

# Modeling range expansion of Northern Snakehead in Arkansas



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# Acknowledgements

- University of Arkansas at Pine Bluff
- Arkansas Game and Fish Commission



- Voracious predators
- Prefer backwater habitats
- “Successful invader”

## Sorting Out Snakeheads

COMPARING THE NORTHERN SNAKEHEAD TO THE NATIVE BOWFIN

**Northern Snakehead**  
*(invasive species)*



Pelvic fins close to pectoral fins and gills

Extended anal fin

- Native to China
- Capable of breathing air, can go dormant in the mud during drought and can move short distances on land using their pectoral fins
- Can grow about 33 inches long and are generally tan with dark brown mottling
- Jaws contain many small teeth similar to pike and pickerel
- Can live out of water for up to three days in moist environment

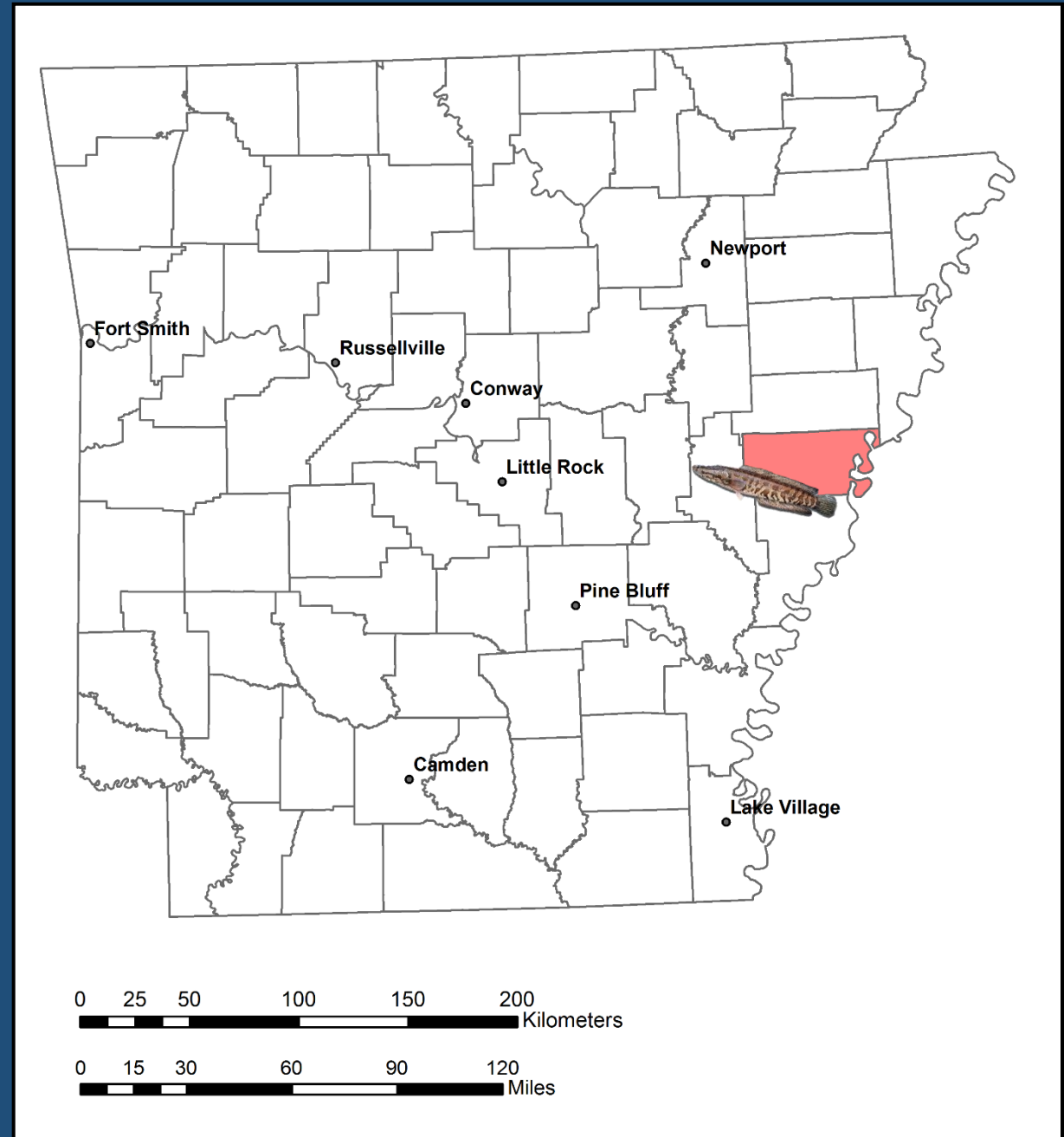
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- Breeding population confirmed April 2008
- Continue to expand their range



Where did they start?

Where are they now?  
Where will they go?



# Objectives

- Evaluate spatial trends in range expansion from 2008 to 2017
- Calculate expansion area from 2008 to 2017
- Create preliminary models to predict probability of expansion into new areas



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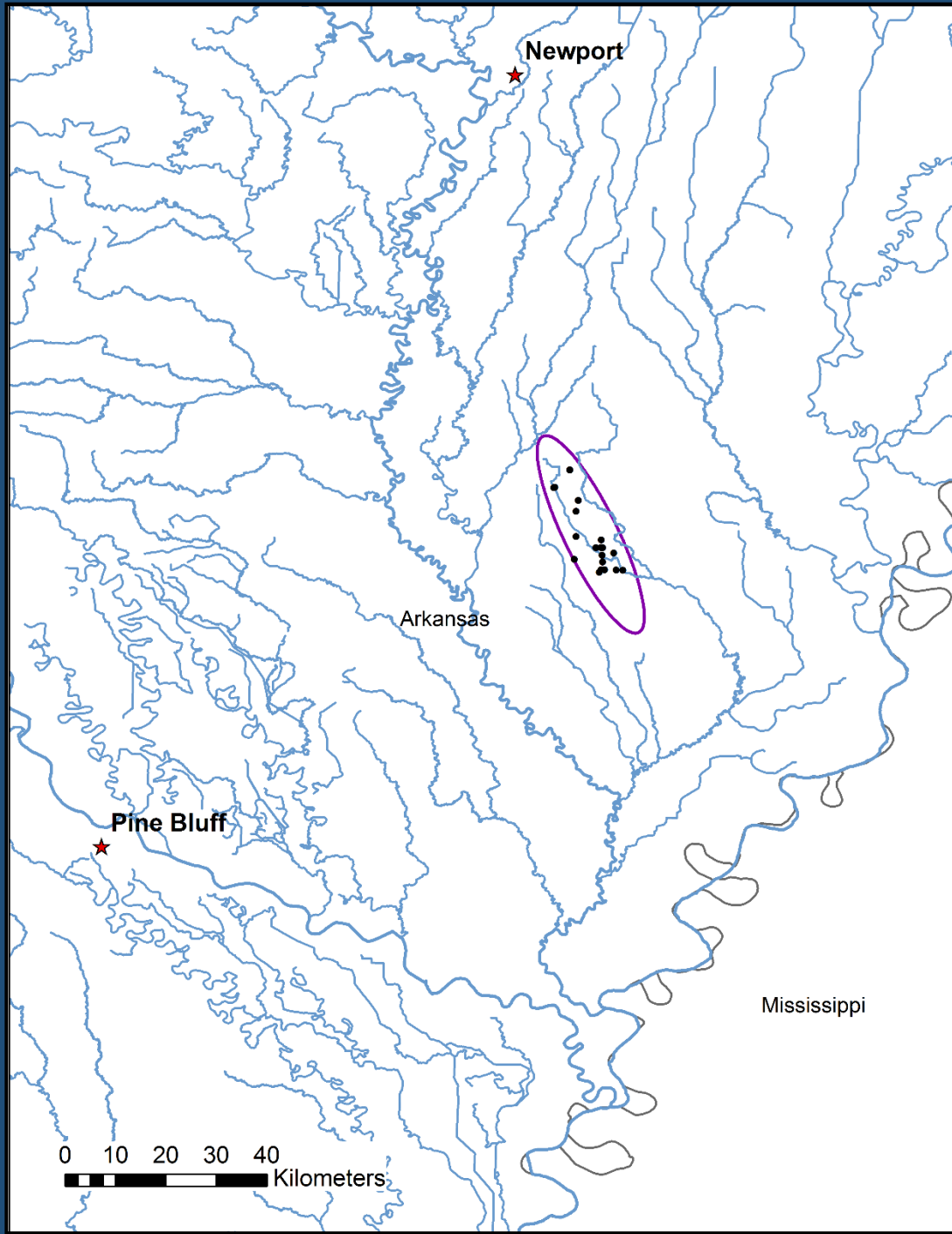
# Snakehead data

- Location (GPS) data from AGFC database 2008 – 2017
  - No 2012 – 2013 reports
- Operation Mongoose, verified citizen reporting, state and federal agency reporting
  - Non-verified locations were excluded from analyses
- Locations by year
- Standard deviational ellipses
  - Encompass 95% of data points



# 2008

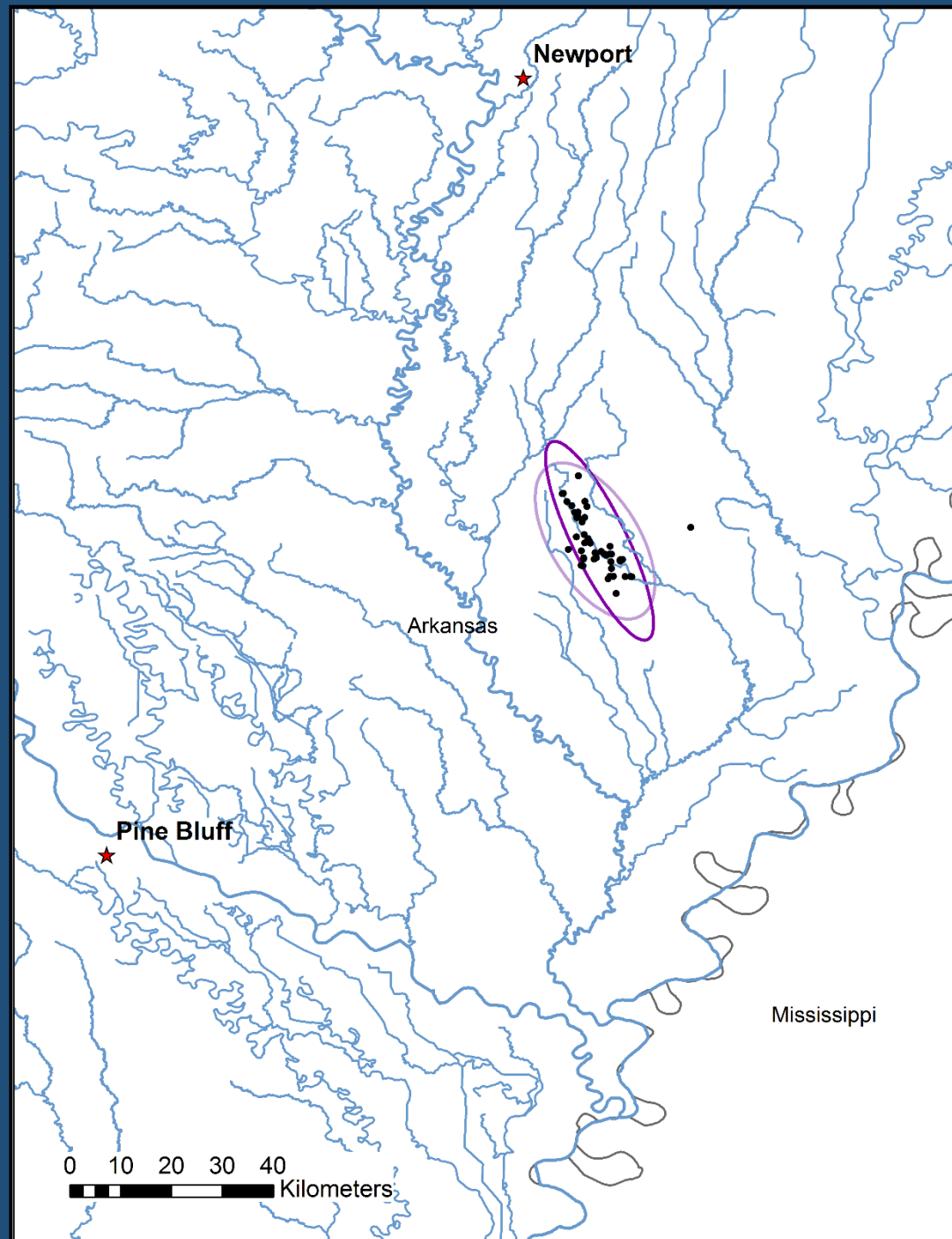
➤ 2008 – Piney Creek drainage





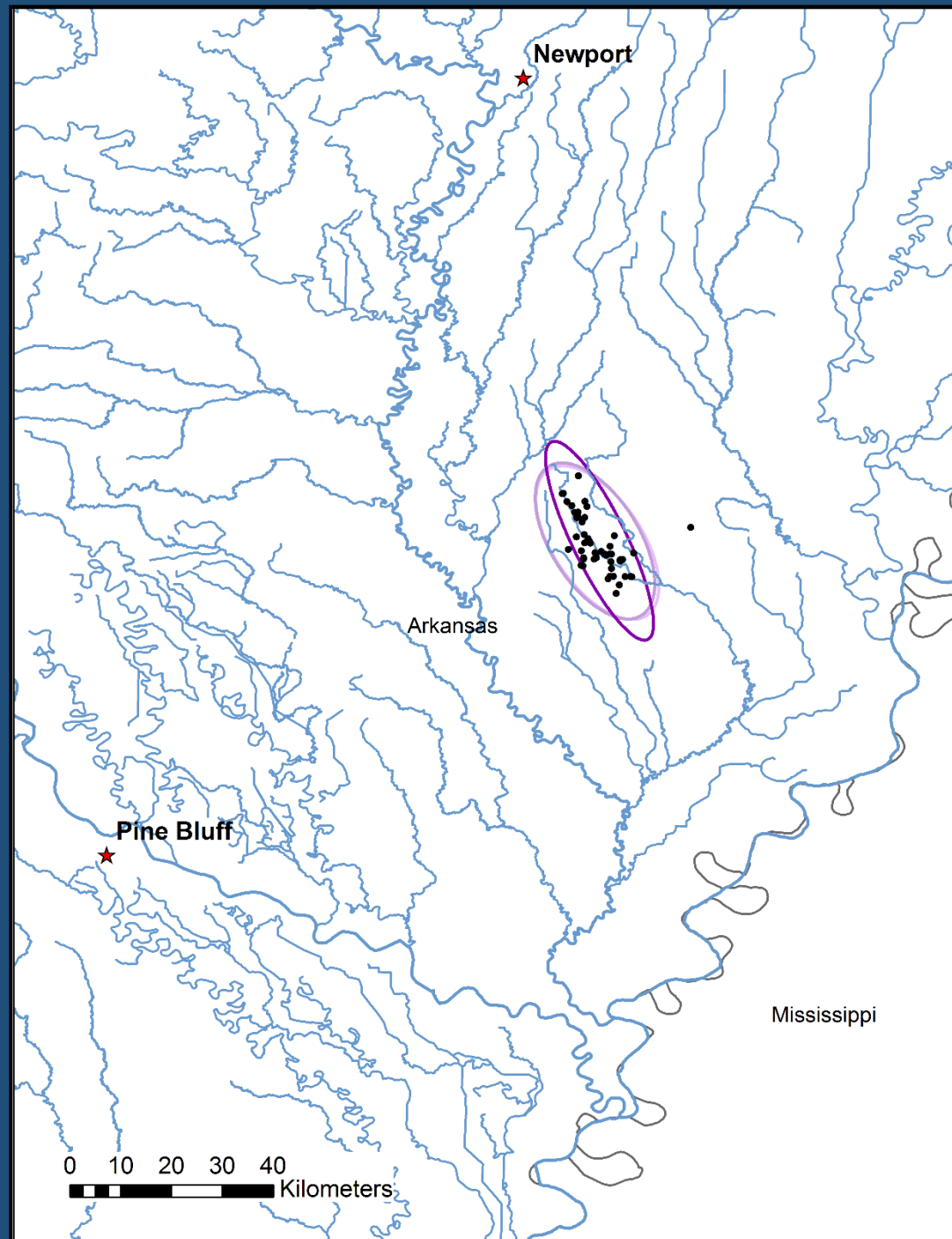
# 2009

- 2008 – Piney Creek drainage
- 2009 – Big Creek drainage



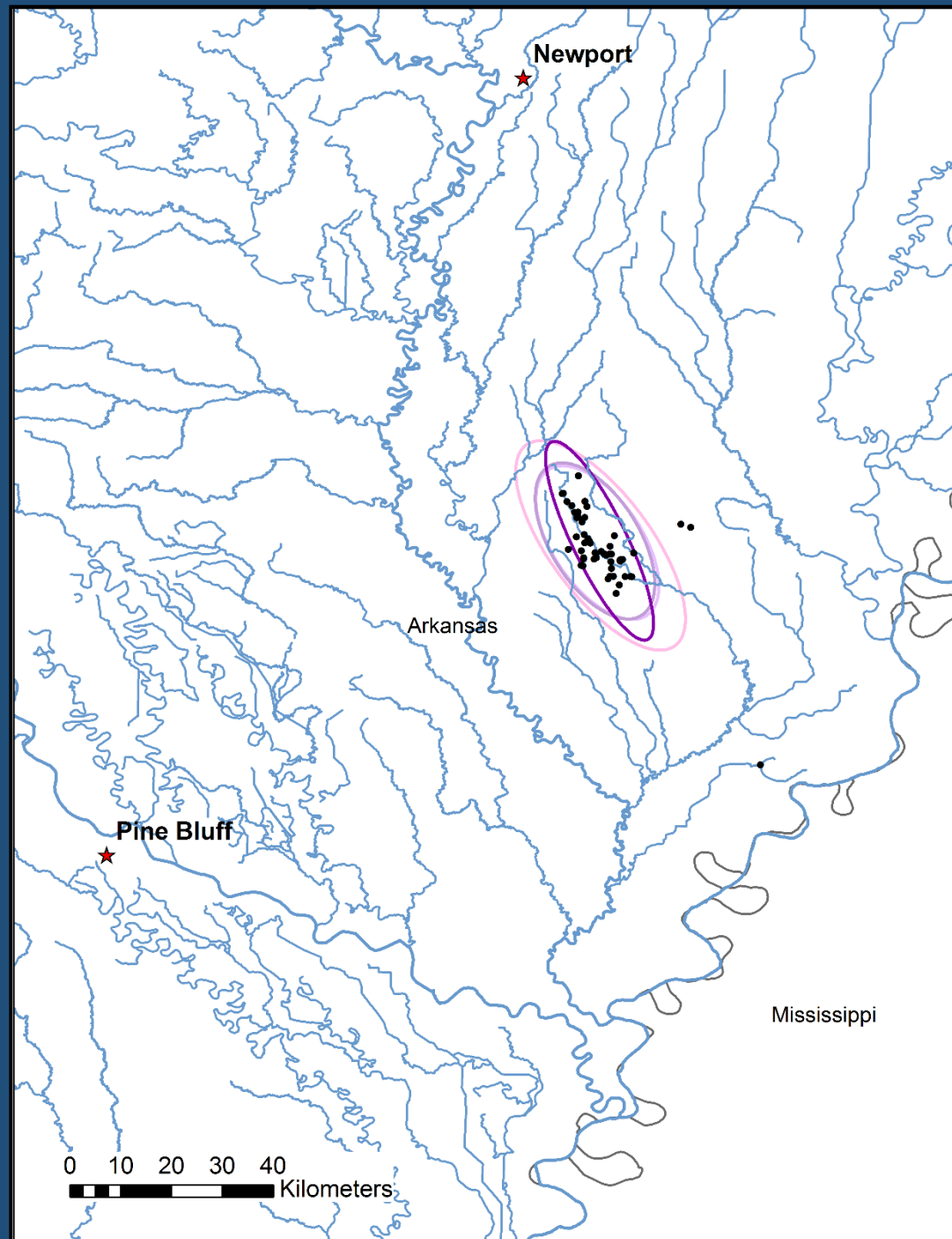
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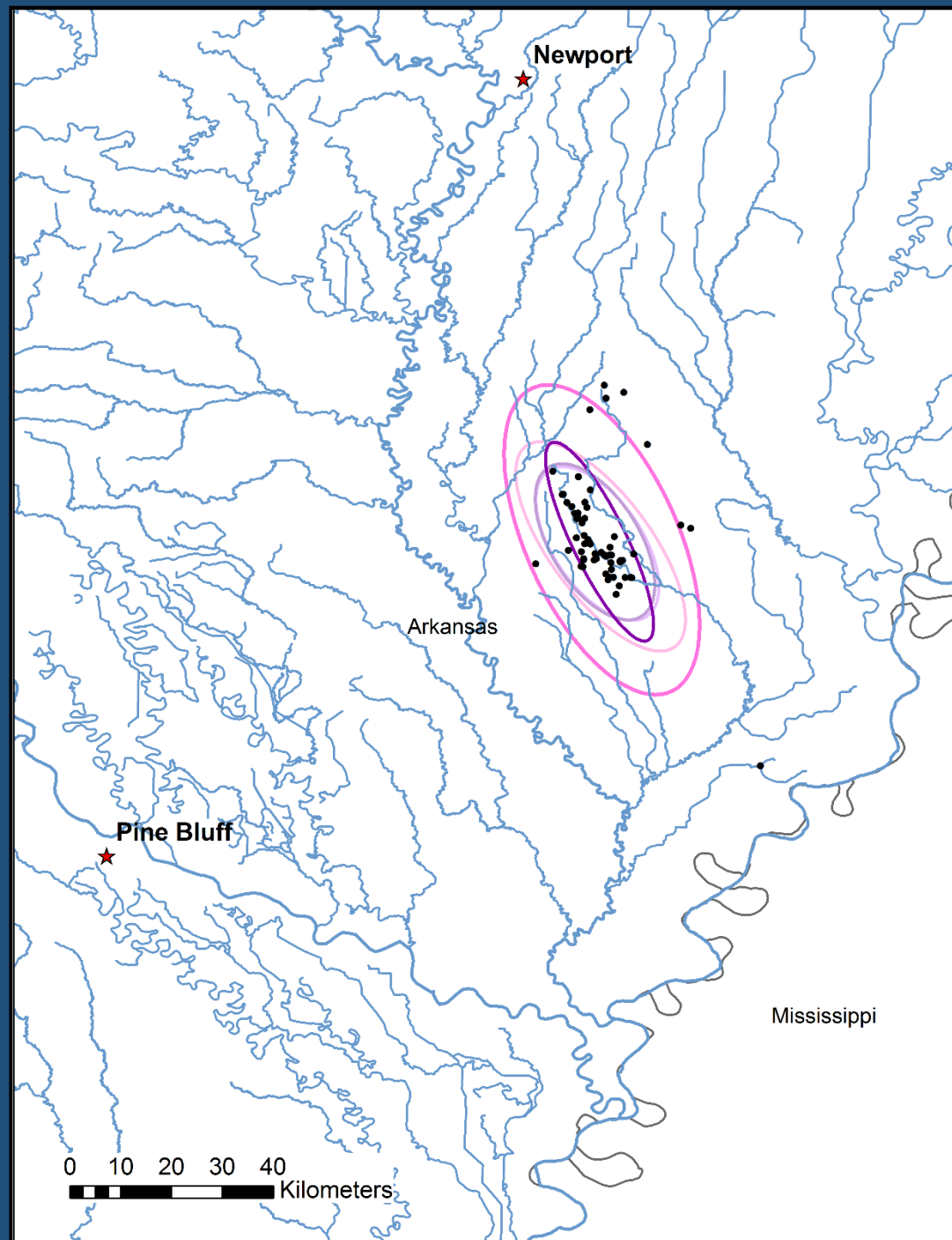
# 2011

- 2008 – Piney Creek drainage
- 2009 – Big Creek drainage
- 2011 – Cypress Bayou



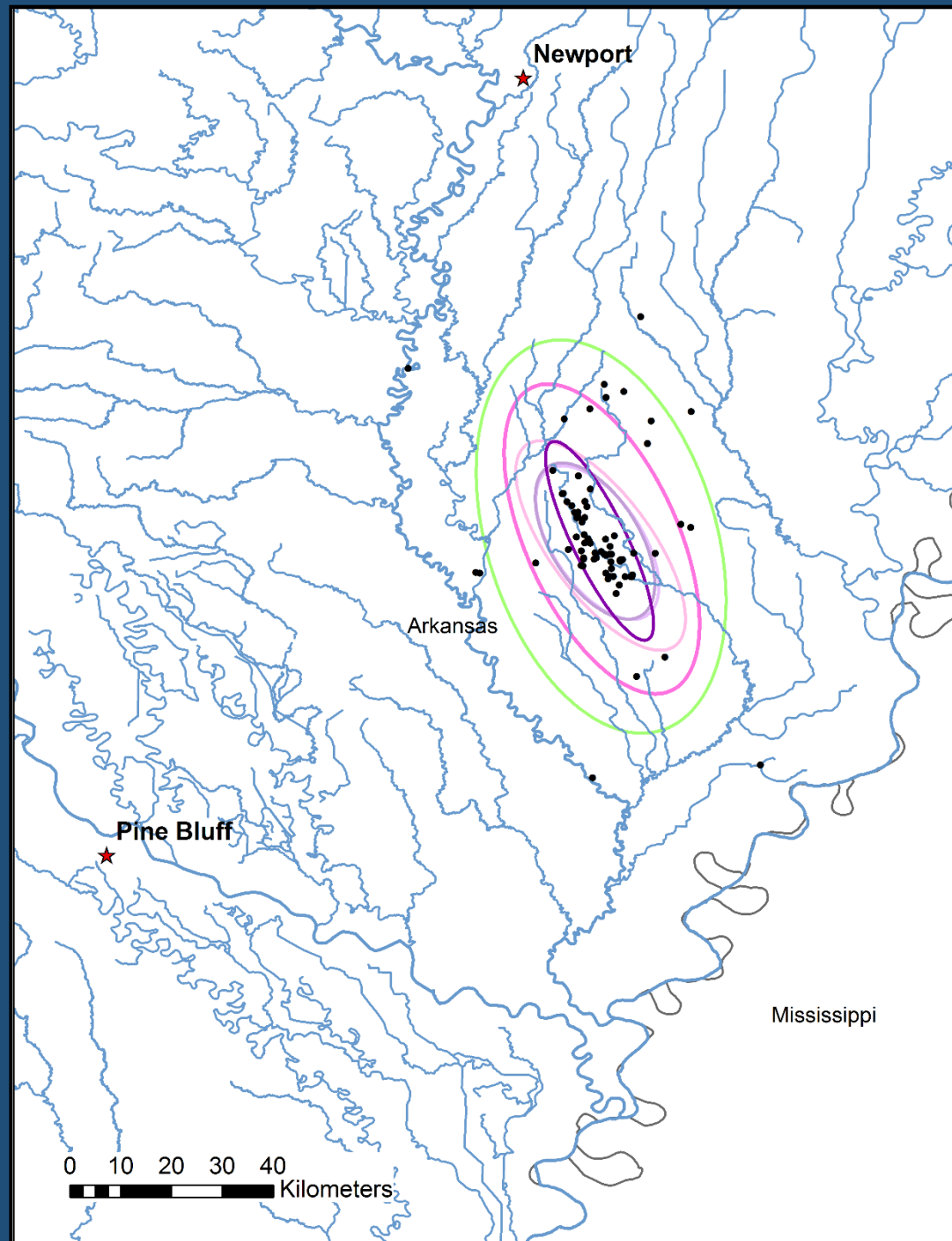
# 2014

- 2008 – Piney Creek drainage
- 2009 – Big Creek drainage
- 2011 – Cypress Bayou
- 2014 – East Flat Fork Creek, moving towards L'Anguille, White



# 2015

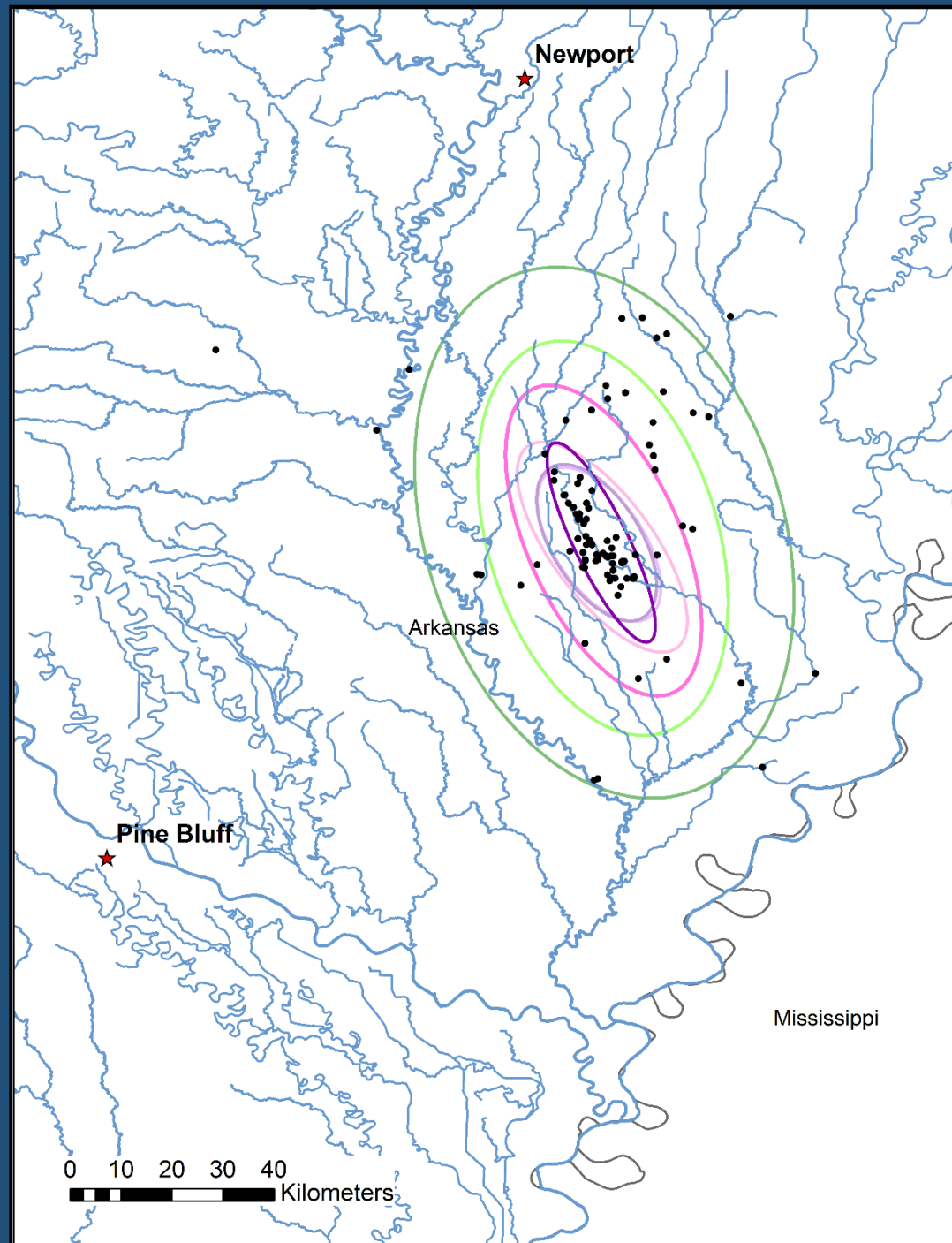
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- 2015 - Little Cypress Creek, White River, Caney Creek, ditches near Cache River

# 2016

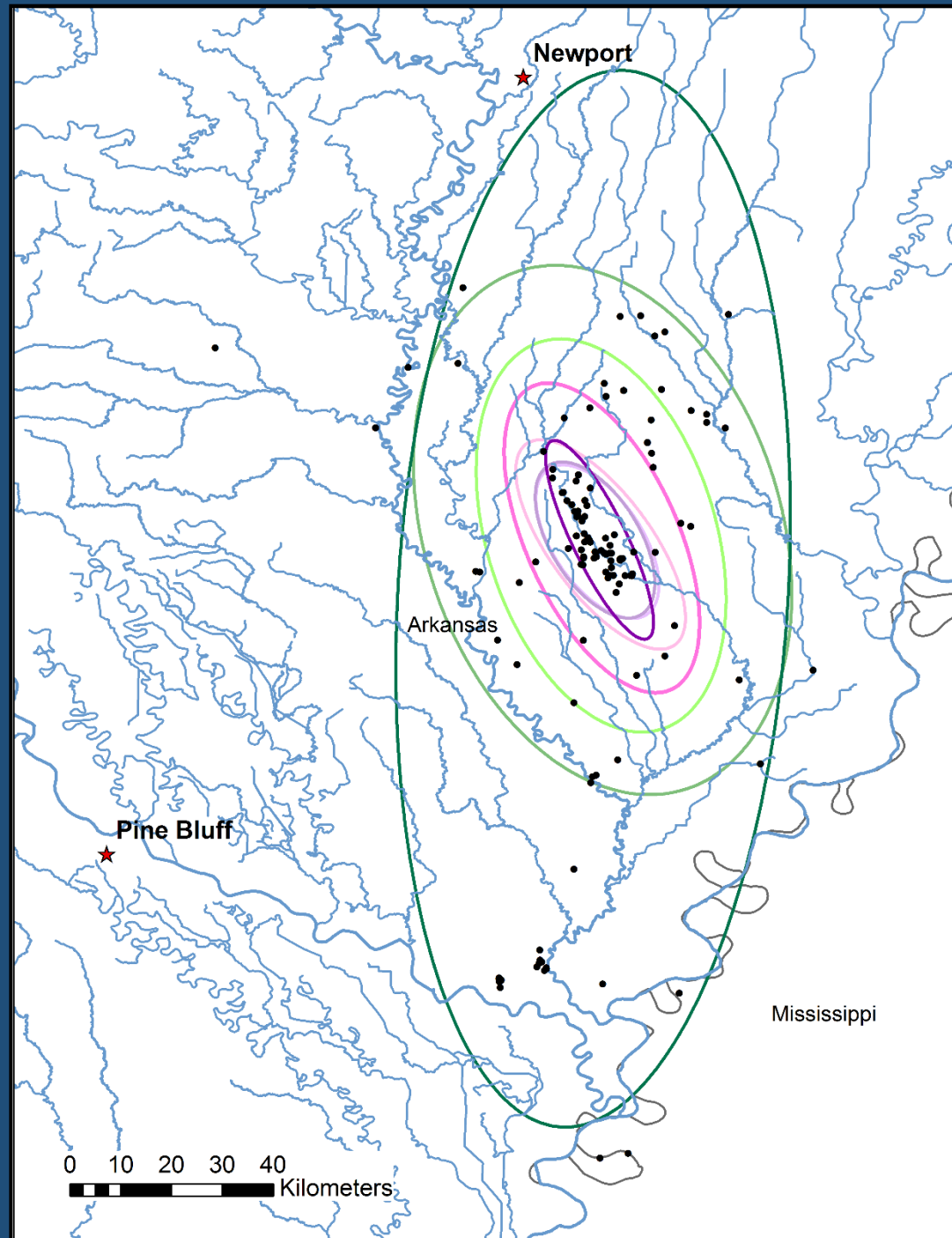
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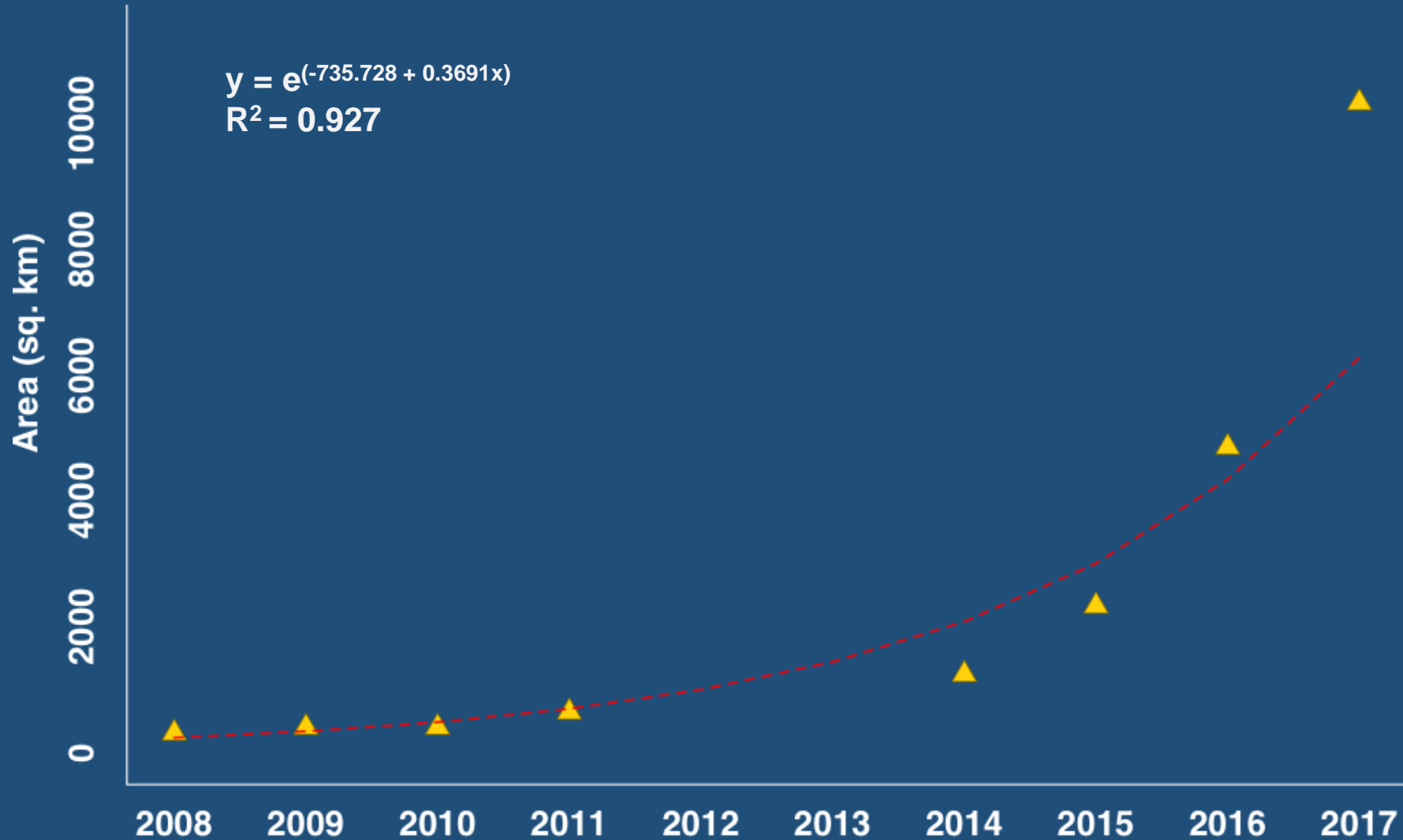
# 2017

- 2008 – Piney Creek drainage
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- 2014 – East Flat Fork Creek, moving towards L'Anguille, White



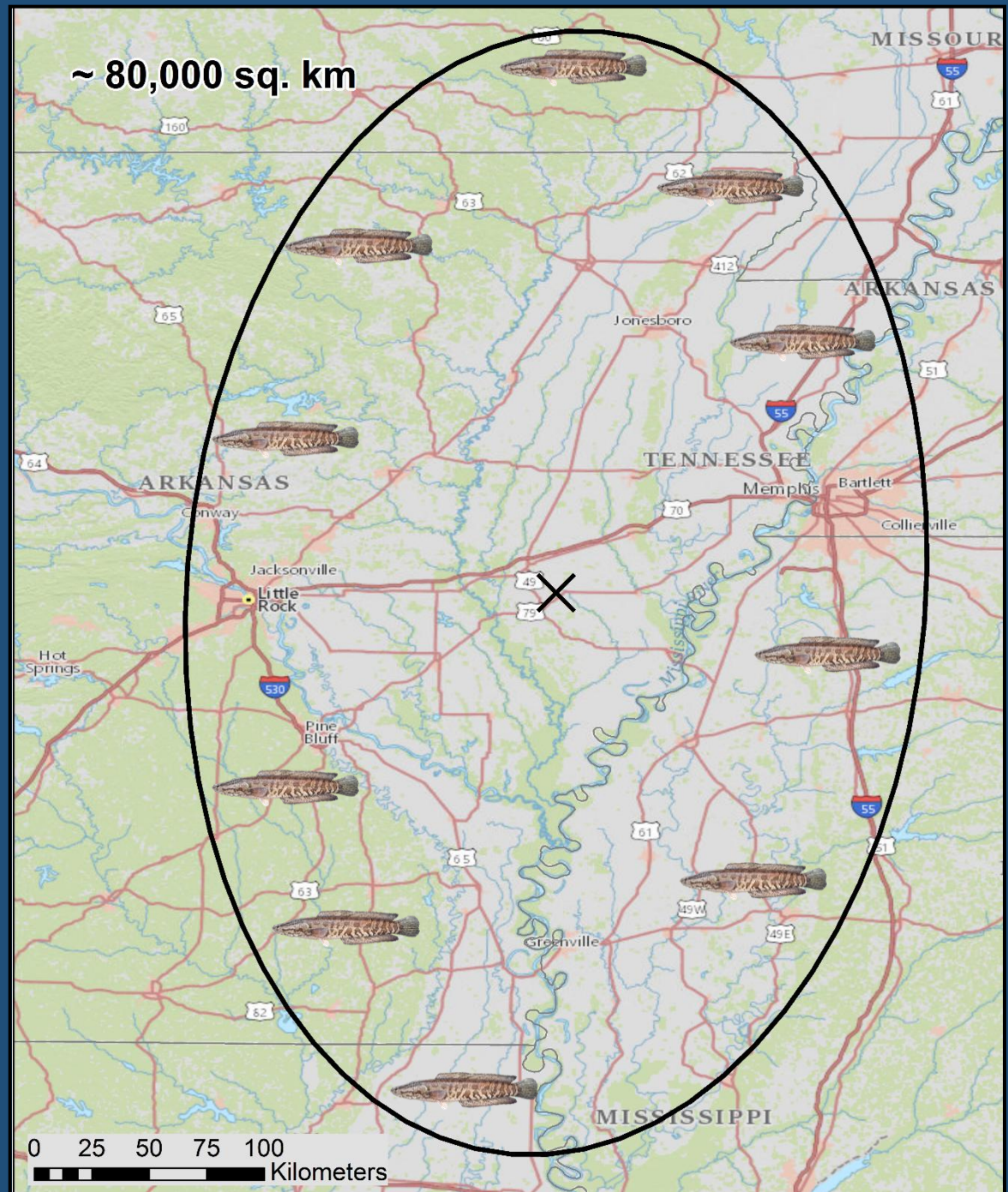
- 2015 - Little Cypress Creek, White River, Caney Creek, ditches near Cache River
- 2016 – L'Anguille River, DeView Bayou, Lick Creek, towards Bayou Des Arc
- 2017 – Cache Bayou, between White and Arkansas Rivers, across Mississippi River

# Expansion from 2008 - 2017





Estimated  
occupied area in  
5 years



# Objectives

➤ Evaluate

➤ Calculate

➤ Create probability maps  
into new areas

1983 to 2017

Expansion



**Maximum entropy modeling**  
(Phillips et al. 2006)



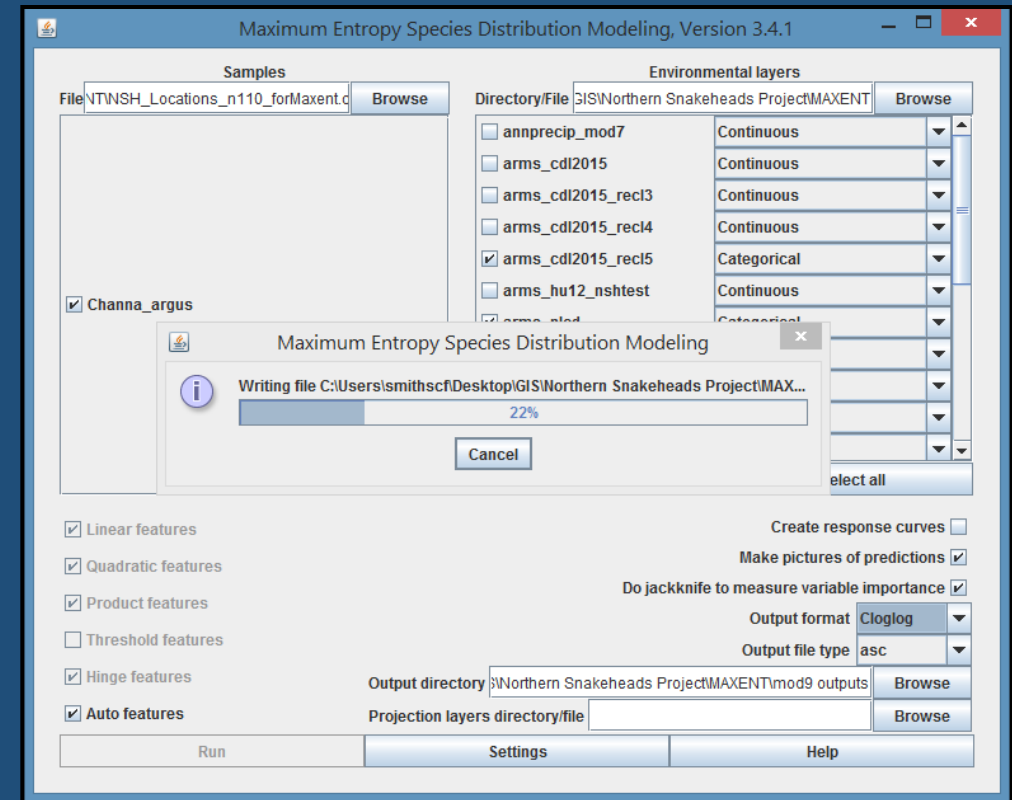
# Maxent explained

- Probability of presence for a species based on environmental constraints and known occurrence locations
- Presence-only data
- Environmental predictors across landscape of grid cells
- Results averaged over multiple runs
- Evaluation → area under the receiver-operator curve (AUC)

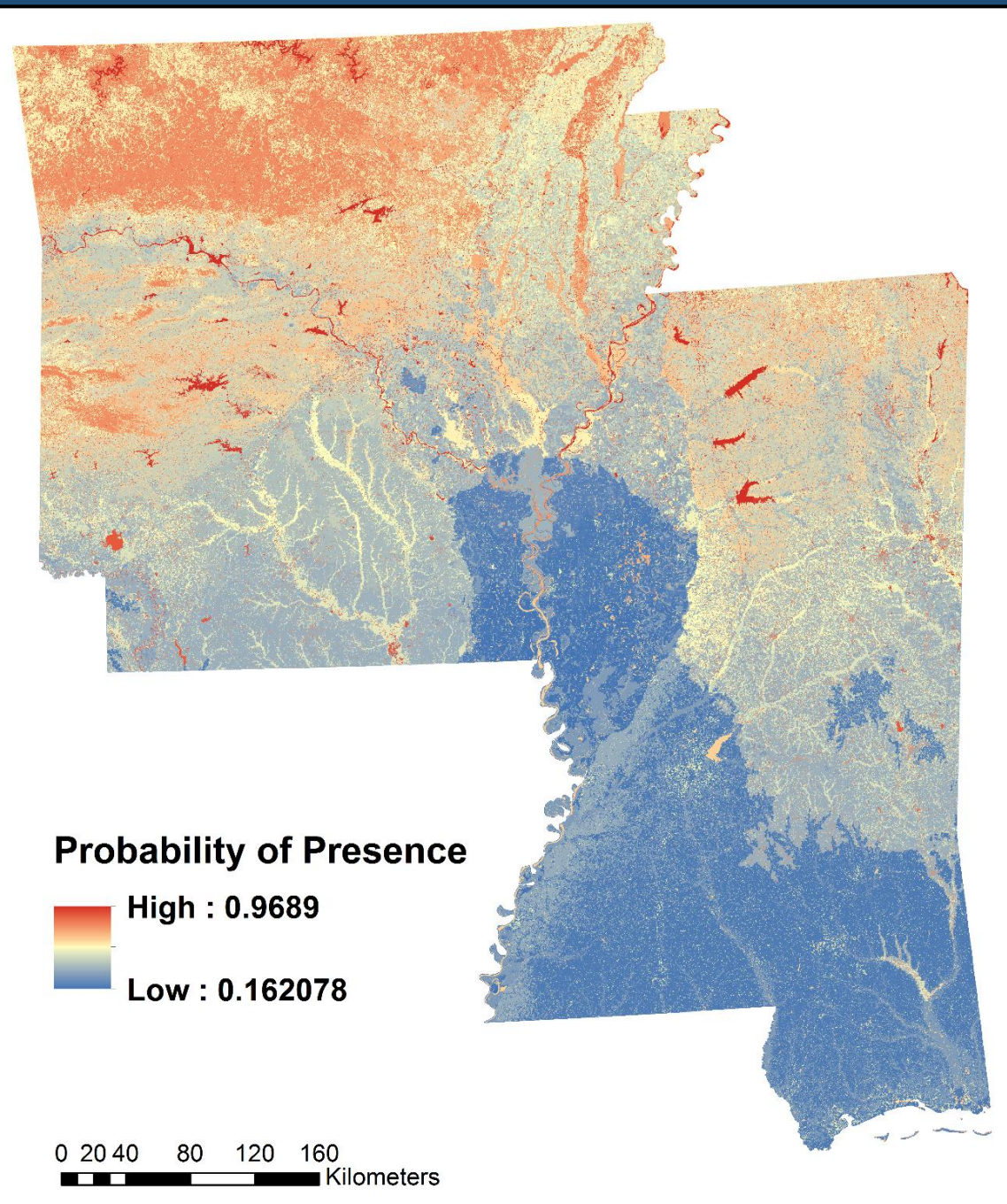


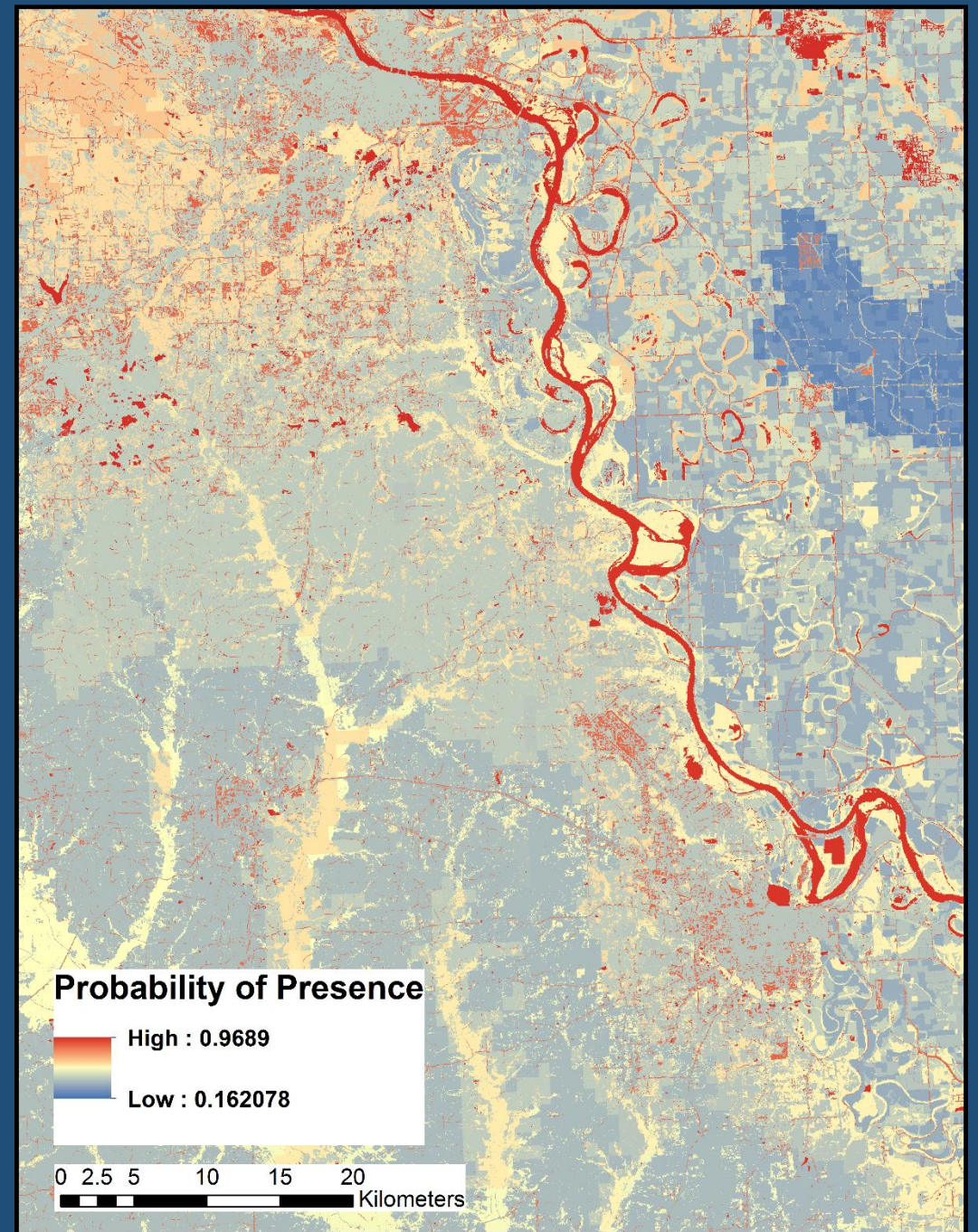
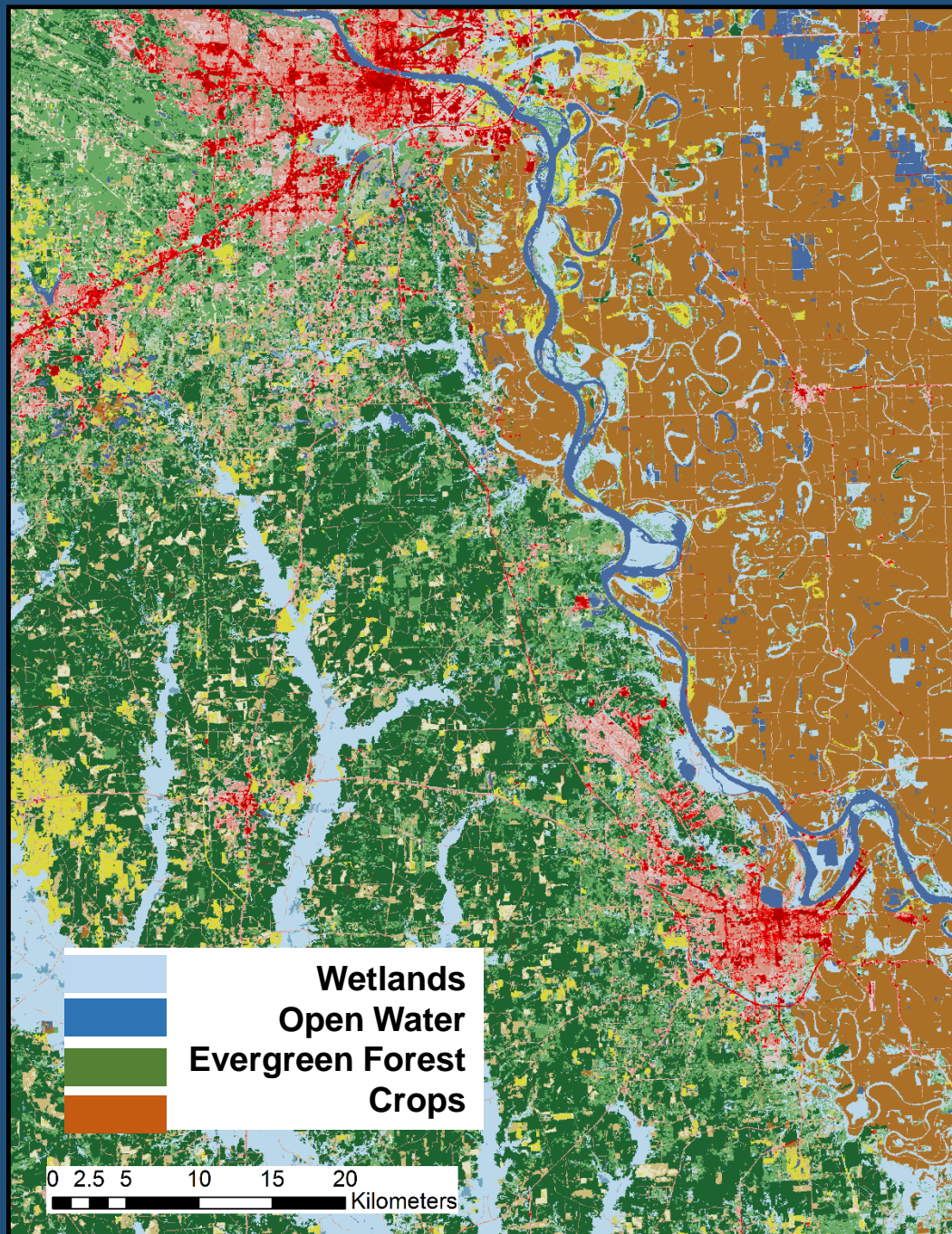
# Maxent model parameters

- N = 28 (from 2008 - 2017)
- Landscape = AR and MS
- 3-fold crossvalidation
- Environmental variables:
  - Land cover
  - Crop type cover
  - Annual precipitation (mean)
  - Minimum air temperature (mean)
  - Maximum air temperature (mean)



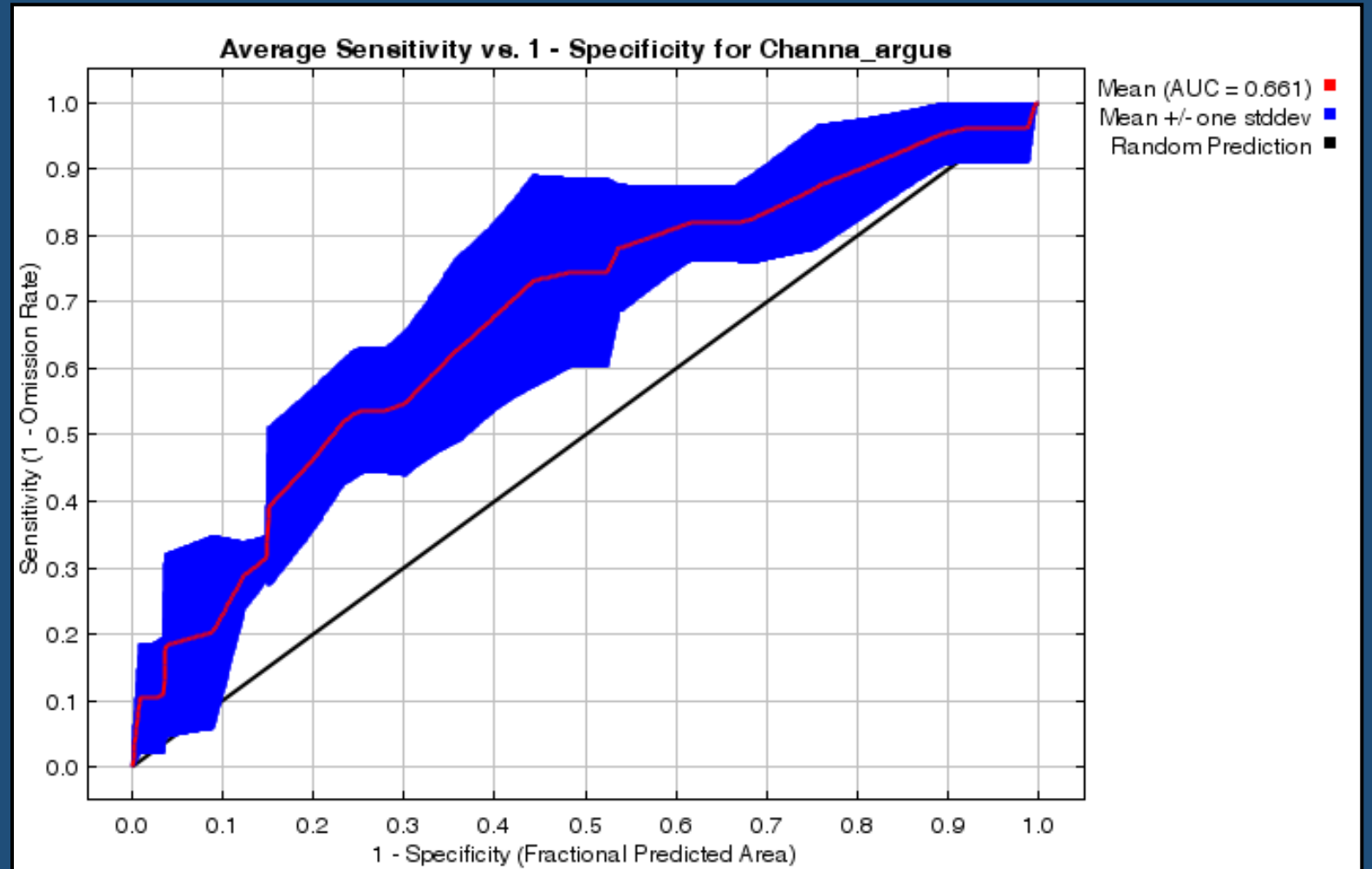
# Maxent model





# Maxent model evaluation

Mean AUC = 0.661  
 $0.661 > 0.5$  (random)



# Maxent model summary

- Variable importance
  - Crop/land cover – 71.4%
    - Deciduous forest, crops, wetlands
    - Rice, soybeans, fallow/idle
  - Min. temperature – 25.2%
    - 52 and below
  - Max. temperature – 3.4%
  - Annual precipitation – 0%





# Conclusions

- Expansion rapid, following drainages
- Modeling can indicate what areas may be more susceptible to colonization
- Inform monitoring and eradication efforts

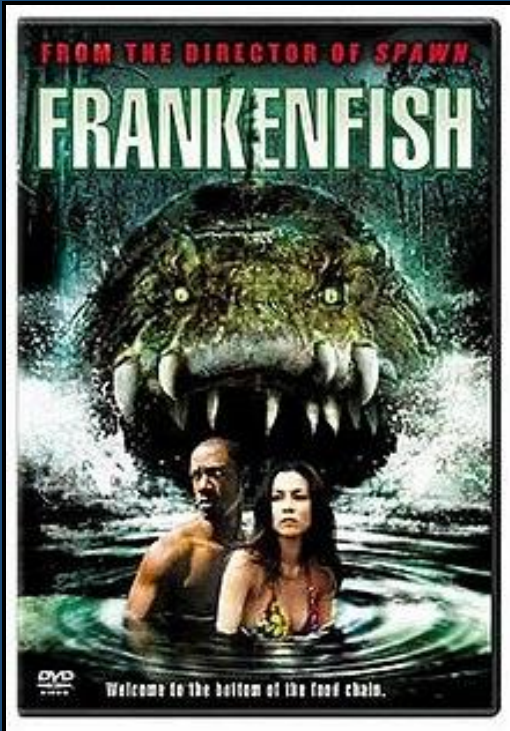


# Future models

- Further optimization
- Environmental predictors
  - Elevation
  - Another indicator of annual discharge/river stage
- Movement patterns (Micah Tindall's research)



Thanks!



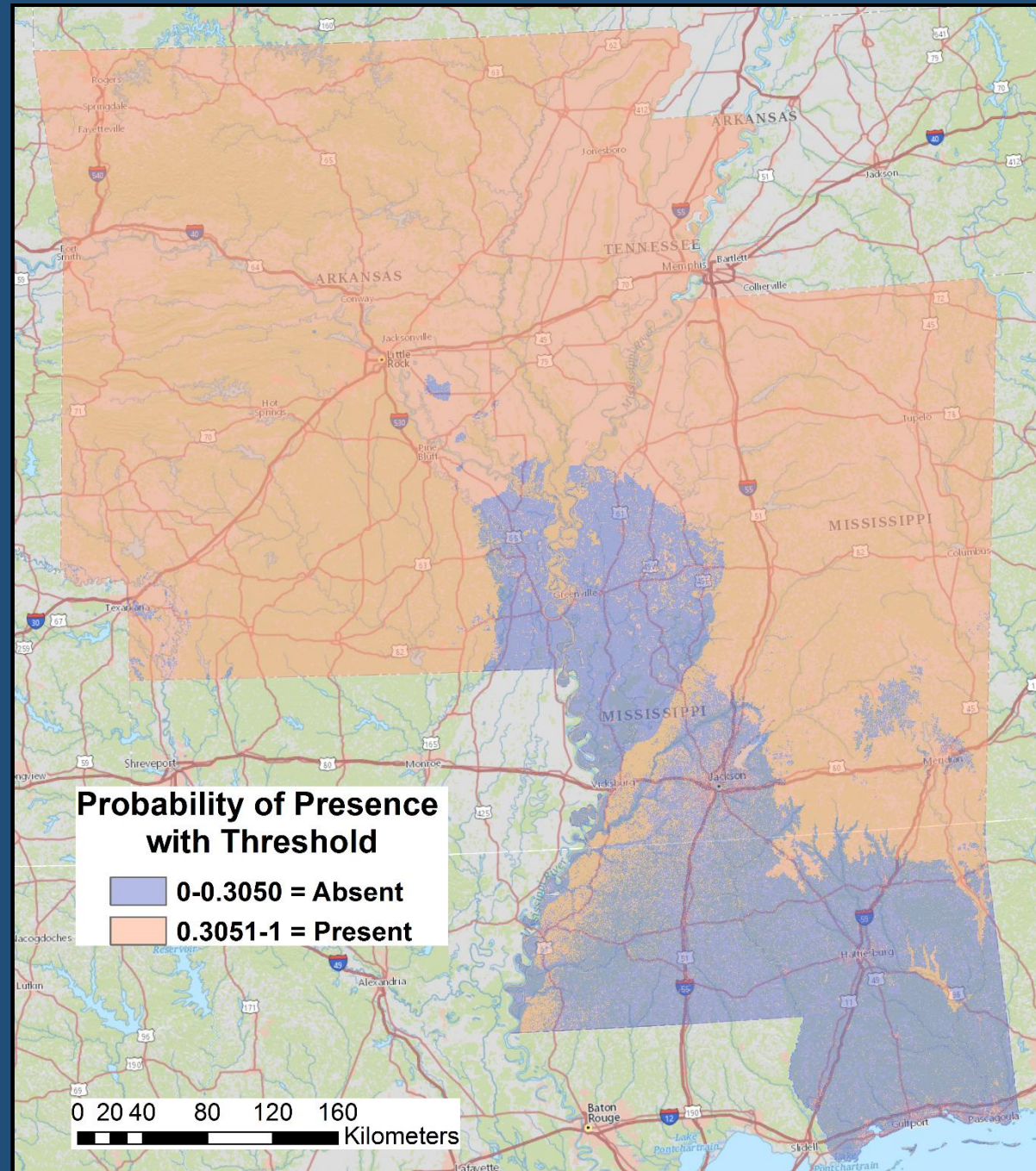
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Shannon Smith  
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# Maxent model

10<sup>th</sup> percentile threshold

Excludes the 10% of localities with lowest values



# Equations- Phillips et al. 2017

- Probability of presence of the species within a quadrat (according to IPP):

$$\text{Probability of presence} = 1 - \exp(-c_p A \exp(\alpha + \beta'x(z)))$$

Where  $\exp(\alpha + \beta'x(z))$  is spp occurrence from IPP as log-linear function of real-valued features  $x(z)$  and  $\alpha$  is normalizing constant and  $\beta$  is the coefficient

- Cloglog transform probability of presence:

$$\text{Probability of presence} = 1 - \exp(-\exp(H)p_\lambda(z))$$

Where  $p_\lambda(z)$  is probability density based on IPP