# Importance of Genetics for Sturgeon Supplementation

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Chelan County PUD workshop
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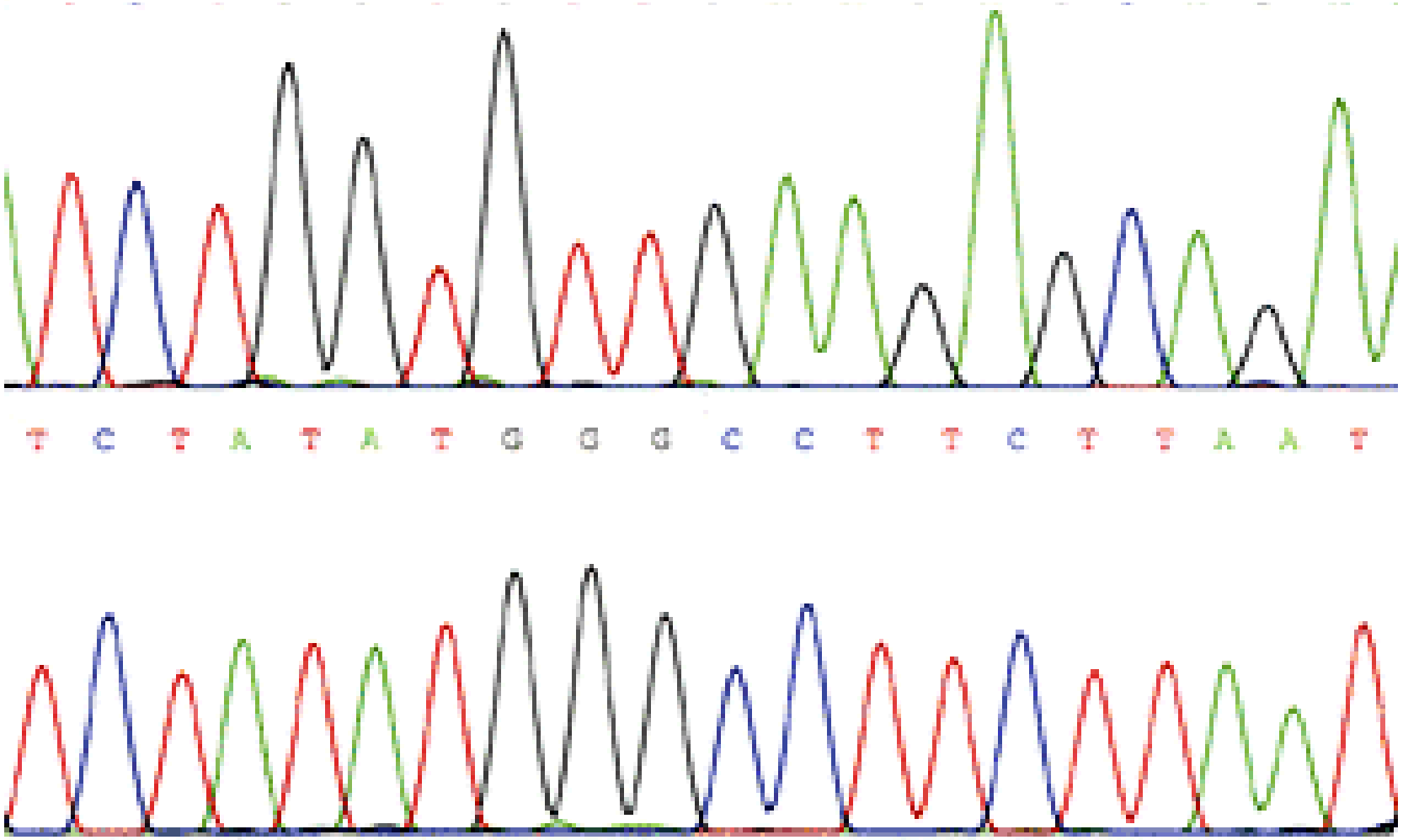
# Outline

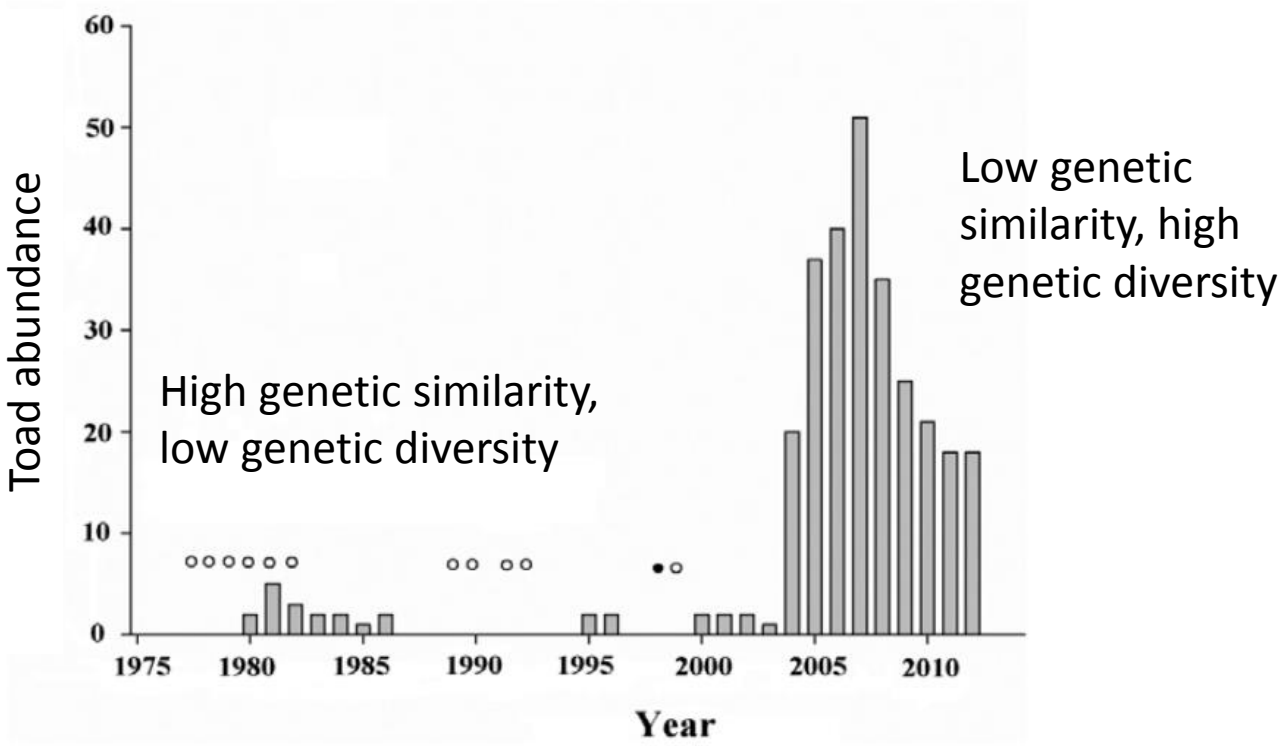
- Genetic Considerations
- Maximizing Genetic Diversity
- Broodstock vs Larval Approaches
- Spontaneous Autopolyploidy

# Consideration 1: Genetic Diversity



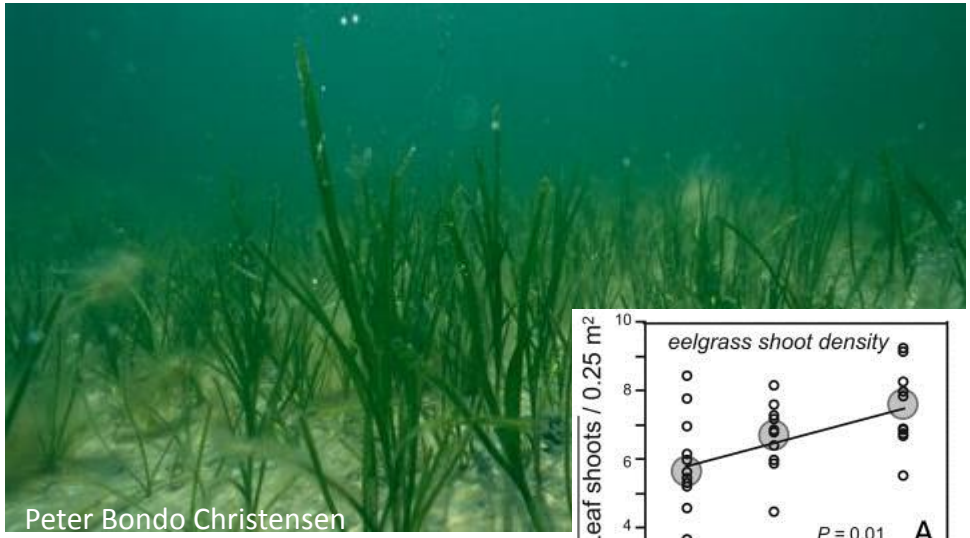
# Why is genetic diversity so important?

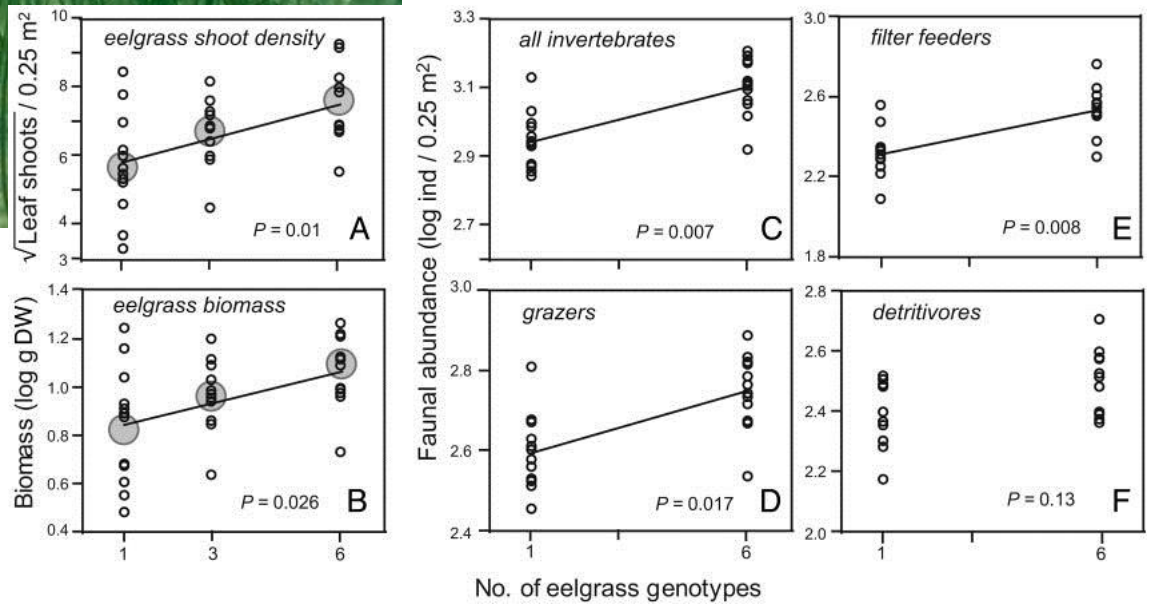
- Genetic diversity = raw material for natural selection




Reproduced from Zeisset and Bebee (2012) Animal Conservation 16(3):359-366

# Genetic diversity of populations can affect whole communities




Reusch et al. (2005) Proc Nat Acad Sci 102(8): 2826-2831

# Relevance to Supplementation

- Stocked cohorts should possess as much genetic diversity as possible

- Broodstock or larvae should represent genetic diversity of recipient population

# Consideration 2: $N_e$

- Determines manner in which genetic diversity is maintained
- High $N_e$ = greater retention of diversity (low drift)
- Low $N_e$ = greater genetic diversity loss (high drift)

# Several factors can reduce $N_e$

- These include:
  - Unequal sex ratio
  - Individual variance in reproductive success
  - Changes in population size

# Relevance to supplementation

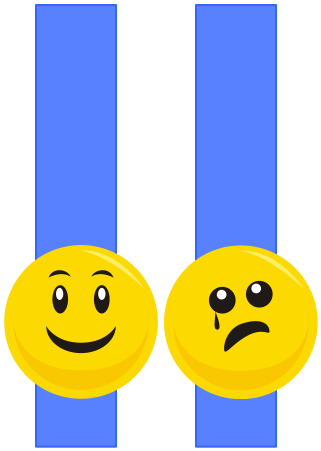
- Maximize $N_e$ of stocked cohorts = greater ability to maintain genetic diversity

# Consideration 3: Inbreeding and Outbreeding

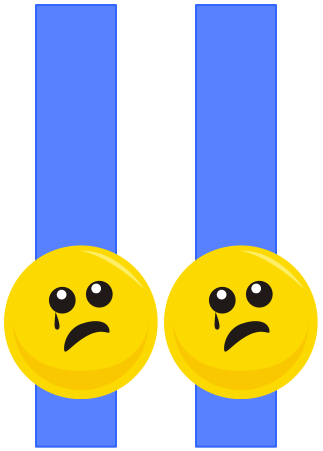
- Inbreeding depression
  - Expression of deleterious alleles leads to low fitness
- Introgression/outbreeding depression
  - Mixing two very different genomes leads to lowered fitness

# Inbreeding depression decreases individual fitness

Two potential causes:
1) Shielding of lethal alleles

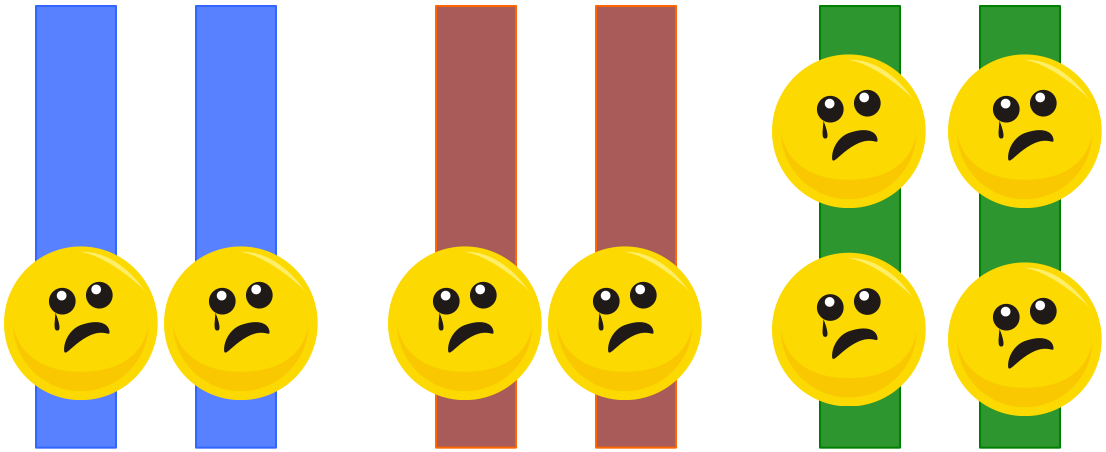


Organism is ok, recessive allele **not** expressed



Organism not ok, recessive allele is expressed

2) Accumulation of many mildly deleterious recessive alleles across loci

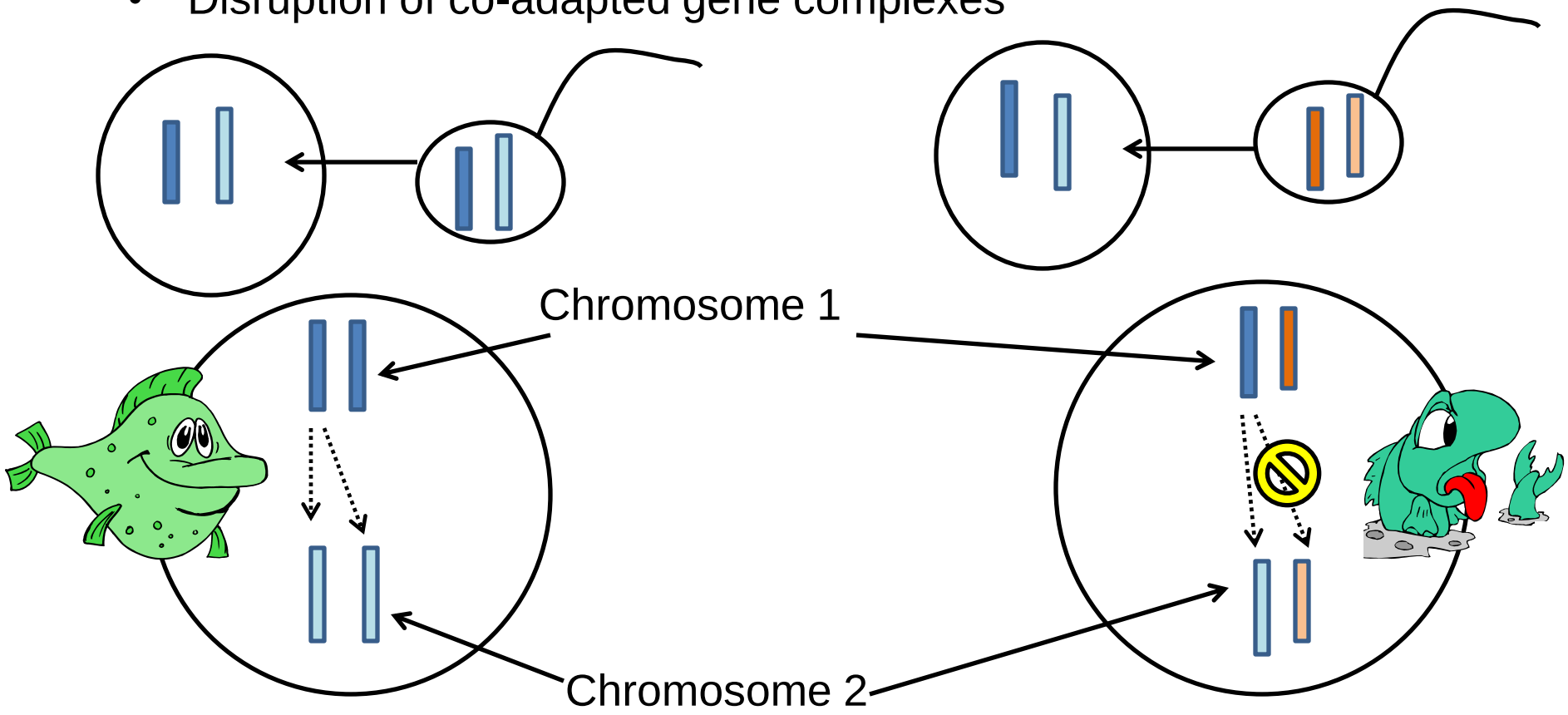


Low fitness

# Gene flow between populations that are too differentiated can lead to outbreeding depression.

Outbreeding depression can be caused by:

- Introduction of maladaptive alleles
- Disruption of co-adapted gene complexes



# Supplementation should minimize inbreeding and outbreeding

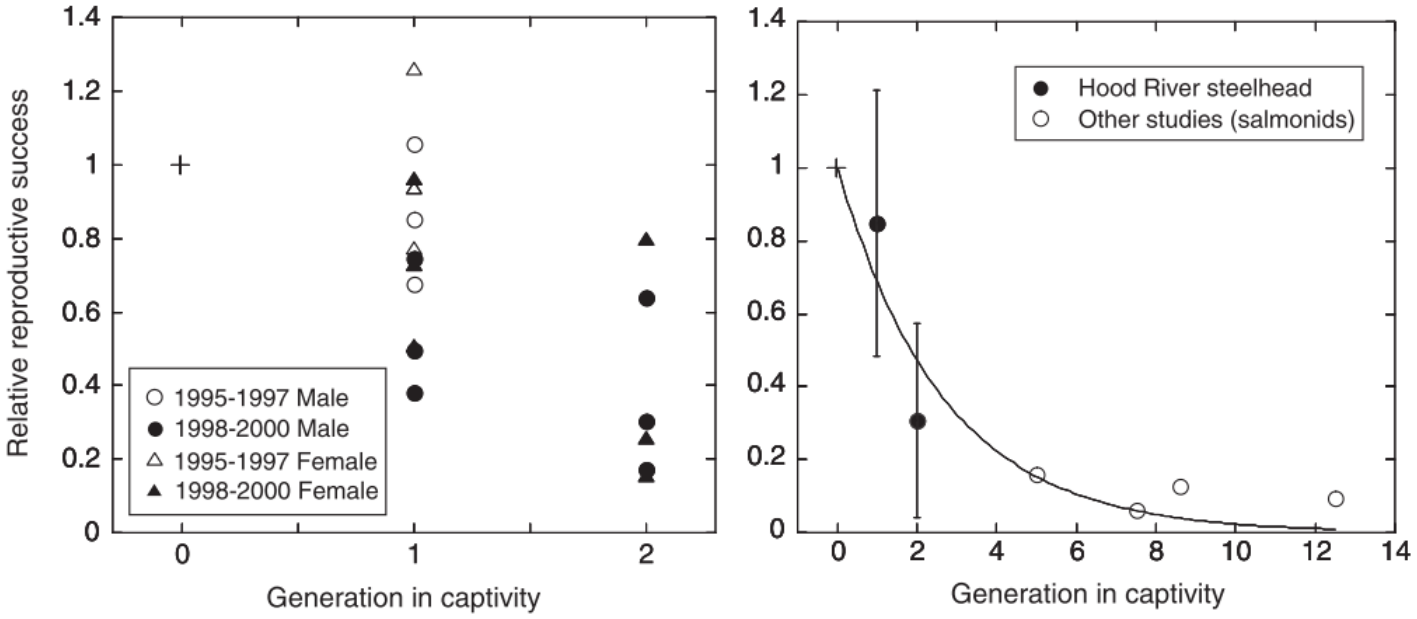
- Don’t mate close relatives
- More families means less chance for inbreeding at adulthood
- Select broodstock or larval sources that are genetically similar to recipient population

# Consideration 4: Domestication

- Reduction in fitness due to “soft” selection
- Artificial selection pressures

# Salmonid studies have shown evidence of domestication.

- **Araki et al. (2007):** Unintentional selection within hatcheries reduces fitness



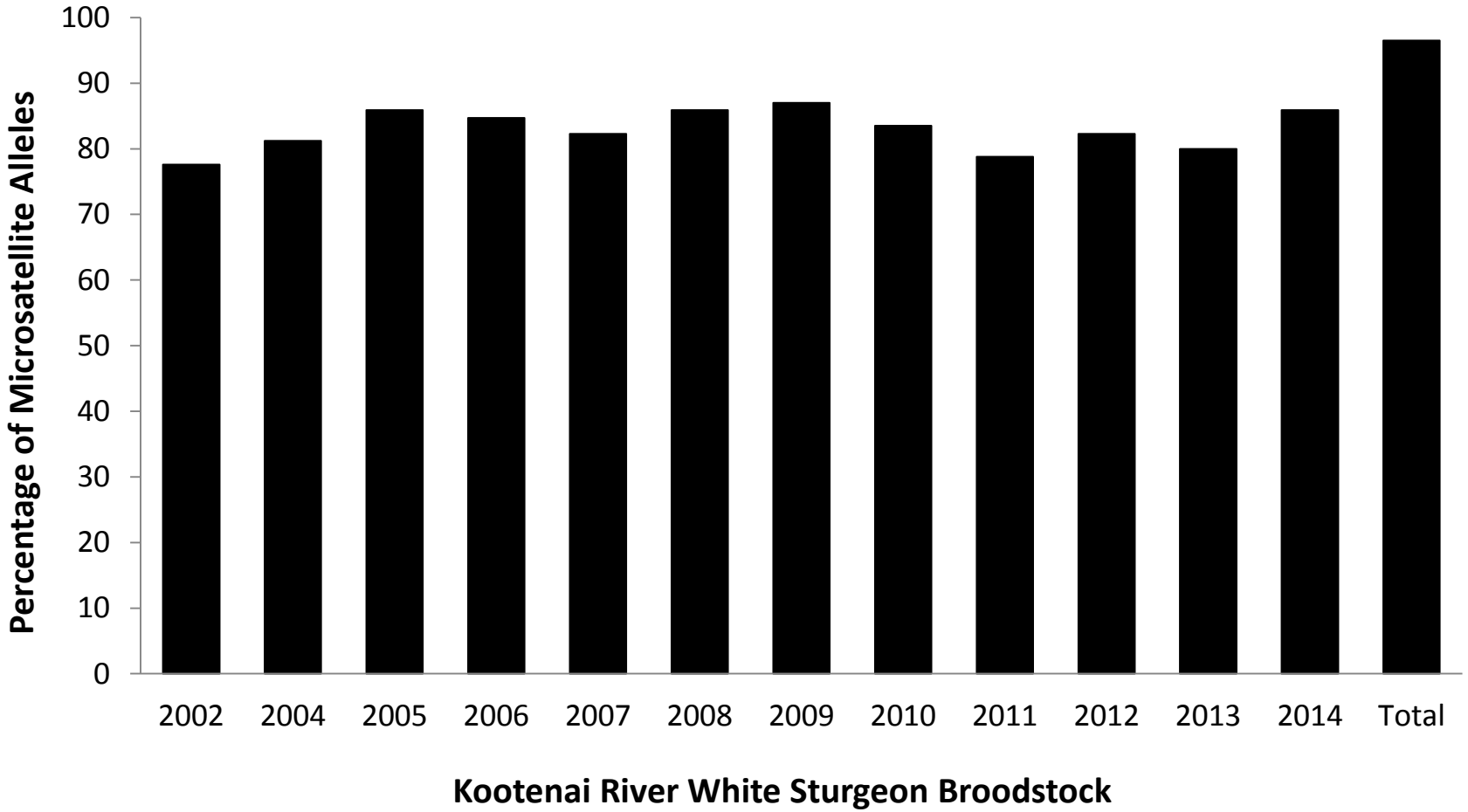

Reproduced from Science 318:100-103

# Supplementation strategies can minimize domestication

- Wild sources of broodstock or larvae
- Random sampling

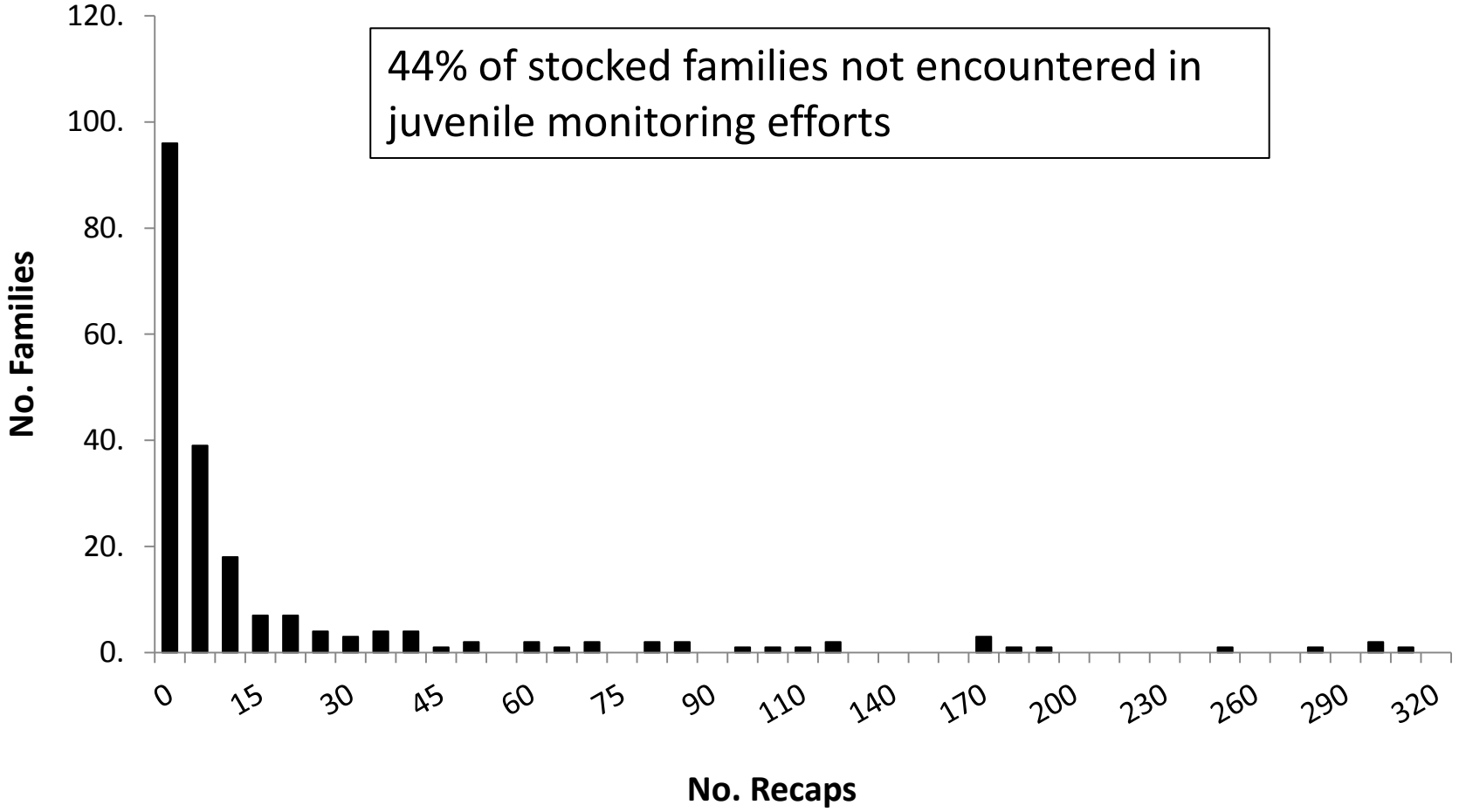
# Maximizing Genetic Diversity in Sturgeon Supplementation


# Stock over multiple years using unique parents each year



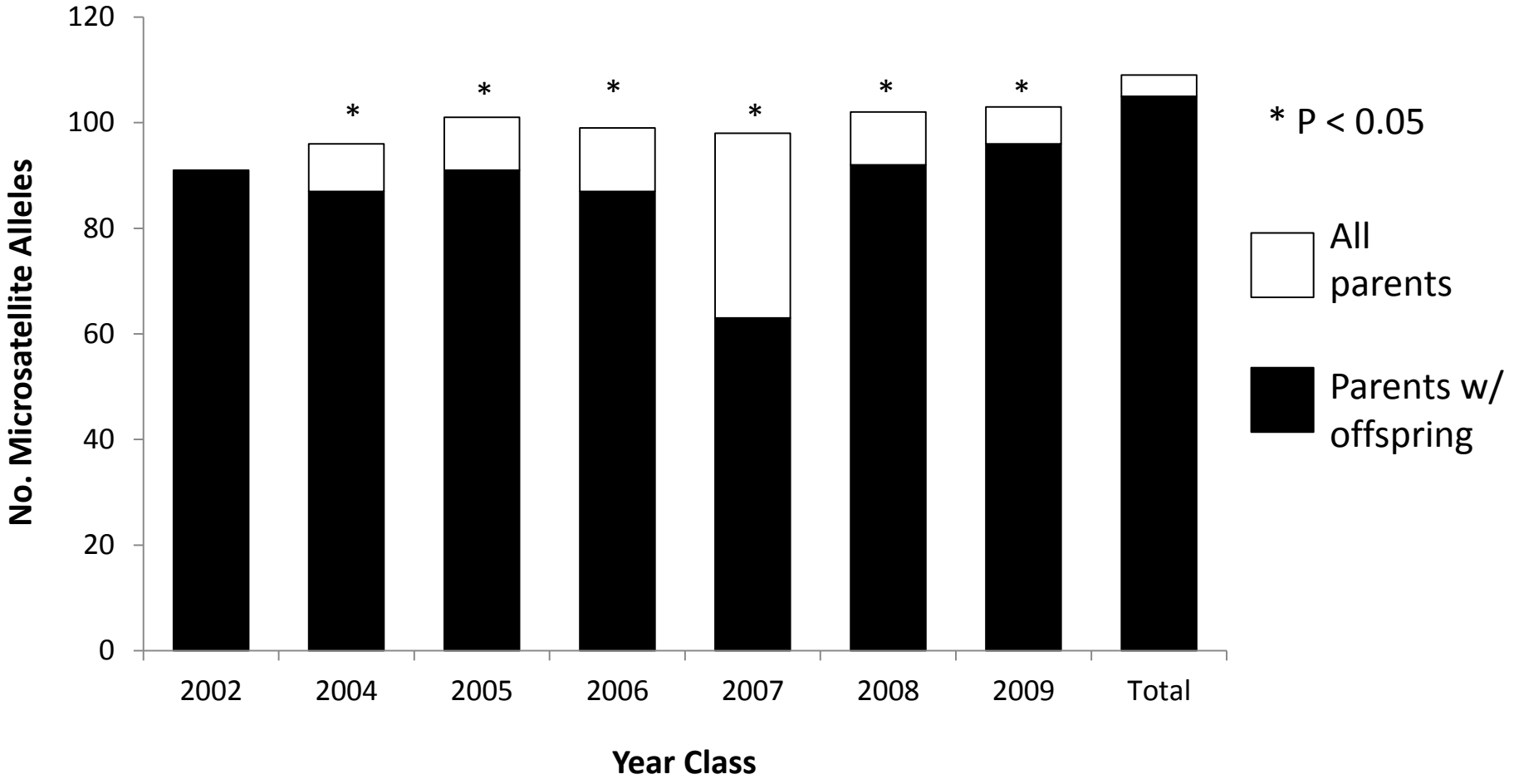

Drauch Schreier et al (2012); Schreier unpubl data

# Minimize post-release mortality




Schreier et al (2015) Biological Conservation

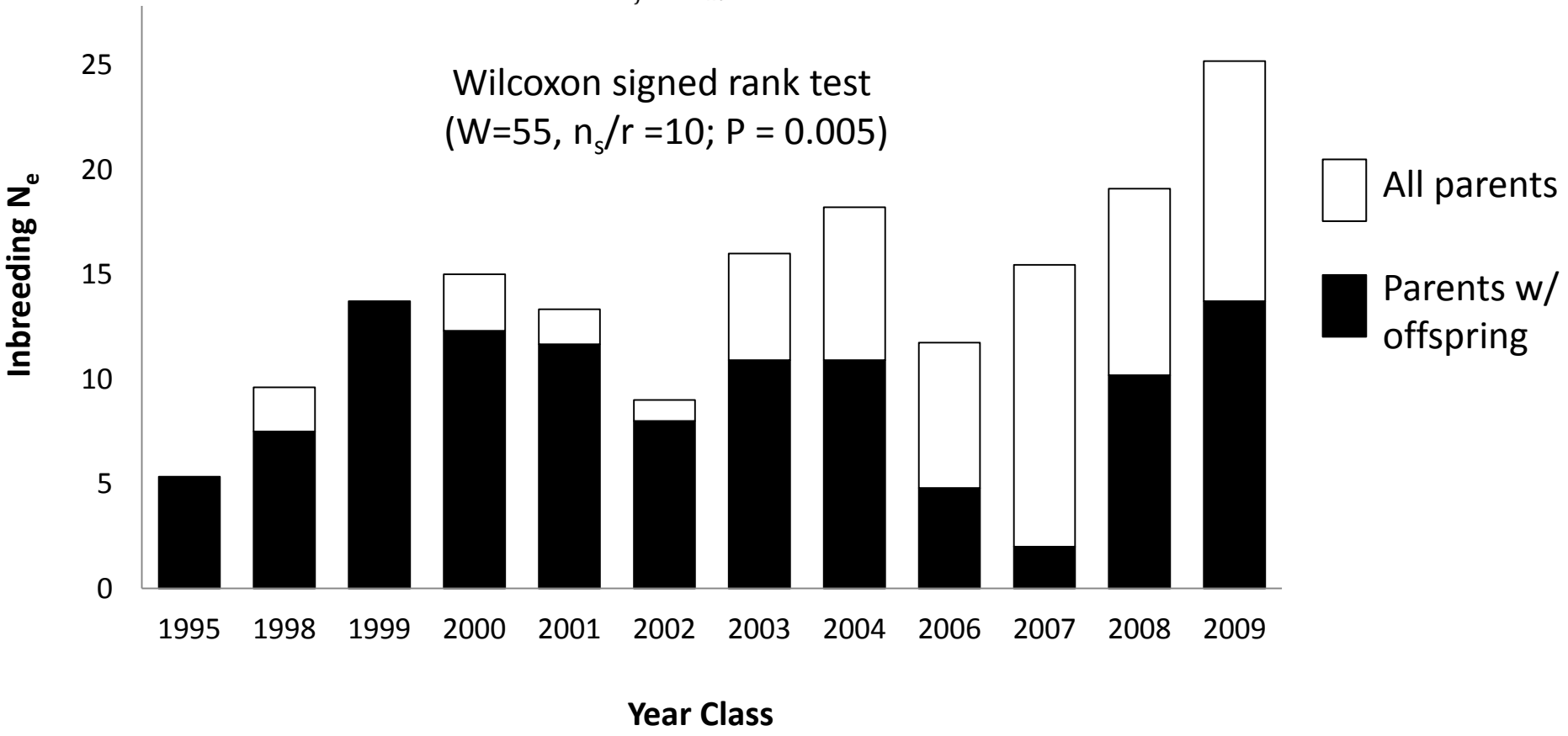
# Post-release mortality reduces genetic diversity preservation




Schreier et al (2015) Biological Conservation

# Post release mortality significantly reduces $N_e$

$$N_e = \frac{4NfNm}{N_f + N_m}$$




Schreier et al (2015) Biological Conservation

# Broodstock or Larvae?

- Strategy 1: spawn (wild) adults in captivity, stock offspring

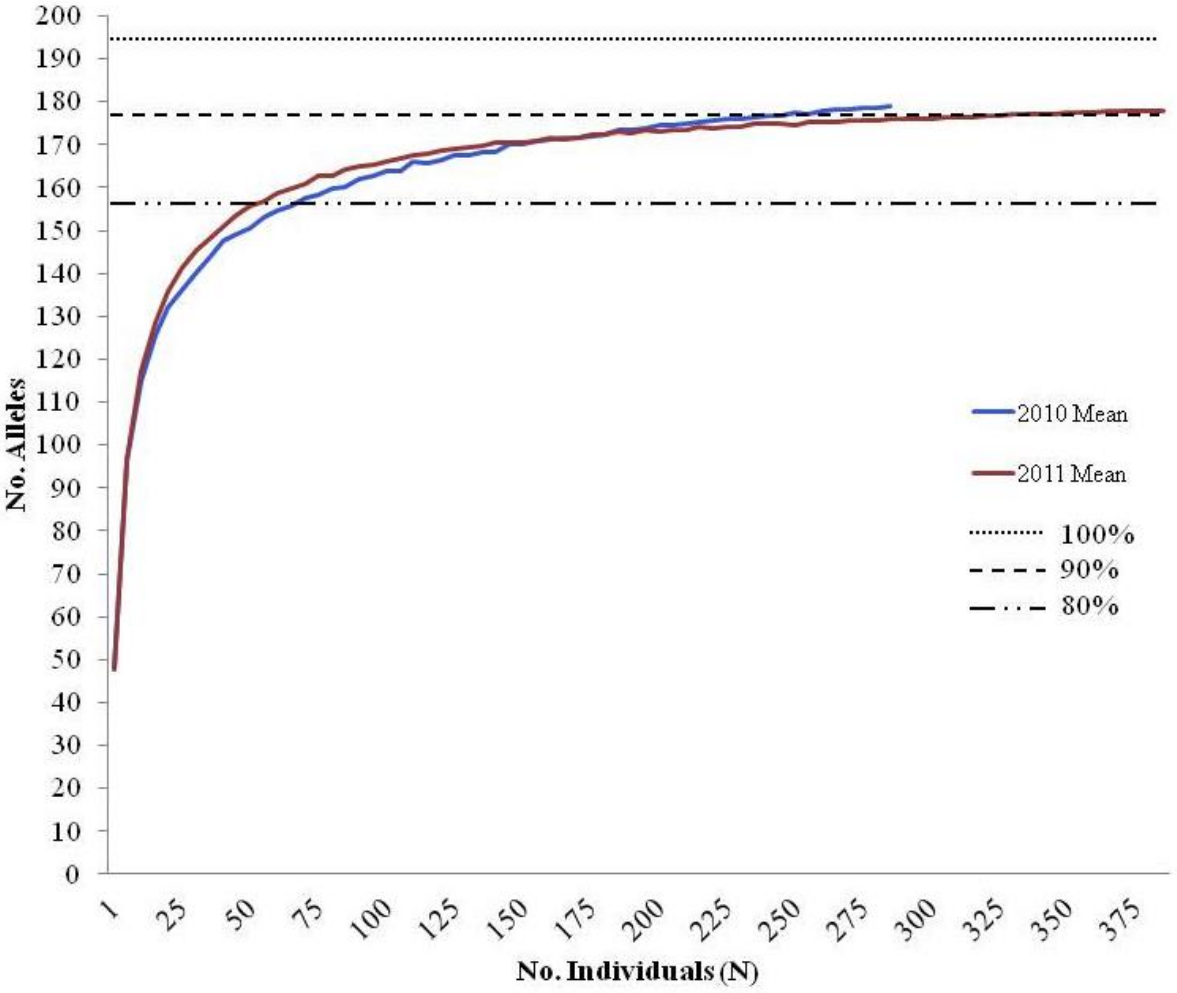
- Strategy 2: collect larvae from wild environment, rear in captivity, stock

# Comparison of strategies in Upper Columbia

| Program | $N_T$ | $N_G$ | No. Alleles |
|---|---|---|---|
| $BC_{01}$ | 3 | 3 | 78 |
| $BC_{02}$* | NA | NA | NA |
| $BC_{03}$ | 6 | 6 | 96 |
| $BC_{04}$ | 6 | 6 | 99 |
| $BC_{05}$ | 8 | 5 | 95 |
| $BC_{06}$ | 16 | 14 | 114 |
| $BC_{07}$ | 11 | 11 | 120 |
| $BC_{08}$ | 14 | 14 | 118 |
| $BC_{09}$ | 21 | 21 | 132 |
| $BC_{10}$ | 15 | 15 | 121 |
| $Rp_{10}$ | 522 | 285 | 180 |
| $Rp_{11}$ | 500 | 383 | 179 |
| $BC+Rp_{10}$ | 537 | 300 | 180 |

# How many larval sturgeon needed?

Rate of Genetic Diversity Accumulation in 2010 and 2011 Repatriation



# Other Advantages of Repatriation

- Repatriation allows possibility of natural reproduction (more parents)
- Less risk of unintentional selection in broodstock handling
- Preserves natural mate choice behaviors

# Spontaneous Autopolyploidy

- Polyploidy = >2 sets of chromosomes
- Autopolyploidy = genome duplication within species
- Spontaneous autopolyploidy = spurious formation of autopolyploids

# Sturgeon are ancient polyploids.

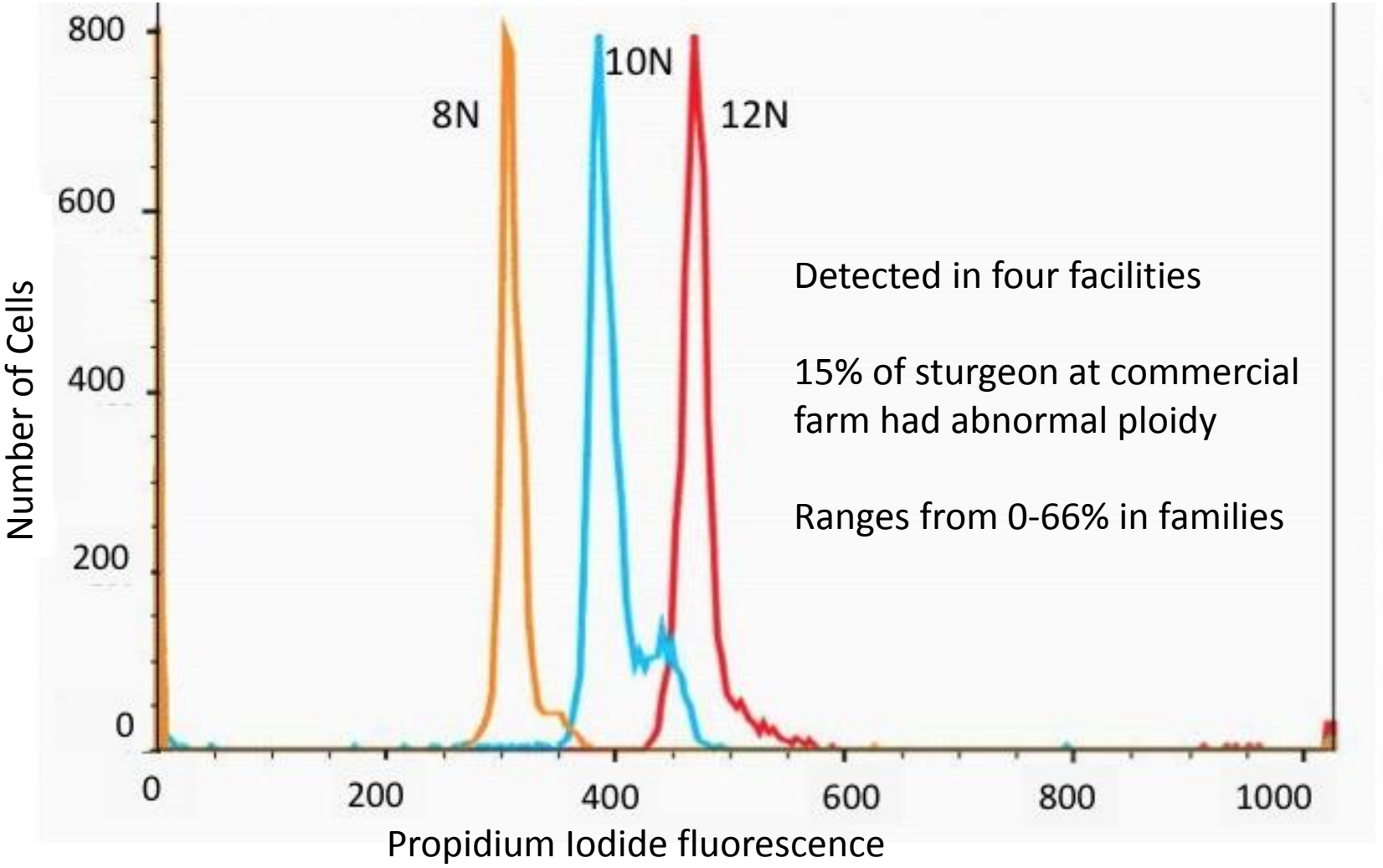
Group A: 120 chromosomes (tetraploid)

Group B: ~240 chromosomes (octoploid)

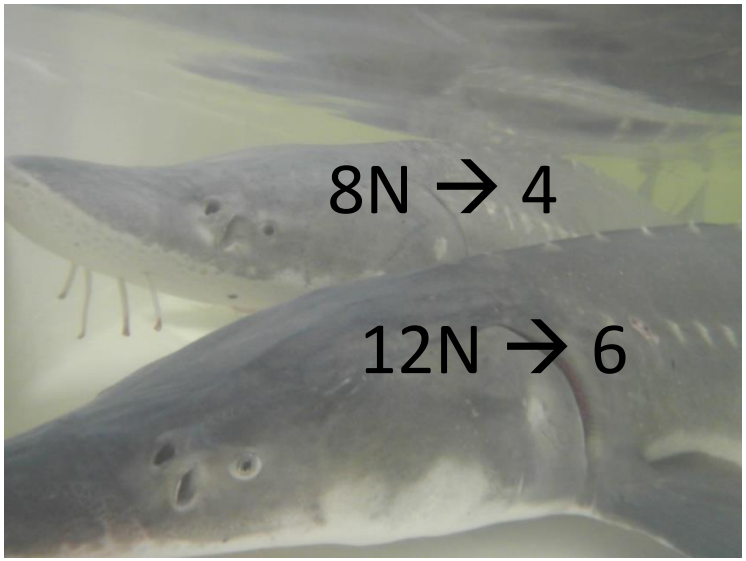
Group C: 360 chromosomes (dodecaploid)

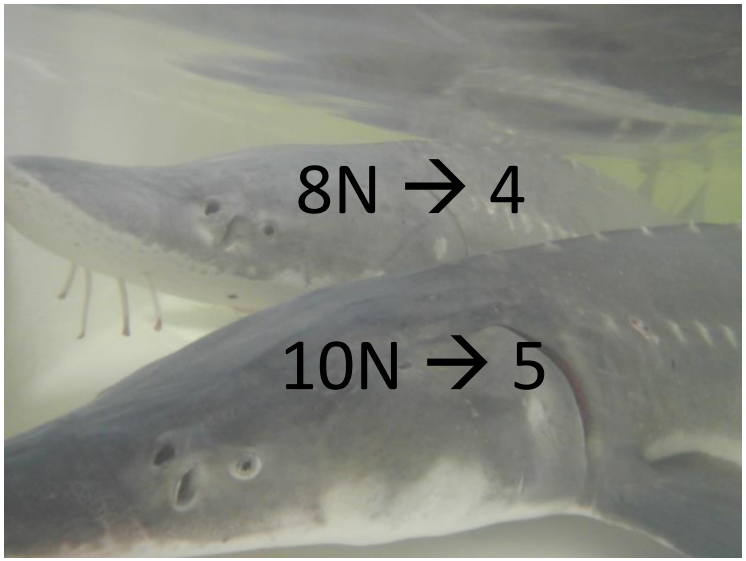
White sturgeon are evolutionary octoploids (2x=8N)

# Three ploidy classes have been detected at white sturgeon culture facilities.



# Implications

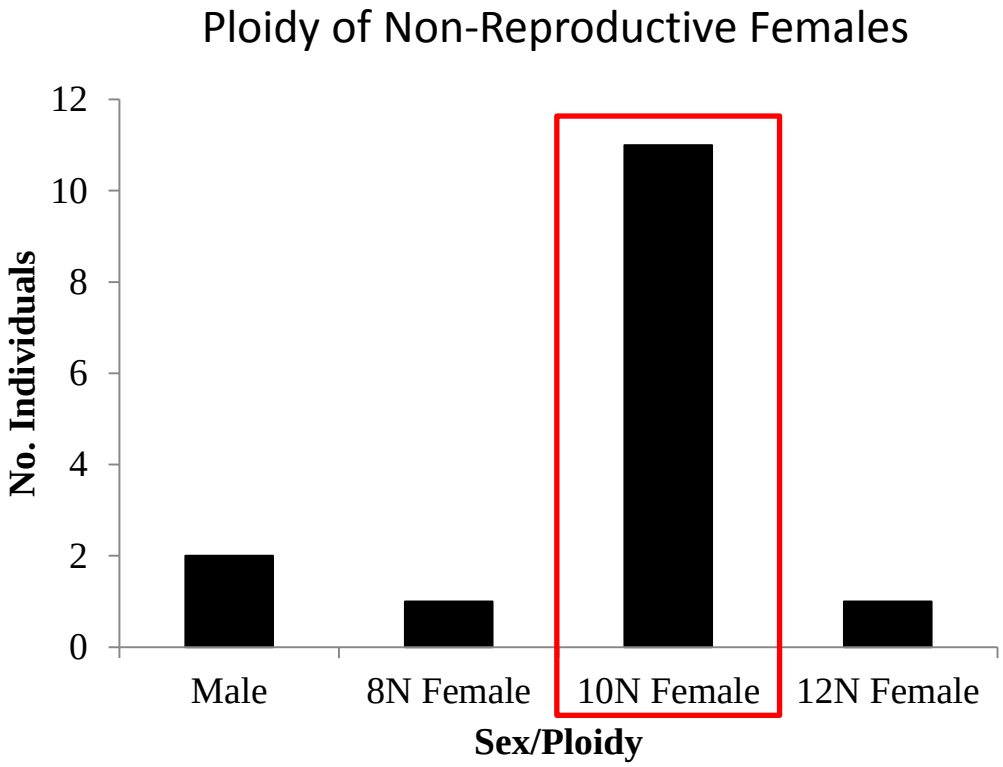




# How might spontaneous autopolyploids affect the supplementation programs?

- 10N progeny of 8N x 12N crosses may have reproductive impairments



# Minimizing spontaneous autopolyploidy

- Use larvae

- Screen families before release

# Acknowledgements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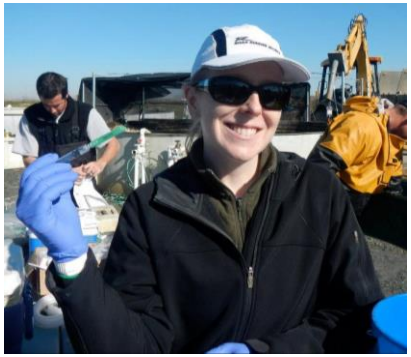


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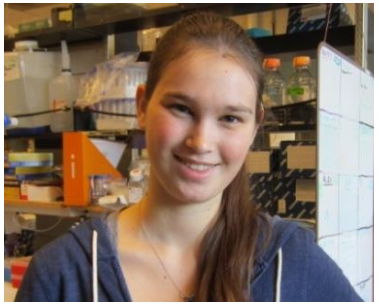

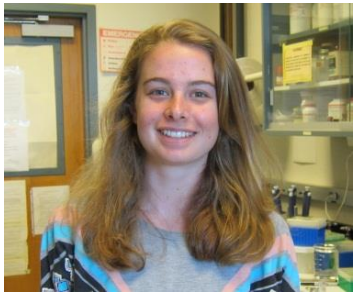

# $N_e$ doesn't work for all species.

- $N_e$ methods assume the population has no overlapping generations

- $N_b$ = Number of breeders/generation

$N_e = 4N_b$ when iteroparity low