

Science and Habitat Restoration Work Group Meeting
November 30, 2017

Meeting Materials:

Meeting Agenda

Meeting Minutes

GWG Priority Projects [not included]

Proposed 2018 ScW/HR Work Plan

ScW/HR Genetics Priorities [spreadsheet not included]

Genetic Monitoring of RGSM: Status of Wild and Captive Stocks in 2017 [presentation]



Middle Rio Grande Endangered Species
Collaborative Program
Est. 2000

**Science and Habitat Restoration Work Group
Meeting Agenda**

November 30, 1:00 PM – 3:00 PM
Location: U.S. Army Corps of Engineers

Meeting Agenda

Conference Call information:
Phone: (712) 451-0011 Passcode: 141544

1:00-1:05	Welcome and Introductions	<i>Debbie Lee</i>
	➤ Approval of Agenda	
1:05-1:40	Scope of Work Updates	<i>Debbie Lee</i>
	<ul style="list-style-type: none">• Genetics• Tamarisk• Early Life History	
1:40-2:00	Population Monitoring SOW	<i>Debbie Lee</i>
	<ul style="list-style-type: none">• Population Monitoring Group<ul style="list-style-type: none">• Data Analysis Team	
2:00-2:30	Discussion of Science Strategy	<i>Rick Billings</i>
2:30-2:40	Summary and Next Steps	<i>Debbie Lee</i>
2:40	Adjourn	



Middle Rio Grande Endangered Species
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Science and Habitat Restoration Work Group
Meeting Minutes
November 30, 2017 – 1:00 - 3:00 PM
Location: U.S. Army Corps of Engineers

Decisions:

- The agenda was approved without change and no objections voiced.
- The group decided to ask the Executive Committee (EC) for direction regarding projects and tasks in 2018.

Actions:

WHO	WHAT	BY WHEN
WEST	Will develop short summaries of the two Scopes of Work (SOW) going to the Executive Committee (EC) for approval and circulate to group.	ASAP
WEST	Will add Yasmeen Najmi, Middle Rio Grande Conservancy District (MRGCD), to the Genetics and Early Life History SOW subgroups mailing lists.	ASAP
WEST	Will circulate the Tetra Tech Tamarisk Habitat Restoration (HR) site identification report to the group. (Tetra Tech. "Habitat Relationships Along the Middle Rio Grande in New Mexico for the Endangered Southwestern Willow Flycatcher." Prepared for U.S. Army Corps of Engineers, January 2015.)	ASAP
Mike Marcus	Will send the previous Collaborative Program long-term science plan to Western EcoSystems Technology, Inc. (WEST) to circulate to the group.	December 5, 2017
Debbie Lee	Will contact Vicky Ryan, U.S. Fish and Wildlife Service (USFWS) about next steps if an HR site is identified near an active Southwestern Willow Flycatcher (SWFL) nest, and, if there are not guidelines, whether the Program can be involved in developing them.	December 15, 2017
WEST	Will Re-circulate Rick Billing's draft Science Strategy.	December 15, 2018
All	Will send WEST any information regarding as-built bank lowering projects to be sent to Ari Posner.	January 5, 2018
Justin Reale	Will identify water data sets and reports, and where they are located as part of the data assessment.	Ongoing
PMW/DAT	Will provide updates to the Science and HR Work Group (ScW/HR) on the Rio Grande silvery minnow (RGSM) data re-analysis task	Ongoing

Request/Recommendations:

- It was recommended that the old long-term science plan should be reviewed to decide what is still relevant to use as the basis for a new long-term science plan.
- It was suggested that SOWs for funding by Program Signatories should be prioritized so that they are ready as funding becomes available. Priorities identified from the panel recommendations can be the starting point to develop the list of projects for SOW development.
- The group would like to see the development of a larger network for external review for the SOWs as part of a future science long term plan or strategy.

Announcements:

- The U.S. Bureau of Reclamation (USBR) is conducting a survey of as-built bank lowering HR sites to develop a set of bank lowering guidelines.

Next Meeting:

January 16, 2018, Location TBD

Meeting Notes

Welcome and Introduction

- Debbie Lee, WEST, called the meeting to order and invited the attendees to introduce themselves.
- The agenda was approved without change and no objections voiced.

Discussion of Scopes of Work

Development of RGSM High Throughput Markers SOW (Genetics SOW):

- The Genetics Subgroup will reconvene on December 7 to make final changes to the SOW and will present a summary of the SOW to the EC on December 12. The SOW is almost complete but does need a refined budget and timeline before it can go to USBR.
- The group remarked that they would like to see the SOW before it is sent to the EC. WEST is developing summaries for the SOW to be sent to the EC so as not to bog them down with too many details. The short time frame prior to the EC necessitates a short turn around on comments if the SOW is circulated.
- WEST will add Yasmeen Najmi, MRGCD, to the Genetics and Early Life History SOW subgroups mailing lists.

Identifying Restoration Priorities for Threatened Tamarisk Dominated Habitat to Benefit Future Habitat for Southwestern Willow Flycatcher (Tamarisk SOW):

- Julie Dickey, WEST and Lynette Giesen, U.S. Army Corps of Engineers (USACE), are developing the Tamarisk SOW and intend to have it ready for approval at the December 12 EC meeting. As with the Genetics SOW, a short summary will be prepared for the EC to review.
- Julie Dickey reviewed the SOW:
 - Tetra Tech did an analysis in 2014 identifying 103 tamarisk dominated sites for possible HR. The current SOW will expand on the previous study by reevaluating the areas with new vegetation data from USBR and ground-truthing the sites to confirm that they meet restoration standards. The contract will likely be awarded under an Indefinite Delivery and Indefinite Quantity (IDIQ) contract the USACE has with Tetra Tech.
 - WEST will circulate the 2014 Tetra Tech report the Tamarisk SOW is based on.

- Questions were asked about the protocol for restoring a possible HR site that suffers from tamarisk beetle damage, but is also an active SWFL nesting site.
 - Debbie Lee will contact Vicky Ryan, USFWS, about next steps if an HR site is identified near an active SWFL nest, and, if there are no existing guidelines, whether the Program can be involved in developing them.

RGSM Early Life History SOW (Early Life History SOW):

- The Early Life History Subgroup decided to redraft the Early Life History SOW to refocus on temperature degree days as the experimental variable for RGSM reproductive readiness and success (measured as the survival of the offspring to the juvenile stage). The previous SOW had been in development for several years, and by refocusing on a discrete variable and starting over, the new SOW can lead to a study design that takes into account the most up-to-date science and relevant recommendations from the recent panel reports. The study would be conducted in a laboratory setting rather than in the field and would investigate the survival and growth rates of RGSM larvae from early versus late spawning events. The management action derived from the study would be to help water managers decide when to release supplemental water to assist the minnow's survival.
- The group asked whether this study would need to be done after the completion of the Genetics SOW. The completion of the high throughput markers development would add to the accuracy of the Early Life History SOW.
- Concerns were raised that USACE does not currently have the authorization to release water from Cochiti Dam for endangered species; however this does not mean that USACE's authorization may not change in the future by an act of Congress.

Reanalysis of Historical Rio Grande Silvery Minnow Population Monitoring Data:

- The ScW/HR charged the Population Monitoring Work Group (PMW) to decide whether to further develop the SOW for the reanalysis of RGSM historical Population Monitoring Program (PopMon) data to be acquired from American Southwestern Ichthyological Researchers (ASIR). The PMW decided to conduct the reanalysis within the group and created the Data Analysis Team (DAT) to investigate the peer review recommendations regarding data analysis of the historic PopMon data and conduct the recommended analyses.
 - The PMW and DAT recommended procuring the services of an outside statistician, Charles Yackulic of the Glenn Canyon River Project and the U.S. Geological survey (USGS), as another source of external review and oversight. USACE has agreed to fund Charles Yackulic's participation in the project.
 - The group is focusing on the recommendations from the population monitoring panel review (Hubert et al.), but is incorporating recommendations from the adaptive management panel review (Noon et al.) when they overlap.
- The final data set of historical RGSM PopMon data will become available after December 15.
- The PMW and DAT have requested ASIR's involvement in the reanalysis effort as they believe ASIR would provide added value.
- The PMW will continue to give updates to the ScW/HR regarding the reanalysis task.

Discussion of Habitat Restoration Sites

- An attendee mentioned that they observed many dead cotton wood poles at an HR site in the Valle Del Oro National Wildlife Refuge. This observation was confirmed by another attendee, who had observed that almost all of the young trees at that site are dead despite looking healthy in the spring.

- It was suggested that high water levels may have submerged the trees for too long, causing them to die.
- The group discussed investigating what the factors are which predict HR site success. An attendee mentioned that current HR procedures have high success rates, but that recent extenuating circumstances have contributed to the last few years' high failure rates.
- It was mentioned that USACE would like direction from the EC to do HR monitoring work. It was suggested that the group could perform a literature review regarding HR site success which would inform future studies.
- It was mentioned that an SOW already existed to evaluate HR, but no information was known beyond the SOW existence.

Science Strategy Discussion

- Rick Billings, Albuquerque Bernalillo County Water Utility Authority (ABCWUA), reintroduced developing a science strategy and coordinating a state of the science meeting to identify the biggest problems in the Program and codify what we know now.
 - WEST will circulate Rick Billings' science strategy document to the group.
- The group discussed how the ScW/HR can play a large role in developing and implementing an interim science plan while the Collaborative Program's Adaptive Management Program (AMP) is developed.
- It was mentioned that Mike Marcus, Assessment Payers Association (APA), while contracted with the Program in 2005, developed a long-term science plan which listed all previous work done by the Program up to that point and detailed possible future projects.
 - Mike Marcus will send the previous Program long-term science plan to WEST to circulate to the group.
- It was suggested that the ScW/HR should propose projects the group would like to do to the EC and request direction to pursue those projects for the 2018 calendar year. Possible suggested projects included:
 - An inventory of studies/projects done in support of the Program
 - An inventory of resources available to the Program (e.g. monitoring data, laboratories, expertise, etc.)
 - An inventory of current projects that support the Program
 - An assessment of available data (i.e. what data is available, who owns it, and how it can be accessed)
 - Working with USGS to design the new Database Management System (DBMS)
- A representative from USBR mentioned that they are working to develop a set of bank lowering guidelines for HR sites and would like to survey existing as-built bank lowering sites to assess their efficacy.
 - The group will send WEST any information regarding as-built bank lowering projects to be sent to Ari Posner with USBR.
- The group discussed the assessment of available data task and it was mentioned that the DBMS was originally supposed to be the repository of Program signatory data, but it has instead become a document library. The group agreed to the need for an assessment, and eventual synthesis, of available data. The group also agreed that they would like to work with USGS to design the database aspect of the new DBMS.
 - Justin Reale, USACE, will identify water data sets, reports, and where they are located as part of the data assessment.
- The group would like to do a prioritization of short term studies extrapolated from the three (3) most recent panel recommendations that can be done while the AMP is developed.
- It was recommended that the old long term science plan should be reviewed to decide what is still relevant to use as the basis for a new long term science plan.

- It was suggested that SOW for funding by Program Signatories should be prioritized so that they are ready as funding becomes available. These SOWs can be developed from the priorities identified from the panel recommendations.
 - The group felt that they should continue to create one page SOW proposals based on panel recommendations that the group can choose from to develop into full SOWs.
 - The group would like to see the development of a larger network for external review for the SOWs as part of a future science long term plan or strategy.

Meeting Participants

Participants		Organization
Rick	Billings	ABCWUA
Julie	Dickey	WEST
Kim	Eichhorst	Bosque Ecosystem Monitoring Program
Danielle	Galloway	USACE
Lynette	Giesen	USACE
Alison	Hutson	NM Interstate Stream Commission
Debbie	Lee	WEST
Joel	Lusk	WSFWS
Mike	Marcus	APA
Kate	Mendoza	ABCWUA
Luc	Moulson	WEST
Yasmeen	Najmi	MRGCD
Ari	Posner	USBR
Dana	Price	USACE
Ashlee	Rudolph	USBR
Stephen	Ryan	USACE

Proposed 2018 Science/Habitat Restoration Work Plan

1. Peer Reviews

In recent years, the Collaborative Program has sponsored three independent science panels/peer review panels:

- RGSM Life History (February 2017)
- RGSM Genetics Project Peer Review (February 2016)
- RGSM Population Monitoring (December 2015)

The Collaborative Program has undertaken some prioritization of the recommendations from the panel reports, but has not completed these efforts, or looked at prioritizing the recommendations from all three panels as a whole.

Continuing the prioritization effort will help inform the development of a long-term science work plan, as well as an interim work plan for the next year.

2. Data Inventory and Consolidation

Since its inception, the Collaborative Program and its signatories have collected a large amount of data, including (but not limited to) endangered species population numbers, hydrology, water quality, and habitat restoration.

There is a need to inventory what data are available where, and if possible, to consolidate datasets. This will inform science and adaptive management activities in the Program, and minimize duplicate monitoring efforts.

3. GIS Map of Projects

In 2017, the ScW/HR had begun developing a GIS map of all projects in the MRG. Due to Ken Richard leaving NMISC, that effort had stalled. Completing the map development will inform ongoing and future projects, and help with coordination efforts for on-the-ground activities.

4. DBMS Development

In 2018, the Collaborative Program will be developing a new DBMS through an Army Corps contract with USGS. This new DBMS needs to be responsive to the needs of the Program, including its scientists and technical experts. The ScW/HR as a group can work with USGS to develop a list of requirements for the database and data management portion of the DBMS.

5. Habitat Restoration Assessment

At the last ScW/HR meeting, it was raised that the last few years have seen an increased failure rate of cottonwood pole plantings. It was proposed that the group undertake a research project to assess why a habitat restoration project succeeds or fails.

Genetic Monitoring of Rio Grande Silvery Minnow: Status of Wild and Captive Stocks in 2017



MEGAN OSBORNE & THOMAS TURNER



THE UNIVERSITY of
NEW MEXICO



What Is Genetic Monitoring?

- Tracking genetic diversity over contemporary time scales
- Multiple time points
- Consistent methodology across time series

Diversity Metrics

Microsatellites

MtDNA

Diversity

Gene diversity
Allelic richness
Heterozygosity

Haplotype diversity
Haplotype richness

Effective Size

Variance effective size

MLNE

Moments

TempoFs

Variance effective size

MLNE

Moments

Inbreeding effective size

Linkage disequilibrium

What are we measuring?

Allelic diversity

- Number of alleles per locus (A)
- Dependent on sample size

Allelic/haplotype richness (A_R/n_{ac} , H_R)

- Number of alleles/haplotypes per microsatellite/mtDNA locus corrected for unequal sample size

Bottlenecks and allelic/haplotype diversity

- Depends on the number of alleles and their frequencies
- Rare alleles are most likely to be lost



What are we measuring?

Heterozygosity (microsatellites)/ Gene diversity (mtDNA)

- The presence of different alleles at one or more loci on homologous chromosomes. Proportion of heterozygous individuals for a locus in a population.

Bottlenecks and heterozygosity

- Rate of loss is determined by the genetic effective size of the population during bottleneck
- Rare alleles contribute little to heterozygosity, hence loss of alleles may not be accompanied by loss of heterozygosity



Genetic Effective Size

- Size (N) of an **idealized population** (equal sex ratio, lifetime variance in number of offspring is binomial, constant population size) that would experience the same degree of **genetic drift** as the observed population (N_e).
- Why is it important?
 - N_e determines the amount of variation transmitted from one generation to the next.
- Methods for estimating N_e
 - Variance effective size (N_{eV}) vs. Inbreeding effective size (N_{eI})
 - Provide more accurate estimates (i.e smaller confidence intervals) when N_e is small and genetic drift is strong
 - Difficult to differentiate large from very large N_e (i.e. genetic drift is weak) resulting in large or infinite confidence intervals

Genetic Effective Size

N_{eV} and N_{eI} provide independent information about effective size

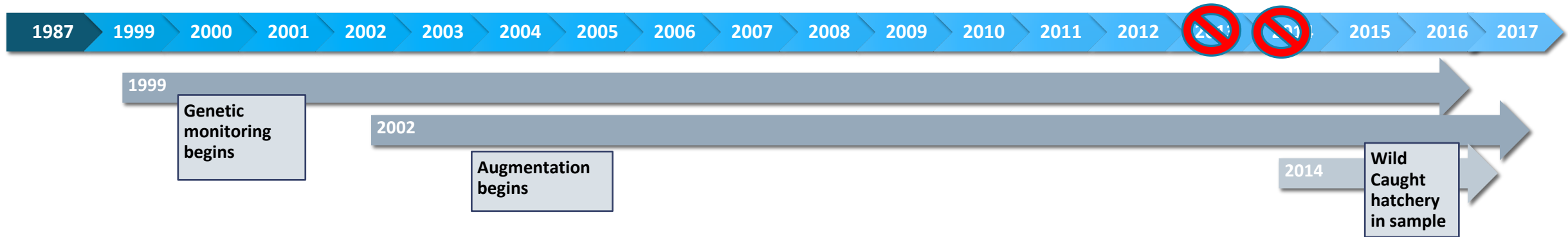
	VARIANCE EFFECTIVE SIZE, N_{eV}	INBREEDING EFFECTIVE SIZE, N_{eI}
How it is measured	Allele frequency changes	Linkage disequilibrium (non-random association of alleles at different loci)
What it measures	Loss of genetic variation from GENETIC DRIFT	Number of parents for the current generation
Number of temporal samples	2	1
Stable populations	=	=
Population fluctuation Supplementation	≠	≠
Assumptions	<ul style="list-style-type: none"> • Mutation is not important • Alleles selectively neutral • Alleles not in linkage disequilibrium with loci under selection • Samples are drawn randomly no immigration from neighboring populations 	<ul style="list-style-type: none"> • Mutation is not important • Alleles selectively neutral • Alleles not in linkage disequilibrium with loci under selection • Samples are drawn randomly no immigration from neighboring populations • Random mating

Why conduct genetic monitoring in RGSM?



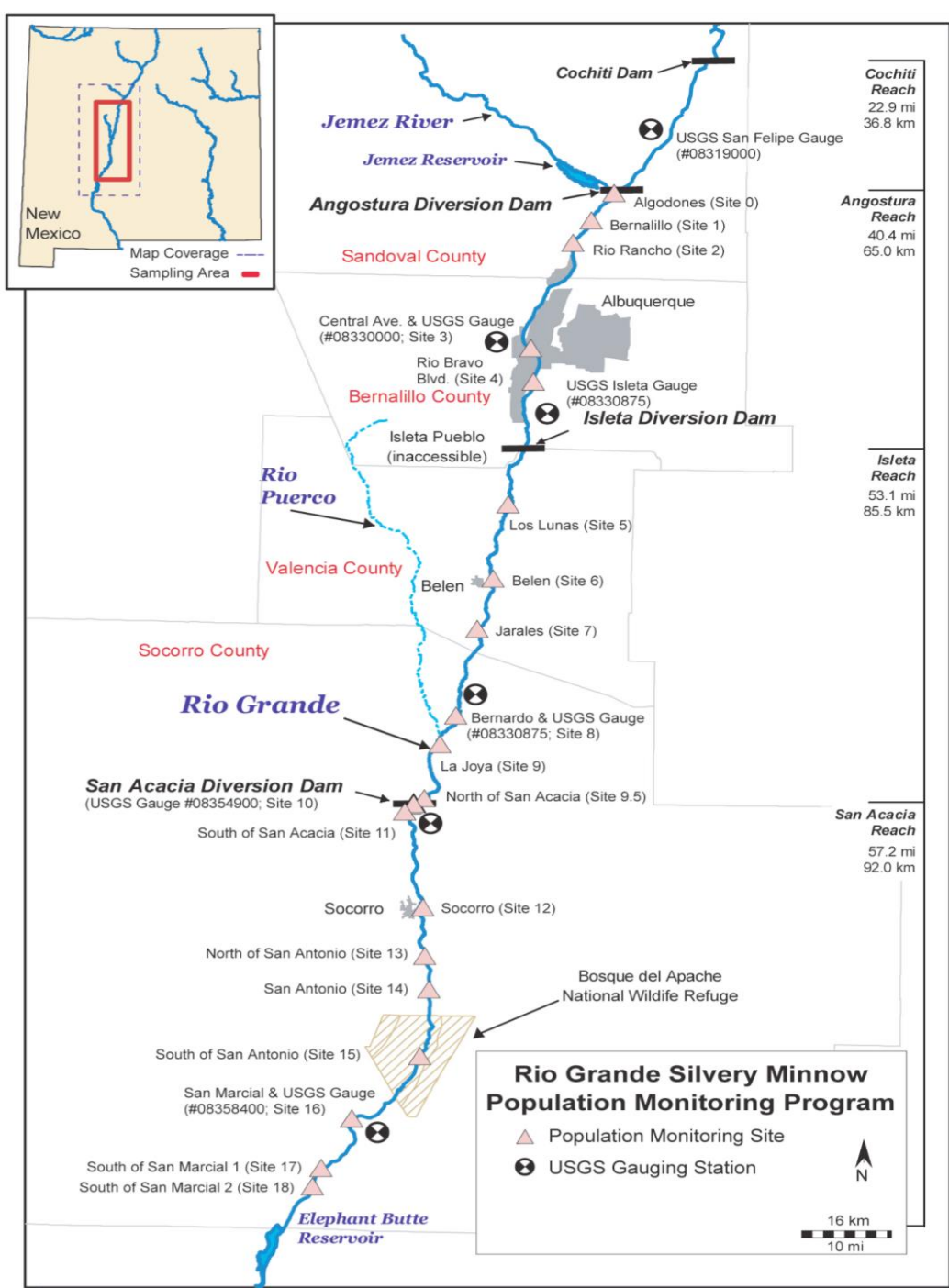
- Short-lived, type III survivorship.
 - Environmental conditions are highly variable
 - Dramatic population fluctuations.
 - Management actions- affect how diversity is distributed
 - Captive propagation and augmentation may increase or decrease diversity and genetic effective size.
-
- Levels of genetic diversity affected over contemporary time scales.

Background to RGSM Genetic Monitoring



- Neutral genetic markers:
 - MtDNA-ND4 gene Microsatellites (9 loci)
- Representative captive stocks released to the MRG (and to Big Bend)
- **Total = 5448 unmarked fish sampled from the MRG**

- **3812 captive bred/reared individuals**



- Unmarked fish sampled from three localities within each river reach
 - Angostura
 - Isleta
 - San Acacia
- Non-destructive sampling
- Total = 5448 unmarked fish sampled from the MRG
- 3812 captive bred/reared individuals

Objectives

1. Collect samples from 'wild/naturally spawned' RGSM population and captive stocks.
2. Establish benchmarks of diversity using existing data.
3. Determine levels of genetic variability to evaluate temporal trends.
4. Estimate contemporary genetic effective size (N_{eV} & N_{eI}) in the wild population to evaluate temporal trends
5. Evaluate genetic effects of captive propagation/augmentation on wild stocks.

OBJECTIVE 1

Ideal sampling:
three sites within
each reach, 50
samples per site

Year	Angostura	Isleta	San Acacia	Total
2017	159	156	154	469
2016	171	121	128	420
2015	75	33	35	143
2014	5	3	4	12
2013	-	-	-	-
2012	147	215	154	516
2011	71	148	140	359
2010	149	146	151	446
2009	175	153	150	478
2008	165	191	123	479
2007	48	128	42	218
2006	95	143	145	383
2005	190	109	95	394
2004	141	15	6	162
2003	71	65	33	169
2002	67	121	201	389
2001	-	65	63	128
2000	-	-	194	194
1999	-	-	46	46
1987	15	-	28	43

OBJECTIVE 2: Establish benchmarks of diversity

- ‘Wild’ (MRG) fish: pooled into one large population ($n \approx 5000$)
- Resampled individuals ($n = 43$) to estimate diversity statistics
- Primary interest is maintaining genetic diversity, the one-tailed benchmark corresponds to the lower 5% of the resampled distribution (as opposed to lower 2.5% for a two-tailed).
- The distribution contained above the benchmark corresponds to a conservative null hypothesis of no loss of diversity.

OBJECTIVE 3

Microsatellites

- Gene diversity and heterozygosity were UNCHANGED from 2015 and 2016 values
- These metrics exceeded benchmarks
- Allelic diversity declined in 2017 and approached the minimum benchmark

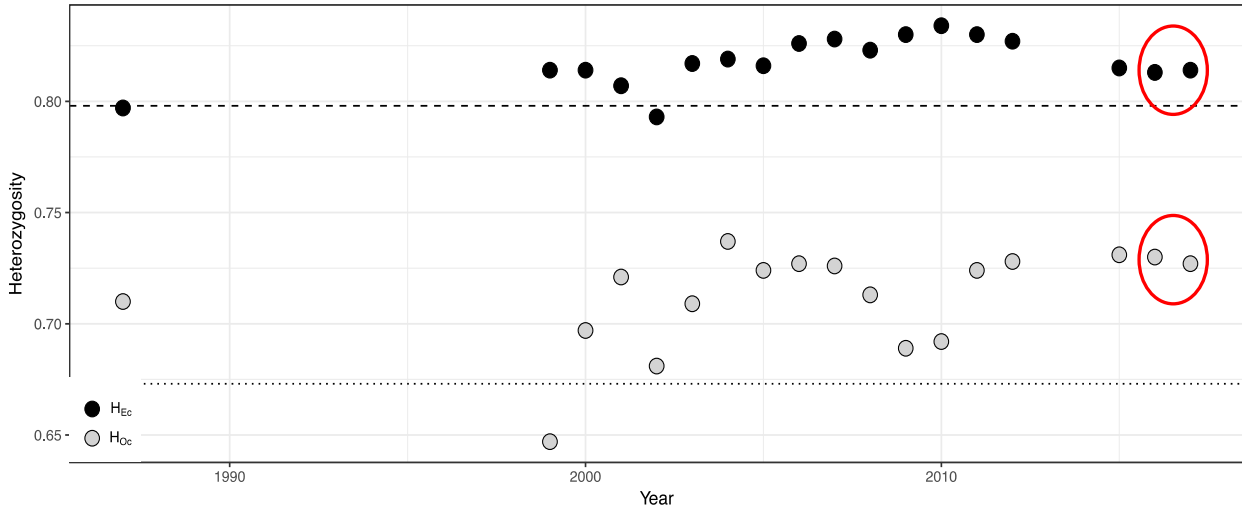
MtDNA

- MtDNA diversity metrics (h and H_R) decreased from 2016 values.
- Detection of three rare haplotypes not seen since 2012.
 - Likely reflects increased number of samples in 2017 > detection of rare alleles
 - Reproductive contribution of old broodstock released in spring of 2016

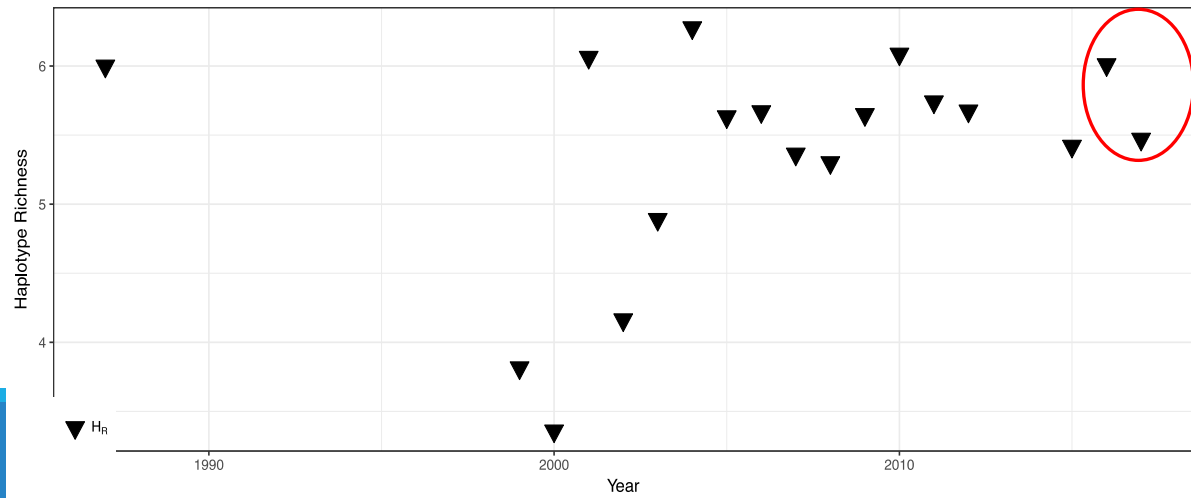
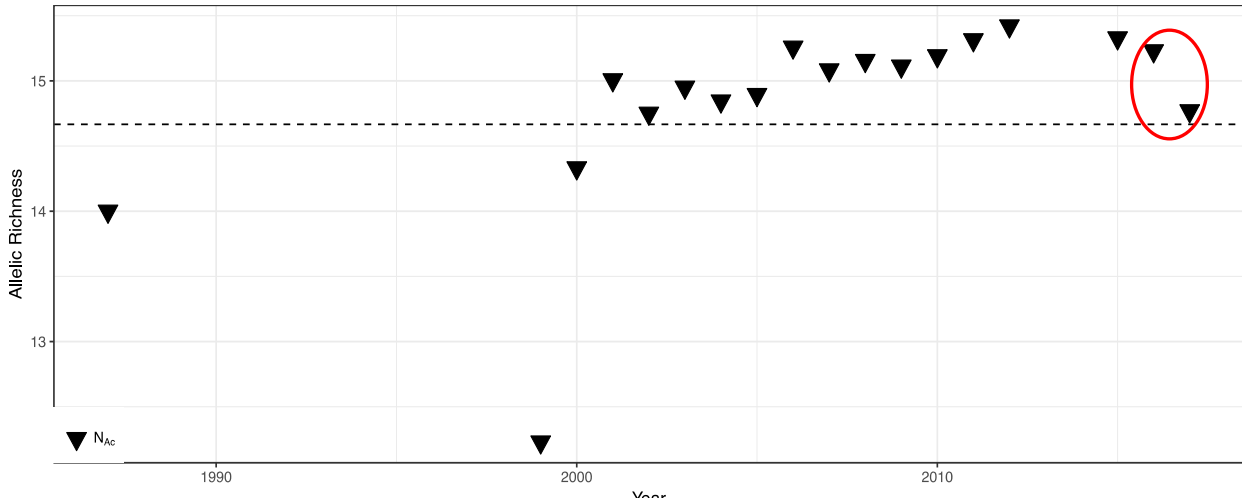
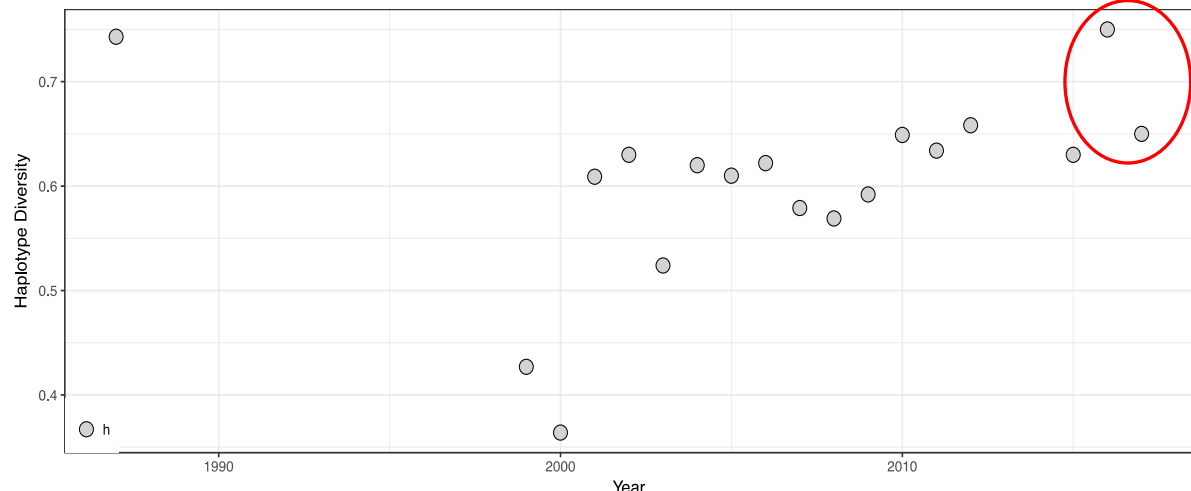
OBJECTIVE 3. Estimate genetic diversity in 'wild' population to assess temporal trends

Dashed line- benchmark

Microsatellites

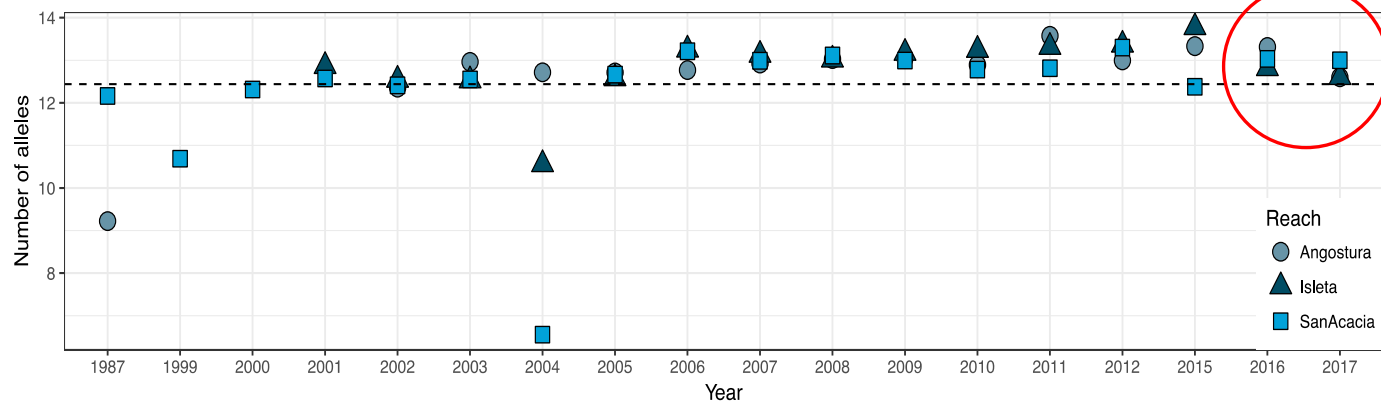
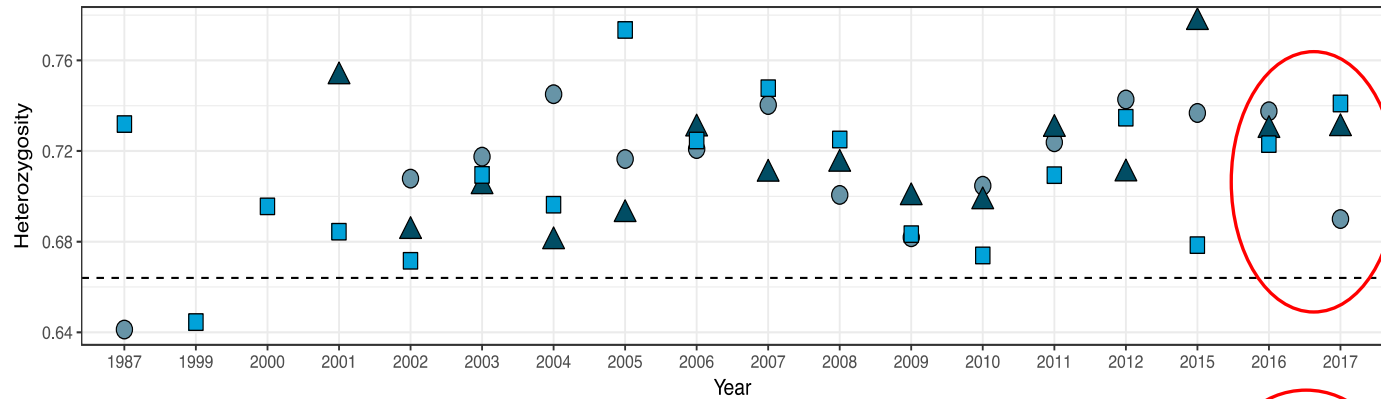
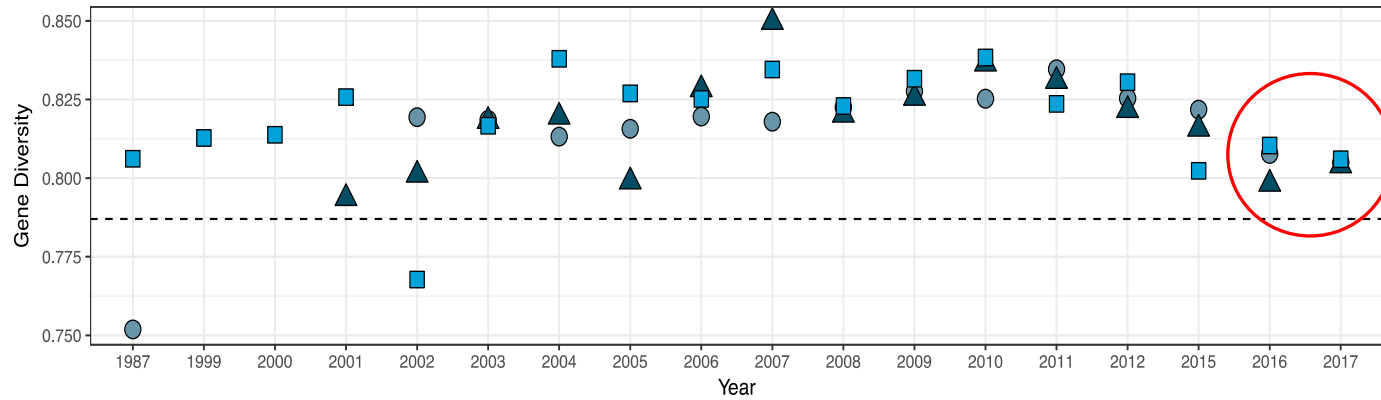


Mt DNA- ND4



OBJECTIVE 3

Diversity by River Reach: Microsatellites



Dashed line- benchmark



Angostura: H_{oc} declined



Isleta: All metrics stable

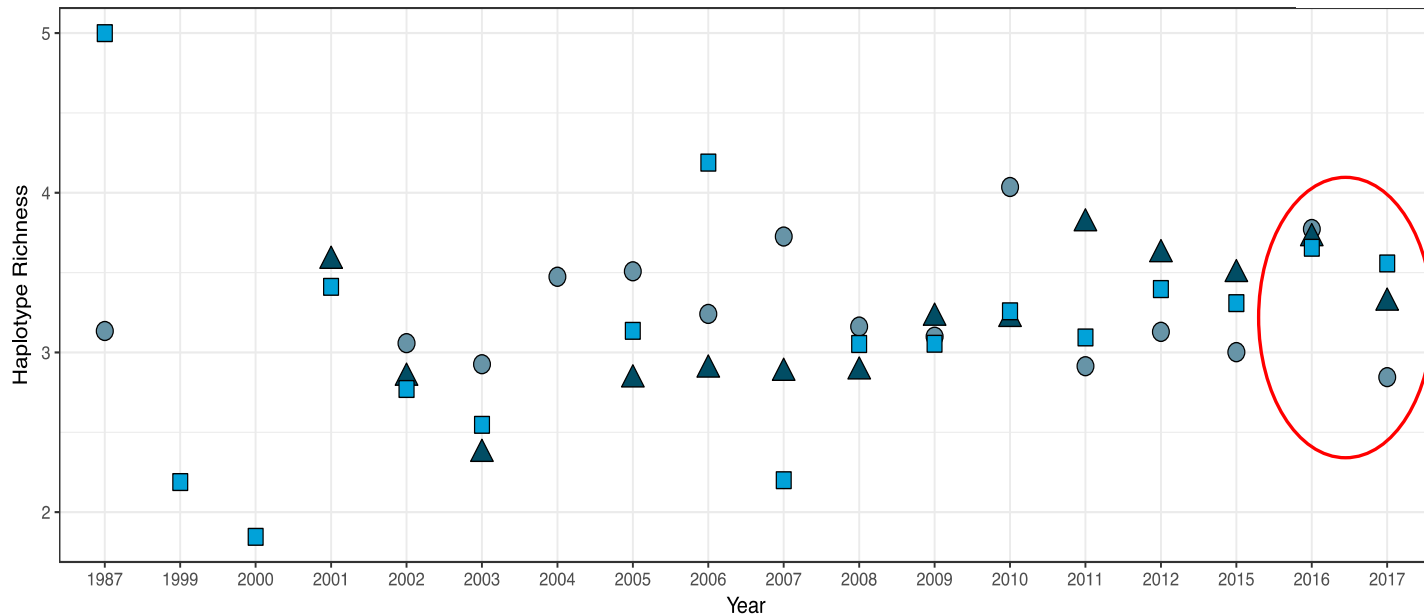
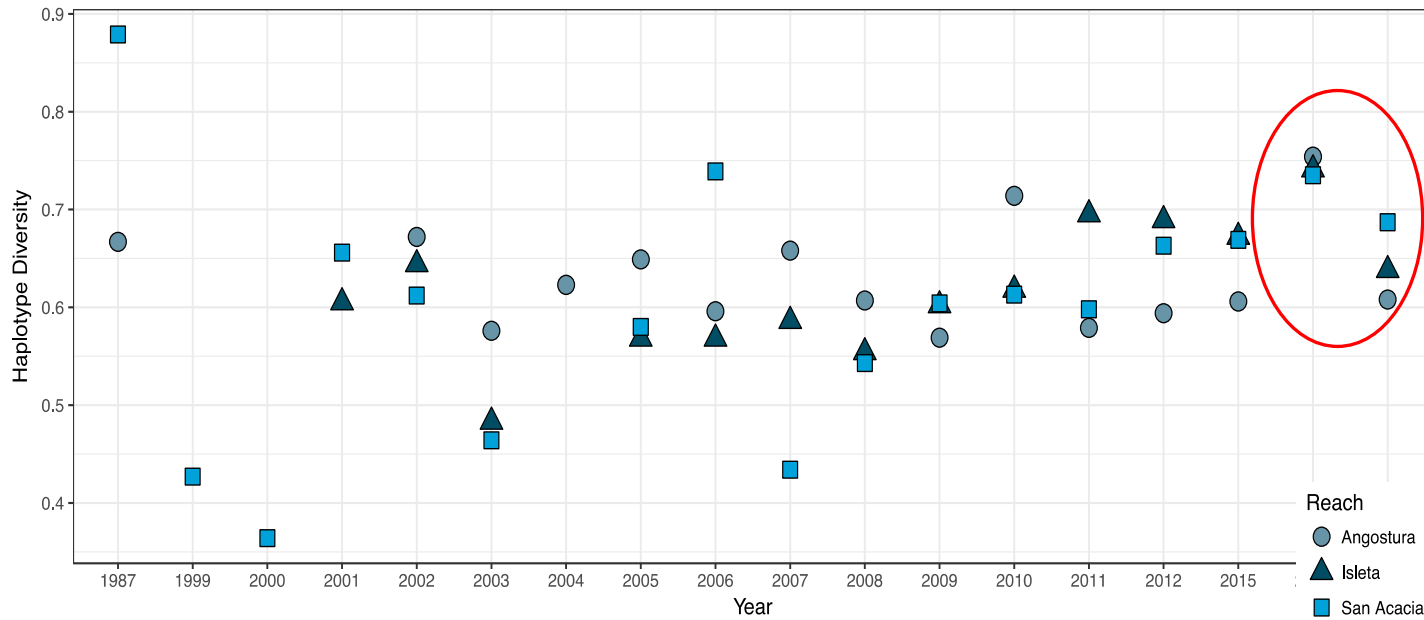


San Acacia: All metrics stable

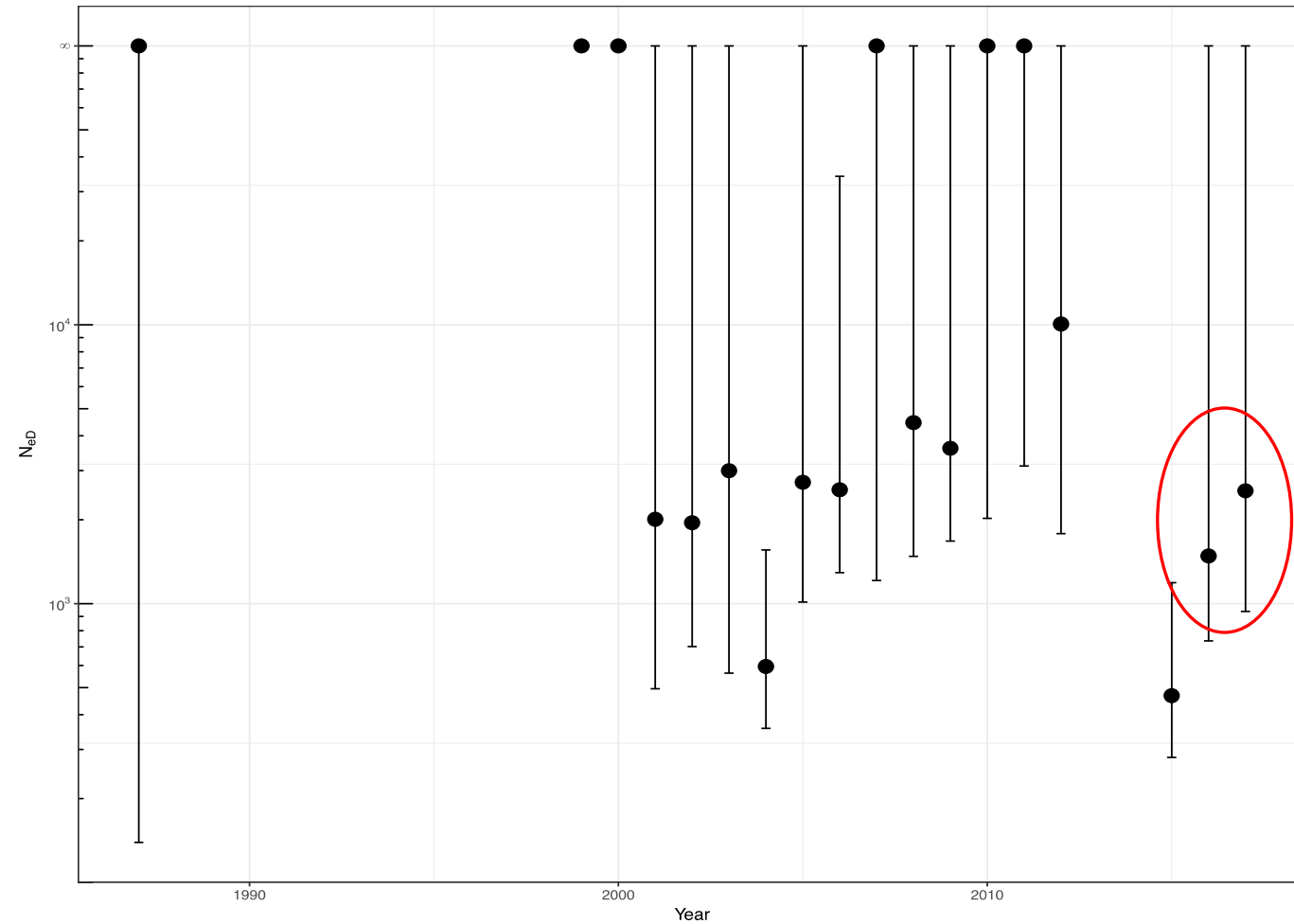
OBJECTIVE 3

Diversity by River Reach: Mt-DNA

- MtDNA diversity statistics decreased at the reach level in 2017



OBJECTIVE 4 Inbreeding Genetic Effective Size



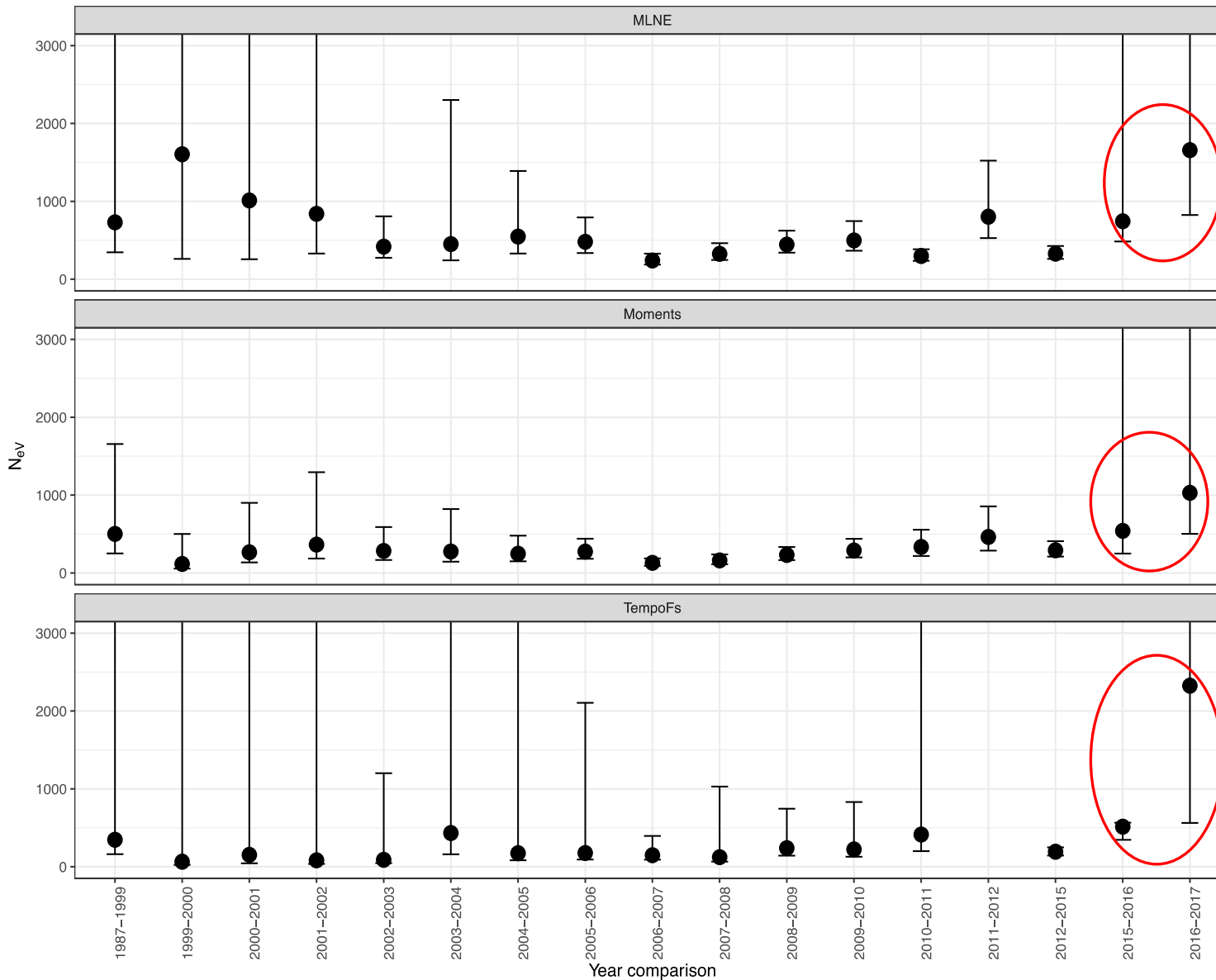
How it is estimated: Linkage disequilibrium (non-random association of alleles at different loci)

What it measures: Number of parents for the current generation

Number of temporal samples: 1

OBJECTIVE 4

Trends in N_{eV}

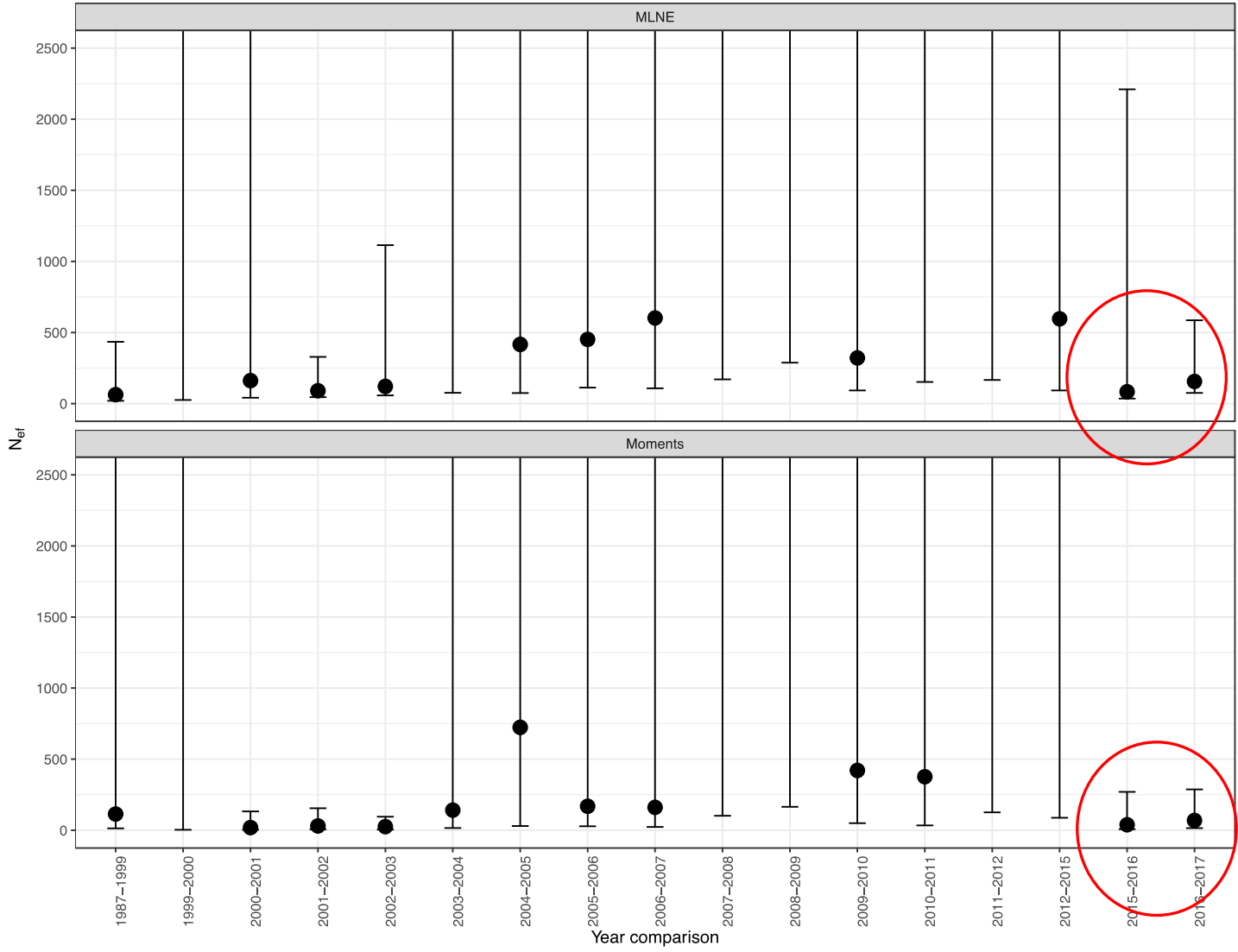


- **How it is estimated:** Allele frequency changes
- **What it measures:** Loss of genetic variation from GENETIC DRIFT
- **Number of temporal samples:** 2
- **Increase in N_{eV} over previous estimate**

OBJECTIVE 4

Female Variance Effective Population Size (mtDNA)

- Marginal increase from 2015-2016 estimate



OBJECTIVE 5

Genetic diversity: Captive stocks 2017

Captive spawned	N	N_{ac}	H_{ec}	H_{oc}	F_{IS}	N_{eD}	-95%	95%	N	N_h	h	H_R
ABP13-003-04 WC	50	13.8*	0.81	0.70	0.13	407	190	infinite	50	5	0.75	5.00
ABP16-003 CS	39	12.9*	0.83	0.74	0.11	79	50	161	39	5	0.53	5.00
Uvalde 2016	100	12.1*	0.79	0.70	0.11	46	36	62	100	7	0.75	5.17
16CSDX-003	100	13.2*	0.80	0.72	0.10	104	80	141	100	6	0.77	6.10
16CSDX-004	98	10.6*	0.80	0.74	0.08	30	25	37	98	6	0.71	5.28
16CSDX-005	100	12.1*	0.80	0.73	0.09	55	41	75	100	6	0.72	5.09
Global 2017 Hatchery	484	13.8*	0.81	0.73	0.11	179	120	284	484	10	0.74	5.08

- Diversity falls below benchmarks
- Number of alleles is a more sensitive metric of loss of diversity
- Larger number of individuals spawned in captivity to maintain diverse captive populations

Genetic Diversity: Broodstock

Captive spawned	N	N_{ac}	H_{ec}	H_{oc}	F_{IS}	N_{eD}	-95%	95%		N	N_h	h	H_R
ABQ Biopark-Bs	110	14.2	0.81	0.69	0.15	966	314	infinite		110	5	0.66	4.73
SNARCC- Bs	59	12.7	0.82	0.69	0.16	616	169	infinite		59	7	0.73	6.53

- Allelic diversity falls below benchmarks for both facilities
- Observed heterozygosity also approaches lower benchmark

Conclusions

- MRG population
 - Gene diversity and heterozygosity exceeded minimum benchmark levels of diversity
 - Strong recruitment in fall 2016, larger effective population size
 - Allelic diversity declined in 2017 and approached benchmark values
 - Replacement of 'wild' population with captive derived stocks
 - Genetic effective size in 2017 increased over recent estimates
 - Reduced genetic drift between 2016 and 2017
 - Strong recruitment
- Captive stocks for release/broodstock
 - Allelic diversity below benchmark levels
 - Broodstock- observed heterozygosity also approaches lower benchmark
 - Increasing the number of individuals used in captive spawning
 - Parentage analysis of fish released in fall 2017

Acknowledgements

- ❖ Bureau of Reclamation- funding
- ❖ UNM: Tyler Pilger, Brian Fitzgerald, Mia Coleman, Alyssa Sanchez, Charisa Bell
- ❖ UNM Molecular Biology Facility
- ❖ Museum of Southwestern Biology– Lex Snyder