

Introduction

- Migration is defined as the seasonal movement of organisms for the purpose of survival or gaining a reproductive advantage.
- Controlled by Genetic and Environmental Factors
- Oncorhynchus mykiss exhibit partial migratory behavior
 - Rainbow trout are residential / non-migratory and spend their entire lives in Sashin Lake • Steelhead trout are migratory and migrate to the ocean, only returning to Sashin Stream to spawn
- Rainbow trout and Steelhead trout can successfully reproduce with each other • Migration is risky but comes with a reproductive advantage
- Access to marine resources increases trout fecundity, or maximum reproductive output Migratory populations are declining
 - Migrant offspring from resident parents my help counter this population decline (Barfuss, 2021)

The purpose of my research is to determine if these migrant offspring produced by resident parents are successfully returning to spawn.



Figure 1. Rainbow trout [Rainbow Trout], (n.d.)



Figure 2. Steelhead trout | NOAA Fisheries, (n.d.)



Figure 3. Clare (2021)

Methods

Objective 1: Confirm that the SNPs found by Barfuss (2021) exist in the research sample

- 1) DNA was extracted from 5 adult steelhead and 5 adult rainbow trout.
- 2) Whole genome sequencing and bioinformatic analysis was utilized to find SNPs between them.

Objective 2: Determine parental origin of migrants

- I) Extract DNA from 20 adult steelhead.
- 2) Design two versions of a forward primer one that binds better to the migrant version of the SNP, and one that binds better to the resident version of the SNP.
- 3) Conduct DMAS-qPCR on 25 total steelhead (20 new + 5 from whole genome sequencing) and determine which forward primer the DNA amplifies better with.
- 4) Analyze SNPs to determine parental origin.
- 5) Sex-type trout for further analysis as per procedure listed by Brunelli et al. (2008)



Figure 4. SNPs single nucleotide norphisms) are enetic differences in a DNA sequence.



Figure 5. DMAS-qPCR. If the sample has migrant parents, the DNA will amplify better with the migrant primer. This can be used with each sample to determine parental origin at each of the 8 SNPs.

There and Back Again: Using Whole Genome Sequencing to Identify the Genes **Associated with Migration Patterns in Rainbow Trout**

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Abstract: Migration, which is defined as the seasonal movement for survival or reproductive advantage such as rainbow trout, the Oncorhynchus mykiss come in two varieties: the migrants (steelhead trout), and the reasons is likely to be traced to their genetic makeup since there is a correlation between the migratory behavior of parents and their offspring. The primary objective of this research project is to identify single nucleotide polymorphisms (SNPs), or genetic differences, that are associated with migratory behavior in rainbow trout. These data were aligned to the trout genome and used to locate genetic differences between the SNPs and genotype them in a larger set of twenty-five migratory steelhead. Research findings suggest that Sashin Lake is producing smolts (young migratory steelhead) that are successfully returning to the stream to spawn. Additionally, while there wasn't a significant difference seen in terms of marine survival between the sexes, females were more likely to migrate in the first place compared to their male counterparts due to the reproductive advantage and greater access to resources that migration offers. This data will support future studies and will benefit conservation studies regarding population decline in migratory species.





Figure 6. The graph depicts the number of cycles it takes the sample DNA to be amplified with the lake primer vs with the stream primer. For example, the blue data points took less cycles to amplify DNA with the stream primer, indicating that these samples are from migrant parents. For all 8 SNPs, clear clustering patterns emerged.



Figure 7. 17 of the 25 migrant trout contained a majority Figure 8. The graph above shows that 19 of the 25 of stream SNPs, indicating that their parents were also steelhead, or 76%, were female. Previous research migrants. 15 of the 25 contained at least 75% of the confirmed that around the same ratio of outmigrating trout migrant SNPs. This is biologically justified since migratory were also female (Barfuss, 2021), meaning that females behavior is largely heritable, meaning that it has a strong are more likely to migrate than males, not just that males genetic component. Five of the migrant trout contained a are dying out at sea. This is evolutionarily justified since majority of lake SNPs, indicating that their parents females invest more into the reproductive process, and originated from the lake. Five of the migrant trout therefore having access to a wider array of resources contained around an even split of migrant and resident from the ocean increases female fecundity, or potential SNPs, indicating admixed origin. reproductive output.

DISCUSSION

- Research by Barfuss (2021) concluded that Sashin Lake is producing outmigrating smolts.
- nonmigratory parents.
- However, this research showed that the lake does produce migrants.
- This can contribute to limiting the population decline seen in migratory steelhead.
- applied to other declining migratory populations as well.

• This research project confirmed that these migrants are successfully returning to the stream to spawn. Migration is largely heritable, which is why most migrants have migrating parents and most nonmigratory fish have

Understanding this can support environmentalists and other conservatory efforts and, upon future research, can be



Future Studies

Experimental findings can be enhanced in future studies through:

- A larger sample size
- Testing more years for both outmigrating smolts and returning steelhead trout
- Testing more geographic locations to factor in the role of the environment, since this is important in broader conservation studies
- Looking at the number of resident offspring being produced by migrant parents

References

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