Snail tale:

Ecology and conservation of the Kanab ambersnail

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Broecher

The Big Picture

1. Snail ecology
2. High-flow experiments
3. Conservation implications
4. Current status

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The Big Picture

Mystery!

Politics!

1. Snail ecology
2. High-flow experiments
3. Conservation implications
4. Current status

Drama!

Intrigue!

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Kanab ambersnail (*Oxyloma haydeni kanabensis*)

- Shell ~1cm in length
- Lifespan of 15 months[1]
- Discovered in Utah 1909, named in 1948[2]
- Closely related subspecies ***O. haydeni haydeni*** is more widespread
- Highly **variable** population size, difficult to accurately census[3,4,5]

1. Stevens et al., 1997 **2.** Pilsbry 1948 **3.** Sorensen and Kubly 1997 **4.** Gloss et al. 2005 **5.** USFWS 2011

Ecology of Kanab ambersnail

- Habitat: spring-fed wetlands & **crimson monkeyflower**
- Dispersal by birds[6,7] and water[8]
- Air-breathers (survive 2-3 days in water) [9]
- Affected by loss and modification of **wetland habitat**[7]

6. Green & Figuerola, 2005 **7.** Wada et al., 2011 **8.** Culver et al. 2013 **9.** Miller et al. 2000

Distribution of Kanab ambersnail

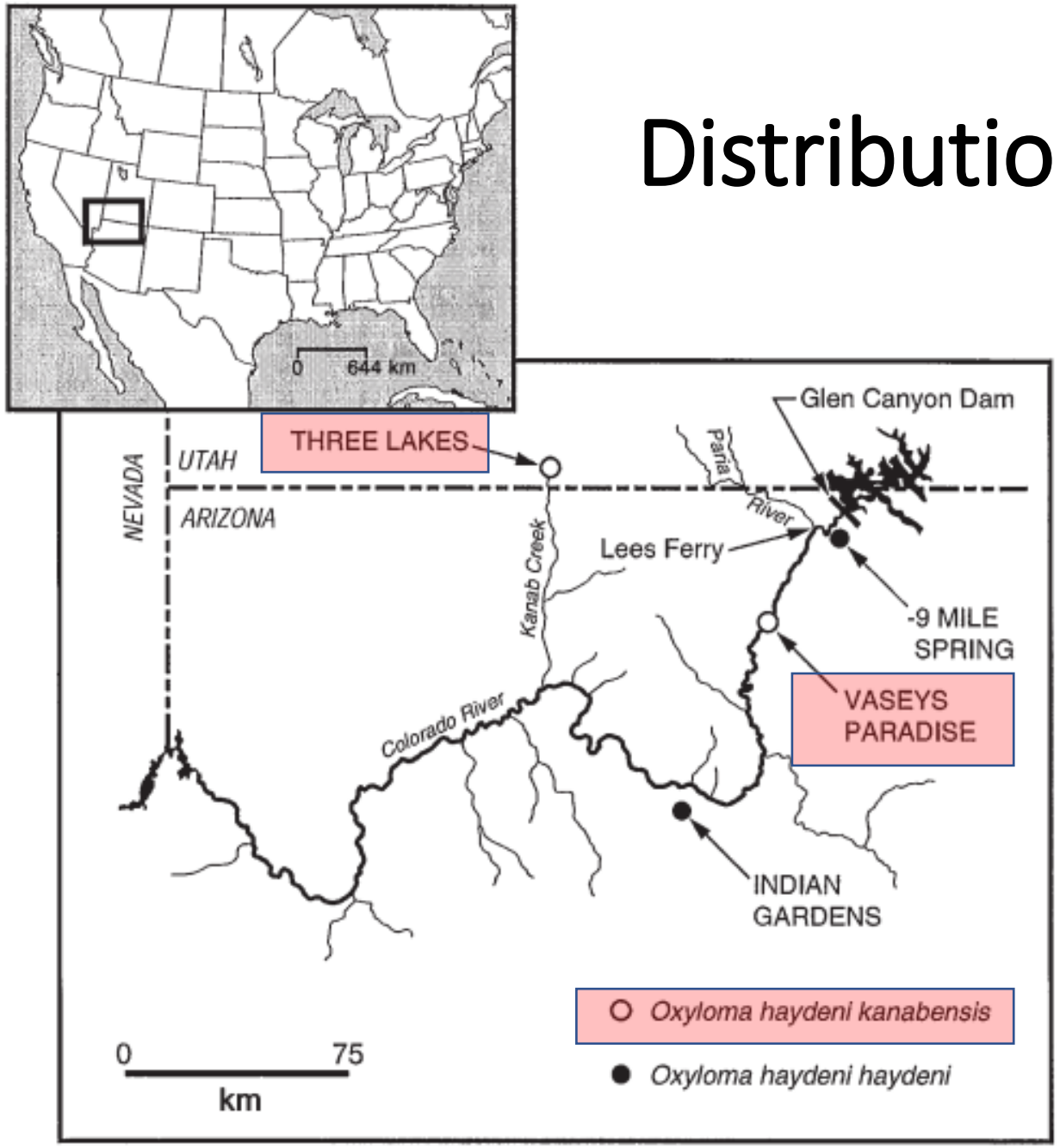
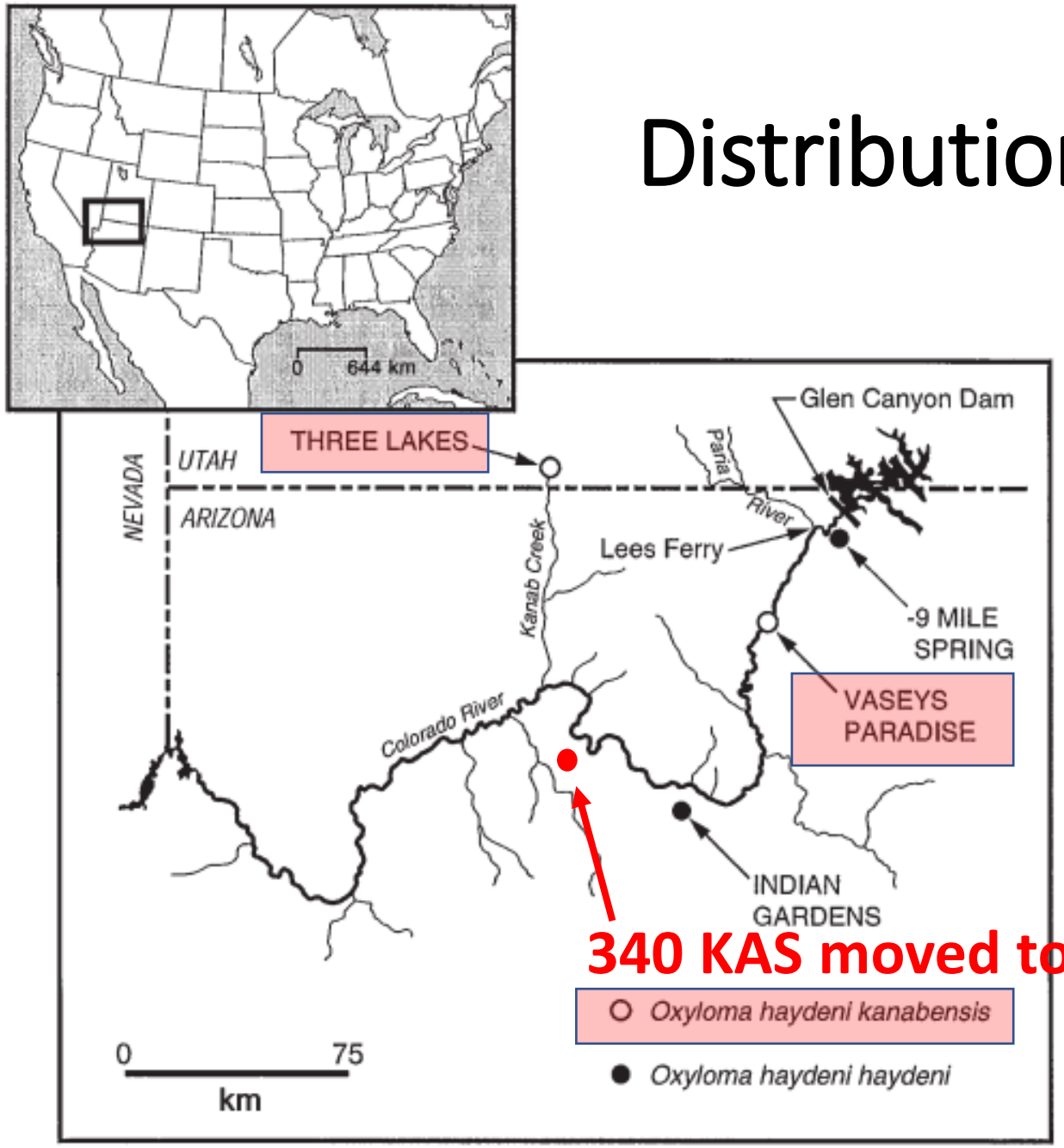


Figure adapted from Miller et al. 2000

- Inhabit 3 sites: **Vasey's Paradise** & **Upper Elves Canyon** in Grand Canyon (AZ); Three Lakes (UT)
- Listed as **Endangered Species** in 1992
- Similar individuals found in Alberta, Canada[8]

8. Culver et al. 2013

Distribution of Kanab ambersnail



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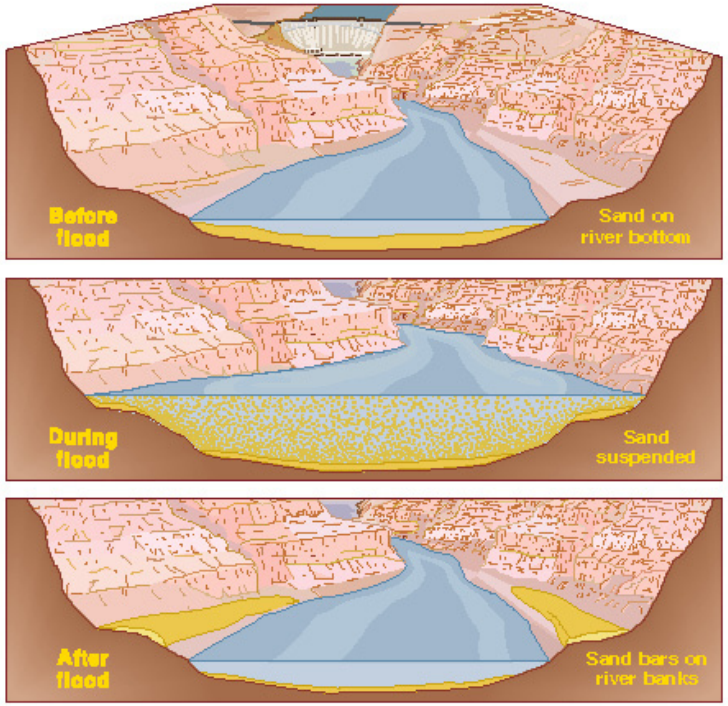
Conservation questions:
Grand Canyon high-flow experiment (1996)



Sand on the river bed will be suspended by the controlled flood and deposited in sand bars along the banks.

- High flows may benefit fish habitat[10]
- But changes in flow regime on dammed rivers can have negative consequences for invertebrates[11]
- Special measures taken to protect **Kanab ambersnails**

10. Meretsky et al., 2000 **11.** Kennedy et al., 2016

Conservation questions:
Grand Canyon high-flow experiment (1996)

- Estimate: High-flow destroys snail habitat[12]
- Plan for saving snails: relocate 90% of snails below worst case inundation area[13]
- Two problems:
  - More snails than estimated
  - More dormant snails than estimated (finding dormant snails requires destroying habitat)
- New plan: relocated 75% of snails from 50% of inundation area
- Snail populations/habitat impacted but not destroyed by high-flow experiment

12. USBR 1996 **13.** USFWS 1996 **10.** Meretsky et al., 2000

Conservation questions: **Species vs. Ecosystem**

- **Trade-offs** between flood and damage to Kanab ambersnail populations/habitat
- **Endangered Species Act** provides highest level of protection
  - Protects species and habitats
  - Includes subspecies, varieties, and (for vertebrates) distinct population segments
  - "**Conservation Unit**"[14]

14. Mortiz 1994

Conservation Implications

- Conservation increasingly incorporates genetic data
- Genetic analysis determines amount of genetic diversity in a species (**more = better**; once lost, genetic diversity is hard to get back)
- Is KAS genetically distinct from related subspecies?

  Mixed reviews:

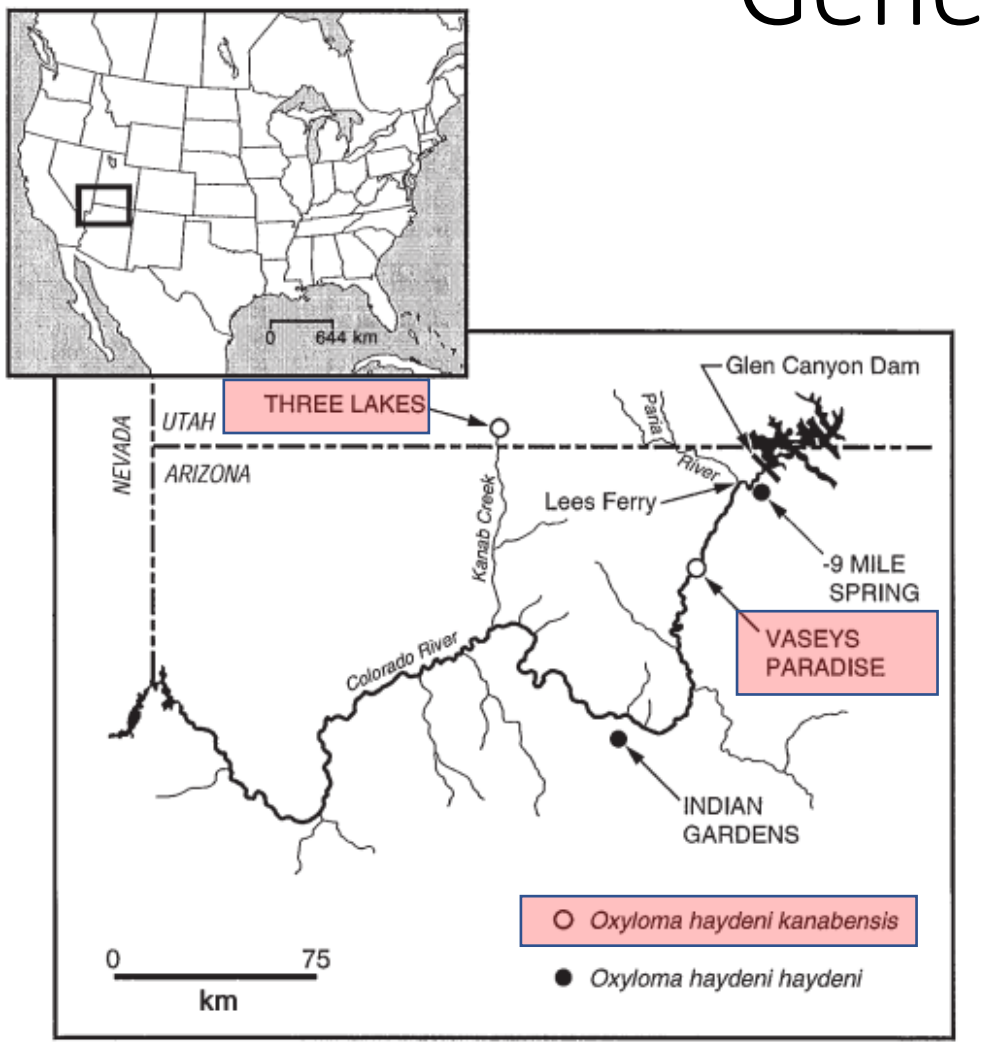
  - Miller et al., 2000 YES
  - Culver et al., 2013 NO

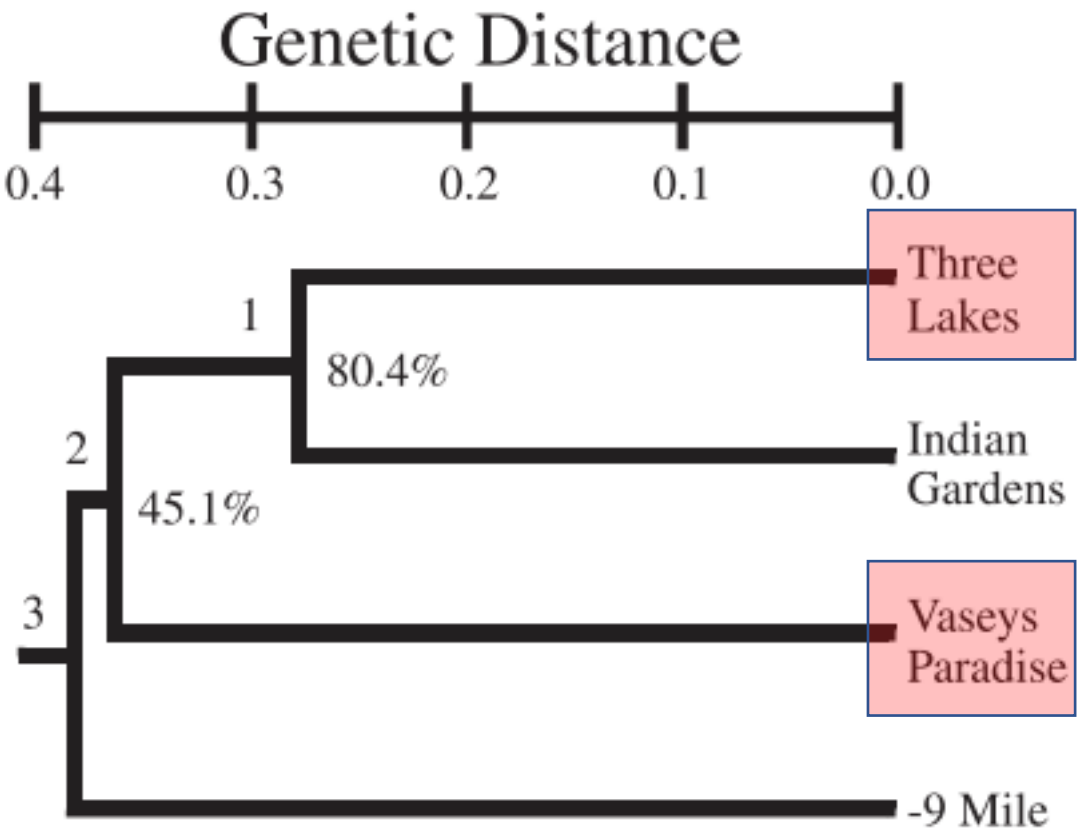
  (neither study with complete data & best methods)

Example of genetic data used in conservation: migration timing is genetically based and probably difficult to re-evolve[16]

16. Prince et al. 2017

Is KAS an endangered species?
Genetic comparisons





Figures adapted from Miller et al. 2000

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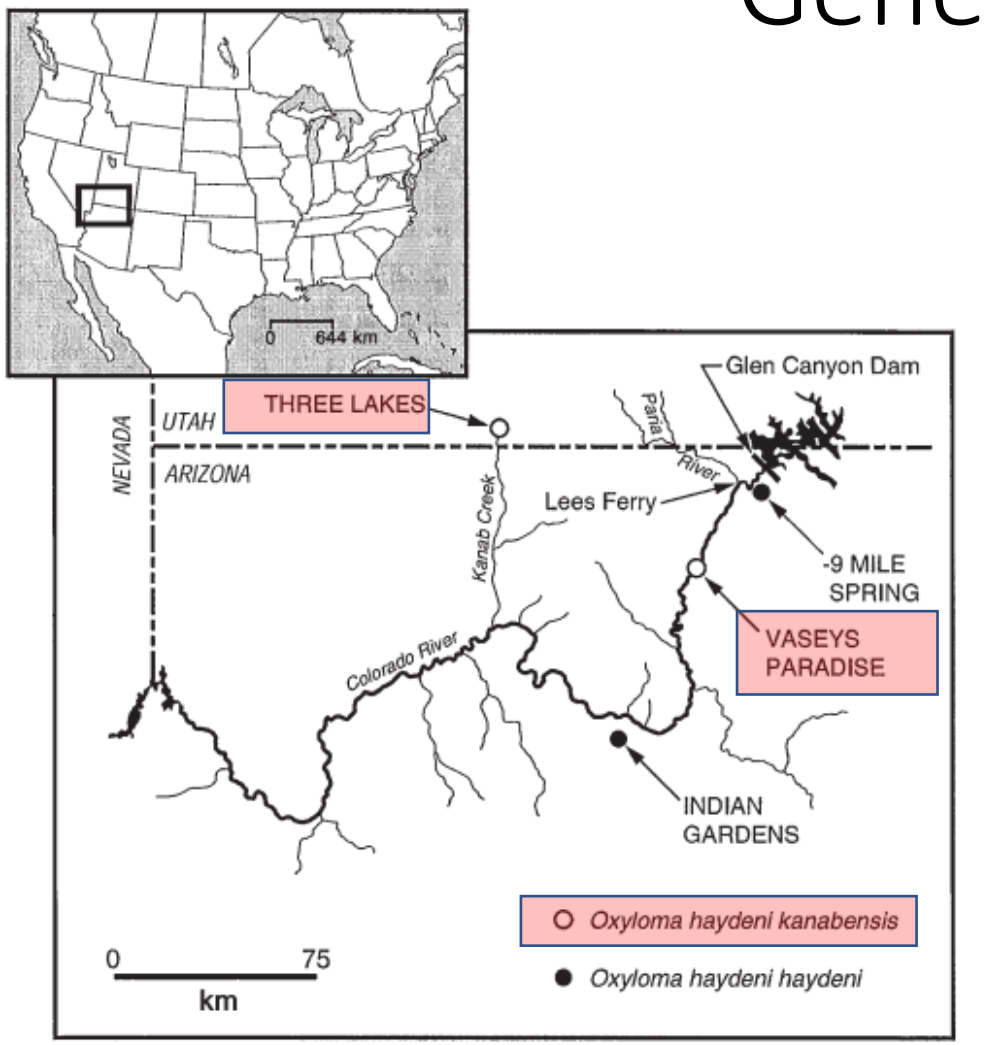

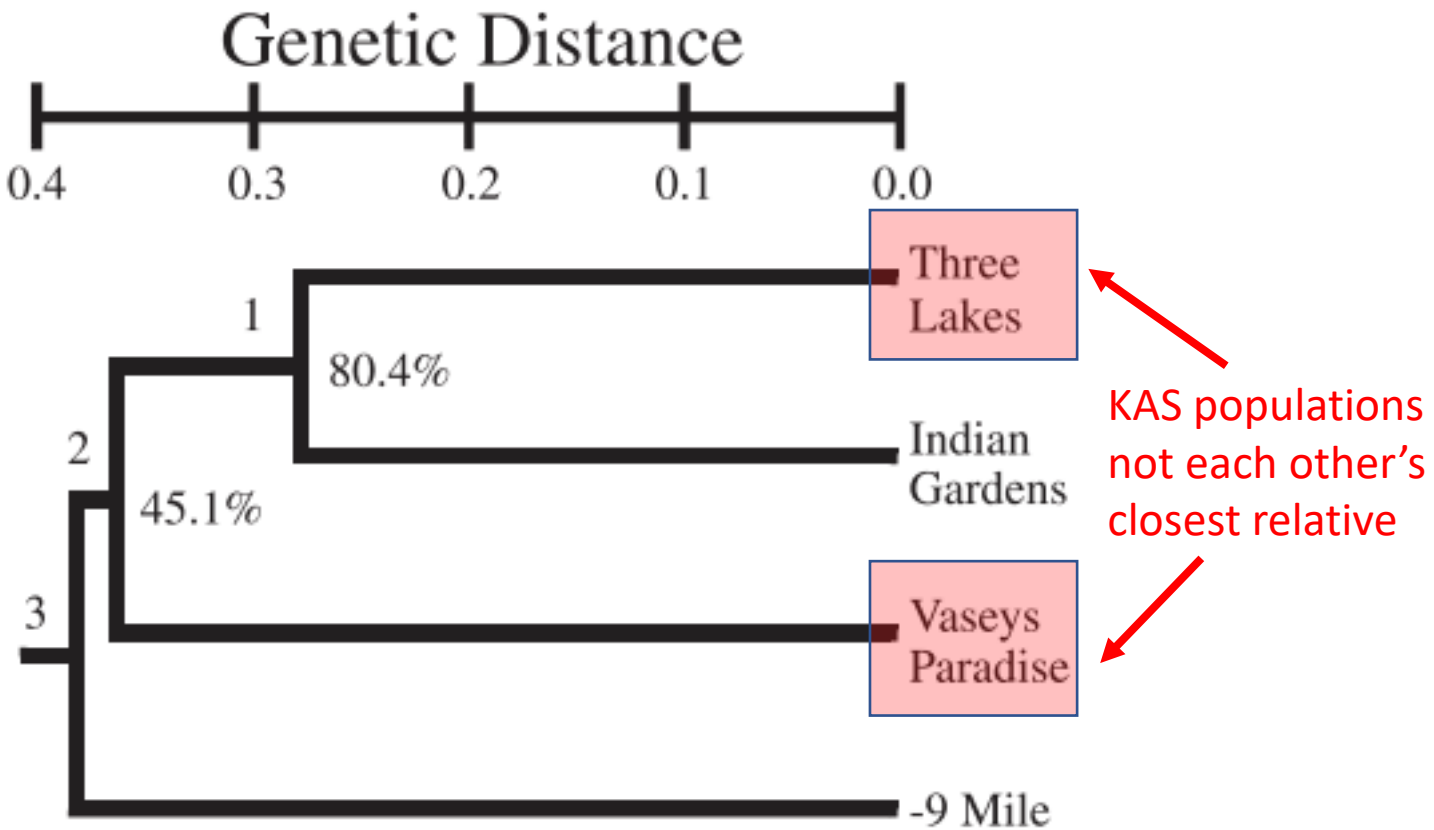

Figures adapted from Miller et al. 2000

KAS evolutionary history vs. current reality

- KAS evolved in free-flowing rivers
- KAS **wetland** habitat is likely greatly reduced due to human impact
- **"Boom and bust"** population cycles may be normal for KAS[8]
- But reduction of **wetland** habitat may affect survival of KAS as a species[15]

Upper Elves Canyon, KAS habitat

8. Culver et al. 2013 **15.** Hurt 2004

Current status: Need more data!

- Genetic diversity and relatedness of ambersnails in AZ & UT poorly understood/incomplete
- Re-evaluated **Endangered Species** with more data[17]
- Criteria for **removing** from **Endangered Species** list[10]
  1. Locate/establish additional populations so that 10 separate populations of KAS exist with long-term viability; and
  2. Establish formal land management designations and/or implement land management plans that provide long-term, undisturbed habitat for 10 populations

➢**Not met!**

10. USFWS 1992 **17**. Noss et al.,

Summary

Mystery!

- **Kanab ambersnails** have limited range and specific habitat requirements
- **Conservation** of Kanab ambersnails may be at odds with conservation of ecosystem as a whole

Drama!

- **Endangered Species** protections are the best way to protect the Kanab ambersnail and its habitat

Politics!

- Poorly understood genetic diversity/relationships of ambersnails complicate **conservation** efforts

Intrigue!

Questions?

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