Reproductive success of bonytail (*Gila elegans*) in isolated off-channel habitats

THE UNIVERSITY of NEW MEXICO

Museum of Southwestern Biology

Bonytail (*Gila elegans*)

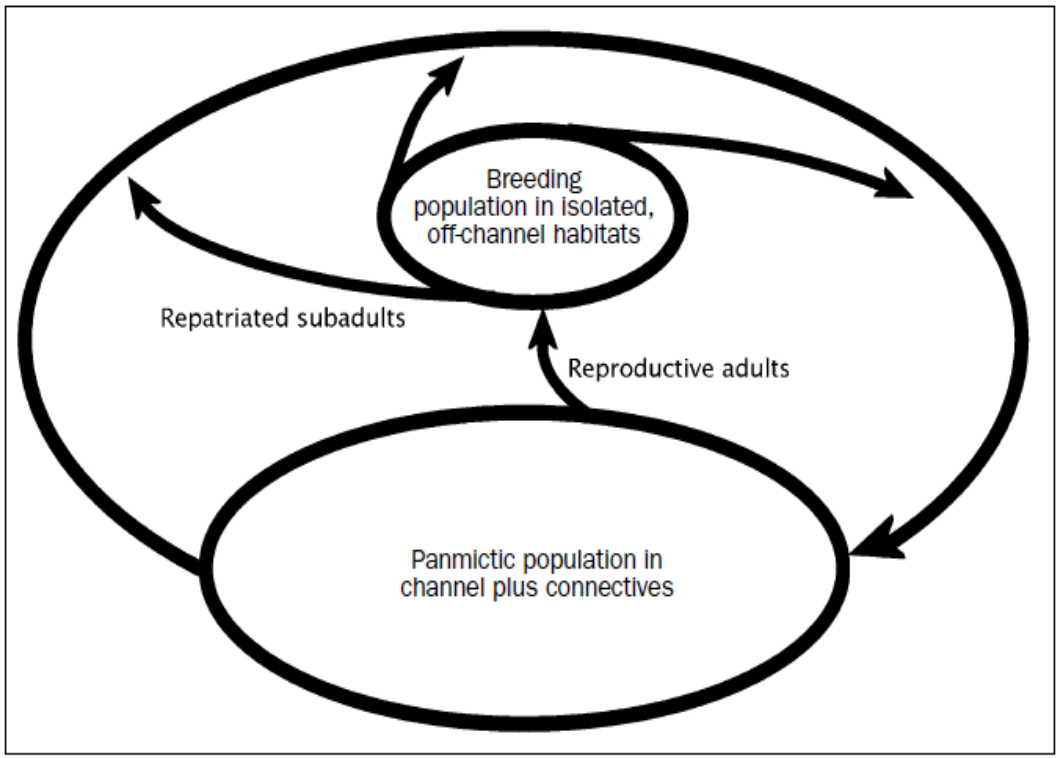
- Moderately large (>50 cms TL), long lived (>40 yrs) cyprinid
- Former range: upper and lower Colorado basin from Wyoming to Mexico.
- Experienced the most abrupt decline of the Colorado's big river fishes.
- Endangered (US FWS 1978, 1980)
- Functionally extinct in the wild

(no evidence of reproduction/ recruitment in the wild)

A Conservation Plan for Native Fishes of the Lower Colorado River

W. L. MINCKLEY, PAUL C. MARSH, JAMES E. DEACON, THOMAS E. DOWLING,
PHILIP W. HEDRICK, WILLIAM J. MATTHEWS, AND GORDON MUELLER

MAJOR THREAT TO NATIVE FISHES: Predation on larvae and juveniles
BUT native species can reproduce in predator-free habitats.



- Natives breed and progeny would grow, in protected off-channel habitats
- Protected from some predation
- Selective pressures present
- Natural mating behaviors preserved

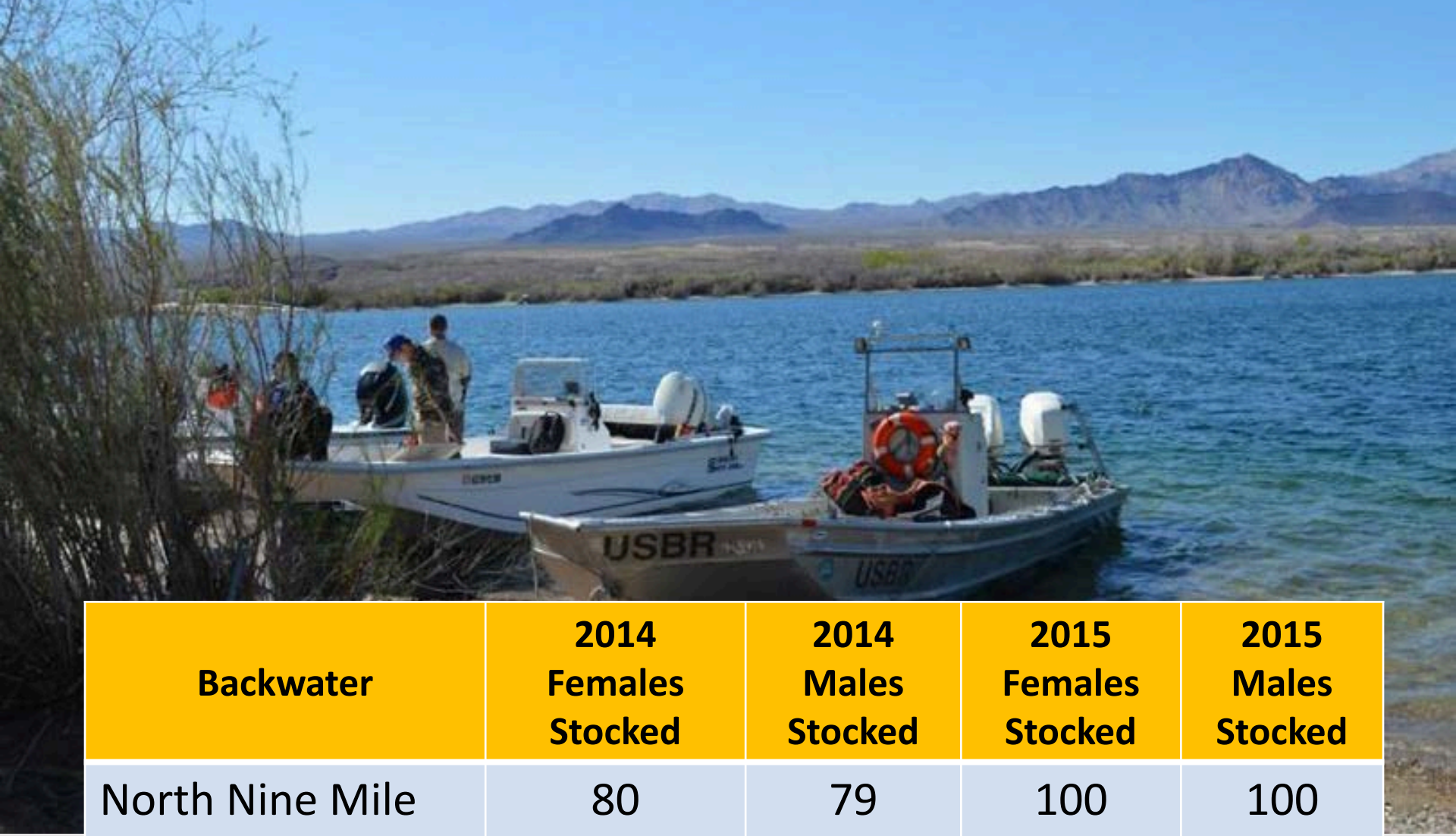
- Captive population of bonytail was established in 1981
- Original captive stock (Hedrick et al. 1999)-- 3-8 founders (based on mtDNA data)
- Bred and reared in captivity for release
- Status of bonytail in the wild has not improved
- Preserving remaining genetic diversity is critical

Variance in Reproductive Success

- Bonytail --- Highly fecund, eg. 2 yr old female ~1000-10,000 eggs (Hamman 1985)
- Aggregate spawner, deposit adhesive eggs
- Aggregate breeding- little or no monopolization of individuals or space, mechanism for large amounts of genetic mixing through multiple matings.
- BUT, some individuals may contribute disproportionately.
- Reduce genetic diversity and genetic effective population size.
- Increase risks of adverse genetic effects like inbreeding depression.

Objectives

- How many individuals make a reproductive contribution in backwaters stocked with bonytail?
- Is genetic diversity preserved between parental and progeny generations?
- Is variance in reproductive success similar between backwaters and males/females?



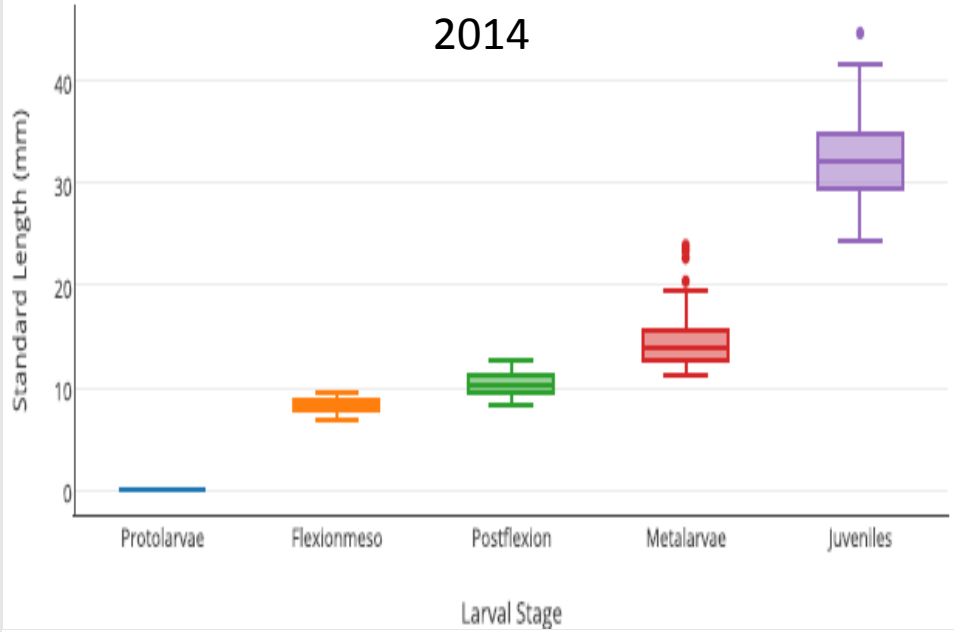
Backwater	2014 Females Stocked	2014 Males Stocked	2015 Females Stocked	2015 Males Stocked
North Nine Mile	80	79	100	100
Nevada Egg	80	80	100	100
Nevada Larvae*	80	81	0	0

* Little reproduction in Nevada Larvae, not genotyped

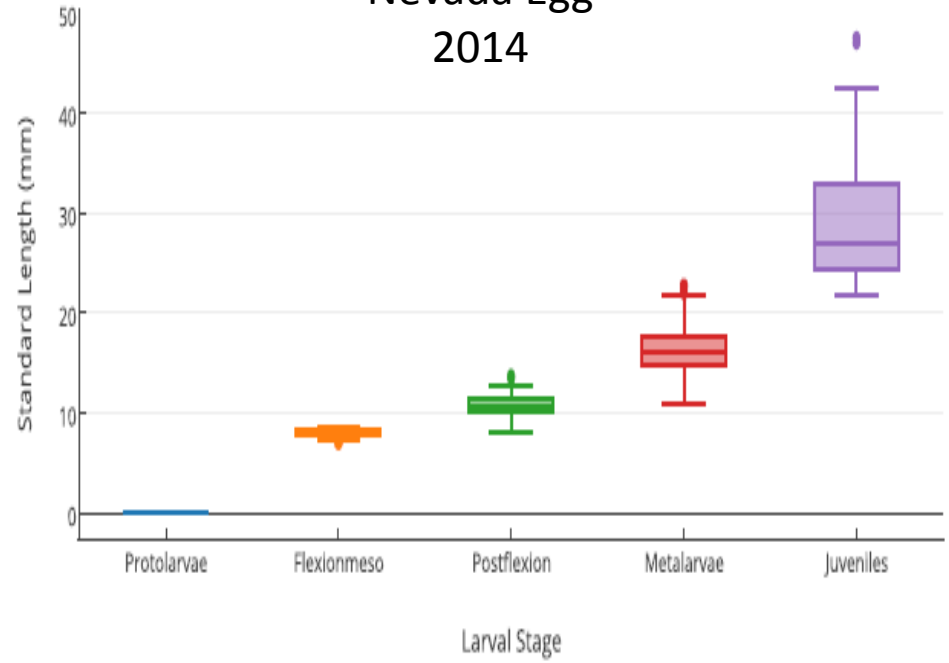
Nevada Egg Backwater

North Nine Mile Backwater

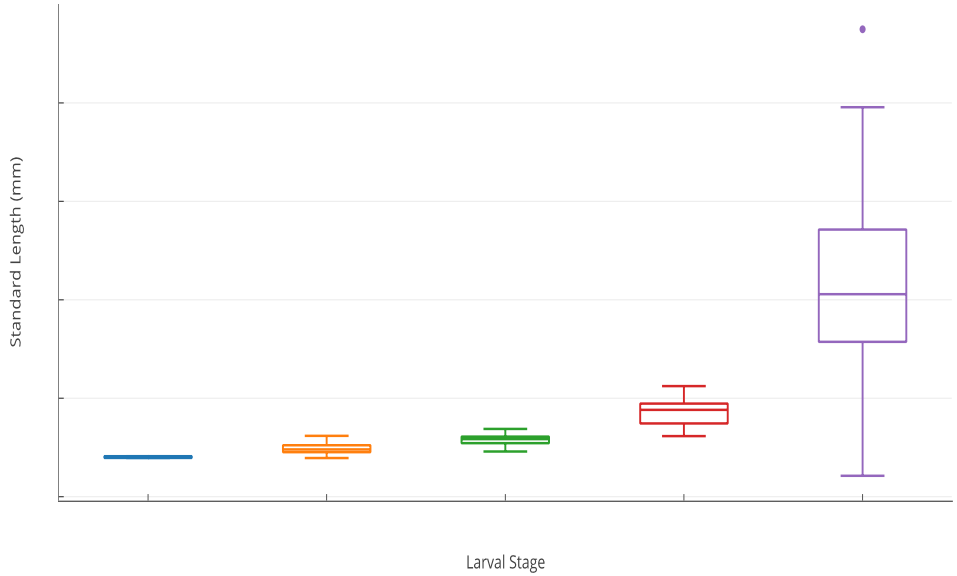
North Nine Mile 2014



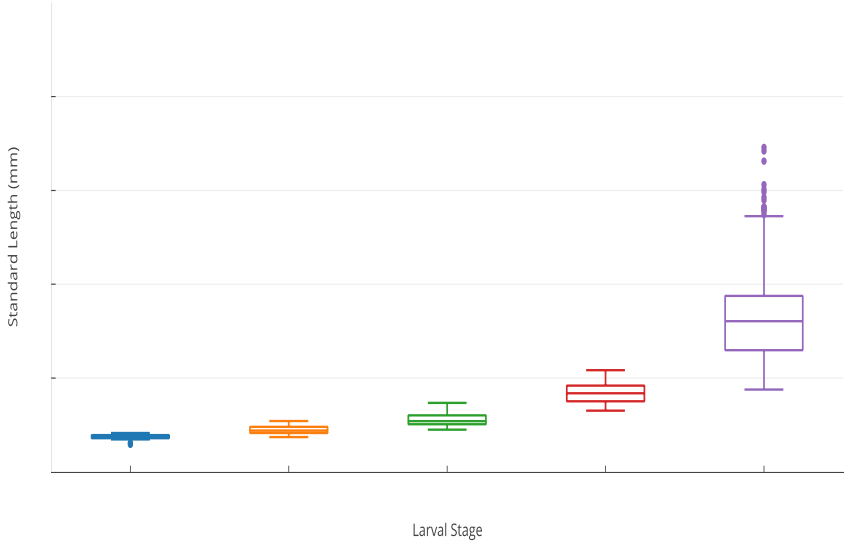
Nevada Egg 2014

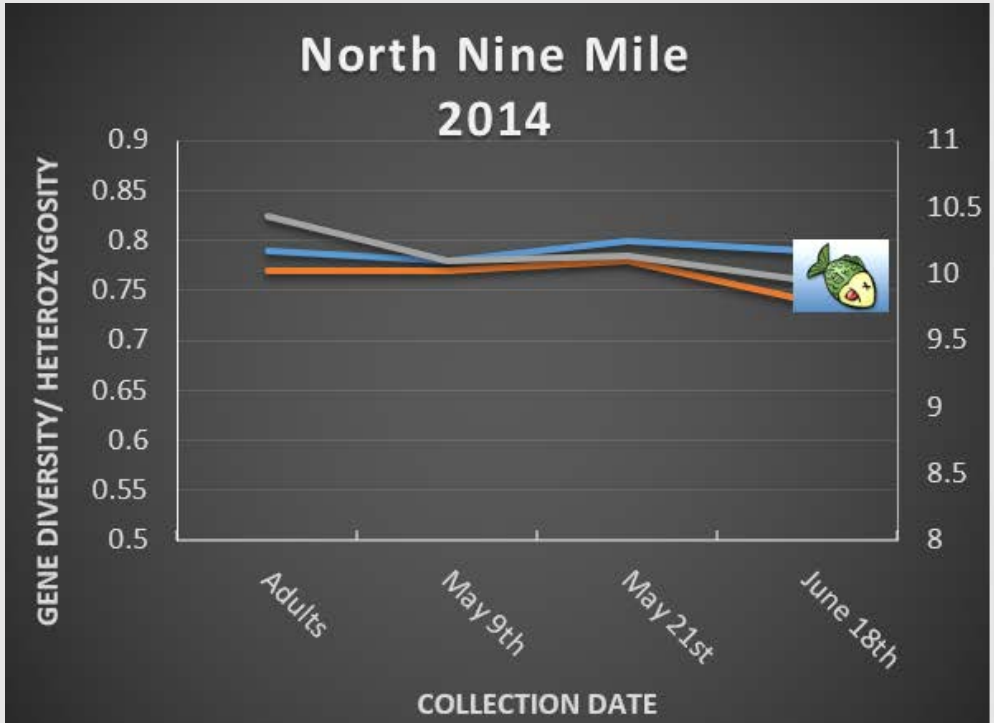


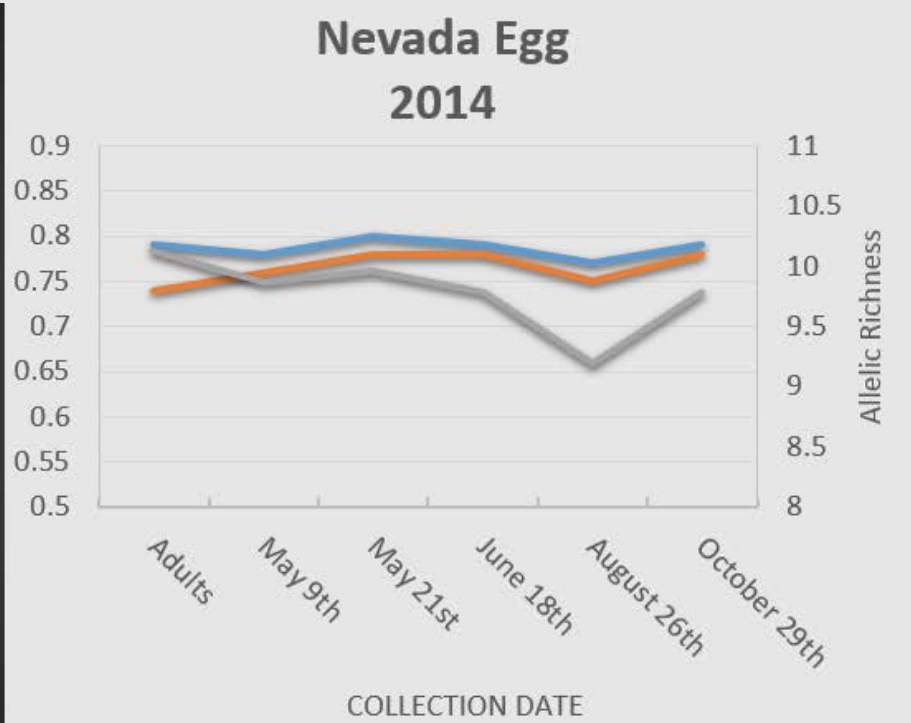
2015

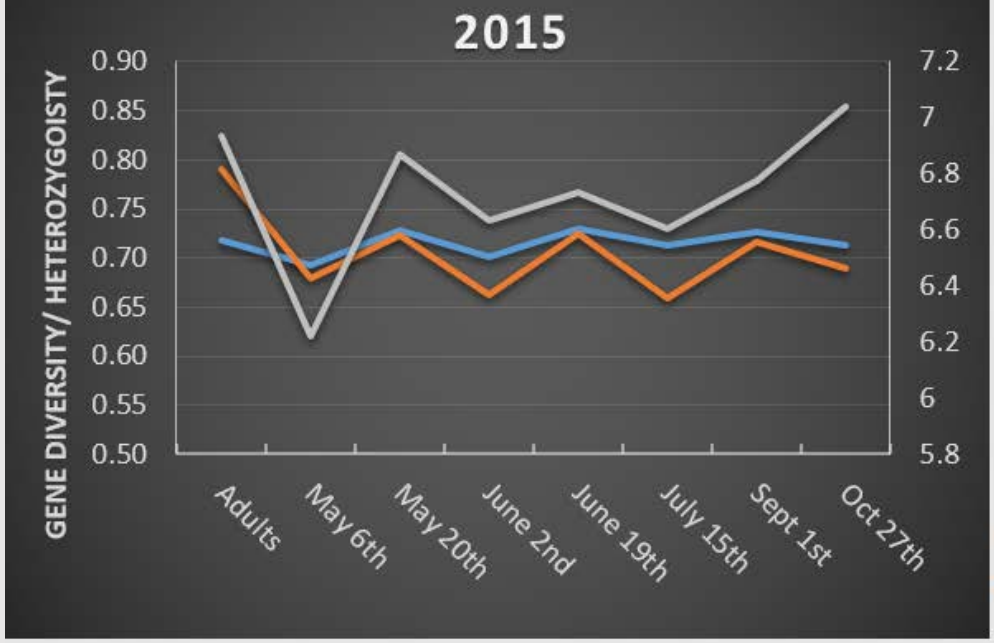


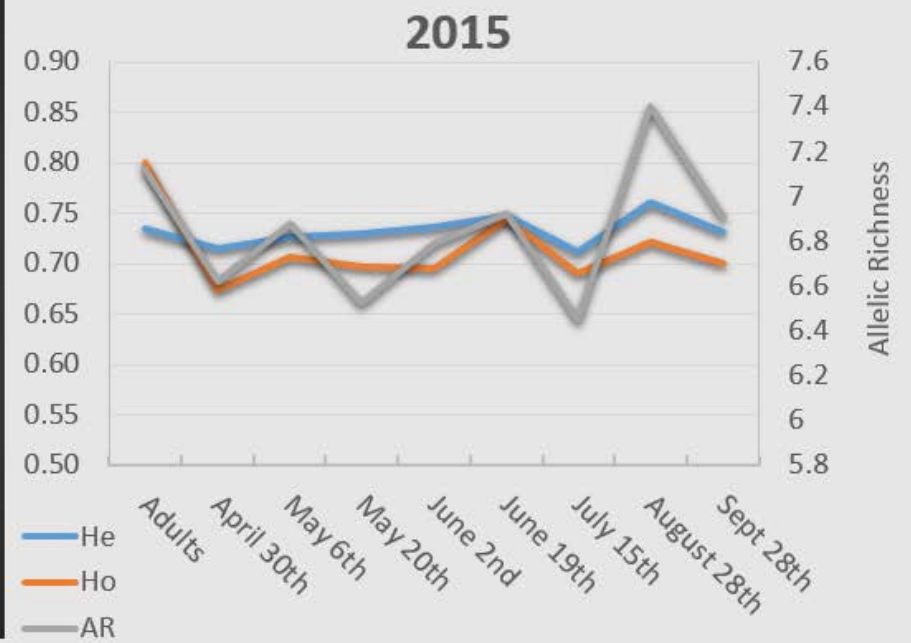
2015




North Nine Mile
2014
GENE DIVERSITY/ HETEROZYGOSITY
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
11
10.5
10
9.5
9
8.5
8
Adults
May 9th
May 21st
June 18th
COLLECTION DATE


Nevada Egg
2014
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
11
10.5
10
9.5
9
8.5
8
Allelic Richness
Adults
May 9th
May 21st
June 18th
August 26th
October 29th
COLLECTION DATE

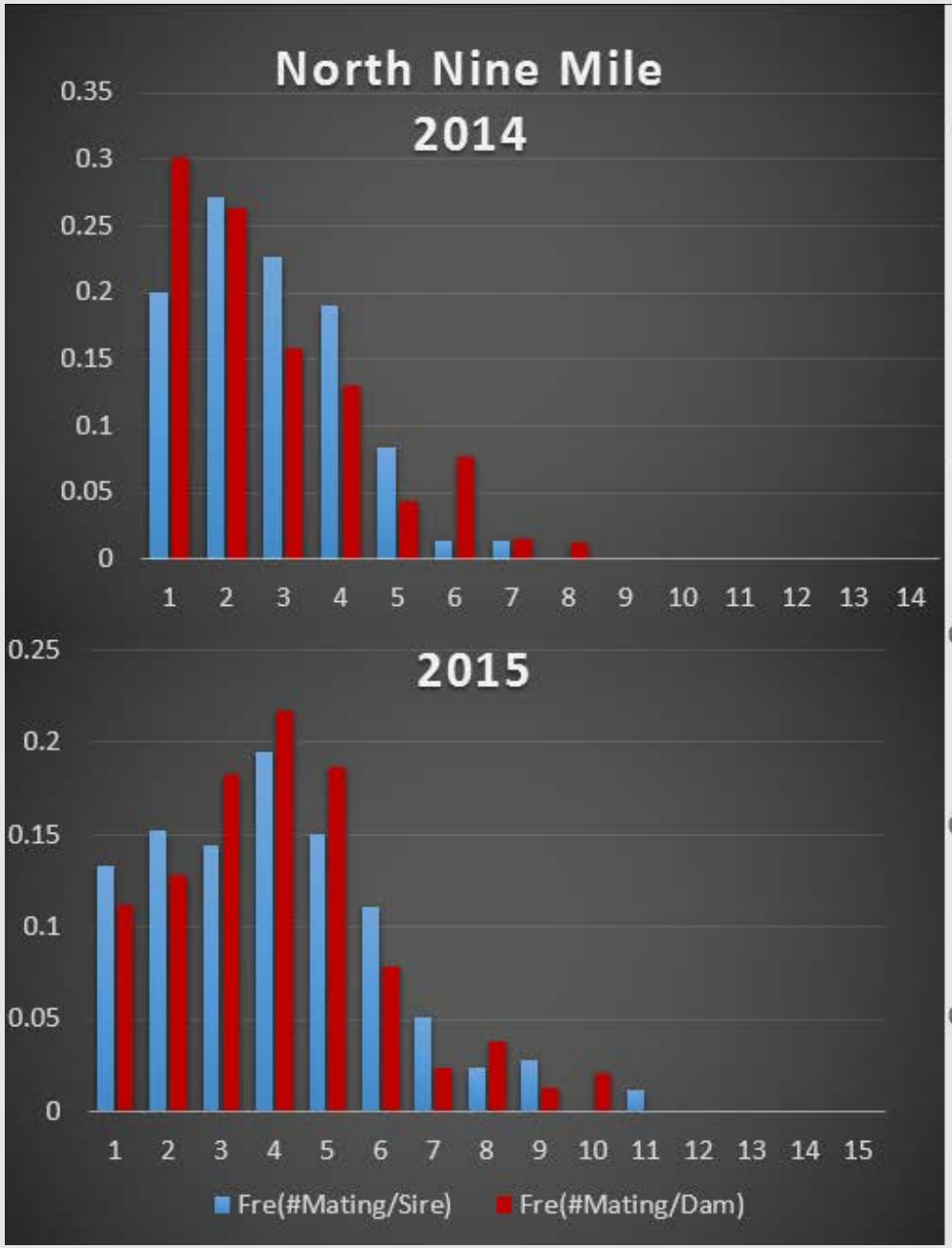

2015
GENE DIVERSITY/ HETEROZYGOISTY
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
7.2
7
6.8
6.6
6.4
6.2
6
5.8
Adults
May 6th
May 20th
June 2nd
June 19th
July 15th
Sept 1st
Oct 27th

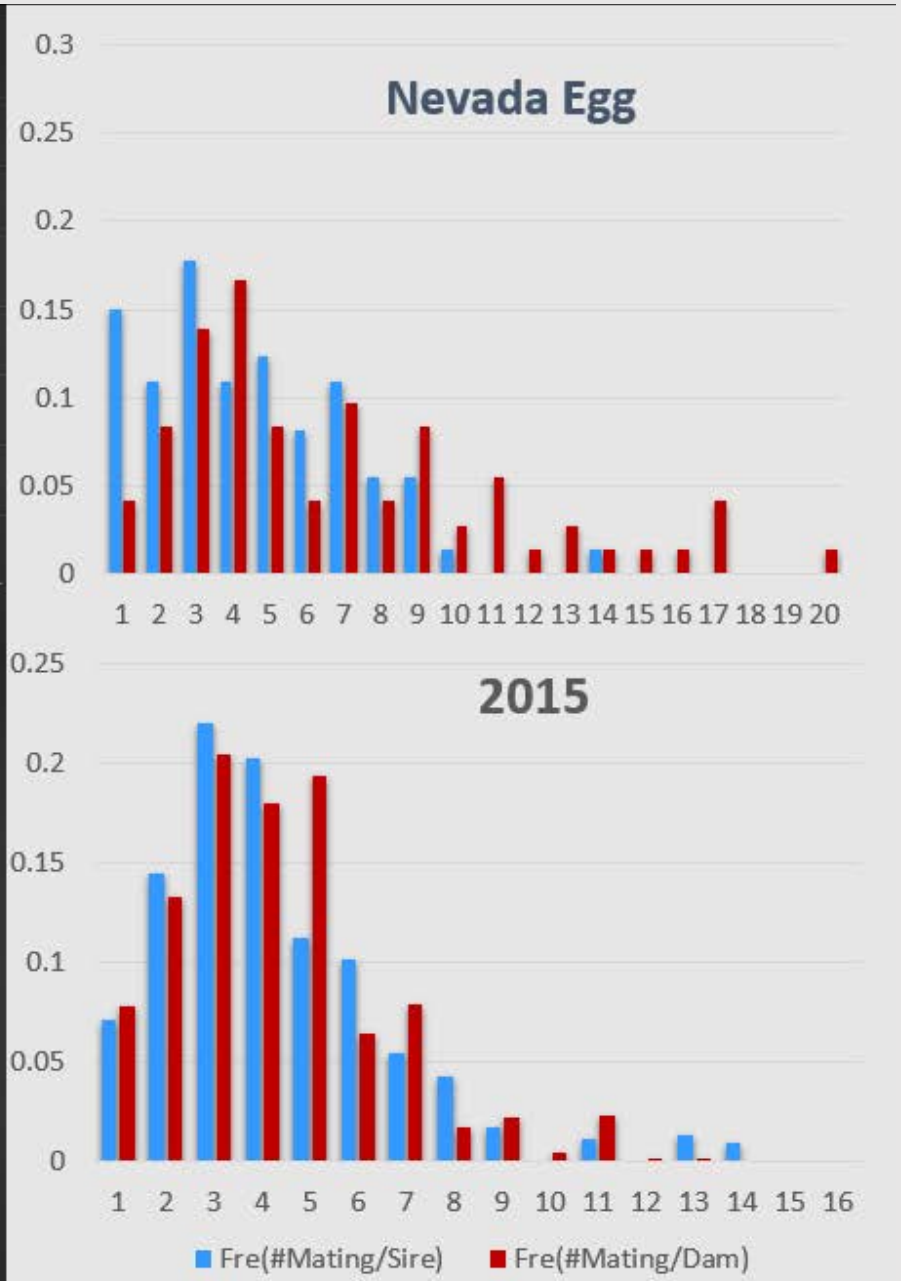

2015
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
7.6
7.4
7.2
7
6.8
6.6
6.4
6.2
6
5.8
Allelic Richness
Adults
April 30th
May 6th
May 20th
June 2nd
June 19th
July 15th
August 28th
Sept 28th
He
Ho
AR

High reproductive contribution by both males and females in both backwaters.

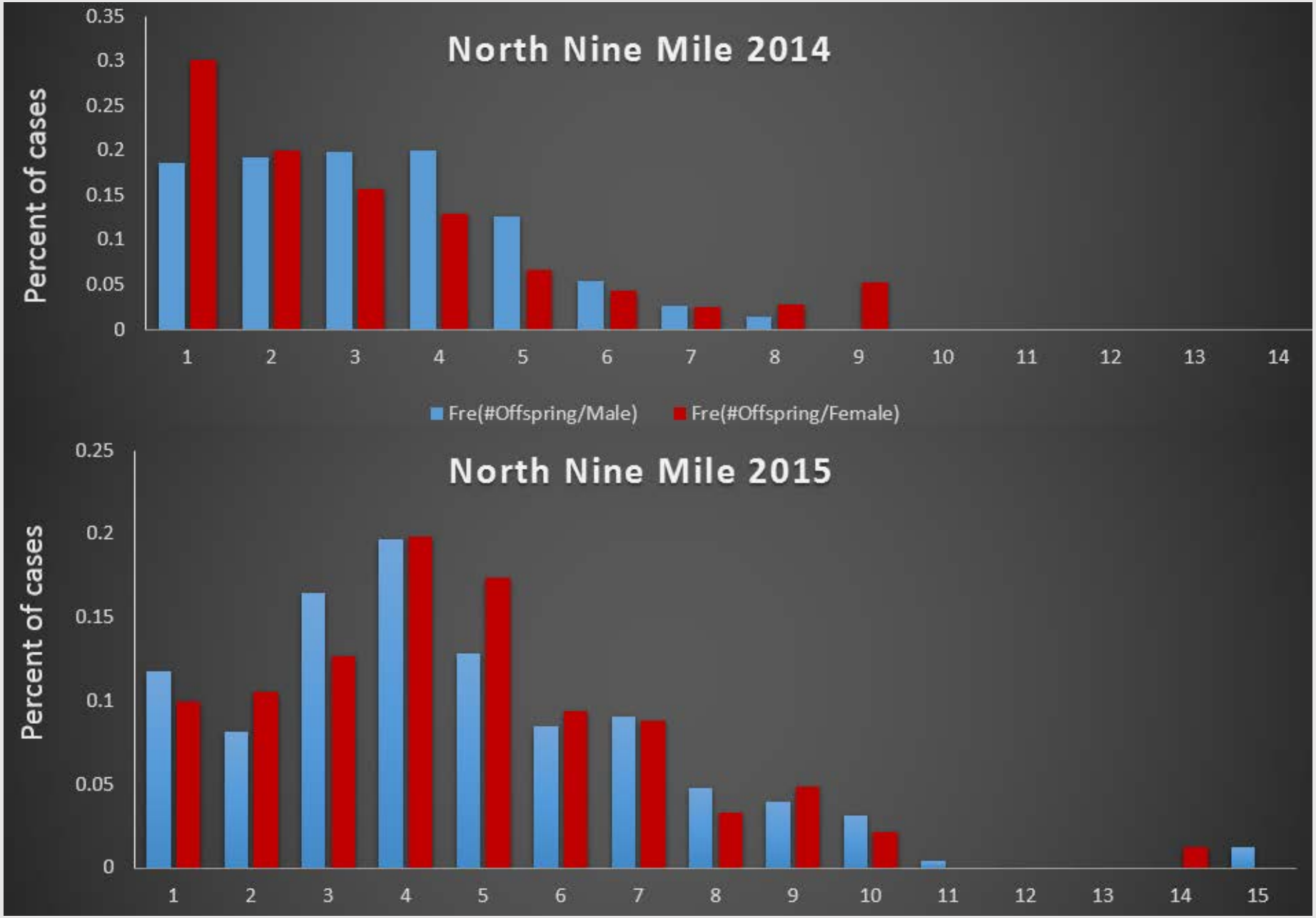
Backwater	Year	Number of Offspring	Reproductive contribution
North Nine Mile	2014	239 (3 collections)	91% males 93% females
	2015	383/744 (5 collections analyzed of 7 total)	76% Males 75% Females
Nevada Egg	2014	604 (5 collections)*	91% males 89% females
	2015	434/798 (5 collections analyzed of 8 total)	87% Males 86% Females

Matings per Sire/ Dam

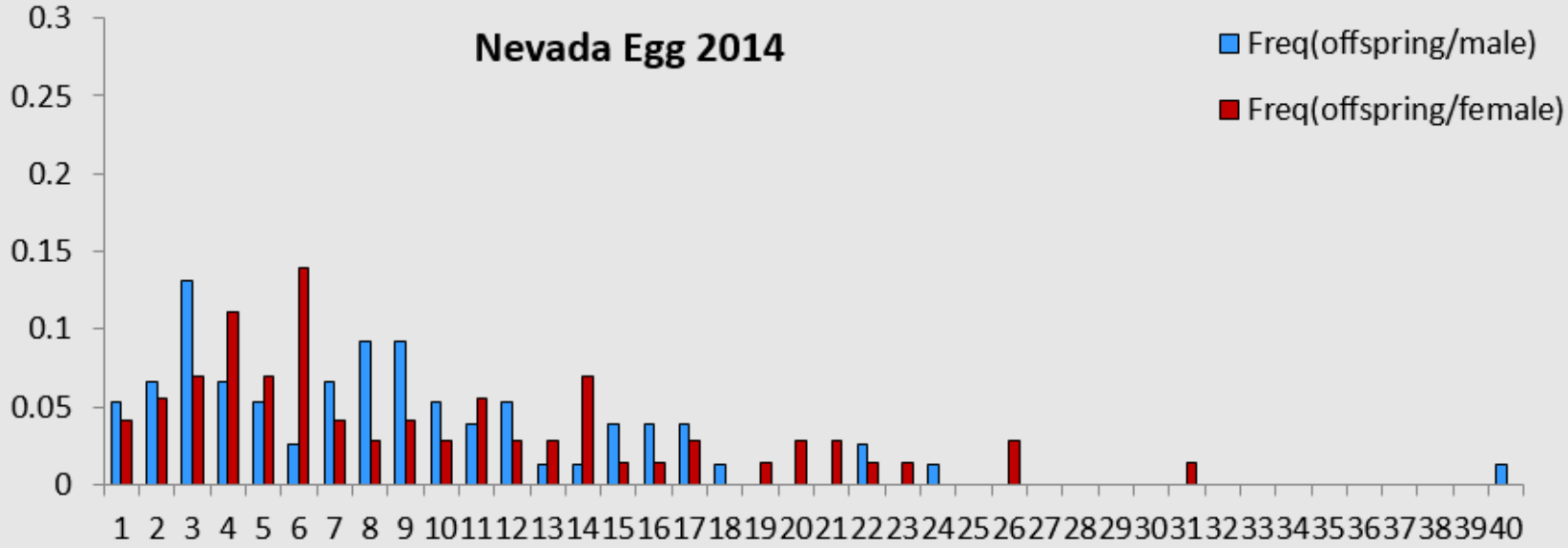


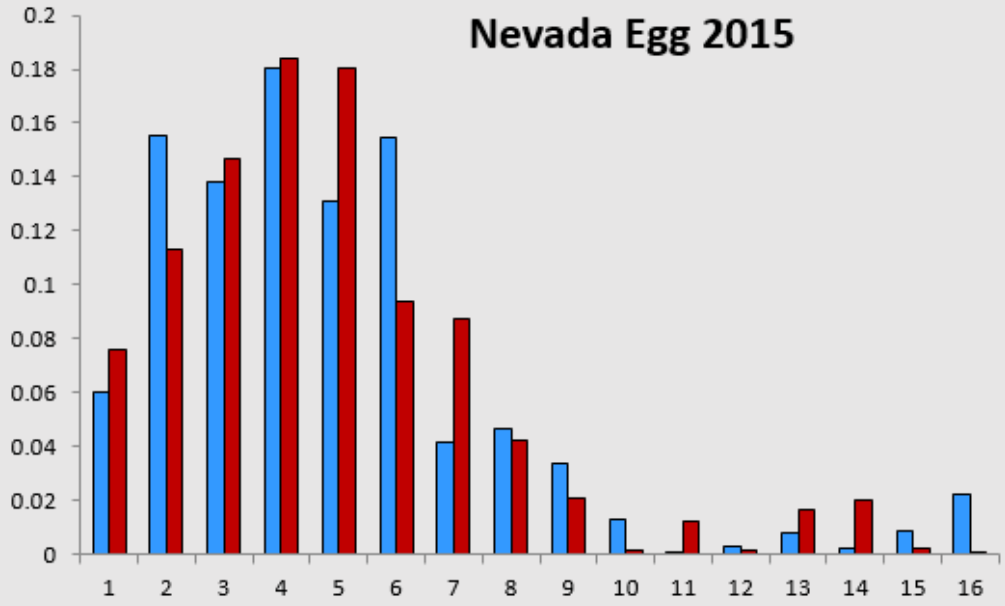


Offspring per Sire/Dam



Offspring per Sire/Dam





	North Nine Mile							
	2014		2015		2014		2015	
	Mates/ Sire	Mates/ Dam	Mates/ Sire	Mates/ Dam	Offspring/ Sire	Offspring/ Dam	Offspring/ Sire	Offspring/ Dam
Mean	2.49	2.65	4.14	4.19	2.82	2.91	4.93	4.53
SD	1.62	1.94	2.21	2.23	1.87	2.37	2.76	2.54
Max	7	7	11	14	8	9	15	14
	Nevada Egg							
Mean	6.37	6.77	4.33	4.23	8.50	8.44	4.68	4.77
SD	3.73	4.50	2.61	2.17	6.77	7.12	3.02	2.79
Max	22	20	14	11	40	28	15	15

Significant differences between backwaters with higher number of mates and offspring per individual in NE compared to NM in 2014.

- ✓ **Nevada Egg**: average ~6 mates per male/female 2014, ~4 mates per male/female
- ✓ **Nine Mile**: average ~2 mates per male/female 2014, ~4 mates per male/female
- ✓ **Nevada Egg**: average ~8-9 offspring per male/female in 2014 and 5 offspring per male/female in 2015, maximum- 28-40 in 2014 and 15 offspring in 2015
- ✓ **Nine Mile**: average ~3 offspring per male/female in 2014 and 5 offspring per male/female in 2015, maximum- 28-40 in 2014 and 14 offspring in 2015

Effective Population Size

Backwater	Year	N_e(sibship) (95% CI)
North Nine Mile	2014	138 (109-175)
	2015	156 (125-197)
Nevada Egg	2014	114 (90-150)
	2015	152 (121-194)

Conclusions

- How many individuals make a reproductive contribution in backwaters stocked with bonytail?
  - ~75-93 % of individuals

- Is genetic diversity preserved between parental and progeny generations?
  - No significant difference in diversity metrics
  - Genetic effective size is lower in Nevada Egg, due to increased variance in reproductive success in 2014
  - Genetic effective size in 2015 is not different between backwaters

Conclusions

- Do certain males or females contribute disproportionately?
  - ❖ No, males and females make very similar contributions
- In variance in reproductive success similar between backwaters and males/ females?
  - ❖ Variance in reproductive success differed by backwater (i.e habitat) in 2014 but not between males and females (i.e. individuals) in either year.

Acknowledgements

- Alyssa Sanchez, Nicolas Smith (UNM)
- Funding-- MSCP
- Bureau of Reclamation: Jeff Lantow, Eric Loomis
- Lex Snyder (Museum of Southwestern Biology)
- Howard Brandenburg (ASIR) for assistance with larval stage identification