GENETIC MONITORING AND BIOLOGICAL CONTROL OF RECRUITMENT IN BONYTAIL REARING PONDS

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U.S. Fish and Wildlife Service

Southwestern Native ARRC

Dexter, NM

BACKGROUND

- The Southwestern Native ARRC in Dexter, NM maintains the only broodstock of *Gila elegans* (Bonytail)
- Broodstock are spawned each year with larvae being reared at several facilities for grow-out
- The target stocking size (> 300 mm) requires a multi-year grow-out period and individuals can spawn during the second summer in grow-out ponds
- This inadvertent spawning may negatively impact growth and survival due to overcrowding in ponds
  - Poor water quality and oxygen depletions
- Genetic diversity may also be decreased as few individuals may contribute to offspring

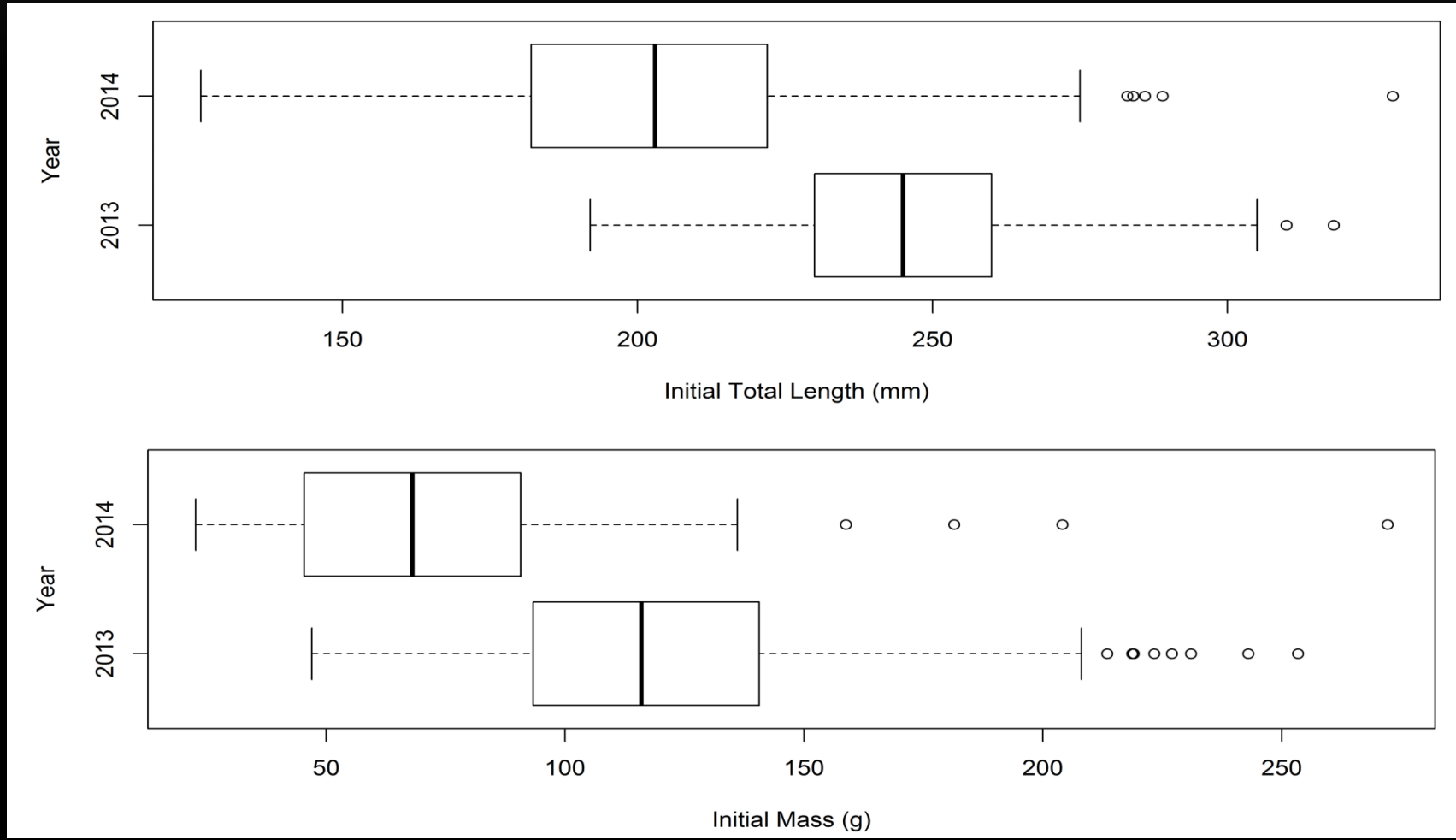
OBJECTIVES

- To address the management implication of natural recruitment in grow-out ponds this study has three objectives:
  - Fish Culture
    - Explore the use of *Ptychocheilus lucius* (Colorado Pikeminnow) as biological control and reduce recruitment in grow-out ponds
    - Optimize species growth and stocking rates specifically for pond culture
  - Genetics
    - Use microsatellite markers to assess the genetic diversity and parentage of the offspring (recruits)

METHODS

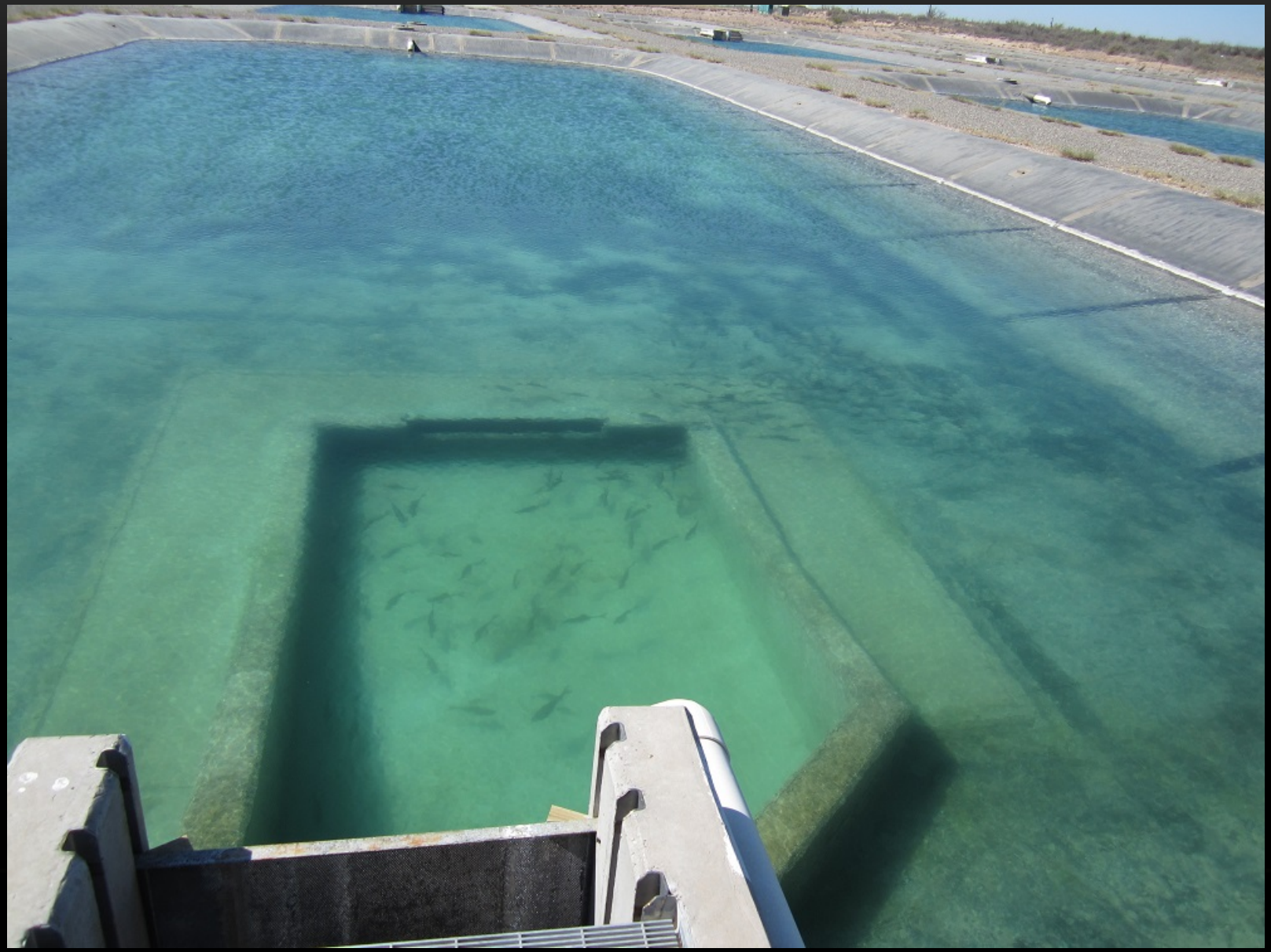
- Experimental Fish Year One (2013)
  - Age-4 Bonytail (2009 Year Class)
  - Age-0 Colorado Pikeminnow (2012 Year Class, mean length 60.6 mm)
  - All parental Bonytail received PIT tags
- Experimental Fish Year Two (2014)
  - Age-2 Bonytail (2012 Year Class)
  - Age-0 Colorado Pikeminnow (2013 Year Class)
  - All parental Bonytail received PIT tags

BONYTAIL - INITIAL SIZE AND MASS



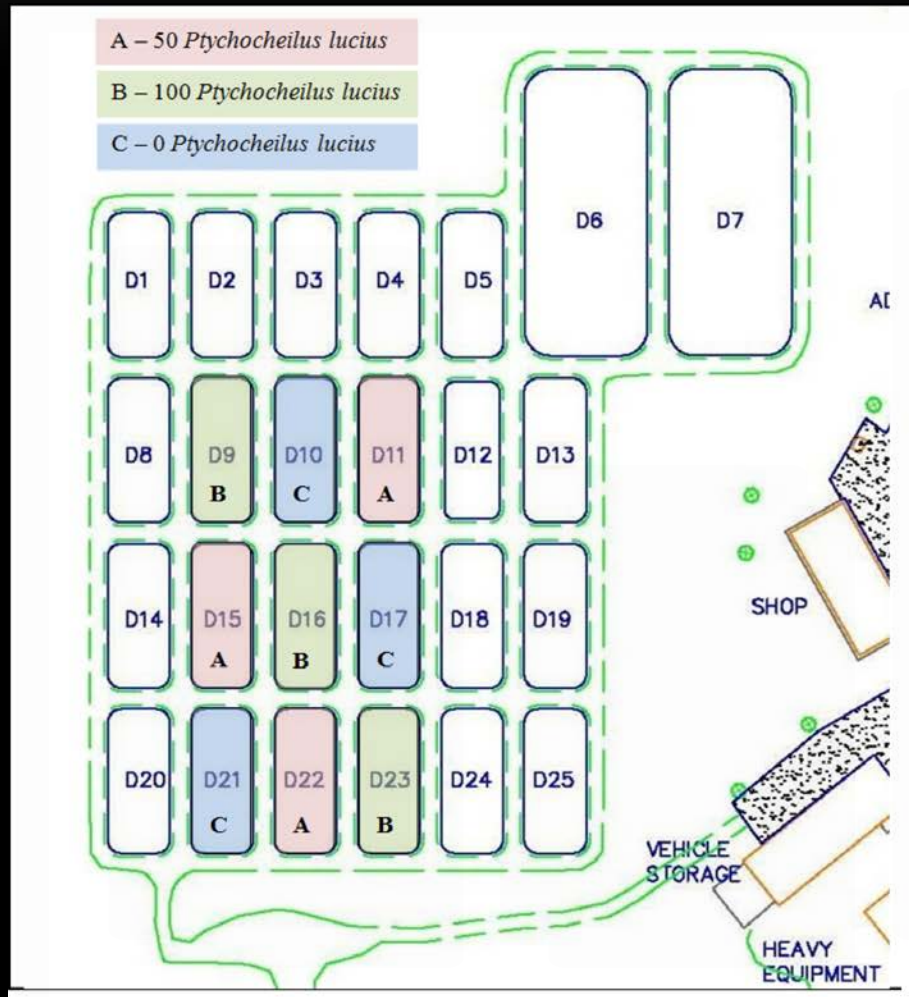
METHODS

- Experimental Design
  - 0.04 ha lined ponds
  - Two stocking treatments and control (three replicates each)
    - Control – 100 male and 100 female Bonytail, 0 Colorado Pikeminnow
    - Treatment 1 – 100 male and 100 female Bonytail, 50 Colorado Pikeminnow
    - Treatment 2 - 100 male and 100 female Bonytail, 100 Colorado Pikeminnow
  - Both Years - Stocked in Spring and harvested in Fall (5 months)

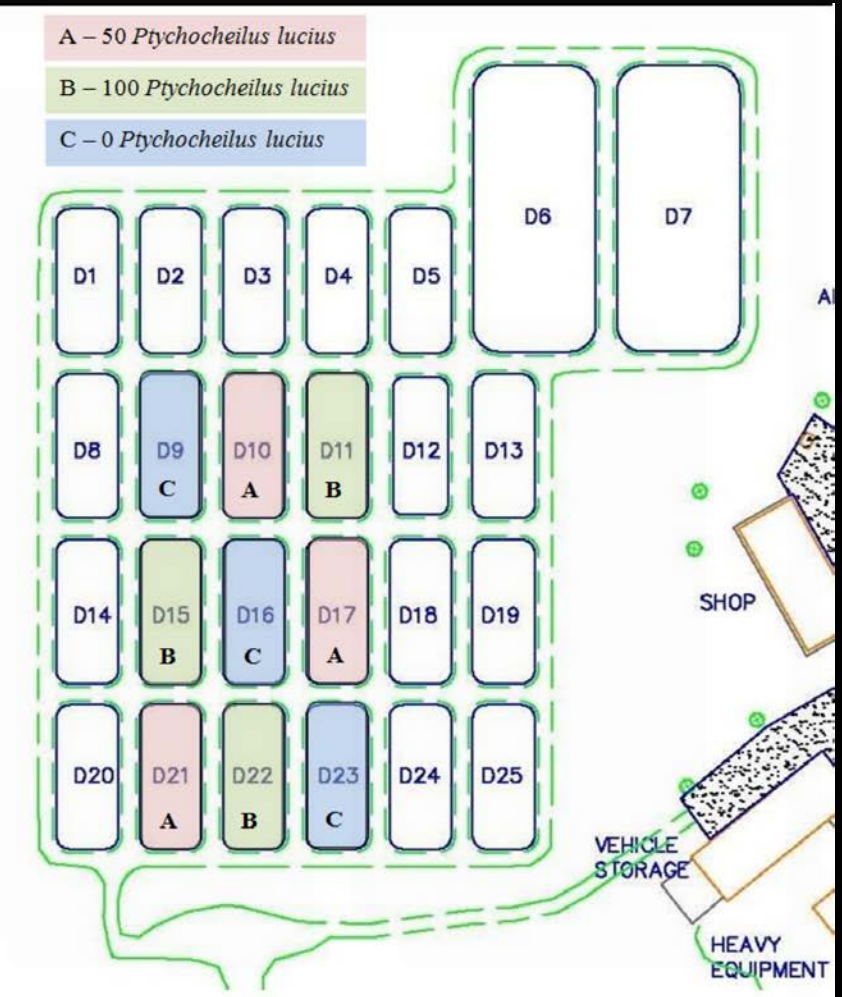


EXPERIMENTAL POND LAYOUT

Year One (2013)



Year Two (2014)



METHODS

- Experimental Design (con’t)
  - Initial and final lengths and weights were recorded on subsamples
  - Water quality (temperature, DO)
  - Number of recruits was calculated based on bulk weight

METHODS

- Genetics
  - 15 microsatellite loci
  - Genotyped all adult Bonytail (control ponds) & subsample of 100 offspring per pond
  - Descriptive statistics
    - Number of alleles
    - Allele frequency
    - Heterozygosity
  - Parentage Analyses
  - Effective Size

FISH CULTURE RESULTS

- Bonytail recruits significantly reduced in ponds with Colorado Pikeminnow (range = 3 - 63) compared to ponds without Pikeminnow (2,854 - 6,969)
  - No difference between the two treatments (50 vs. 100)
- 2013 (2009 Year Class) – mean of 3,752 recruits with a mean mass of 3.19 g
- 2014 (2012 Year Class) – mean of 5,216 recruits which averaged 4.51g
- Parental population of 2013 (2009 Year Class) had previously been graded
  - Slower growing adults which may have produced slower growing offspring – possible genetic component
  - 2012 YC not graded previously

FISH CULTURE RESULTS

			G. elegans			*P. lucius*		
Study Year	**Treatment**	**Replicate**	**Total Recruitment**	**Mean Individual Mass (g)**	**Adult Survival (%)**	**Mean Individual Mass (g)**	**Survival (%)**	**Total Biomass (g)**
2013	0 (control)	1	3931	2.9	99.0	-	-	44839
		2	4472	2.7	99.0	-	-	49059
		3	2854	3.9	98.0	-	-	46458
	50	1	14	10.4	98.0	43.3	90	37748
		2	24	4.1	99.0	45.4	92	40257
		3	35	13.6	99.0	40.2	70	39275
	100	1	62	12.1	96.5	35.8	90	39417
		2	11	6.9	98.0	32.3	97	39034
		3	3	5.8	99.0	32.0	95	37934
2014	0 (control)	1	4239	5.0	99.0	-	-	56990
		2	4441	5.1	98.5	-	-	62898
		3	6968	3.4	98.5	-	-	61843
	50	1	27	10.9	99.0	44.3	84	44874
		2	63	20.2	99.0	53.5	100	46729
		3	15	12.1	99.0	49.6	86	46814
	100	1	22	10.3	99.5	42.3	88	47092
		2	23	9.9	100	42.1	95	45866
		3	18	10.1	99.5	49.9	90	45086

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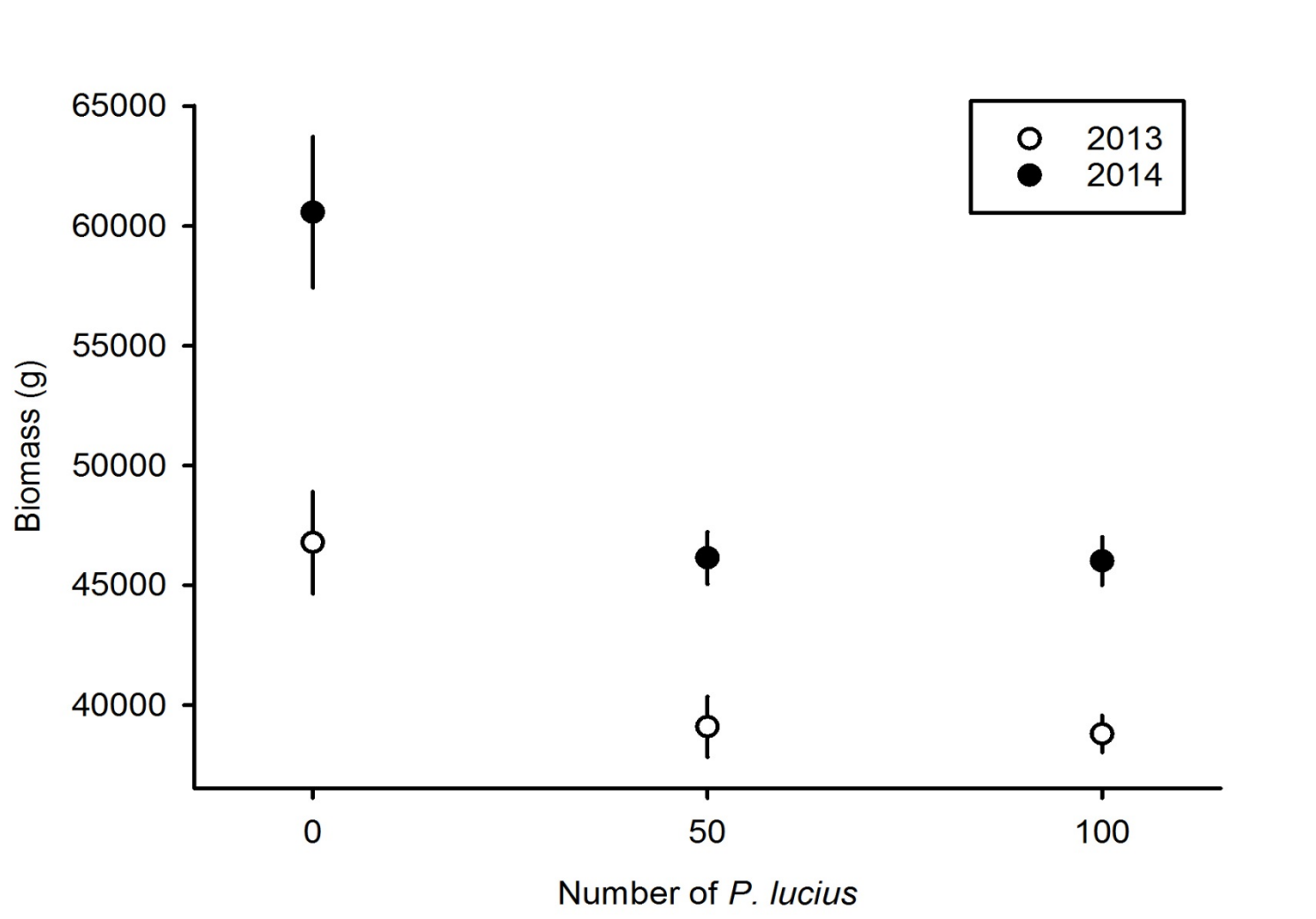
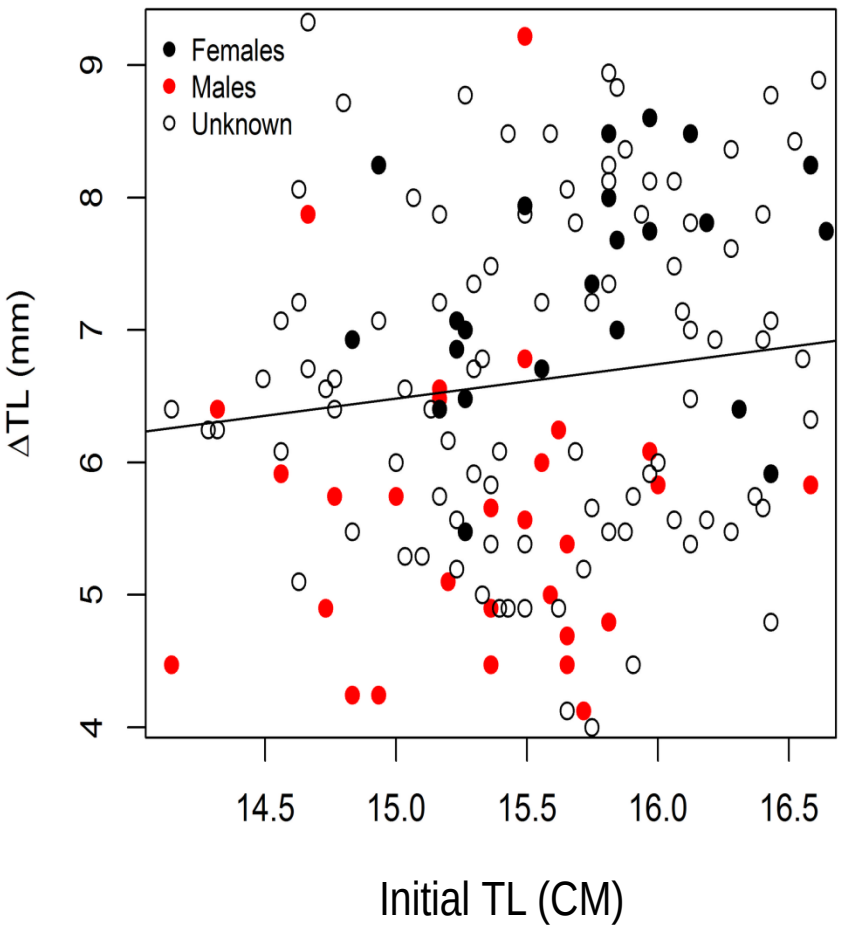
FISH CULTURE RESULTS (POND BIOMASS FINAL)

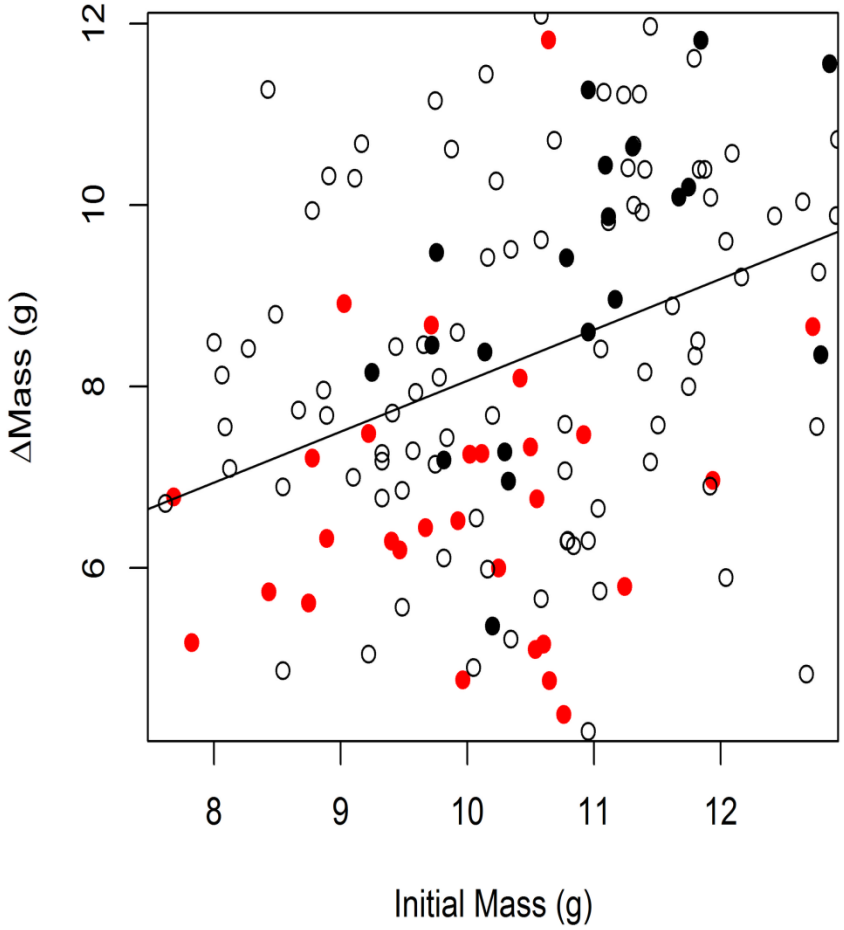


FISH CULTURE RESULTS (GROWTH AND GENDER)

- Gender data collected on the control group in 2013 revealed a difference in both length and weight between females and males

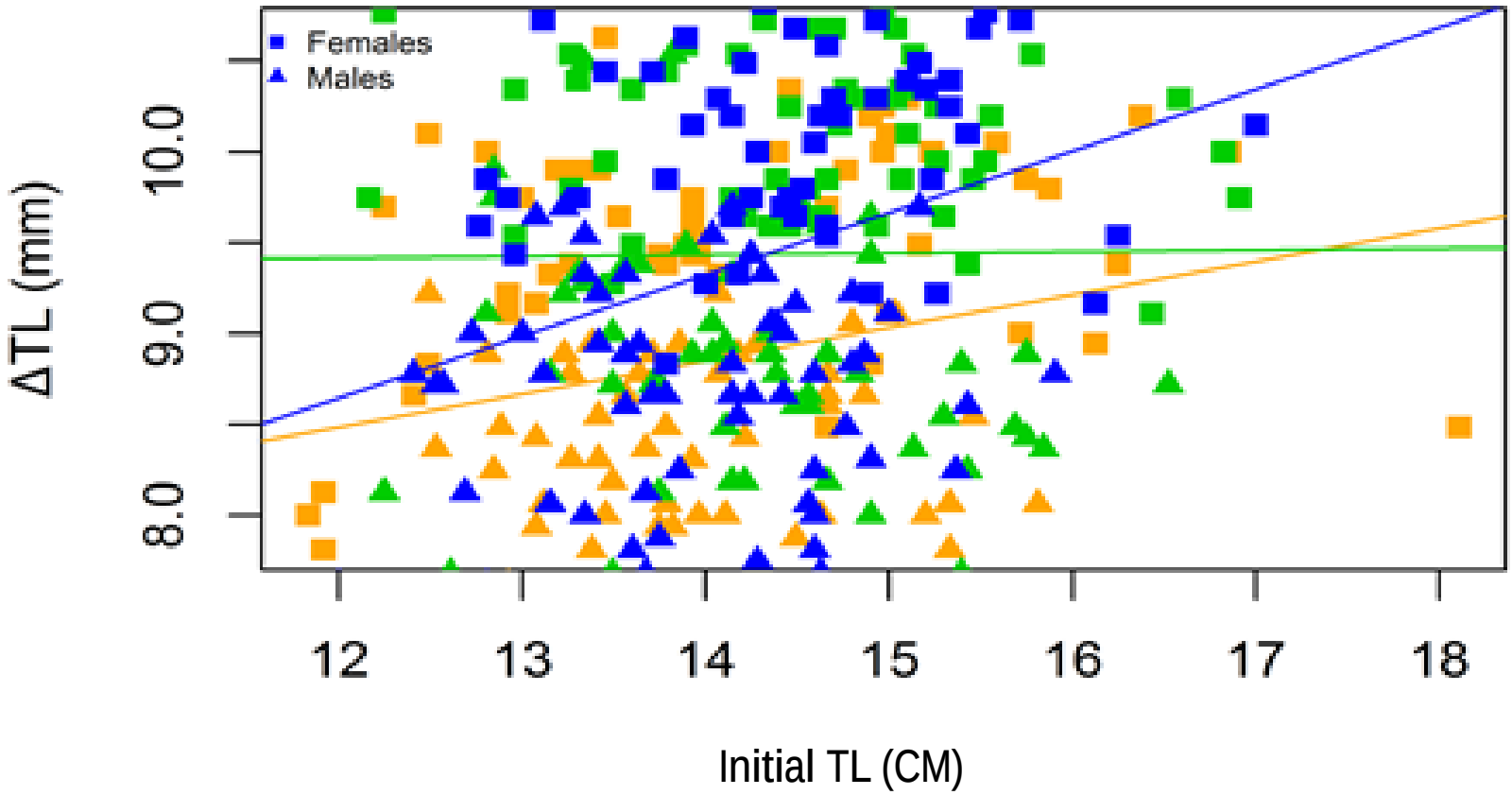
FISH CULTURE RESULTS (2013 GROWTH BY GENDER)





FISH CULTURE RESULTS (2014 GROWTH BY GENDER)

a.



GENETIC RESULTS (DESCRIPTIVE STATISTICS)

- 2,913 individuals were sampled and genotyped
- No significant difference mean number of alleles per locus
    - Between replicates in 2013 or 2014
    - Parents (2009YC) vs. recruitment (2013YC)
  - Was significant difference (P =0.03) between parents (2012YC, μ = 10.22) and recruits (2014YC, μ = 9.89)
- Allele frequencies ranged from 0.005 to 0.690
  - Low frequency alleles often preserved in recruits even if found in only one parent

Pond	Sample Number	Parent/Recruit	Year Class	N_A	A_R	H_O	H_E	F_{IS}
10D	100	Parent Females	2009	10.60	9.93	0.828	0.813	-0.017
	100	Parent Males	2009	10.53	9.97	0.812	0.799	-0.019
	100	Recruit	2013	10.27	9.53	0.811	0.798	-0.017
17D	100	Parent Females	2009	10.13	9.71	0.799	0.812	0.015
	100	Parent Males	2009	10.60	9.78	0.815	0.785	-0.043
	100	Recruit	2013	10.27	9.70	0.819	0.799	-0.021
21D	100	Parent Females	2009	10.53	9.92	0.824	0.815	-0.012
	100	Parent Males	2009	10.67	9.71	0.793	0.781	-0.019
	99	Recruit	2013	10.60	9.85	0.811	0.808	-0.004
9D	100	Parent Females	2012	10.20	9.61	0.829	0.814	-0.015
	100	Parent Males	2012	10.13	9.56	0.882	0.791	0.011
	100	Recruit	2014	10.13	9.35	0.808	0.809	0.005
16D	100	Parent Females	2012	10.27	9.69	0.814	0.807	-0.007
	100	Parent Males	2012	10.13	9.41	0.806	0.796	-0.014
	100	Recruit	2014	9.80	9.35	0.782	0.810	0.038
23D	100	Parent Females	2012	10.07	9.46	0.797	0.806	0.016
	100	Parent Males	2012	10.53	9.77	0.812	0.811	-0.001
	100	Recruit	2014	9.73	9.19	0.806	0.809	0.008

GENETIC RESULTS

- Number of spawners by gender ranged from 38 to 61
- Number of offspring per individual ranged from 1.79 to 2.90
  - 2012 YC more offspring per individual than the 2009 YC
- Number of mates per individual ranged from 1.57 to 2.46
  - Correlation between number of offspring/ individual and number of mates per individual (r = 0.958, P < 0.00001)
    - significant for both genders, but stronger for females (r = 0.980, P = 0.0006) than males (r = 0.942, P = 0.005)
- These are underestimates due to sample size of 100 vs. thousands

Parent Year Class	Pond	Gender	# Spawners	Mean Number of Offspring/Individual (Max)	Mean Number of Mates/Individual (Max)	Effective Size
2009	10D	Male	56	1.79 (5)	1.57 (4)	
	10D	Female	50	1.92 (7)	1.72 (5)	
	10D					111 (83-150)
	17D	Male	54	1.83 (5)	1.61 (4)	
	17D	Female	49	1.92 (5)	1.80 (4)	
	17D					132 (99-175)
	21D	Male	52	1.90 (6)	1.71 (5)	
	21D	Female	52	1.90 (6)	1.71 (5)	
	21D					110 (84-148)
2012	9D	Male	52	2.00 (9)	1.73 (6)	
	9D	Female	49	2.00 (6)	1.80 (5)	
	9D					103 (77-141)
	16D	Male	49	2.04 (7)	2.04 (7)	
	16D	Female	38	2.52 (9)	2.05 (6)	
	16D					80 (57-112)
	23D	Male	38	2.52 (7)	2.18 (5)	
	23D	Female	47	1.89 (5)	1.66 (4)	
	23D					92 (67-128)

CONCLUSIONS

- Bonytail recruits harvested from each pond was significantly reduced in ponds with Pikeminnow (range = 3-63) compared to ponds without pikeminnow (2,854 - 6,969)
  - No between the two levels of the Pikeminnow treatment
- Gender had impact on growth with females growing faster than males
  - Conservation and stocking implications (gender ratio bias)
- Genetic diversity is preserved between parents and offspring
  - Caution: if sex ratio is altered in parental population genetic diversity could be decreased in recruits
    - i.e., fewer females due to grading
      - Study exploring this in progress - 2009 YC at end 85% Males

ACKNOWLEDGEMENTS

- Funding of this project was provided by the U.S. Bureau of Reclamation, LCR MSCP
- Southwestern Native ARRC staff for culture and laboratory help
- Megan Osborne (UNM) for helpful discussions

THANK YOU!