

# Genetic Interrelationships among populations of *Gila cypha* in the Colorado River Ecosystem

Marlis R. Douglas  
Michael E. Douglas

Dept. Fishery & Wildlife Biology  
Colorado State University



# Acknowledgments

Many individuals provided assistance:

K. Bestgen

S. Carothers

J. Jackson

T. Moody

S. Ross

M. Trammel

S. Bingham

L. Coggins

L. Johnston

F. Pfeifer

D. Stone

R. VanHaverbeke

P. Brunner

M. Hudson

C. McAda

B. Ralston

R. Timmons

Who did we forget?

Funding - GCMRC



# *Gila cypha* - Population Structure

- Mainstem / LCR continuum ?
  - 30-Mile vs LCR?
  - LCR vs Middle Granite Gorge
  - LCR vs Western Grand Canyon



# Objectives

- Examine genetic interrelationships on finer
  - spatial scale
  - temporal scale
- Identify MUs
- Nuclear perspective on introgression



# Why Microsatellite DNA?

- fast evolving
  - >> **high variability**
- co-dominant, mendelian inheritance
  - >> **nuclear perspective**
- distributed throughout genome
  - >> **multiple independent loci**



# Molecular Genetic Methods

Tissue collection



DNA-Extraction

DNA Amplification  
(PCR)

Electrophoresis

# What are Microsatellite Loci ?

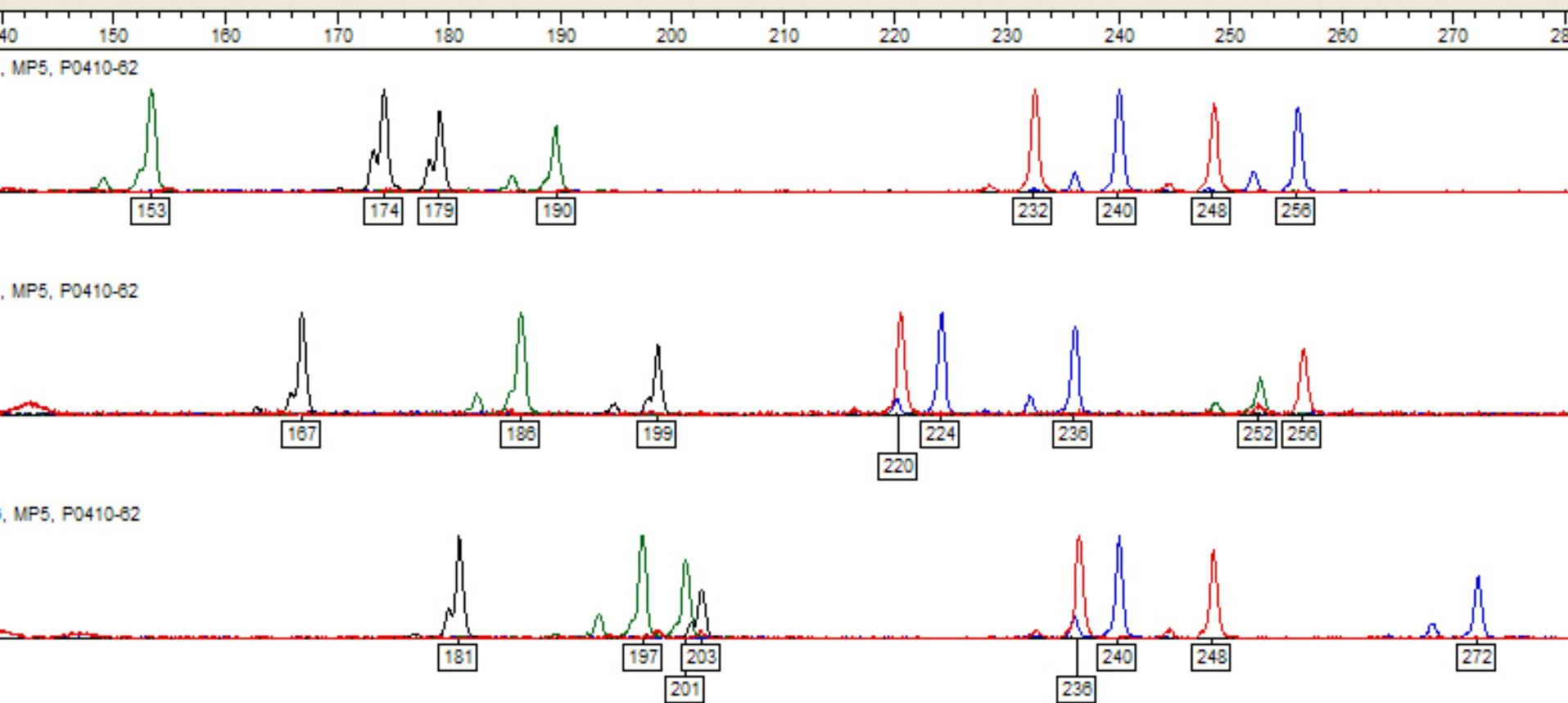
Tandem repeats of short DNA motifs (1-5 b)

$(AC)_5$       ACACACACAC

$(AC)_8$       ACACACACACACACAC

$(AC)_{13}$       ACACACACACACACACACACACACAC

# 4 Msat loci - 3 HBC



# Msat Loci & Sample Sizes

- high variability
  - + population-level analyses
  - # alleles >> # sample sizes
- codominant inheritance
  - + species ecology (e.g., introgression)
  - larger sample size to encapsulate pop. variation



# Msat Data: Today

## 14 Microsatellite Loci

- 2 = di-nucleotide repeats (CA)
- 12 = tetra-nucleotide repeats (CAGT)

# Sampling: Grand Canyon

- 9 locations / 255 individuals

- 30-Mile Springs	11
- Little Colorado River	83
- Lava to Hance	8
- Shinumo Ck	26
- Stephen's Aisle	7
- Randy's Rock	95
- Kanab Ck	4
- Havasu Ck	11
- Western Grand Cn	10



# Sampling: Upper Basin

- 5 locations / 208 HBC + 239 RTC

	HBC	RTC
- Yampa R	7	65
- Desolation Cn	63	19
- Black Rocks Cn	56	63
- West Water Cn	82	61
- 15-mile Reach	-	31



# Sampling: Bonytails

- Broodstock = 15 individuals
  - from Alamosa National Fish Hatchery  
kindly provided by J. Alves, CDOW



# Msat Analysis: Diversity

- High allelic diversity within populations  
mean = 35 alleles / pop.
- Moderate to high levels of heterozygosity
- Unique alleles
  - for populations
  - for basins
  - for species



# Msat Analysis: Diversity

- Allele frequencies between populations  
clear differences (Bonferroni correction)

..... but

- sample size effects
- missing data effect



# Msat Analysis: Pairwise Tests

- Upper Basin
  - significant differences  
between locations (but not all)  
between HBC / RTC (but not all)



# *Gila cypha* - Distribution

- Upper Basin:

- Yampa River 
- Desolation Cn 
- Black Rocks Cn 
- Westwater Cn 
- Cataract Cn

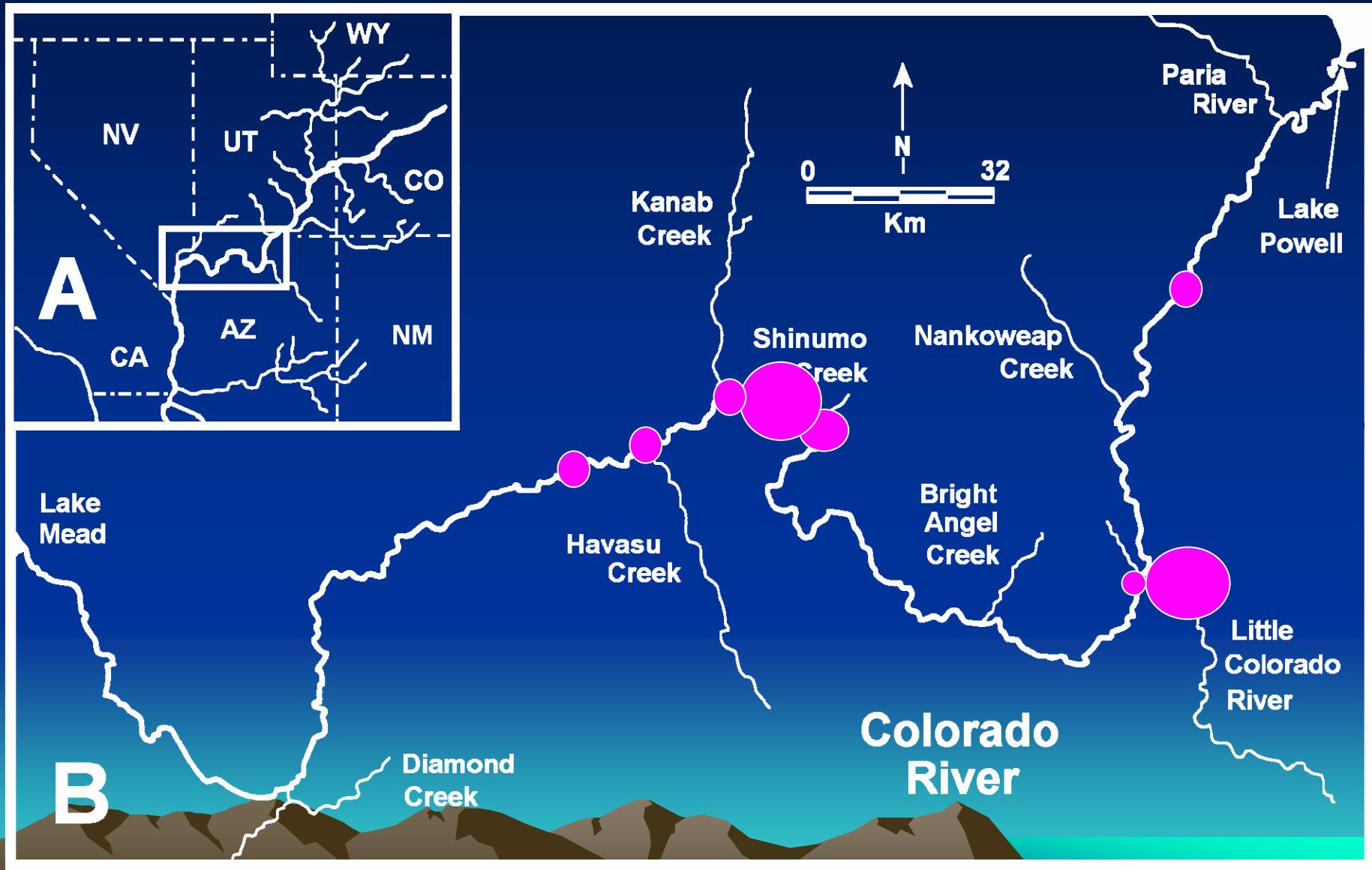


# Msat Analysis: Pairwise Tests

- Grand Canyon
  - significant differences between larger aggregates isolation-by-distance effect



# Populations - Grand Canyon



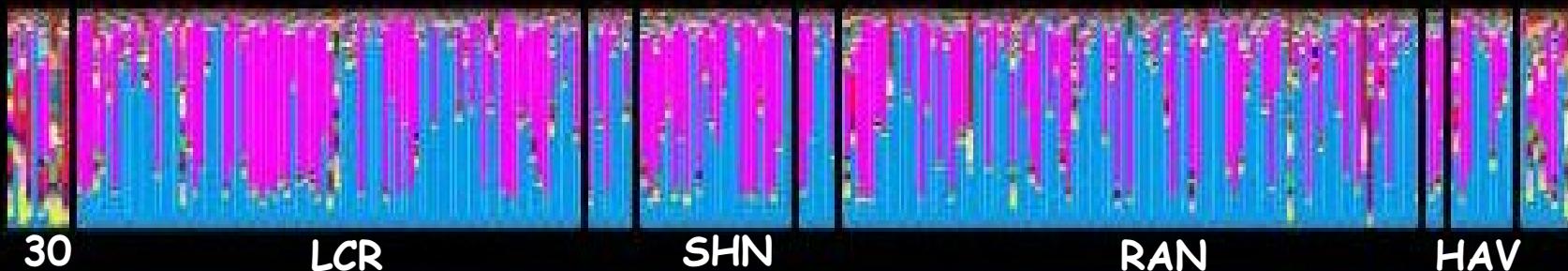
# Msat Analysis: Introgression

- Bonytail
  - characteristic allele size range  
some BTC in HBC  
some HBC/RTC in BTC
- RTC vs HBC ?
  - allele frequencies / size ranges  
considerable introgression in UB

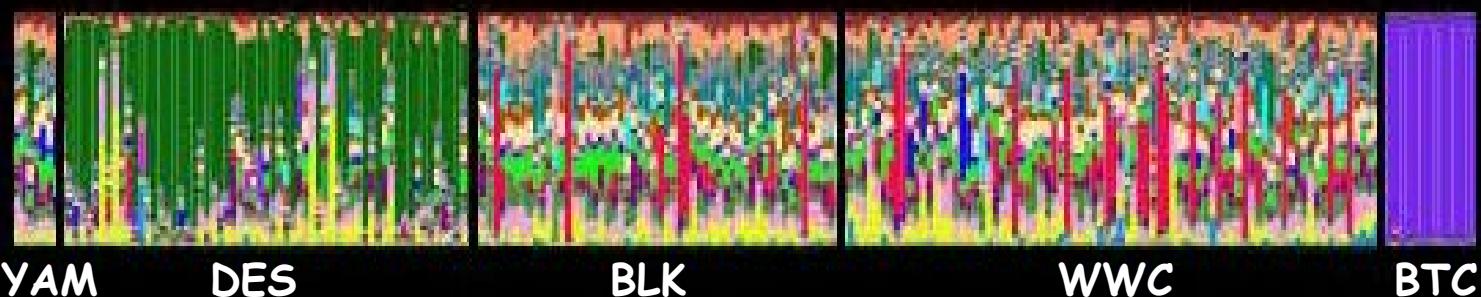


# Msat Distribution -- CRE

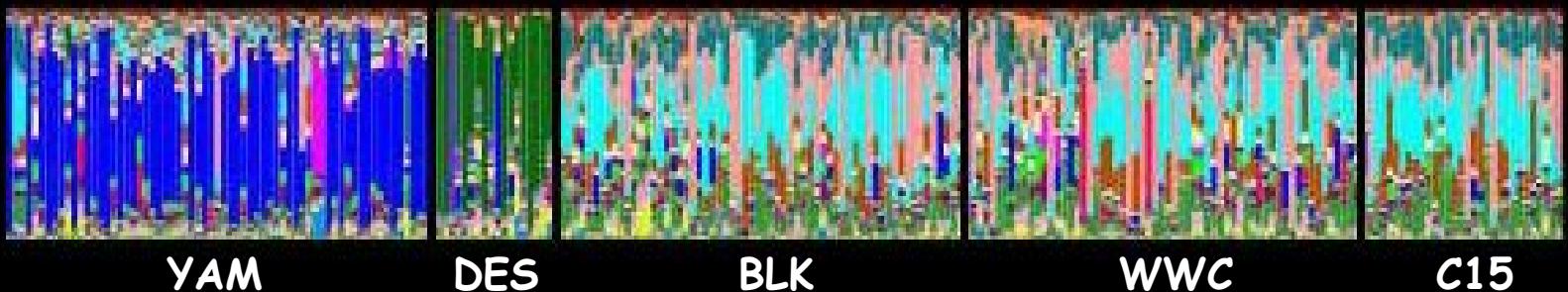
HBC  
GC



HBC  
UB



RTC  
UB



# Preliminary Conclusions (1)

- High genetic diversity based on msat analysis
  - within populations
  - among populations
  - among basins
- Introgression by BTC



# Preliminary Conclusions (2)

- Msat pattern reflect signal of mtDNA
  - *Grand Canyon* distinct
    - unique evolutionary trajectory
  - *Upper Basin*
    - introgression, but still HBC & RTC
- Msat pattern reflect signal of morphology
  - locality effect



# *Gila cypha* (Humpback Chub)



Havasu Ck, Grand Canyon, AZ (45 cm TL)

# Preliminary Conclusions (3)

- Management implications
  - locations harbor unique genetic diversity not found in other areas
    - unique evolutionary trajectories
  - Upper Basin
    - introgression HBC/RTC



Havasu Creek at confluence of Colorado River in Grand Cn

