Exploring Variable Growth Rates in Captive Reared Razorback Suckers (*Xyrauchen texanus*) with Differential Gene Expression Analysis

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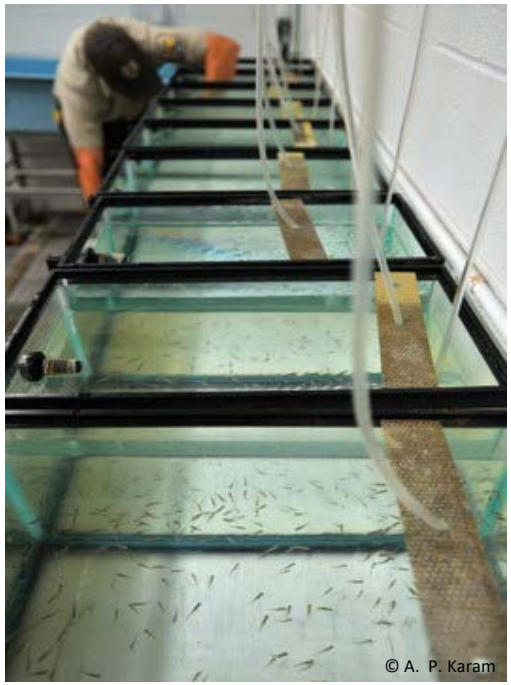
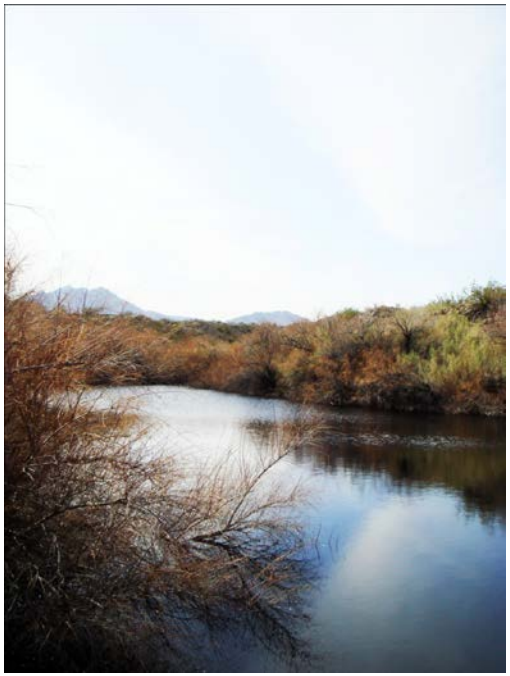
- In Lake Mohave, larvae captured and reared in captivity to avoid predation
  - Includes a combination of aquaria and ponds
- Razorback sucker have highly variable growth rates
  - Variation in growth rates can have impacts on conservation

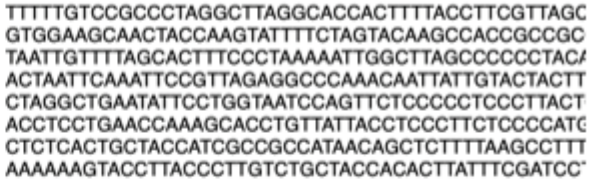




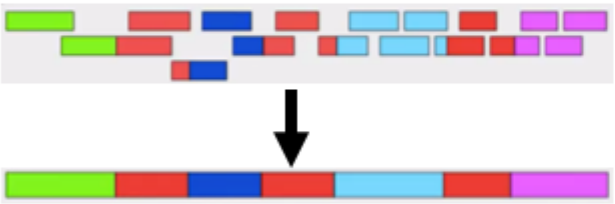
RNA Methods

RNA

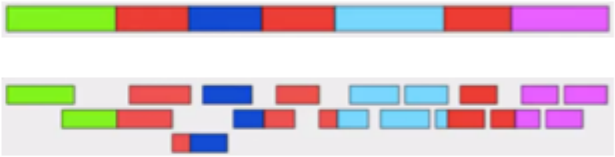
Illumina Sequencing



Millions of 150 Base Pair Reads



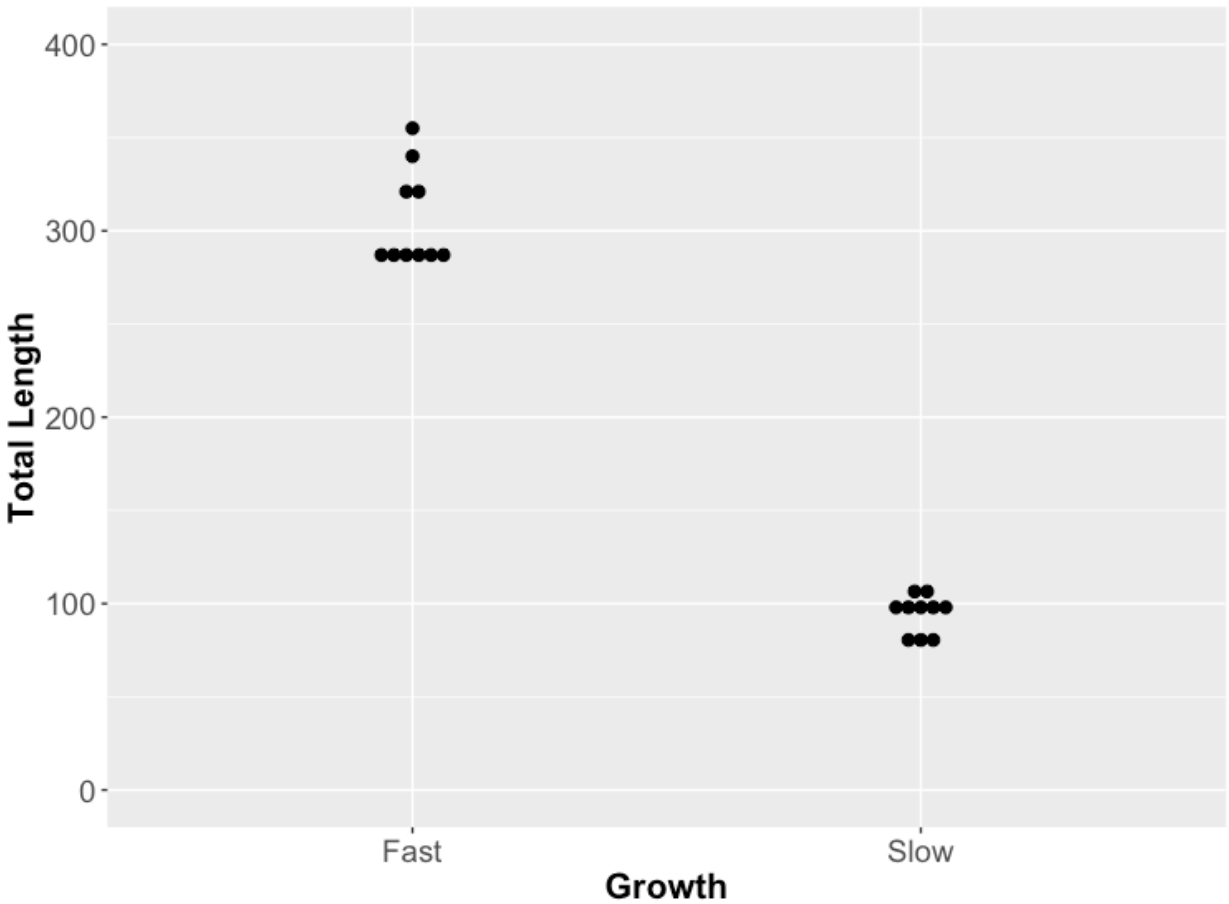
De novo Transcriptome Assembly



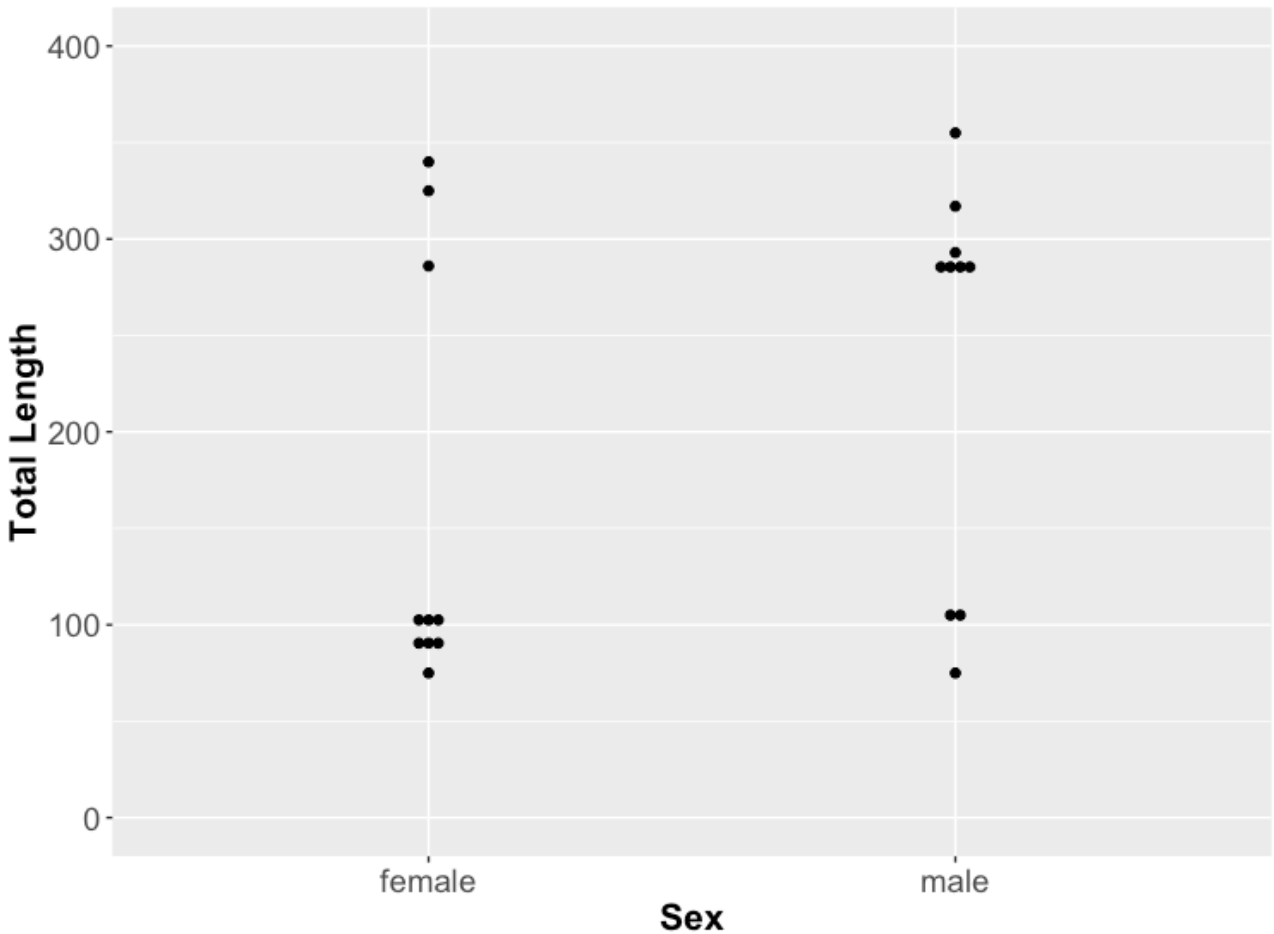
Map reads to specific genes to generate a per gene read counts for each fish

Test for expression differences between groups

Sampled 10 fast growing and 10 slow growing 1 yr olds

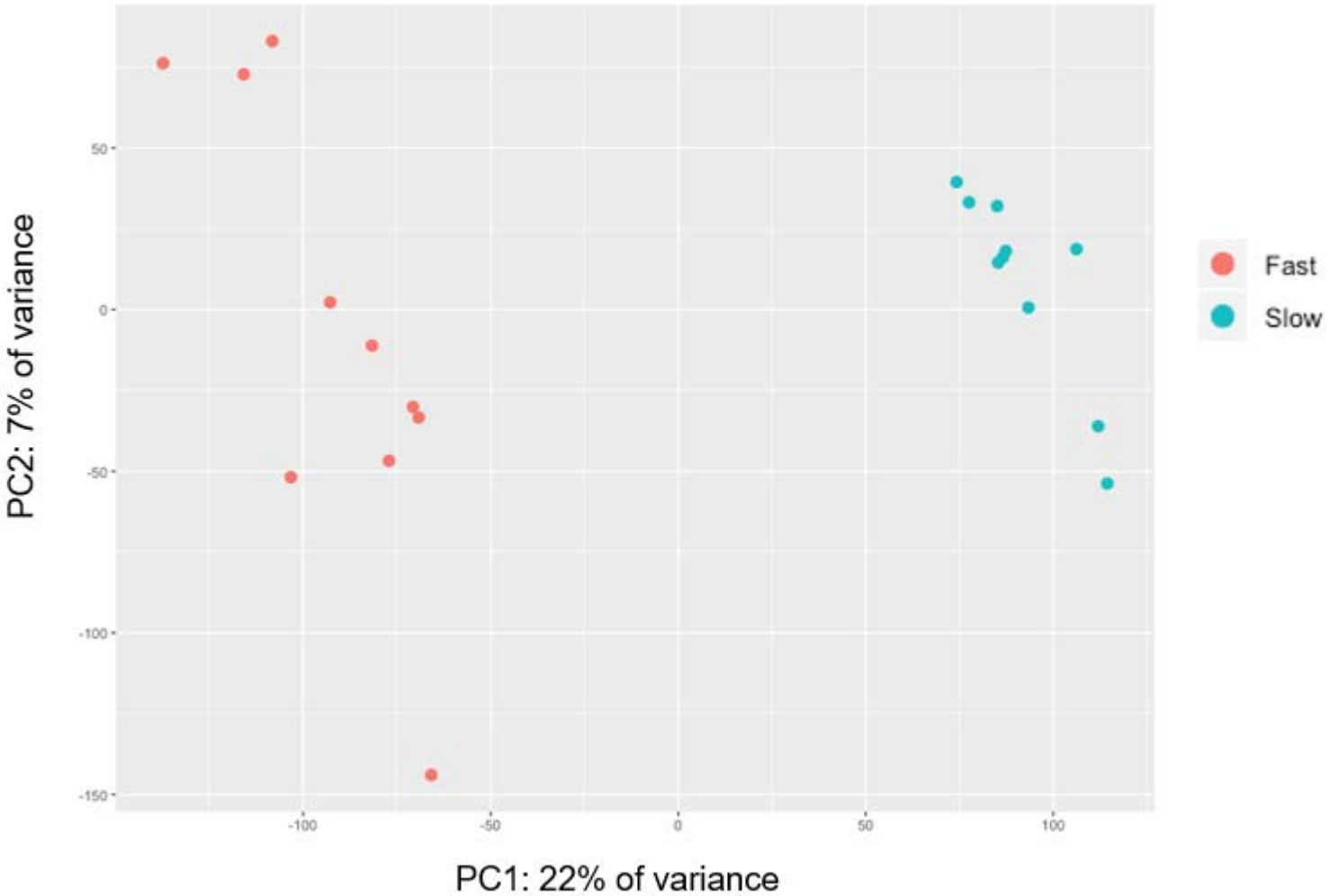


Male-specific markers identified 10 of each sex, with males generally larger than females (t-Test, P = 0.11)



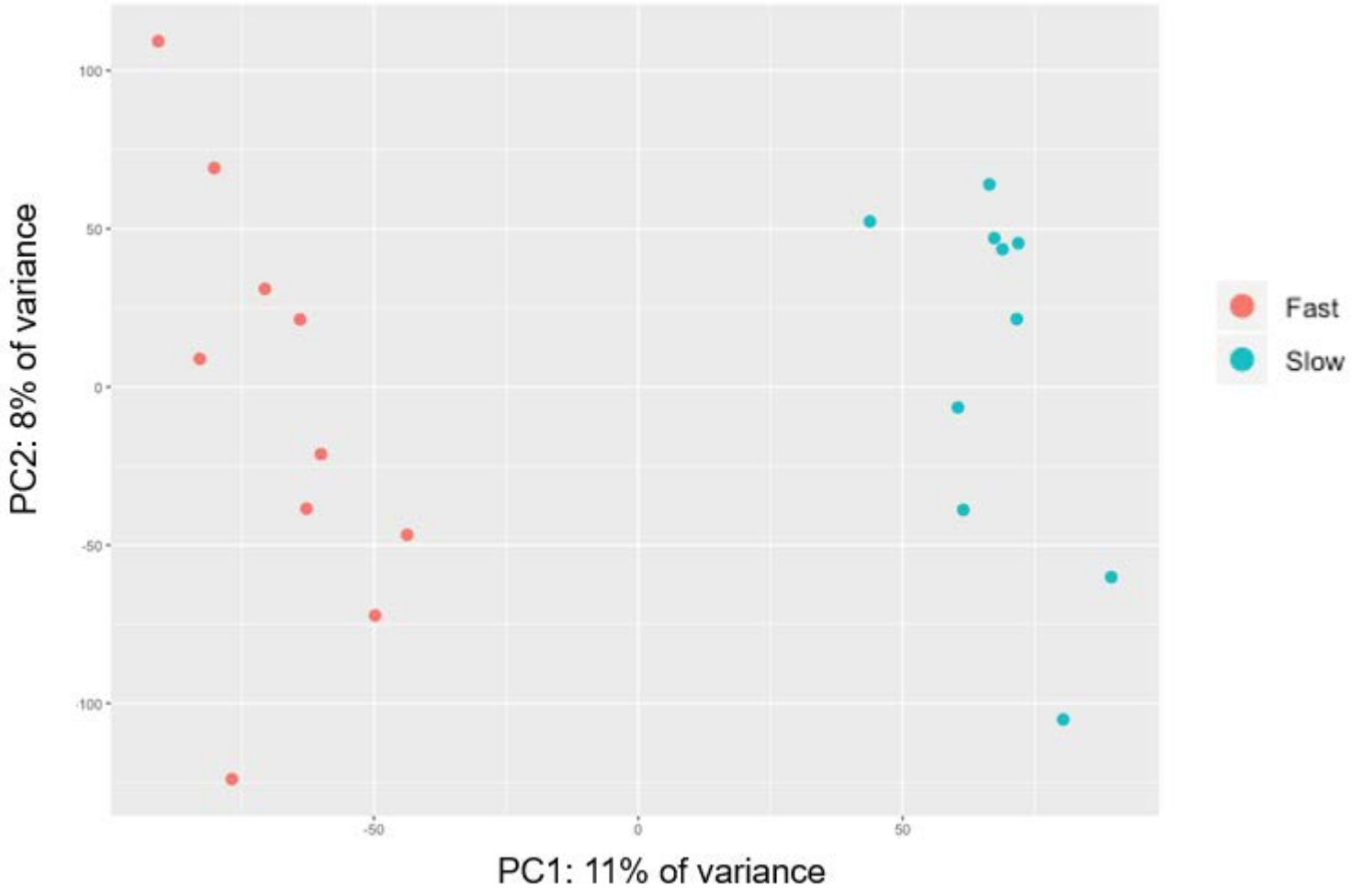
Brain

- 13,330 differentially expressed transcripts between fast and slow growers
- Growth differences correlate with PC1, 22% of variance



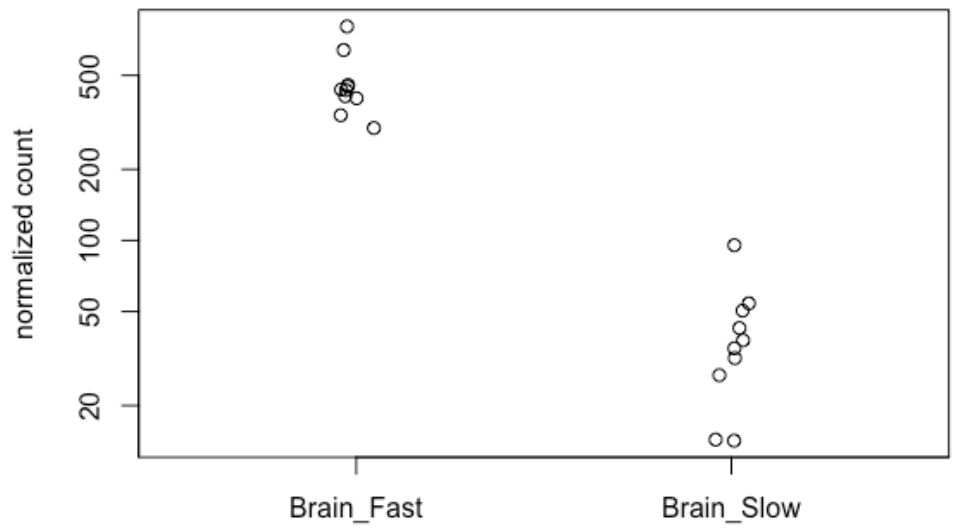
Liver

- 3,286 differentially expressed transcripts between fast and slow growers
- Growth differences correlate with PC1, 11% of variance



Myostatin

- Highly upregulated in brains of fast growing individuals
- However, myostatin is a negative muscle growth regulator
- Inhibits cell growth and differentiation



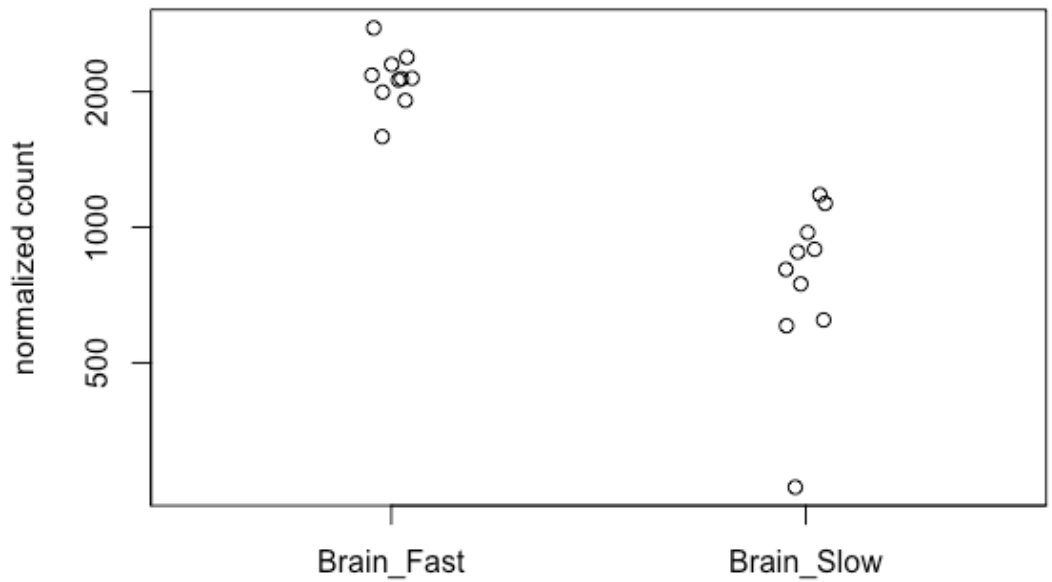
Myostatin

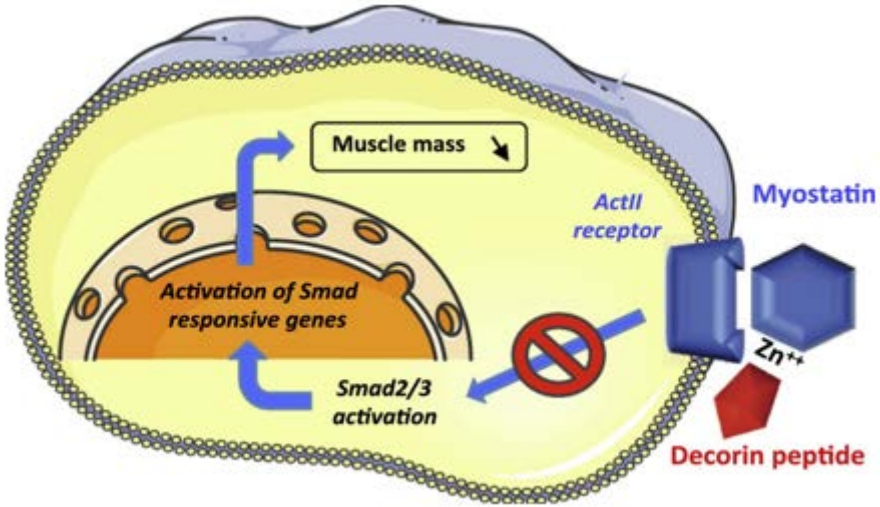
- Commonly used by weight lifters to enhance muscle growth
- Mutations that eliminate activity are common
- **But this is opposite of expectation – why are they larger?**

Knockout of myostatin produces large phenotype in zebrafish (Acosta et al. 2005)

Decorin

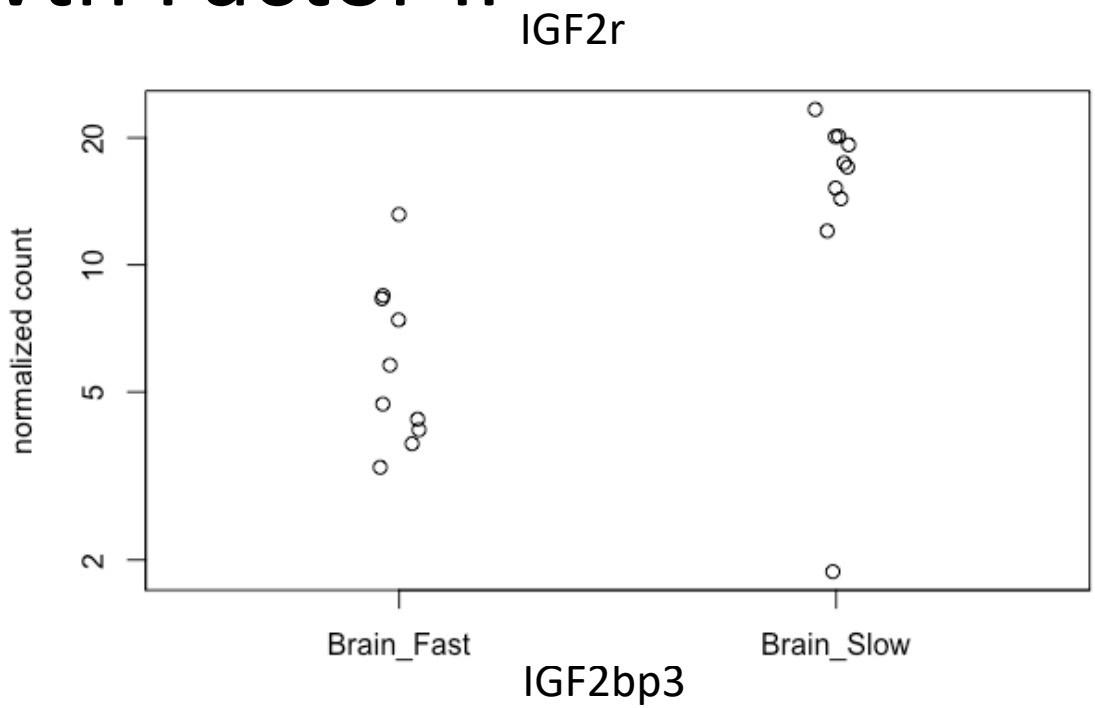
- Decorin is a myostatin inhibitor
- Upregulated in fast growers
- Decorin appears to be blocking the action of myostatin in fast growers
- Compensatory mechanism?

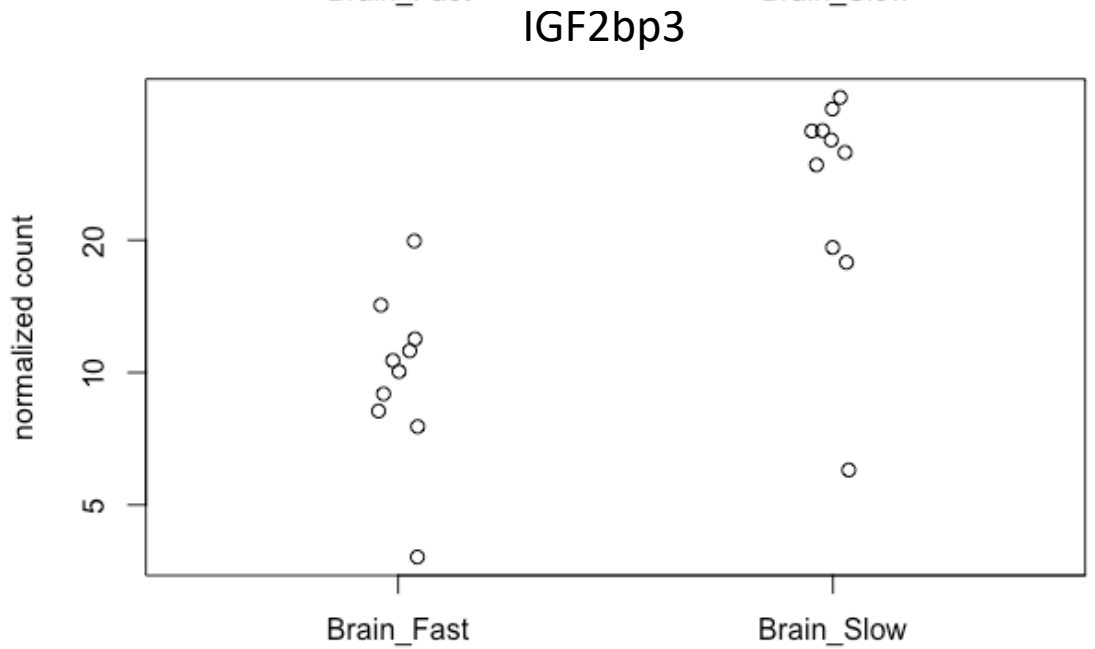




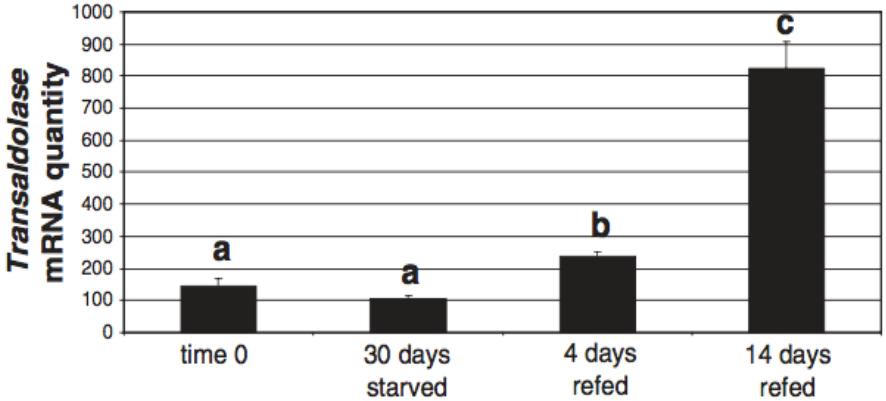
Insulin-like Growth Factor II

- IGF2 is a growth promoting hormone
- IGF2r and IGF2bp3 both repress IGF2
  - These are downregulated in fast growers

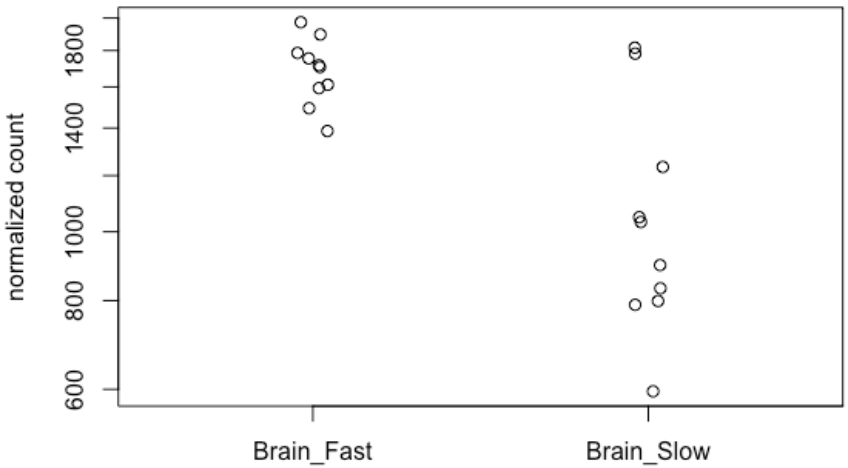




Other potentially important genes



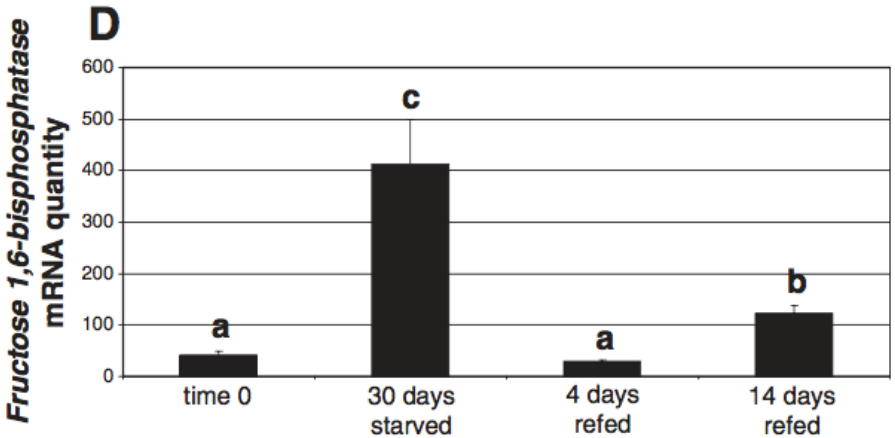
Transaldolase upregulated in trout after food deprivation and refeeding (Johansen and Overturf 2006)



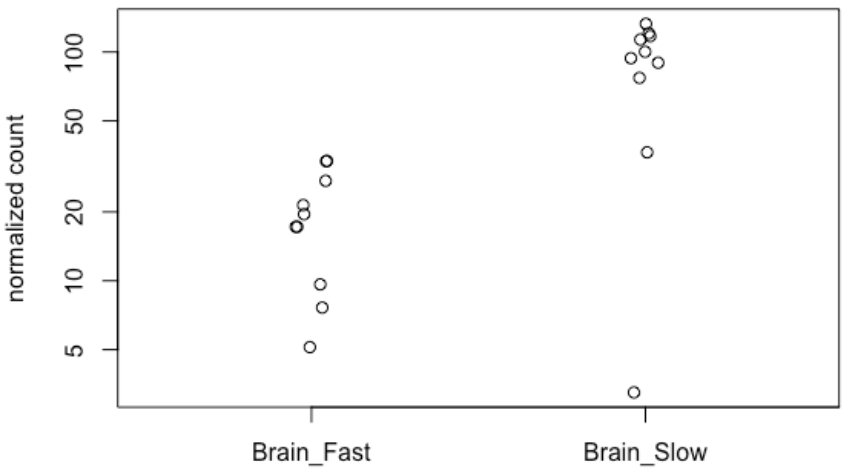
Upregulated in fast growers

Increased transaldolase activity consistent with higher growth in fast growers

Other potentially important genes



Fructose 1,6-bisphosphatase-Upregulated in trout during food deprivation (Johansen and Overturf 2006)



Upregulated in slow growers

Indicative of the use of stored glycogen in slow growers as opposed to glucose as an energy source in fast growers – starvation response?

Conclusions

- These are simply correlations, identifying some potentially interesting hypotheses to test
- Fast growers are downregulating growth limiting genes (or slow growers are upregulating?)
- Slow growers show signs of food deprivation

Hypothesis 1

Fast growers predisposed to getting bigger faster

Limited resources, bigger fish outcompete smaller fish

Slow growers in starvation mode

Downregulation of growth restricting genes

Burning glycogen stores

Hypothesis 2

Fast growers were better competitors → Fast growers get bigger because they get more food → Slow growers in starvation mode

- Burning glycogen stores
- Downregulating myostatin to prevent muscle loss

Acknowledgements

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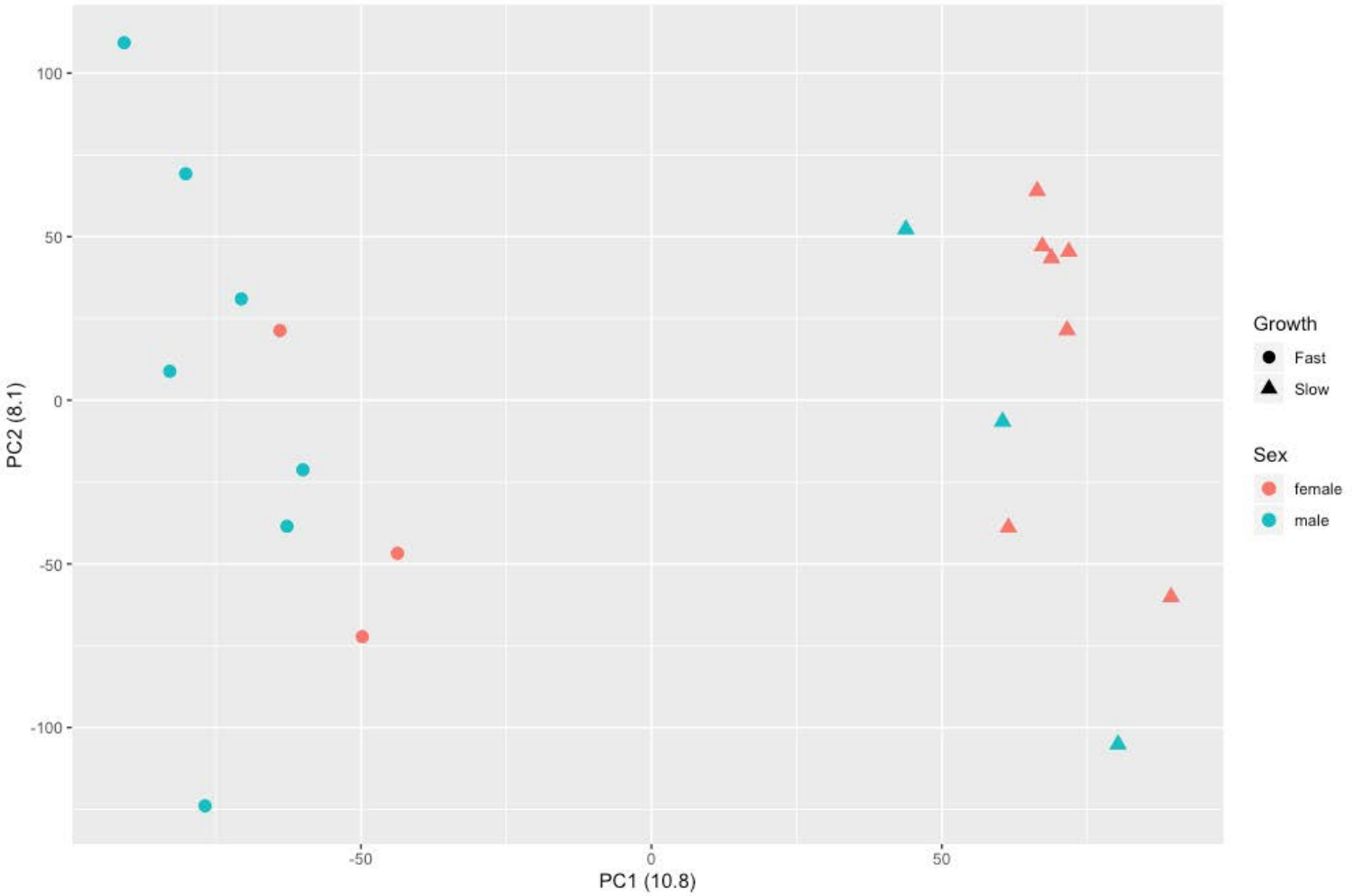
Kelly Pollard

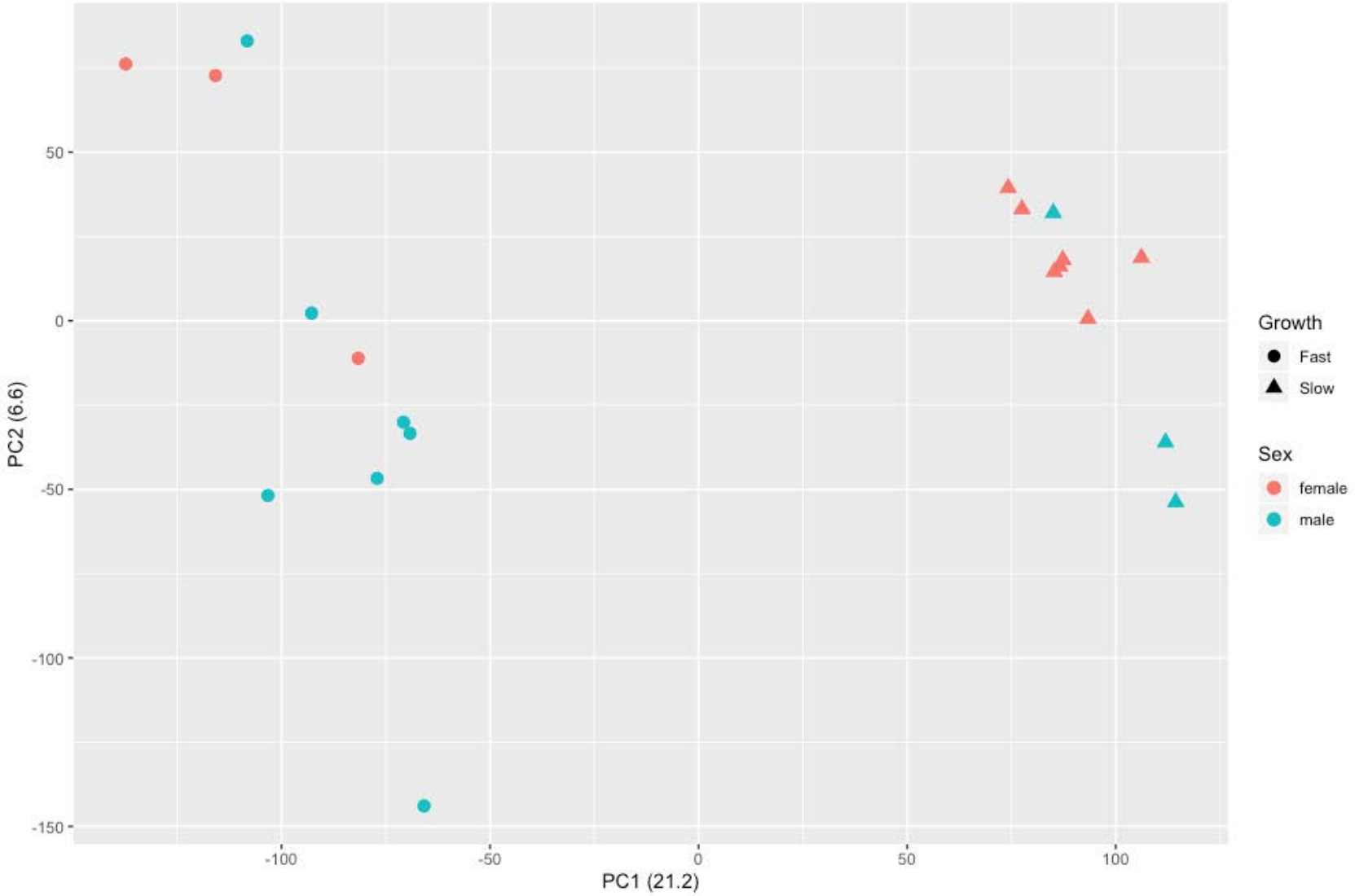
Paul Marsh

Crew at Willow Beach

Liver


100
50
0
-50
-100
PC2 (8.1)
-50
0
50
PC1 (10.8)
Growth
Fast
Slow
Sex
female
male

Brain


50
0
-50
-100
-150
PC2 (6.6)
-100
-50
0
50
100
PC1 (21.2)
Growth
Fast
Slow
Sex
female
male