

# Identification of adaptive genetic variation and application to management in rainbow trout/steelhead

## Part 2

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# Adaptive Genetic Variation

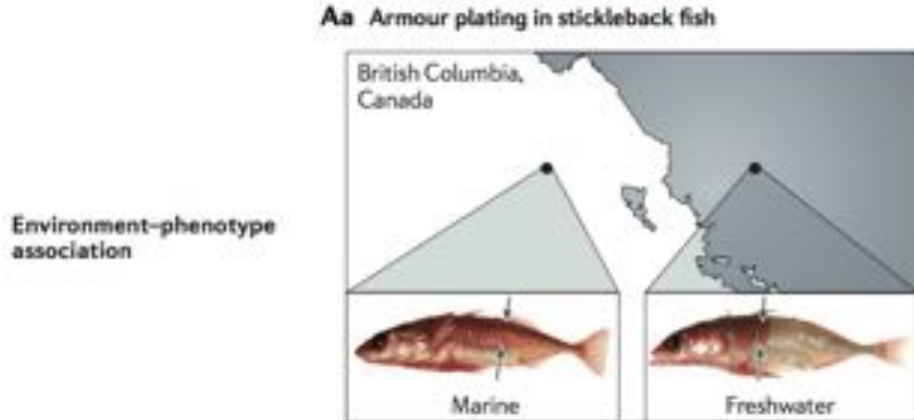
...adaptation is characterized by the movement of a population towards a phenotype that best fits the present environment (Orr 2005)



May require a lot of evidence, so model organisms!

# Adaptive Genetic Variation

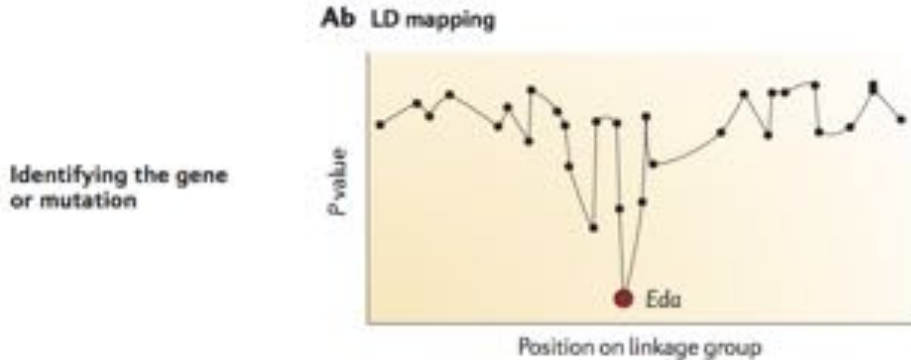
Genetic variation that is under natural selection (Holderegger et al. 2006, Barrett and Hoekstra 2011)



Is variation adaptive if it affects a reasonable phenotype?

# Adaptive Genetic Variation

Genetic variation that is under natural selection (Holderegger et al. 2006, Barrett and Hoekstra 2011)



Is variation adaptive if there is evidence of positive selection?

# Adaptive Genetic Variation

Genetic variation that is under natural selection (Holderegger et al. 2006, Barrett and Hoekstra 2011)

**Ac Gain-of-function**

**Test of gene function**



Low morph

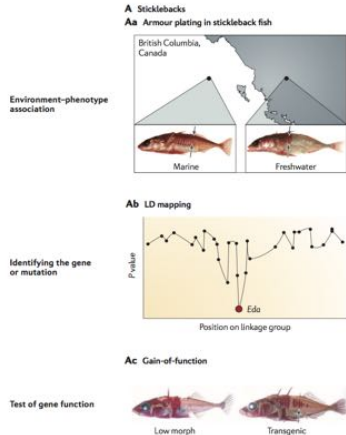


Transgenic

Can direct function be demonstrated?

# Adaptive Genetic Variation

Genetic variation that is under natural selection (Holderegger et al. 2006)



- ▶ Is variation adaptive if it affects a reasonable phenotype?
- ▶ Is variation adaptive if there is evidence of positive selection?
- ▶ For Rainbow Trout, we lack a direct test of function...

Barrett and Hoekstra (2011)

# Identifying Adaptive Genetic Variation in Rainbow Trout

Recall the different life history variants of Rainbow Trout?



- ▶ Rainbow Trout are highly valued for eating and fishing
- ▶ Rainbow Trout have repeatedly moved into situations preventing certain life histories
- ▶ "Knife-Edge Selection" - Northcote

# Identifying Adaptive Genetic Variation in Rainbow Trout

Another situation not favoring anadromy



- Generally, native lineages remain above and are most closely related to below dam fish



# Identifying Adaptive Genetic Variation in Rainbow Trout

Another situation not favoring anadromy

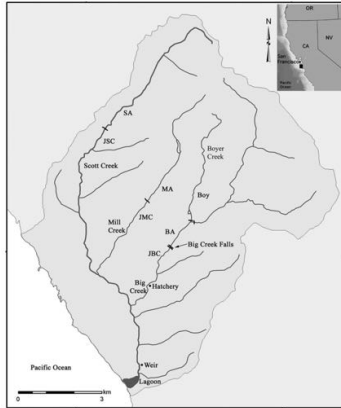


## Consequences

- ▶ Repeated isolation of mixed populations above barriers
- ▶ Both waterfalls and dams, they have different properties
- ▶ Does this affect Rainbow Trout genetics?

# Identifying Adaptive Genetic Variation in RT

## Case Study, Big Creek



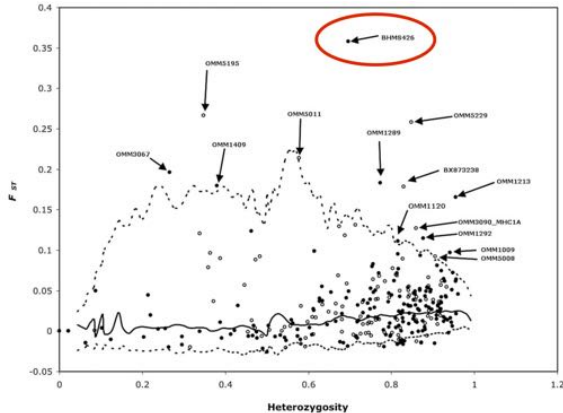
Pearse et al. (2009)

## Consequences in 100 years

- ▶ Historically fishless areas now have trout
- ▶ Trout are less diverse than mixed populations
- ▶ Trout ability to tolerate salt water / swim limited

# Identifying Adaptive Genetic Variation in RT

Case Study, Big Creek



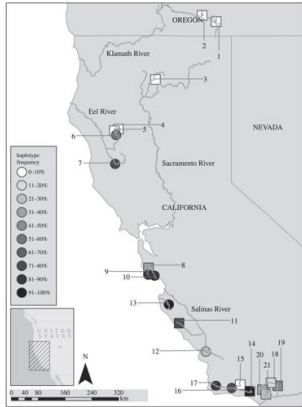
## Microsatellite Screen

- ▶ 363 microsatellites
- ▶ A few outlier loci detected
- ▶ A particular one sits on chromosome 5 (Omy5)

Martinez et al. (2011)

# Identifying Adaptive Genetic Variation in RT

In California

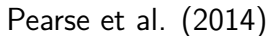


Pearse et al. (2014)

## SNP Study

- ▶ A linked set of loci on Omy05
- ▶ One haplotype was elevated in landlocked (resident) pops
- ▶ An alternative is elevated in below-barrier (mixed) pops

## Linkage



# Identifying Adaptive Genetic Variation in RT

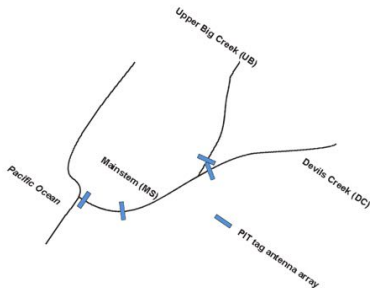
Circumstantial evidence

Recalling the stickleback examples, here we have a likely genetic association with a phenotype. Can we:

- ▶ 1. Demonstrate a direct association between genotype and phenotype?
- ▶ 2. Characterize the underlying genetic variation in terms of function?

# Identifying Adaptive Genetic Variation in RT

Do A or R genotypes behave differently?



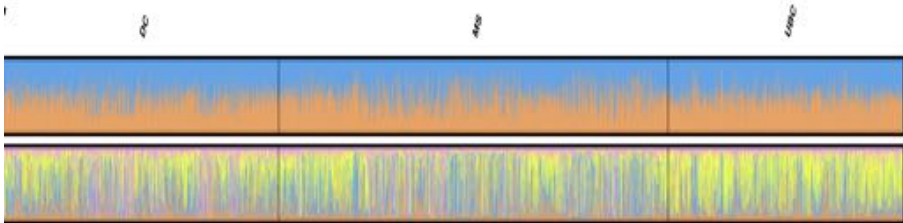
- ▶ Omy05 linked SNP determines genotype
- ▶ PIT tagging with antennae in the creek
- ▶ Data from 2010-2014

In Prep.

# Identifying Adaptive Genetic Variation in RT

No genetic structuring within study

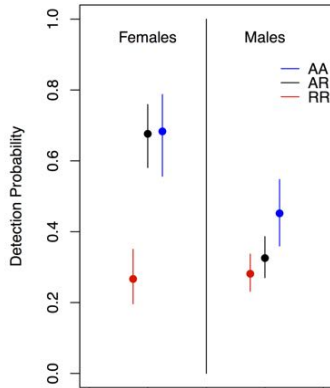
STRUCTURE K=2 and K=5





# Identifying Adaptive Genetic Variation in RT

What is A or R here in the genome?



In Prep.

## SNP Study

- ▶ Omy05 linked SNP determines genotype
- ▶ PIT tagging with antennae in the creek

# Enough evidence?

- ▶ Have I convinced you that the "A" and "R" haplotypes are associated with migration?
- ▶ Major Criticism: What exactly is the genomic basis of "A" and "R" types?