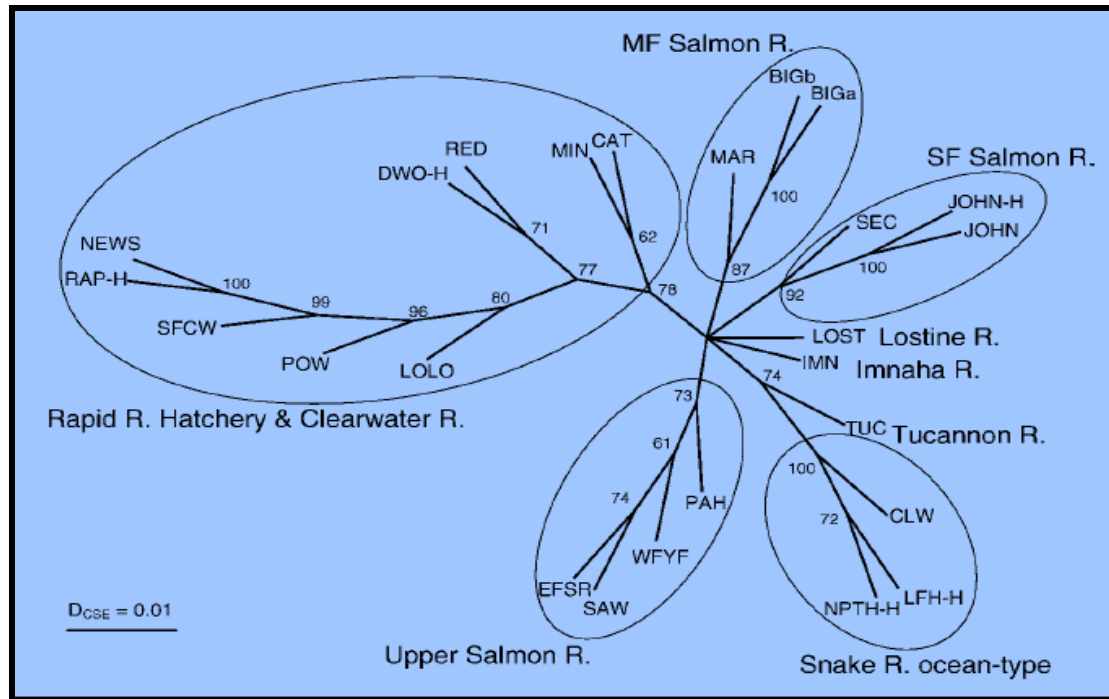


Population Genetics



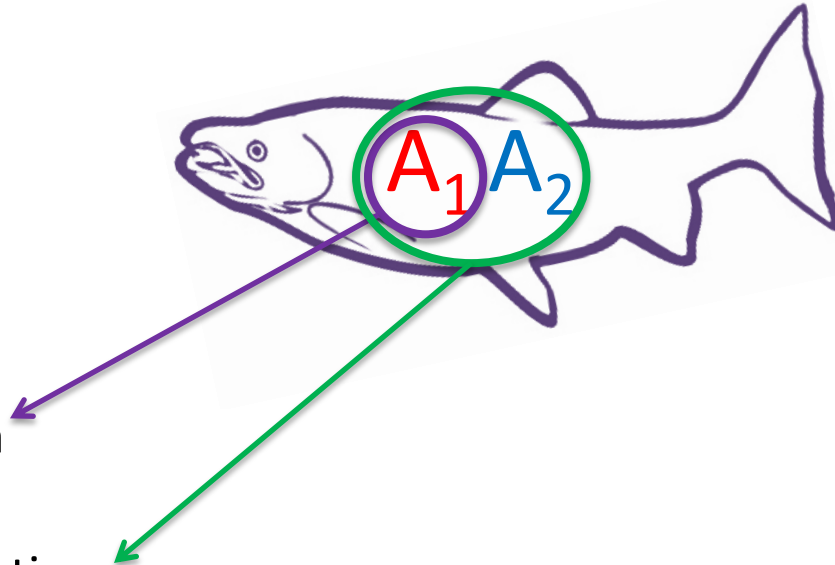
Ben Hecht
 CRITFC Genetics Training
 February 7, 2012

Population Genetics

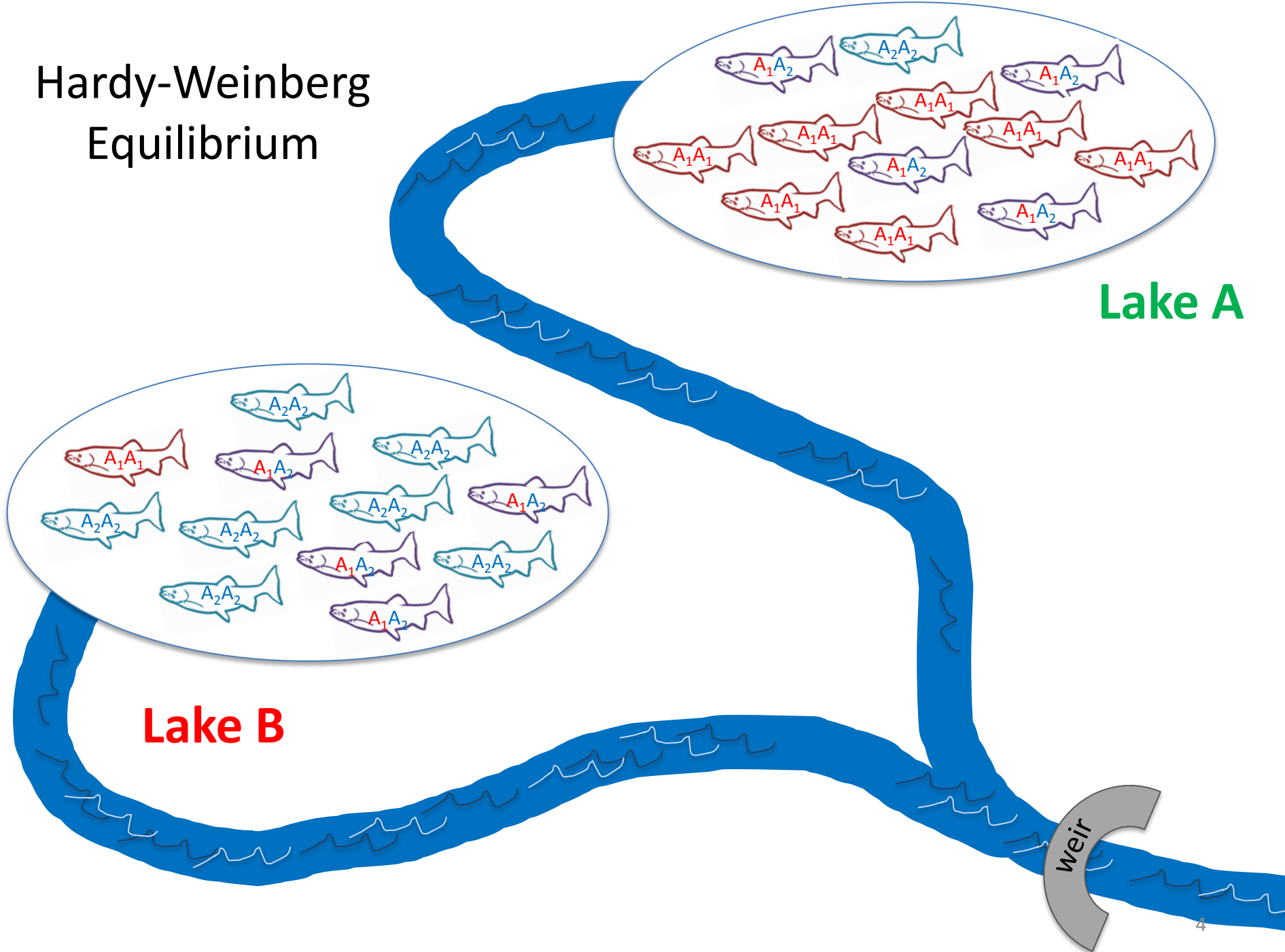
- “Population genetics is the study of the frequency and interaction of alleles and genes in populations” – John Postlethwait, (2009). *Modern Biology*
- Hardy-Weinberg Equilibrium (HWE)
- Genetic Diversity (H_e)
- Genetic Distance (F_{ST})

Hardy-Weinberg Equilibrium (HWE)

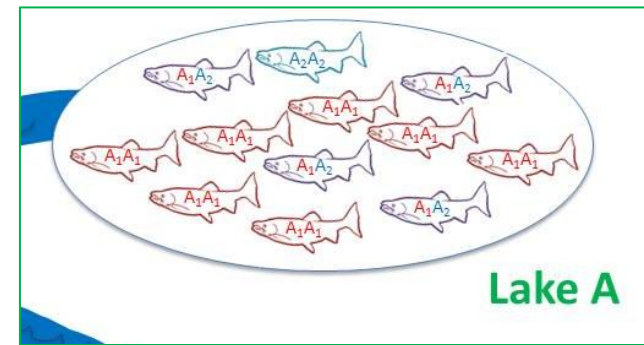
- Allele and genotype frequencies in a population remain constant from generation to generation
- HWE Assumptions
 1. Large population size
 2. Random mating
 3. No mutation
 4. No migration
 5. No natural selection
- **Allele** frequency equation
 - $p + q = 1$
- **Genotype** frequency equation
 - $p^2 + 2pq + q^2 = 1$
- Provides a baseline to test hypotheses against






Hardy-Weinberg Equilibrium



Hardy-Weinberg Equilibrium



Genotype				total
Observed	7	4	1	12
Expected	6.75	4.5	0.75	12

Calculate allele frequencies p and q from observed data

$$p = \frac{(2(A_1A_1) + (A_1A_2))}{2((A_1A_1) + (A_1A_2) + (A_2A_2))} = \frac{(2(7) + (4))}{2((7) + (4) + (1))} = 0.75$$

$$q = (1 - p) = (1 - (0.75)) = 0.25$$

Calculate Hardy Weinberg expectation for genotype frequencies

$$p^2 = A_1A_1 = (0.75)^2 \times 12 = 6.75$$

$$2(p)(q) = A_1A_2 = 2(0.75)(0.25) \times 12 = 4.5$$

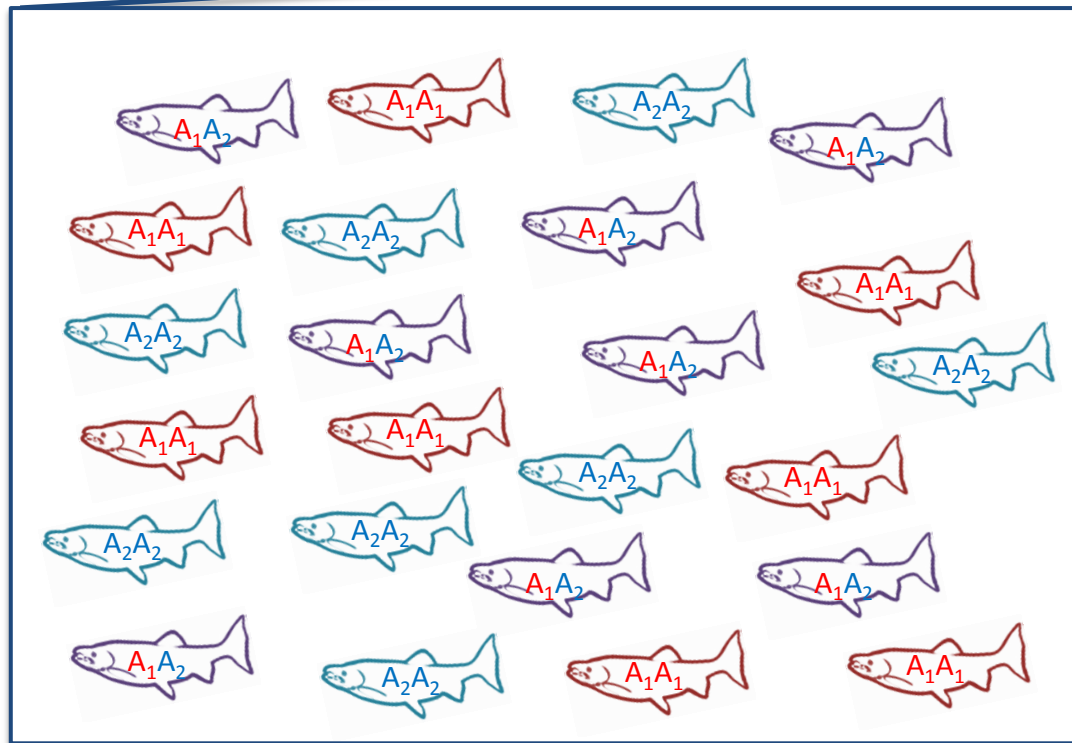
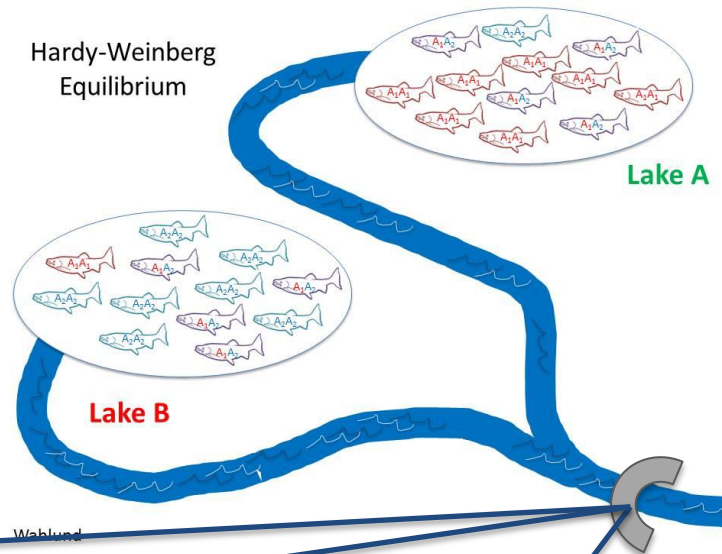
$$q^2 = A_2A_2 = (0.25)^2 \times 12 = 0.75$$

Compare HWE_O to HWE_E
 $HWE_O = HWE_E$

Conclusion:
 In equilibrium

		p	q	A ₁ A ₁	A ₁ A ₂	A ₂ A ₂	conclusion
Lake A	Observed	0.75	0.25	7	4	1	in HWE
	Expected	-	-	6.75	4.5	0.75	
Lake B	Observed	0.25	0.75	1	4	7	in HWE
	Expected	-	-	0.75	4.5	6.75	
Weir	Observed	0.5	0.5	8	8	8	out of HWE
	Expected	-	-	6	12	6	

Hardy-Weinberg Equilibrium



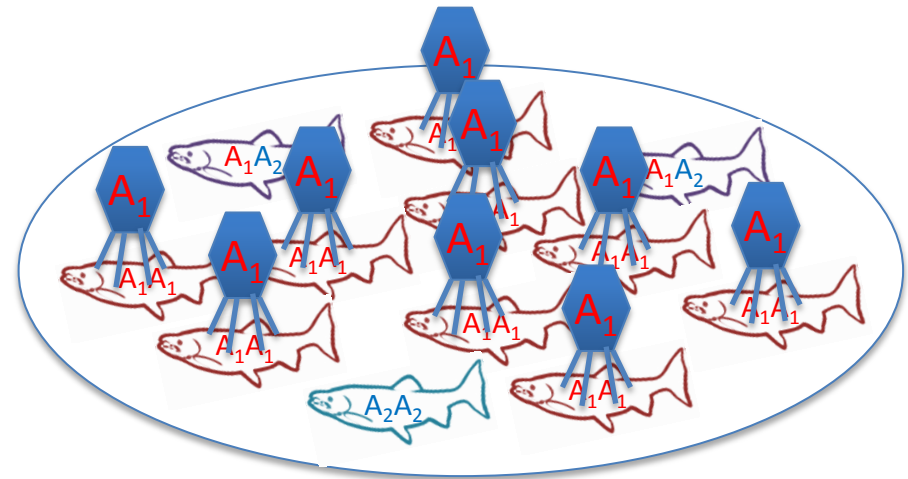
Wahlund Effect

Genetic Diversity (H_e)

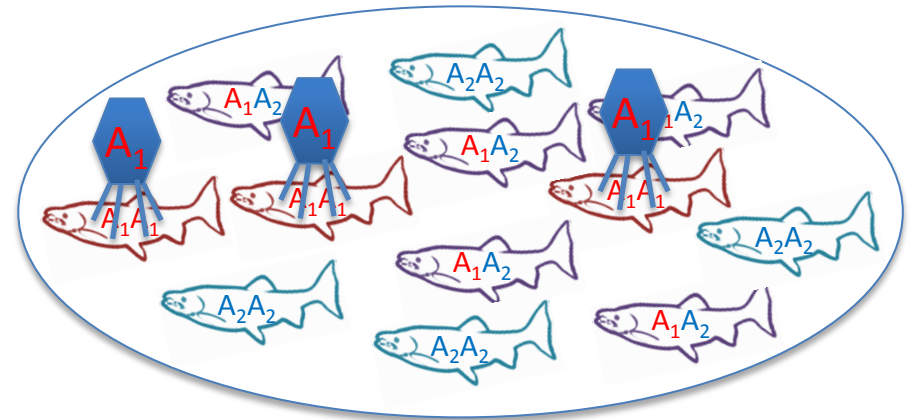
- A measure of variation across the genome
- Genetic variation allows populations to adapt to changing environments
- Measured by estimating heterozygosity (H_e)
 - number of heterozygous (A_1A_2) individuals in a population

Genetic Diversity

- Populations with more diversity can adapt to changing environments
- Populations with low variation may not contain genetic material required to adapt



Low diversity



High diversity

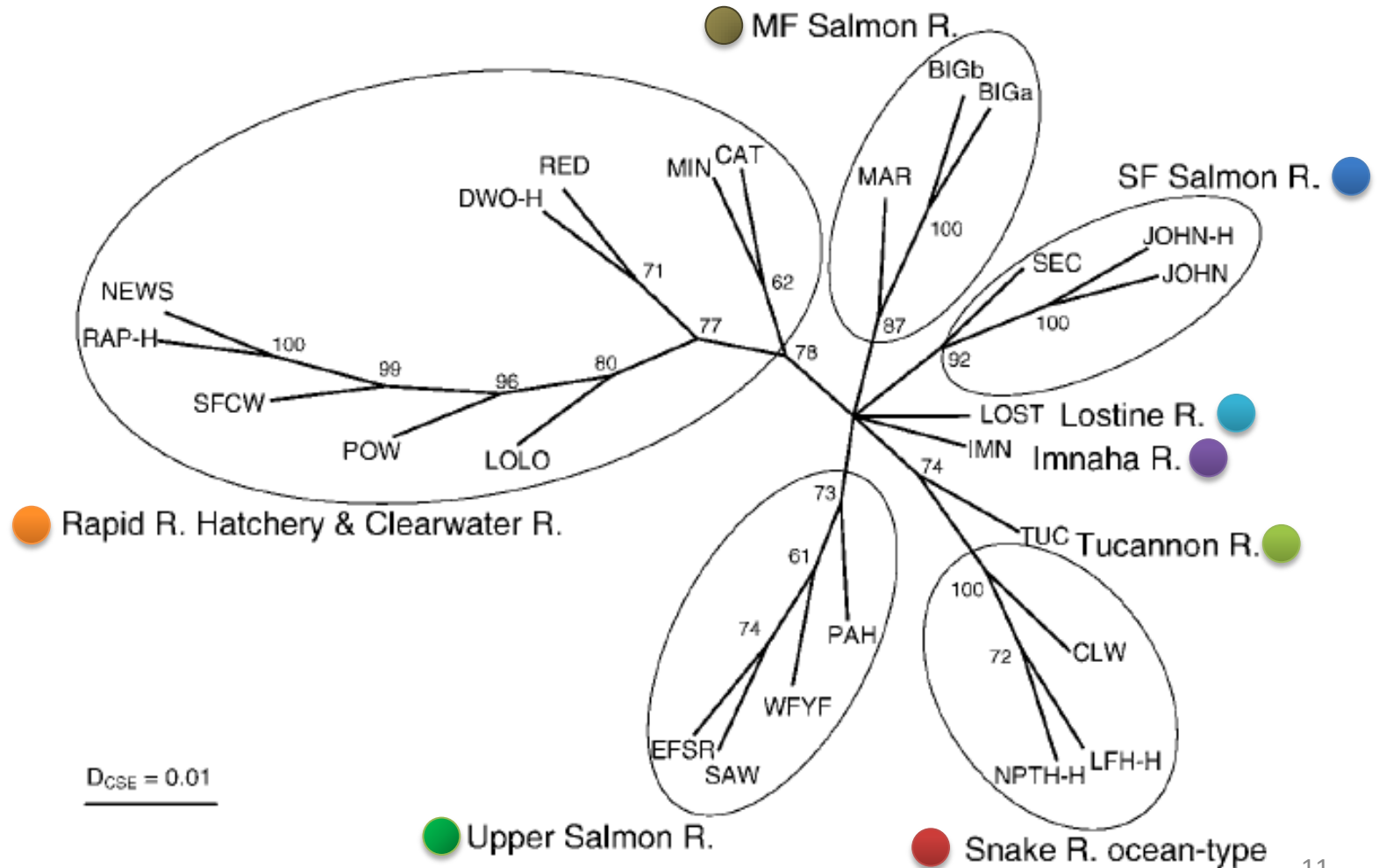
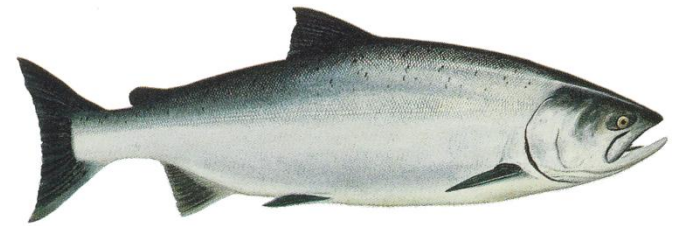
Genetic Diversity

- Low genetic diversity could be caused by:
 - Small population size (drift/bottleneck)
 - Inbreeding
 - Natural Selection

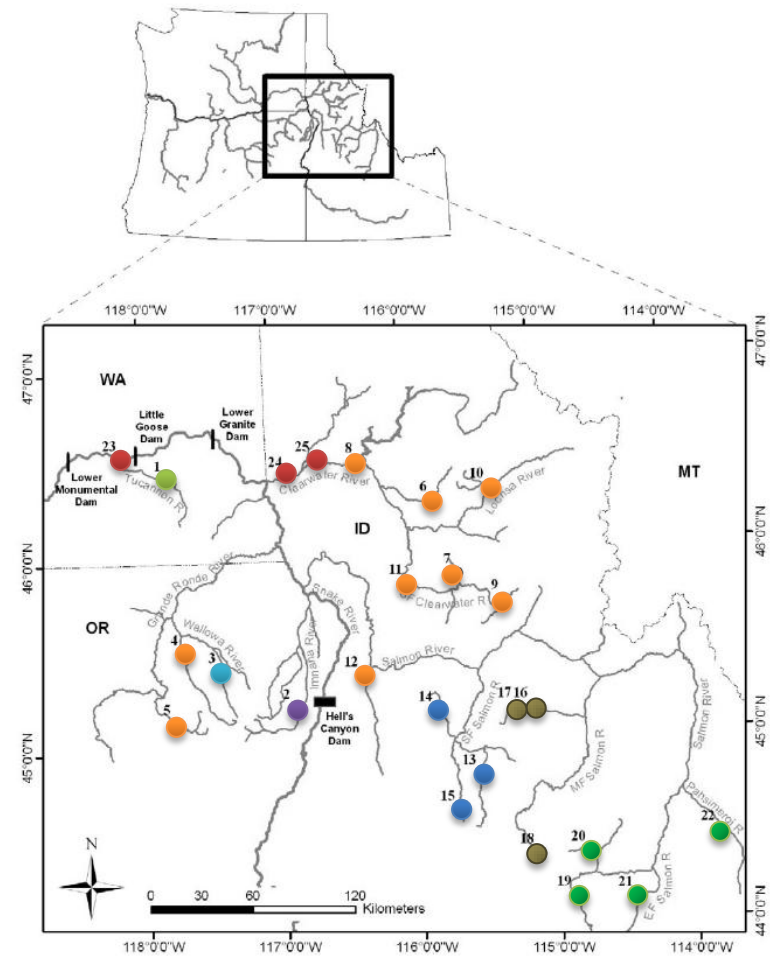
Genetic Distance (F_{ST})

- The level of genetic divergence/similarity between populations
 - High levels suggest divergence (distant relationship/isolation)
 - Low levels suggest similarity (close relationship/gene flow)
- Divergence is due to allele frequency differences among populations
- F_{ST} = fixation index

Genetic Distance



Genetic Distance



Population ● TUC ● IMN ● LOST ● RAP ● SFSR ● MFSR ● UPSR ● Ocean-type

● TUC	na								
● IMN	0.033	na							
● LOST	0.040	0.033	na						
● RAP	0.030	0.017	0.033	0.006					
● SFSR	0.036	0.020	0.041	0.021	0.010				
● MFSR	0.043	0.022	0.045	0.033	0.027	0.020			
● UPSR	0.039	0.021	0.038	0.021	0.023	0.031	0.017		
● Ocean-type	0.083	0.101	0.113	0.095	0.098	0.110	0.103	0.001	

Questions?

