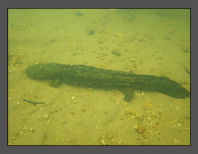
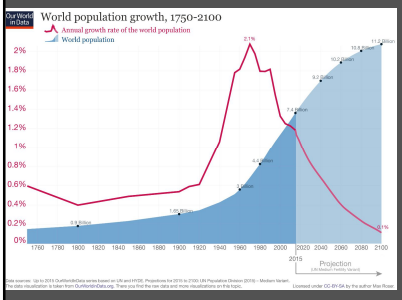
Conserving Tennessee's Largest Salamander

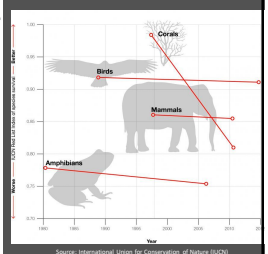




Jeronimo Silva
Graduate Student
Tennessee State University

Outline

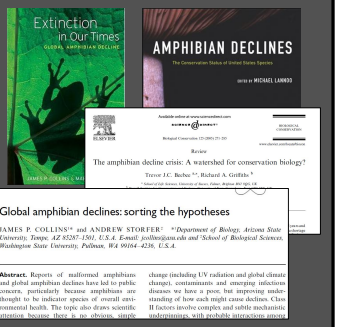
- Amphibian decline and diversity
- What are Hellbenders???
- How are Hellbenders doing???
- Where are Hellbenders???
- Impact of land use on occupancy
- Conservation implications and future research





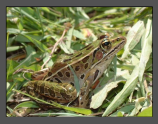
Amphibian declines

- Highest proportion of species threatened with extinction (Cushman 2006)
- Major threats (Beebee and Griffiths 2005)
  - Habitat destruction
  - Diseases
  - Invasive species
  - Exploitation
  - Climate change
- Amphibians are particularly vulnerable
- Good indicators of environmental conditions

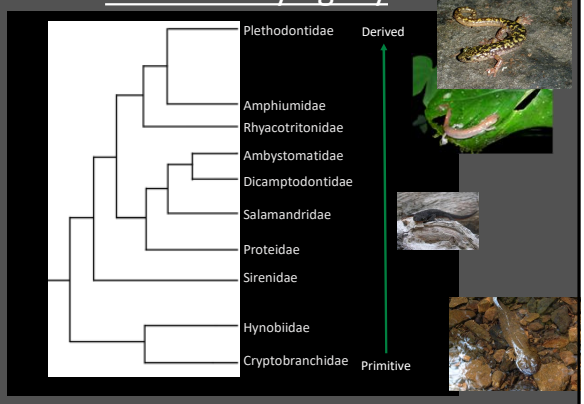


Amphibian Classification and Diversity

- Includes three major Orders
  - Anura (Frogs and Toads)
  - Gymnophiona (Caecilians)
  - Caudata (Salamanders)
- Anura = greatest diversity 6,824 species
- Caudata = 707 species
- Gymnophiona = 206 species



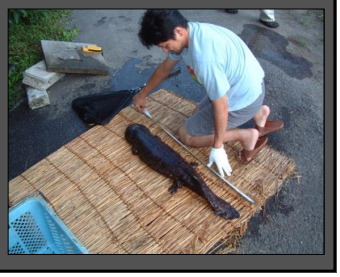
Caudate Phylogeny



Courtesy: Rebecca Hardman

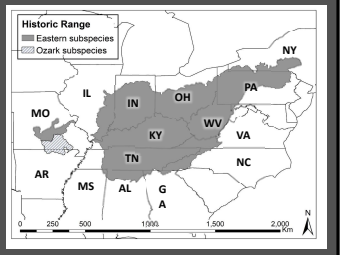
Family Cryptobranchidae

- Crypto- “hidden”, -branch “gill”, - idae “family”
- Two genera (*Cryptobranchus* and *Andrias*)

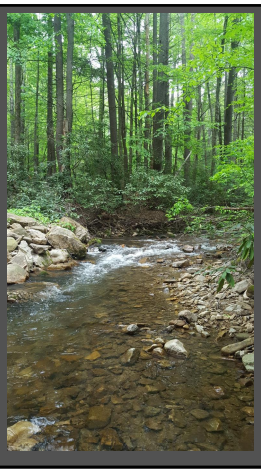


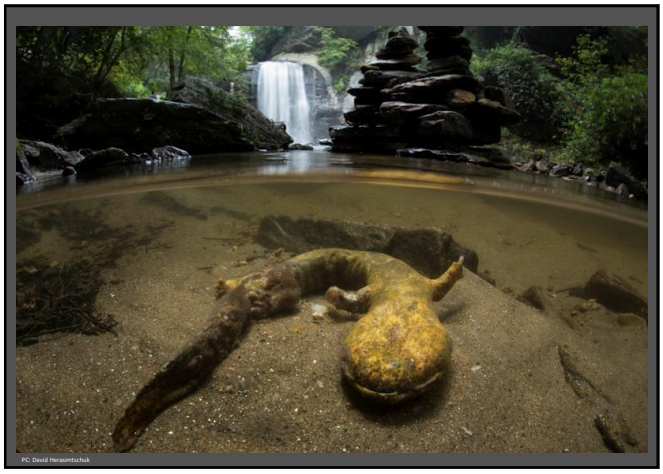
Bishopi ssp. – Federally Endangered

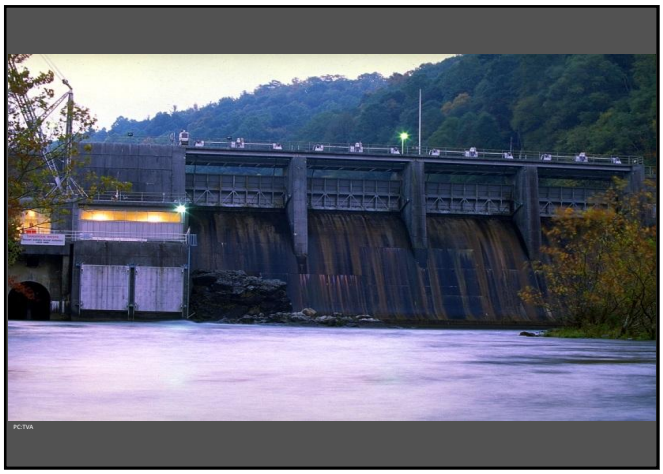
Alleganiensis ssp. – under review

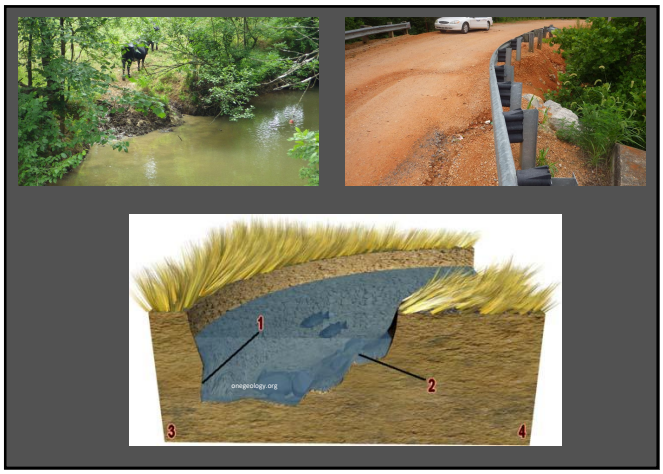


Research by Paul Hime revealed unknown diversity




PC: David Heraimtschuk


PC:TVA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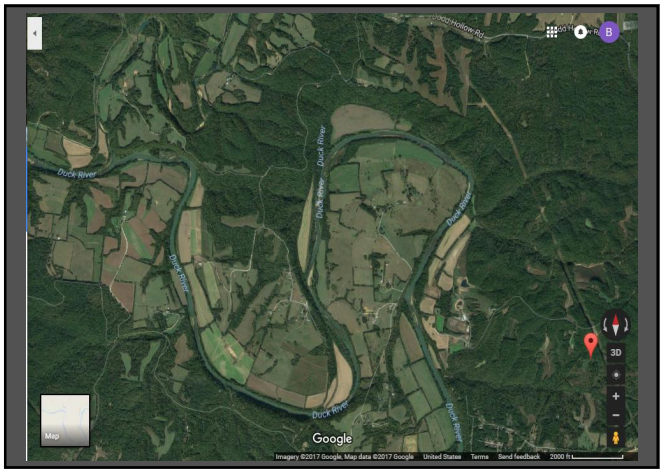
onegeology.org


Duck River
Google
Map
3D


May 24th, 2008, Blue River

Hellbender Total Length: 1990s

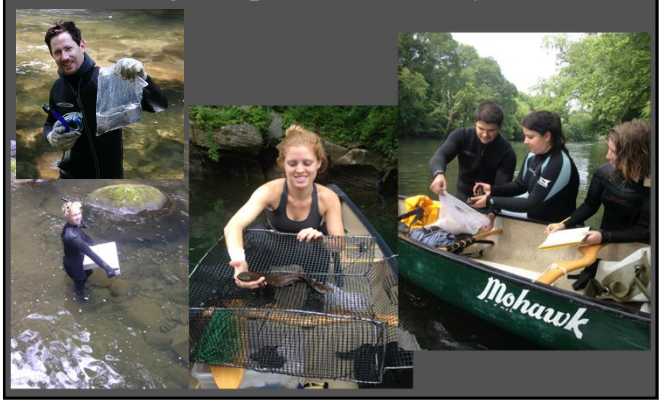
Calfkiller River: 4 hellbenders; 40.2 – 54.5 cm
Duck River: 3 hellbenders; 45.4 – 55.5
Collins River: 42 hellbenders; 40.8 – 54.5
Buffalo River: 28 hellbenders; 11.1 – 60.8

- Calfkiller, Collins, and Duck rivers were sexually mature (Eastern Highland Rim streams)
- By contrast, 25% (n = 7) from the Buffalo River were juveniles (111 mm – 253 mm). Western Highland Rim stream

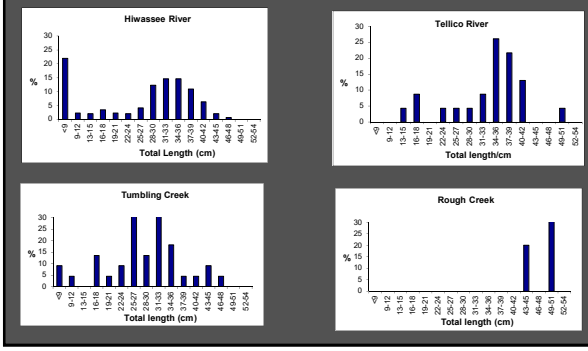
Streams searched for *Cryptobranchus alleganiensis* during July and August 2011.

Stream Name	County	Distance Km (mi)	Person Hours Searched	# Hellbenders found
Collins River	Warren/Grundy	27.60 (17.20)	159.0	0
Calfkiller River	White	10.70 (6.60)	89.0	0
Elk River	Franklin	1.00 (0.70)	17.5	0
Stones River	Rutherford	1.10 (0.50)	24.0	0
Richland Creek	Giles	0.50 (0.31)	6.0	0
Duck River*	Coffee	12.14 (7.30)	81.0	0
Duck River	Bedford	15.11 (9.40)	28.0	0
Little Sequatchie	Marion	2.42 (1.50)	10.0	0
Totals		70.57 (43.51)	414.5	0

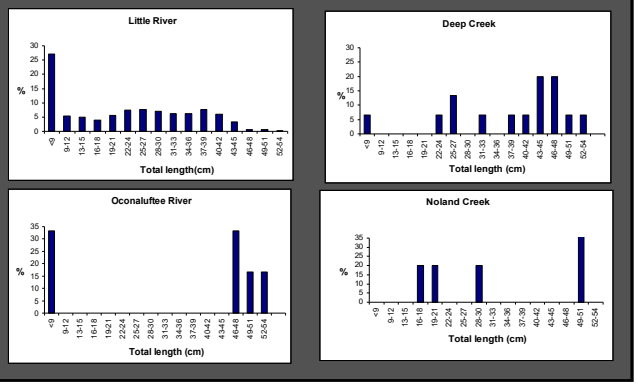
Blue Ridge Population Surveys

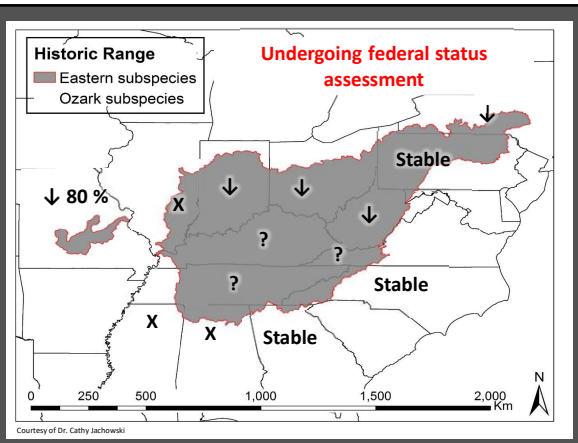


Cherokee NF Population Size Structure

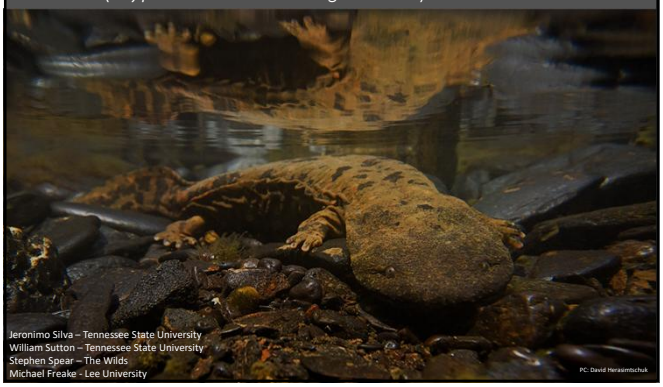


GSMNP Population Structure



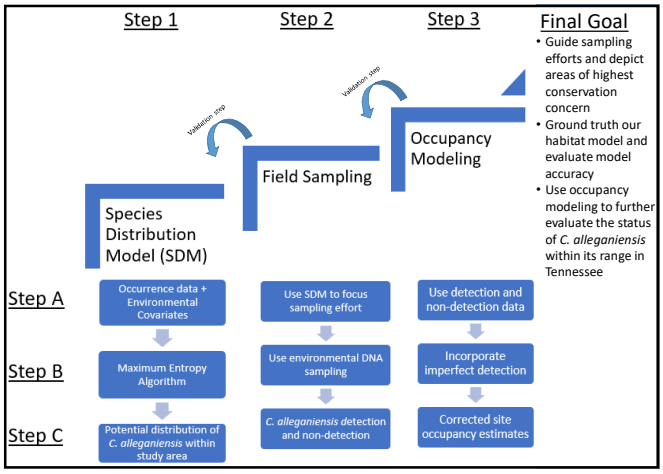


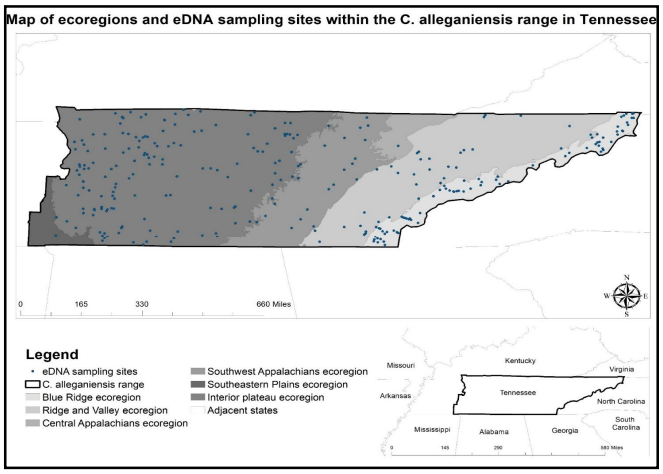
The use of species distribution models (SDM) and environmental DNA to evaluate the distribution of the Eastern Hellbender (*Cryptobranchus a. alleganiensis*) In Tennessee



Jeronimo Silva – Tennessee State University
William Sutton – Tennessee State University
Stephen Spear – The Wilds
Michael Freake - Lee University

PC: David Herasimtschuk

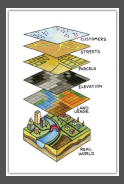




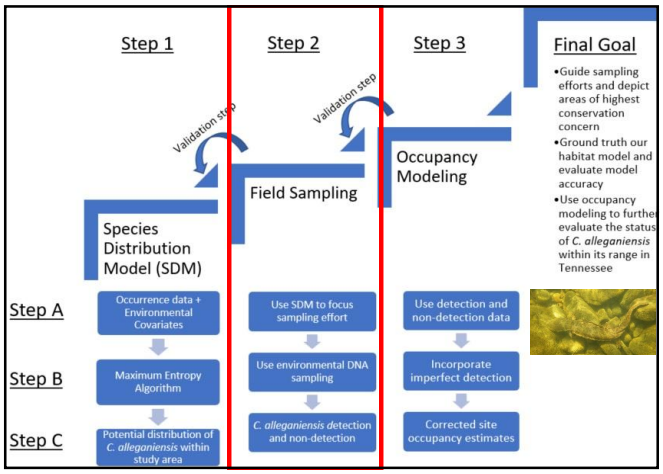
Species Distribution Model - MaxEnt

Distribution data → Presence data
153 occurrence points 1950 – 2015

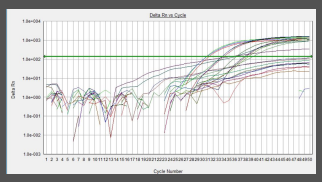
Environmental information → Stream flow
Hillshade
Elevation
Precipitation
Land cover
Geology
Stream order
Temperature

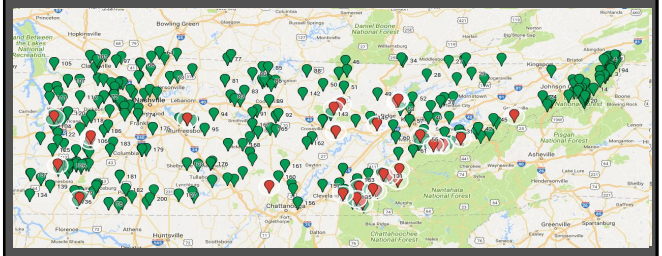


Potential distribution → Across Tennessee



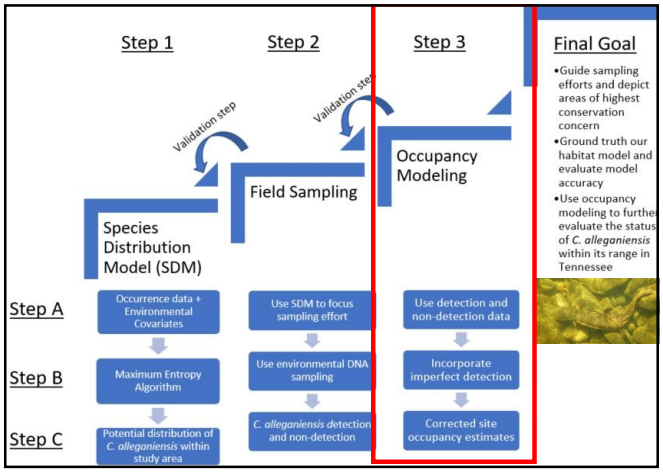
Environmental DNA





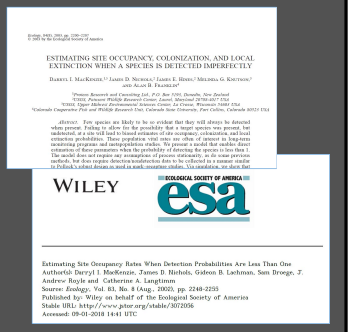
Green = Unknown
- 899 sites
- 1 sample – 1 time

Red = Seasonals = Detectability purposes
- 30 sites sampled during June, July, and August



Occupancy model

- Naïve vs. Corrected occupancy
- Modeling techniques described by MacKenzie et al. (2002, 2003)
  - Single species
  - Single season
- 29 models
- Detection (observation covariate) ->Julian date
- Occupancy (site covariates) -> elevation, geology, Strahler order, land cover, and ecoregion
- AIC_c -> evaluate model performance



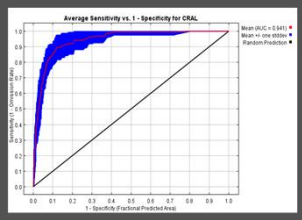
ESTIMATING SITE OCCUPANCY, COLONIZATION, AND LOCAL EXTINCTION WHEN A SPECIES IS DETECTED IMPERFECTLY

WILEY

ESA ECOLOGICAL SOCIETY OF AMERICA

Estimating Site Occupancy Rates When Detection Probabilities Are Less Than One
Author(s): Darryl I. MacKenzie, James D. Nichols, Gideon B. Lachman, Sam Droege, J. Andrew Royle and Catherine A. Langtimm
Source: Ecology, Vol. 83, No. 8 (Aug., 2002), pp. 2248-2255
Published by: Wiley on behalf of the Ecological Society of America
Stable URL: http://www.jstor.org/stable/3072056
Accessed: 09-01-2018 14:41 UTC

Results – Habitat Model



Covariate	Percent contribution (%)
Strahler order	85.4
Geology	7.4
Precipitation	2
Temperature	1.5
Landcover	0.9
Elevation	0.9
Slope	0.8
Hillshade	0.6
Stream flow direction	0.5

Results – Habitat Model

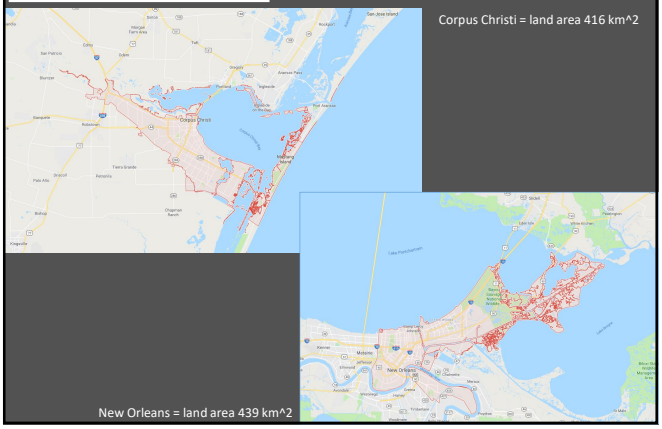
Ecoregion	Suitable stream area per suitability category (km^2)					
	Low	Medium	High	Very high	Total (km^2)	
Central Appalachians	3.09	1.74	0.13	0.00	4.96	
Blue Ridge	29.72	12.07	7.80	5.02	54.60	
Southwest Appalachians	19.33	11.27	2.75	0.13	33.48	
Ridge and Valley	46.75	25.59	22.63	1.91	96.89	
Southeastern Plains	3.59	2.24	0.99	0.76	7.58	
Interior Plateau	102.19	50.64	69.94	2.11	224.88	
Total (km^2)	204.68	103.54	104.25	9.93	422.39	Total (km^2)

	Percent of each suitability category per ecoregion (%)			
Central Appalachians	62.39	35.03	2.58	0.00
Blue Ridge	54.43	22.10	14.29	9.19
Southwest Appalachians	57.73	33.65	8.22	0.39
Ridge and Valley	48.26	26.41	23.36	1.97
Southeastern Plains	47.36	29.51	13.09	10.04
Interior Plateau	45.44	22.52	31.10	0.94

*12% of total available stream area is predicted as suitable

*75% of suitable streams fall within low and medium category

For size reference



Results – Field Sampling

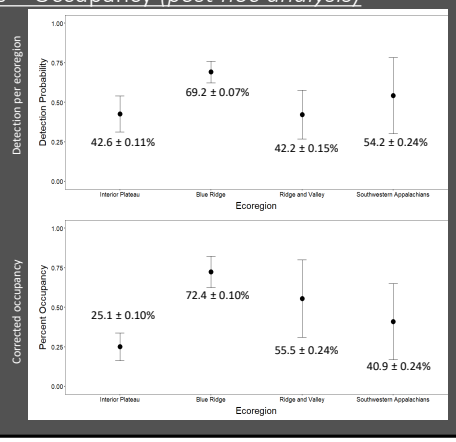
	MaxEnt Suitability Category				
	Low	Medium	High	Very high	Total (#)
Detection (#)	9	12	19	25	65
Non-detection (#)	59	66	65	29	219
Total (#)	68	78	84	54	284
Detection (%)	13.2	15.4	22.6	46.3	22.9
Non-detection (%)	86.8	84.6	77.4	53.7	77.1

Results – Occupancy modeling

Ecoregions	Detection	Non-detection	Total	Naïve Occupancy (%)
Blue Ridge	34	36	70	48.6
Interior Plateau	17	139	156	10.9
Ridge and Valley	10	29	39	25.6
Southwestern Appalachian	4	12	16	25
Central Appalachian	0	1	1	0
Southeastern Plains	0	2	2	0
Total	65	219	284	-

	Occupancy (psi)	Detectability (.)	AIC_c	K	ΔAIC_c
CRALfm19	ecoreg_3	(.)	383.41	5	0.00
CRALfm6	ecoreg_3	survey	384.91	6	1.49
CRALfm29	X11_STD	ecoreg_3	384.99	6	1.50
CRALfm24	(.)	ecoreg_3	385.07	5	1.65

Results – Occupancy *(post hoc analysis)*



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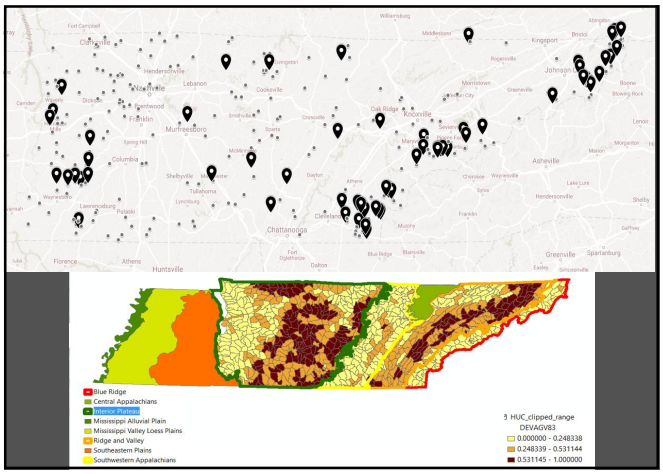
CRALfm29	X11_STD	ecoreg_3	384.99	6	1.50
CRALfm24	(.)	ecoreg_3	385.07	5	1.65

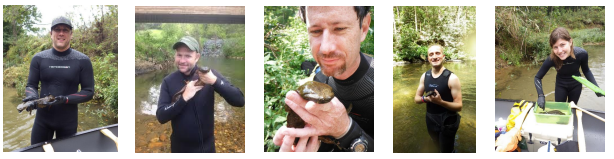
Discussion

- Limited available habitat for the species within its range in Tennessee
- Ecoregion is a strong determinant of occupancy and detection
  - Geomorphology
  - Hydrology
- Where are the stronghold populations?
- Ecoregion and occupancy →Proxy for effect of land use practices
  - Legacy effect
  - Current effect
- eDNA was an effective tool



Conclusions and Conservation Implications

- Habitat degradation seems to be the MVP of hellbender decline
- Future conservation of the species may rely on prioritizing populations and areas of highest conservation need
  - Where would you focus your conservation efforts?
- Future research
  - Compare microhabitat between areas with declining populations functional populations.
  - Quantify sediment input over time
  - Further evaluate effect of land use
- CONSERVATION TOOLBOX



- Ruth
- Jessica
- Thais Lopes
- Private Landowners

If you were a policy maker, what would do to improve hellbender conservation in Tennessee?