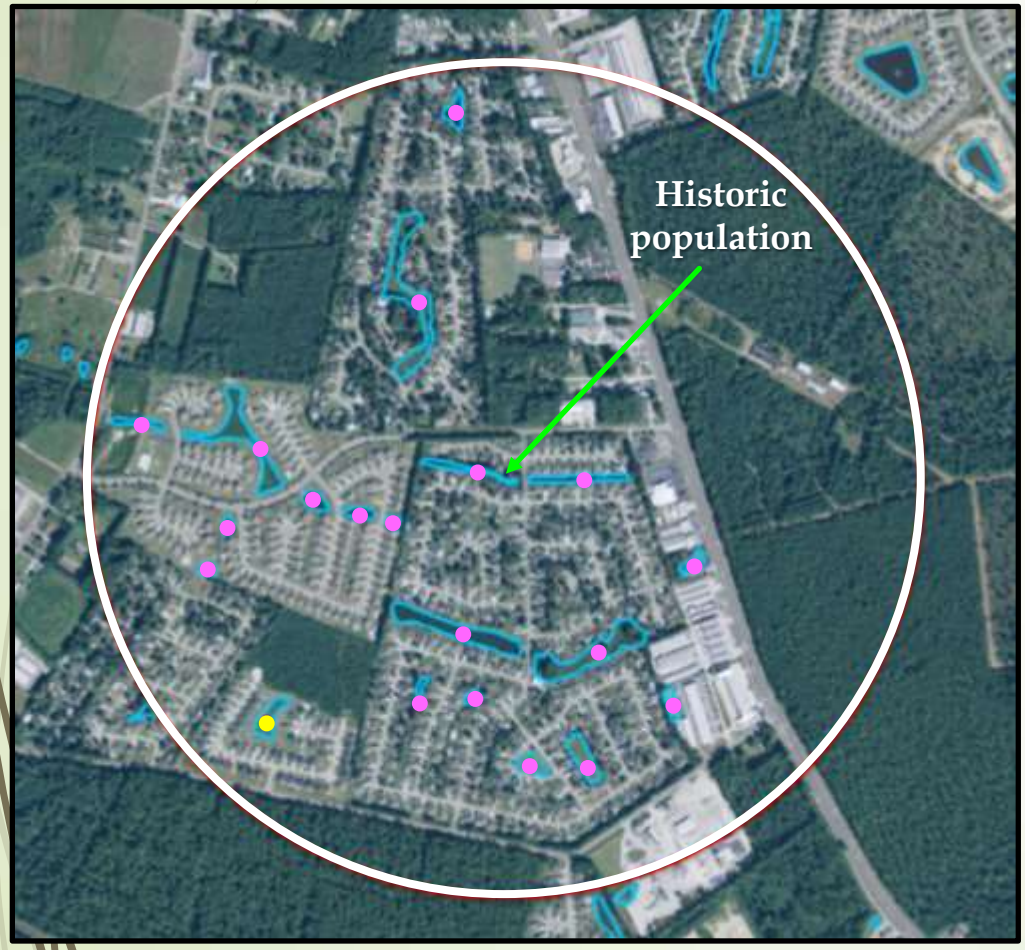


West Ashley:

- 9 of 24 ponds positive for *P. maculata*

- (pink) = no snails observed
- (yellow) = snails observed

Spread Survey

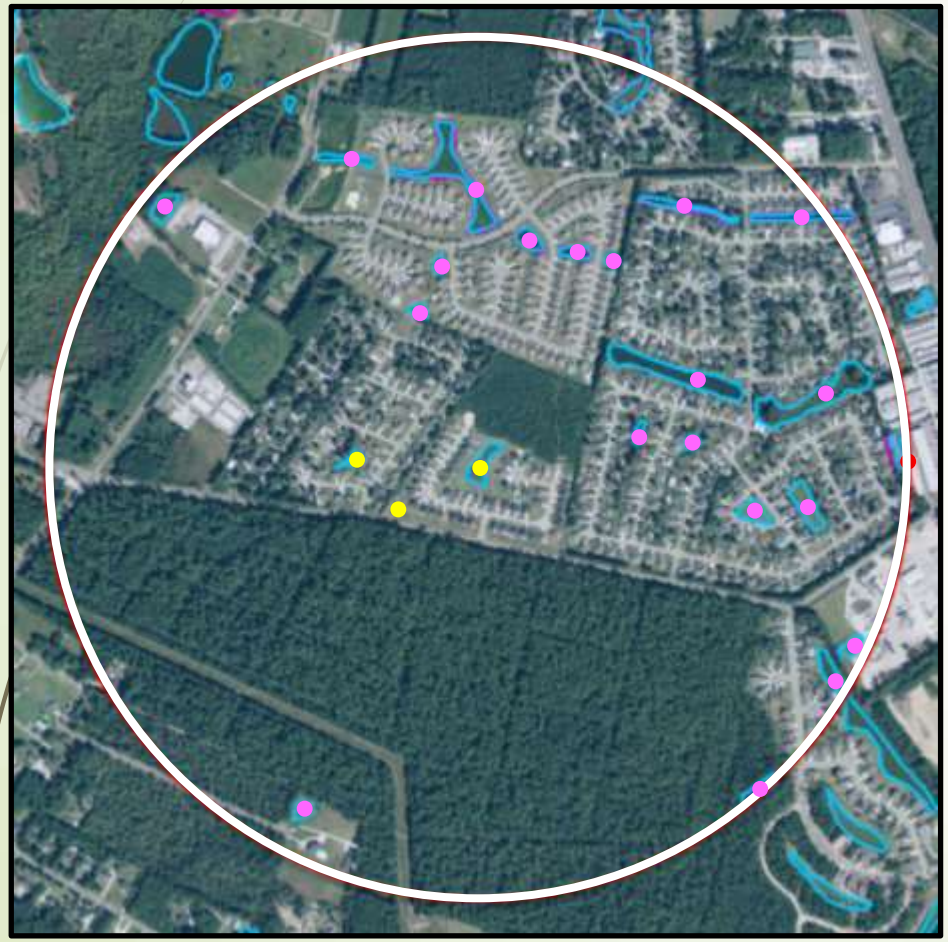


Myrtle Beach I:

- No *P. maculata* found in pond with historic population
- Found 1 pond (out of 20 surveyed) with *P. maculata* snails and egg masses

- (pink) = no snails observed
- (yellow) = snails observed

Spread Survey

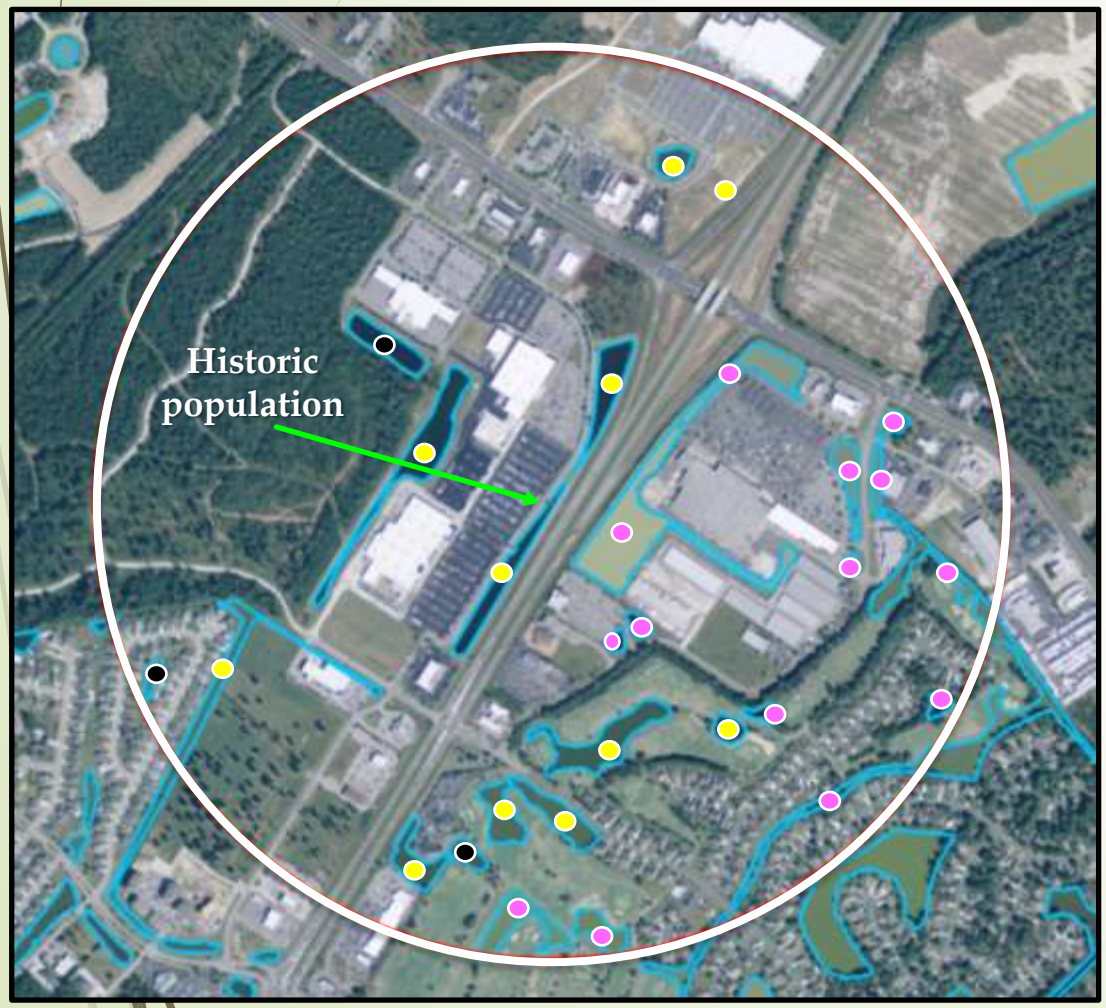


Myrtle Beach II:

- Re-centered survey area around pond where *P. maculata* were observed
- Found 2 more ponds in survey area with *P. maculata* and its egg masses

- (pink) = no snails observed
- (yellow) = snails observed

Spread Survey



Myrtle Beach III:

- Solely a visual survey
- 11 of 28 ponds yielded *P. maculata*
- 3 of 28 ponds had only egg masses
- Always egg masses present when *P. maculata* were observed

- (yellow) = live snails and egg masses
- (black) = egg masses only
- (pink) = no sign of snails or eggs

Waccamaw River

Collected March 16th 2016
by SCDNR Diadromous
Research Section

Georgetown. SC


Yadkin
Winston-Salem
S. Yadkin
Uwharrie
Charlotte
Rocky
Pee Dee
Lumber
Lynches
Florence
Sumter
Waccamaw
Black
Georgetown
Winyah Bay
Wikipedia.org

New Research Directions…

- Determination of presence of *Angiostrongylus cantonensis* in *P. maculata* collected in SC
  - Microscopy and qPCR
- qPCR protocol is already published for *A. cantonensis* (Qvarnstrom *et al.*, 2010)
- *A. cantonensis* DNA (positive control) for qPCR obtained from Dr. Qvarnstorm (CDC)
- Dissections of *P. maculata* from SC collected in 2015 are ongoing…

New Research Directions…

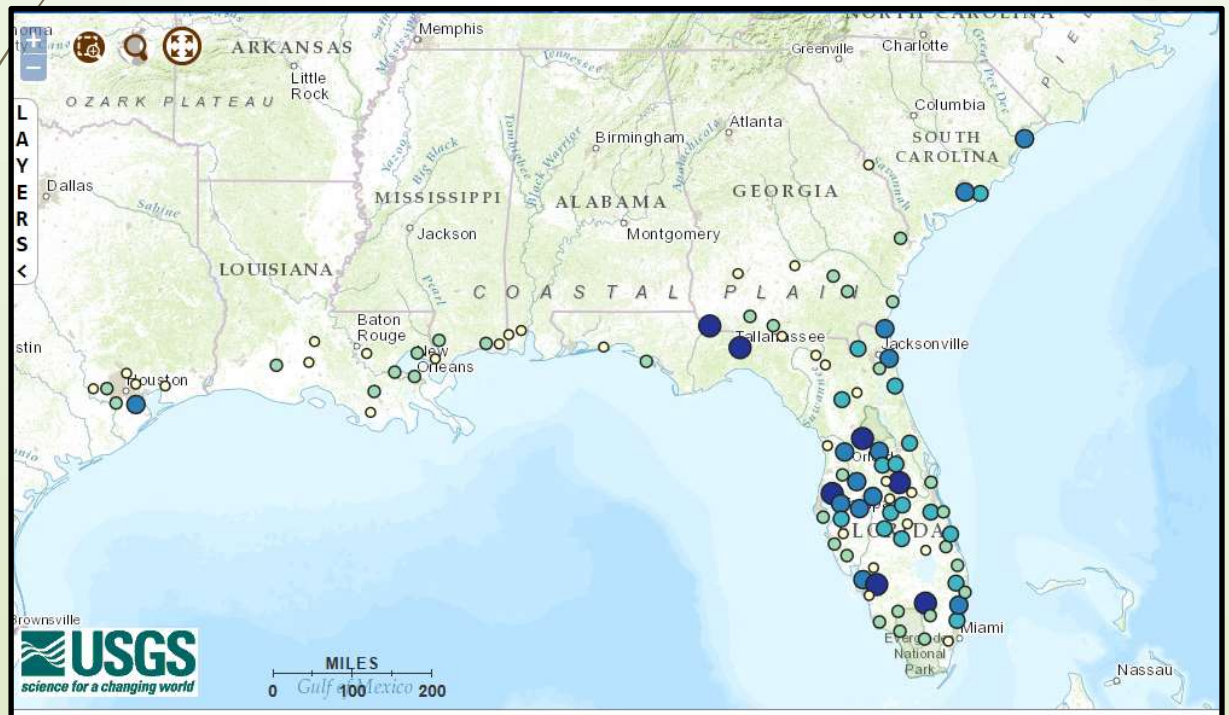
Photo credit: Marlene Kennedy

New Research Directions…

- Sex ratios, size-at-age, reproductive maturity, and mark-recapture studies
- Need to improve our abilities to capture snails in ponds. Baited traps, perhaps…
- Interested in physiological tolerances and diet preferences – different from TX / LA / FL?

New Research Directions…

- Investigate population genetic structure of *P. maculata* in SC using microsatellite markers (Chen *et al.*, 2011)
- Interested in acquiring *P. maculata* tissue from other parts of its invasive range



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Danielle Draewell	SCDNR
Mike Hook	SCDNR
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DNR

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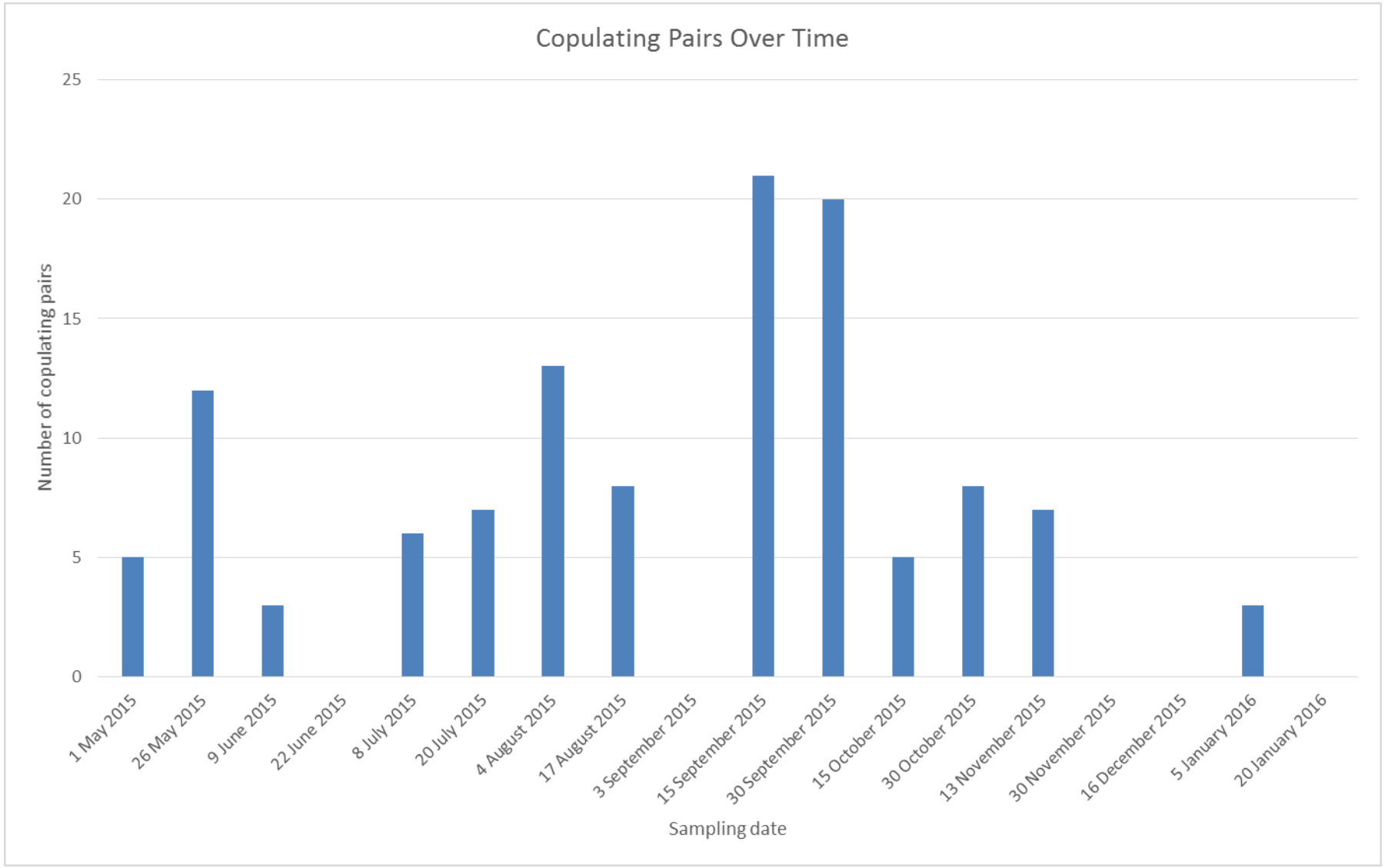
Questions?

Sampling period	# single live snails	# copulating pairs	# egg casings	Min size	Max size	Avg size
1 May 2015	8	5	462	60	85	71.17
26 May 2015	18	12	450	2	80	25.50
9 June 2015	19	3	243	2	80	33.39
22 June 2015	19	0	235	2	80	23.94
8 July 2015	21	6	201	3	81	44.03
20 July 2015	28	7	133	13	82	61.89
4 August 2015	70	13	150	2	87	64.36
17 August 2015	41	8	216	35	86	67.86
3 September 2015	39	0	275	3	93	65.13
15 September 2015	84	21	378	5	85	65.84
30 September 2015	80	20	231	37	83	67.53
15 October 2015	78	14	275	3	82	65.17
30 October 2015	58	17	122	34	83	67.22
13 November 2015	44	7	113	38	83	65.78
30 November 2015	17	0	25	5	76	65.67
16 December 2015	6	0	5	2	82	31.60
5 January 2016	18	3	89	53	75	63.30
20 January 2016	42	0	3	42	83	64.38


Copulating Pairs Over Time
Number of copulating pairs
25
20
15
10
5
0
1 May 2015
26 May 2015
9 June 2015
22 June 2015
8 July 2015
20 July 2015
4 August 2015
17 August 2015
3 September 2015
15 September 2015
30 September 2015
15 October 2015
30 October 2015
13 November 2015
30 November 2015
16 December 2015
5 January 2016
20 January 2016
Sampling date

Spread Survey – Myrtle Beach