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Species Delimitations and Conservation Biology: Barcoding South of the Border

Keith Crandall

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Brigham Young University

http://inbio.byu.edu/Faculty/kac/crandall_lab/

http://crayfish.byu.edu

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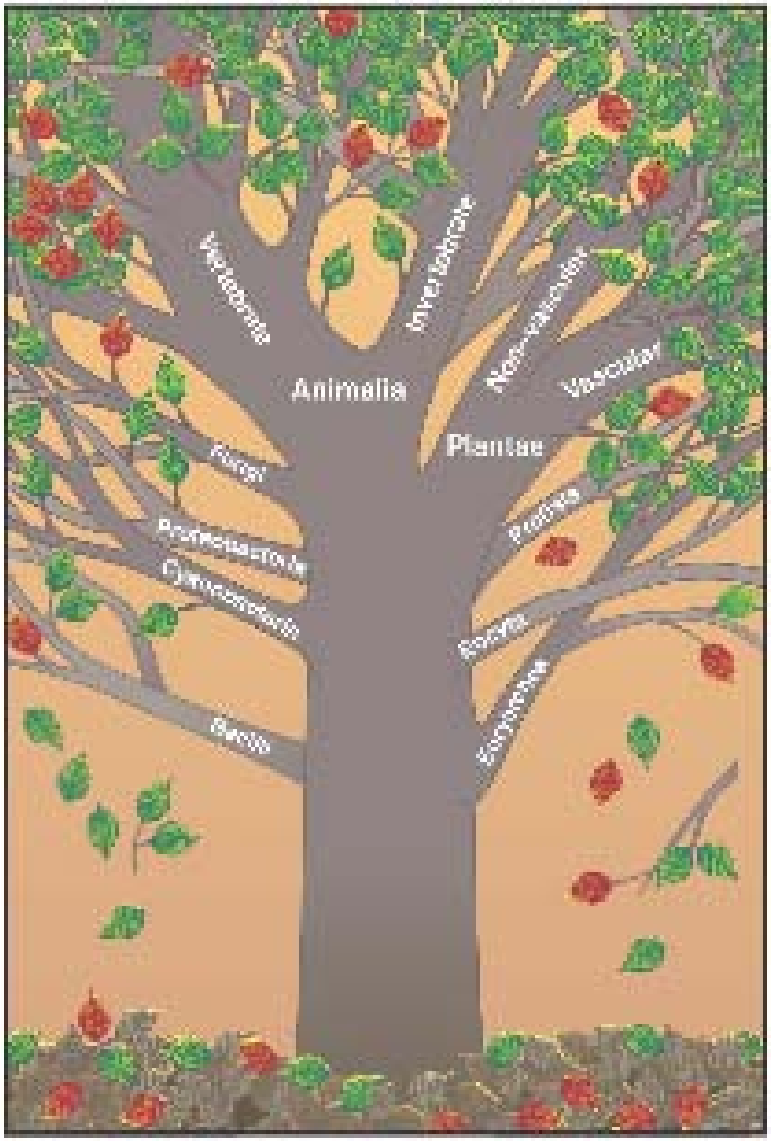
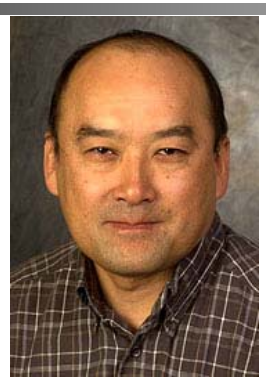
Barcoding and the Tree of Life



Barcoding at BYU

- Fish



- Mammals

- Crustaceans

- Insects

- Lichens

- Vascular Plants

- Herps

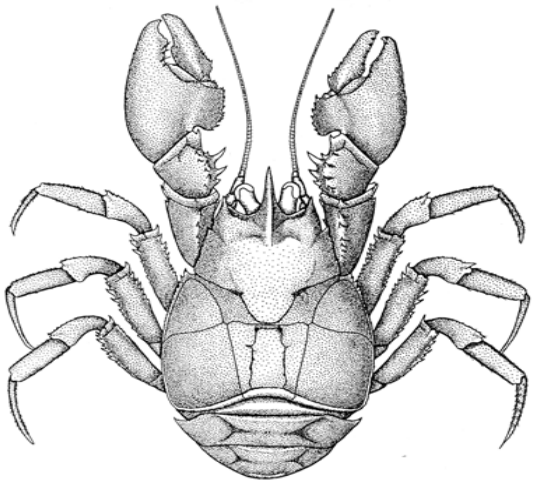
Facilities

Cluster

Supercomputer

Determining Species Boundaries in Conservation

- ESA & other species based legislation
- Determining biogeographic regions



Aegla spinosa

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Determining Species Boundaries in Conservation

- ESA & other species based legislation for conserving biodiversity
- Determining biogeographic regions
- Species Richness for conservation priorities

Orme et al. Nature 2005

A - Species Richness (SR)

B - Threatened SR

C - Endemic SR

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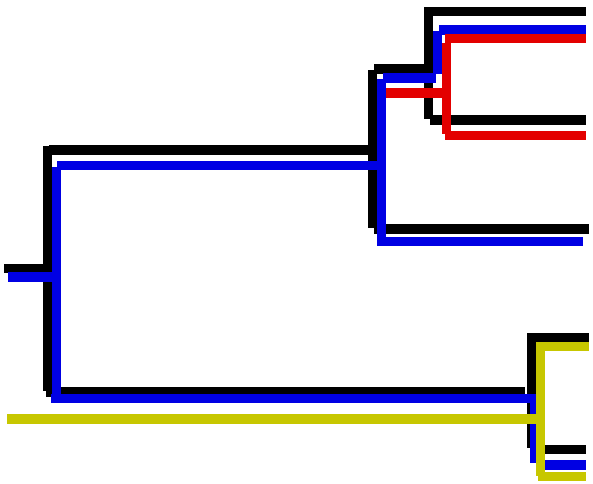
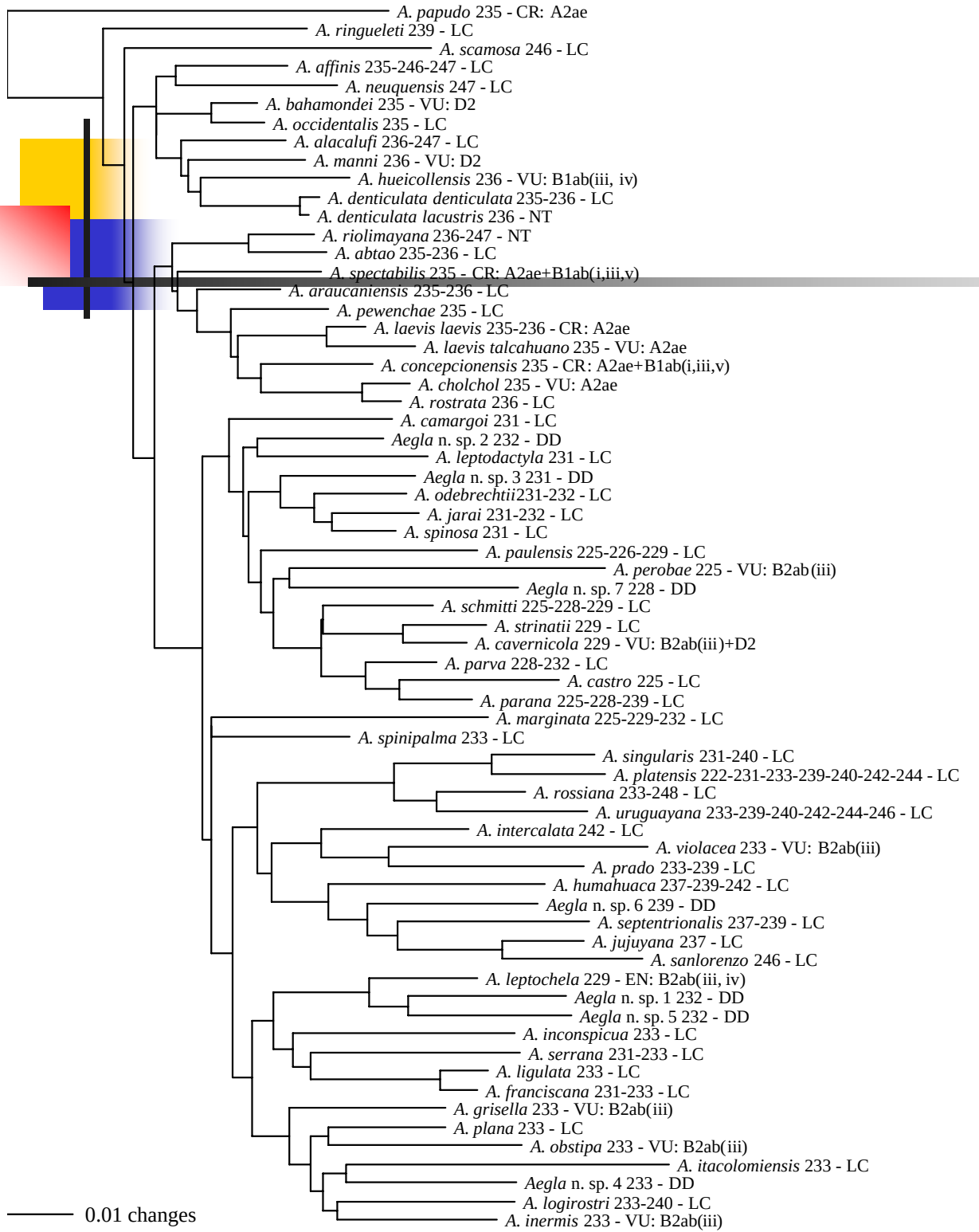
Phylogenies to assign conservation priorities



	Area 1	Area 2	Area 3
Species A	X	X	
Species B		X	
Species C	X		
Species D			X
Species E	X		X



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Priorities

Bioregion	SR	*SRr*	TS	*TSr*	TD	*TDr*	TDE	*TDEr*	GD	*GDr*	PD	*PDr*
222	0	*16-18*	0	*6-18*	1.2	*14-16*	0	*17-18*	0	*16-18*	0	*16-18*
225	6	*5-7*	1	*5*	6.8	*8*	3.8	*10*	0.166	*5*	0.180	*5*
226	1	*13-15*	0	*6-18*	1.5	*13*	0.5	*17*	0.056	*14*	0.057	*14*
228	4	*9-10*	0	*6-18*	3.5	*11*	2.2	*11*	0.105	*10*	0.110	*10*
229	6	*5-7*	2	*3-4*	8.1	*7*	5.1	*7*	0.147	*7*	0.158	*7*
231	7	*3-4*	0	*6-18*	10.3	*5*	8.4	*5*	0.163	*6*	0.176	*6*
232	7	*3-4*	0	*6-18*	9.7	*6*	6.6	*6*	0.209	*3*	0.232	*3*
233	17	*1*	4	*2*	20.8	*2*	16.1	*2*	0.428	*1*	0.552	*1*
235	13	*2*	6	*1*	35.1	*1*	31.1	*1*	0.271	*2*	0.311	*2*
236	6	*5-7*	2	*3-4*	10.5	*4*	8.5	*4*	0.139	*9*	0.149	*9*
237	4	*9-10*	0	*6-18*	2	*12*	2	*12*	0.145	*8*	0.155	*8*
239	5	*8*	0	*6-18*	11.9	*3*	9.8	*3*	0.179	*4*	0.195	*4*
240	1	*13-15*	0	*6-18*	1.2	*14-16*	0.6	*14-15*	0.072	*13*	0.074	*13*
242	2	*12*	0	*6-18*	1.2	*14-16*	1.2	*13*	0.093	*11*	0.096	*11*
244	0	*16-18*	0	*6-18*	0	*17-18*	0	*17-18*	0	*16-18*	0	*16-18*
246	1	*13-15*	0	*6-18*	5	*10*	5	*8*	0.049	*15*	0.049	*15*
247	3	*11*	0	*6-18*	6.7	*9*	4.7	*9*	0.079	*12*	0.082	*12*
248	0	*16-18*	0	*6-18*	0	*17-18*	0.6	*14-15*	0	*16-18*	0	*16-18*

Priorities

233
235

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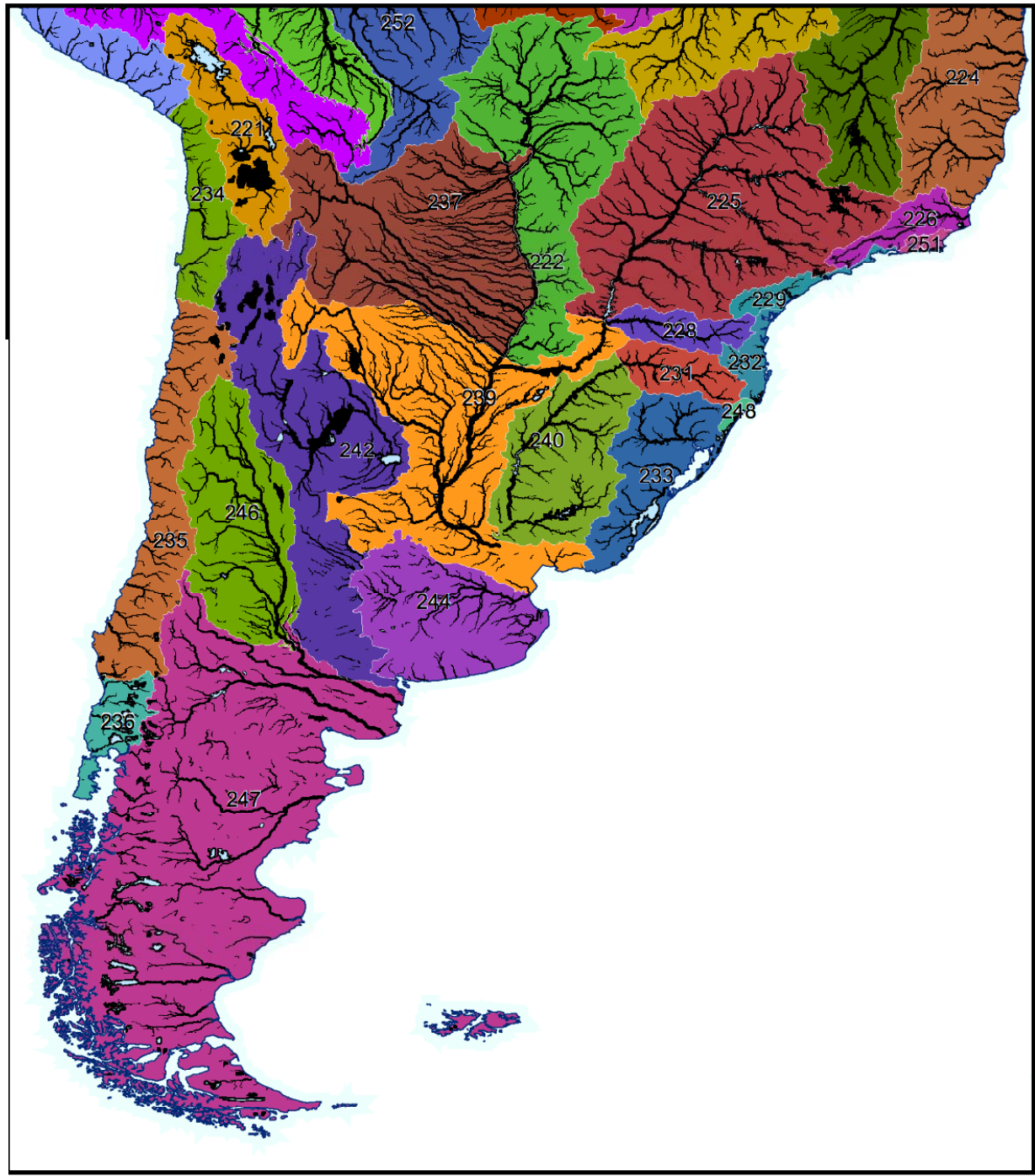
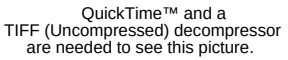
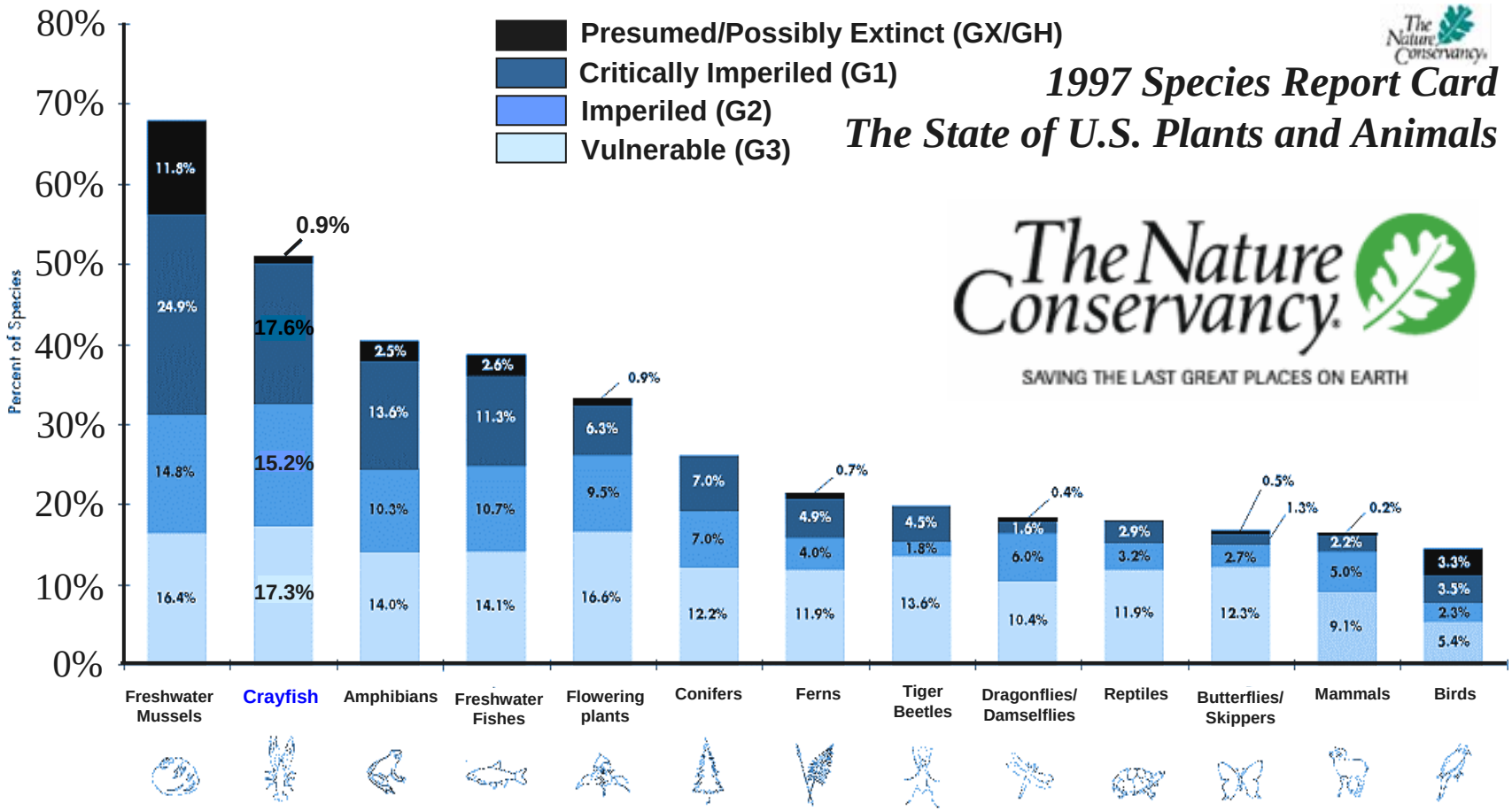


Species Diagnosis via Genetics



- What is this? - DNA Barcoding
- Where did it come from?
- When did it get here?
- What's its function?
  - Molecular, Ecological, Phenotypic
  - Correlations between form and function
  - Correlations between genotype and phenotype

Crayfish Species at Risk

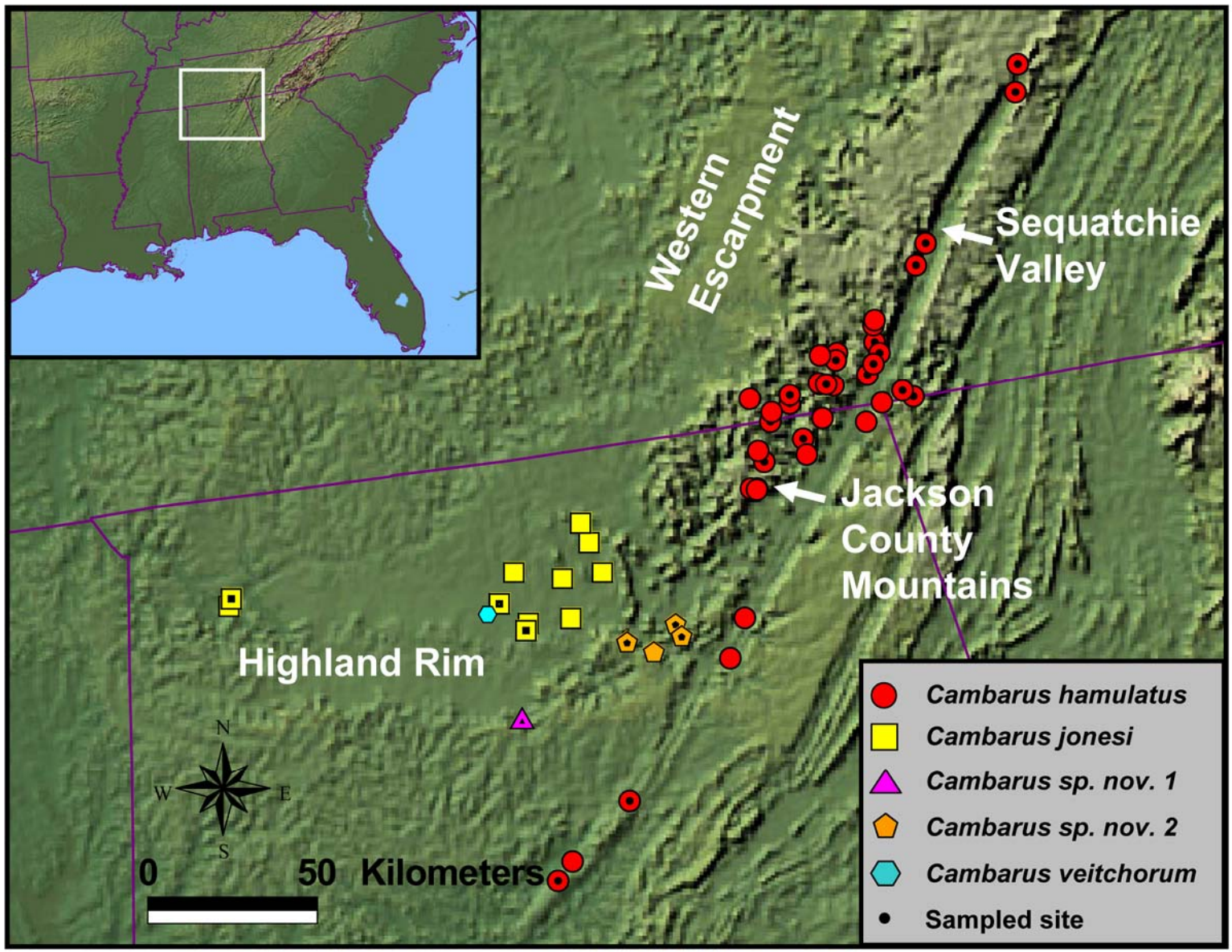


TOTAL	67.9%	50.9%	40.5%	38.7%	33.3%	26.1%	21.6%	20.0%	18.4%	18.0%	16.8%	16.5%	14.6%

Cave Crayfish of Appalachia

- What are the conservation units?
- What is the historical vs current population structure?
- Are species on the decline?
- What is the endangered status?

Southern Appalachian species



Phylogeny

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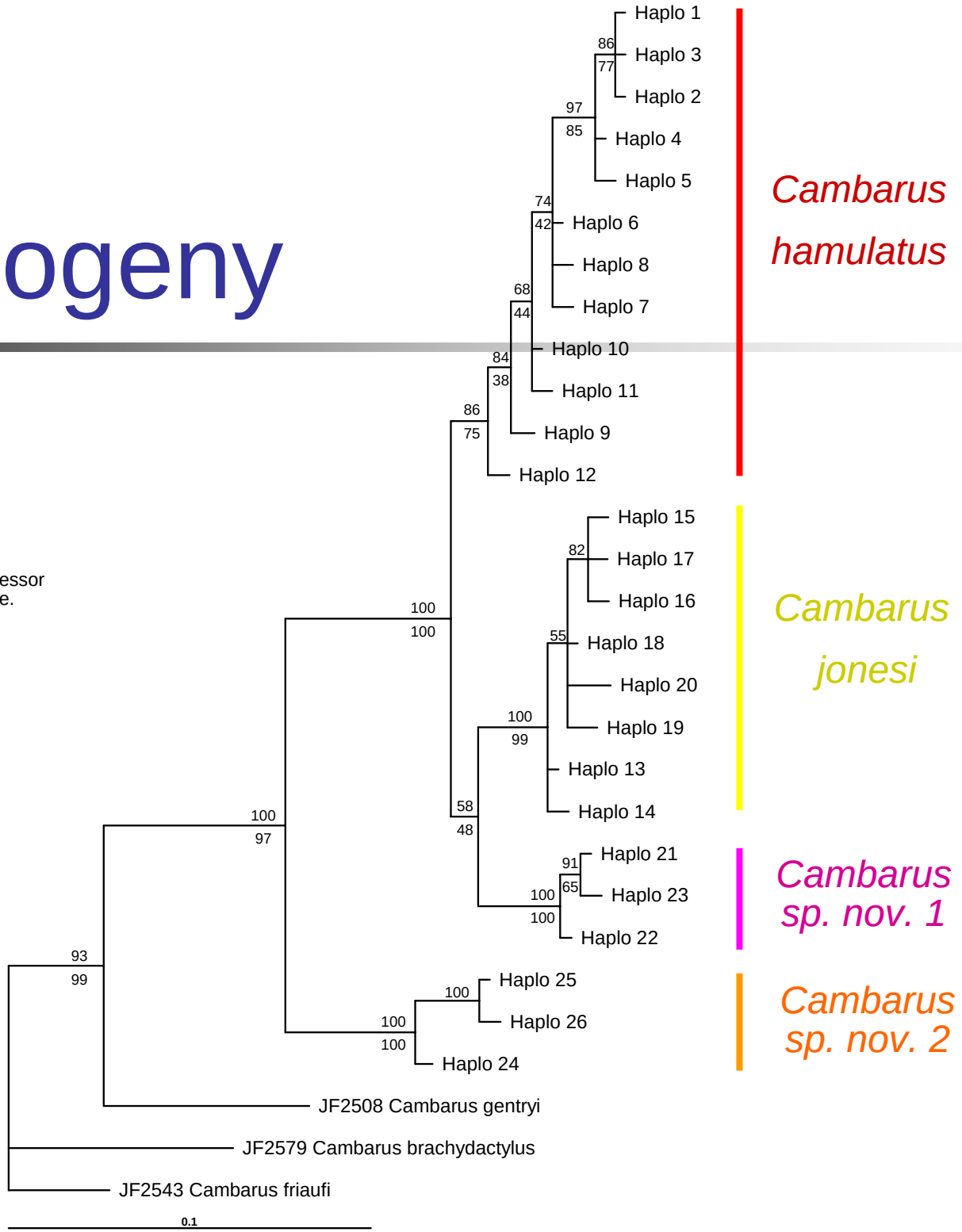
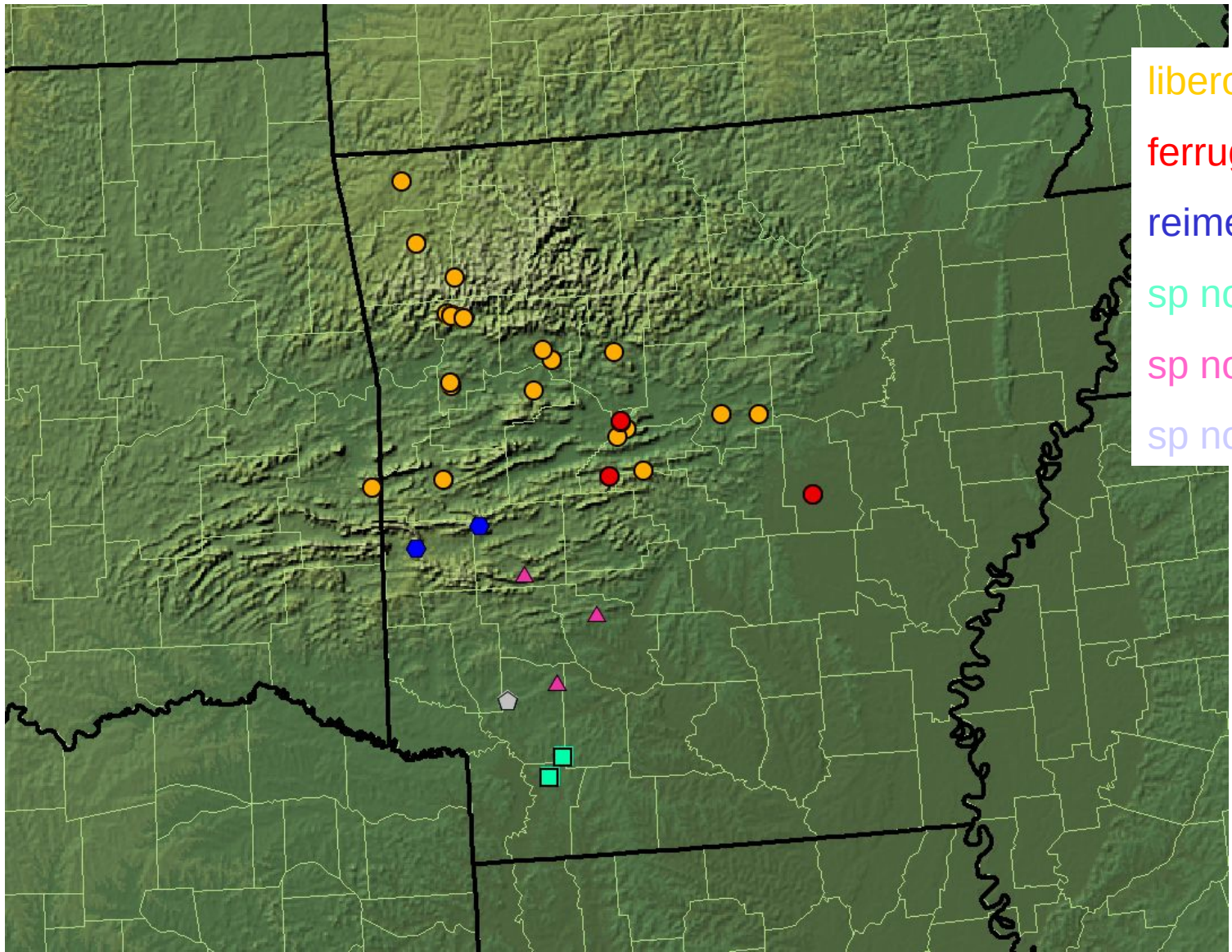


Genetic Diversity

	Current		Historical	
Species	θ_n	N_e	θ_w	N_e
C. hamulatus	0.0044	40182	0.0048	43364
C. jonesi	0.0045	41091	0.0059	53182
C. sp. nov. 1	0.0021	18727	0.0020	18000
C. sp. nov. 2	0.0037	33545	0.0048	43455
O. luteus	0.0250	50020	0.0608	121526
O. juvenilis	0.0039	7880	0.0318	63588

Utility of Museum Specimens



Extinction through nonexistence

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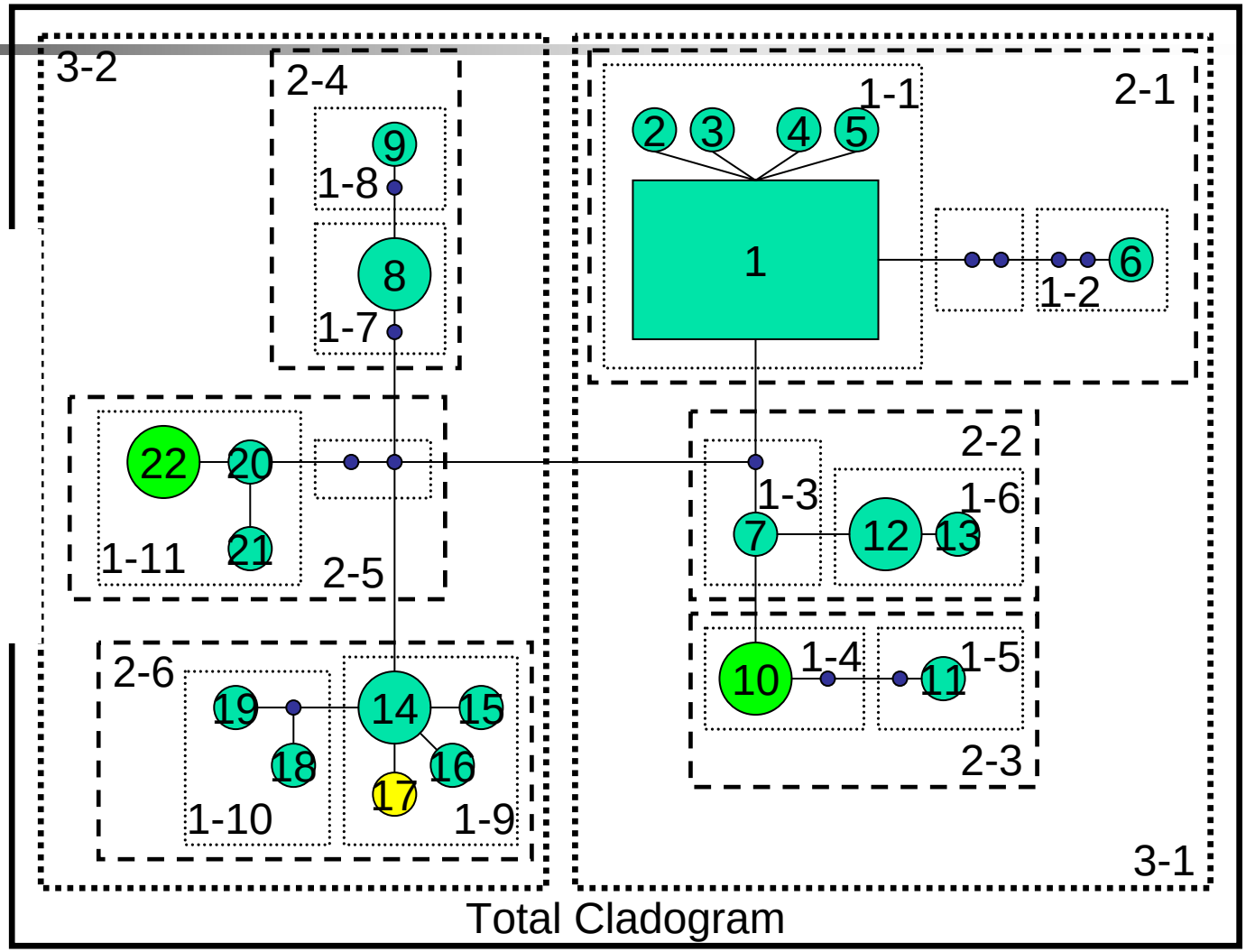

P. liberorum

P. ferrugineus

P. liberorum + P. ferrugineus

Conclusions

- Species delimitations and diagnostics have implications across a broad range of conservation biology
- Population genetics and phylogenetics provide some powerful tools for diagnosing species for conservation and answering conservation relevant questions like current versus historical population structure, diversity, and population dynamics
- Inferences help establish species boundaries, discovery of new species, diagnosis of ESU, develop priorities

Acknowledgments

- Jen Buhay - cave crayfish studies
- Henry Robison - AR crayfishes
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- NSF, Arkansas Fish & Game, NSS, Cave Conservancy Foundation, Cave Research Foundation, BYU, National Geographic, Fulbright Foundation