Assessing the Effects of Parental Traits On the Production of Hatchery Spring Chinook Salmon Minijacks

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Effect of Parental Traits on Growth and Minijack Production

Study questions:

- Do parental traits (i.e. parental age, size, egg weight) have significant effects on **size of fry at emergence**?
- Do parental traits have significant effects on **size of juveniles in April** when either smolting or maturing as minijacks, and are they different than any observed at the fry stage?
- Do parental traits have significant effects on **maturation reaction norms** (maturation threshold) in April at release?

Effect of Parental Traits on Growth and Minijack Production

<u>Study questions</u> - cont:

- Do parental traits have significant effects on **<u>maturation rates</u>** in April when fish are either smolting or maturing as minjacks?

Effect of Parental Traits on Growth and Minijack Production

Study Design:

- 3 broodyears: 2014 to 2016
- Factorial mating of **Natural Origin** broodfish of different ages:
  - females (Age 4 or 5)
  - males (3 [jack], 4 or 5); added Age 1 NO microjacks in BY 2015 and 2016

Effect of Parental Traits on Growth and Minijack Production

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Study Design:

- 3 broodyears: 2014 to 2016
- Factorial mating of NO broodfish of different ages:
  - females (Age 4 or 5)
  - males (3 [jack], 4 or 5); added Age 1 NO microjacks in BY 2015
- Rear juveniles (50 fry per mating) to smolt stage (April) in common environment
- Blood samples collected for 11-KT assays
- Tissue samples collected for genotyping and parentage analysis

Effect of Parental Traits on Growth and Minijack Production

Females

Males

	Age	4	5	4	5	4	5
Age		**F01**	**F02**	**F03**	**F04**	**F05**	**F06**
3	M01	200 eggs	200 eggs				
4	M02	200 eggs	200 eggs	Cross No. 1			
5	M03	200 eggs	200 eggs				
3	M04			200 eggs	200 eggs		
4	M05			200 eggs	200 eggs	Cross No. 2	
5	M06			200 eggs	200 eggs		
3	M07					200 eggs	200 eggs
4	M08				Cross No. 3	200 eggs	200 eggs
5	M09					200 eggs	200 eggs

Effect of Parental Traits on Growth and Minijack Production

Sept → **March** → **April**

200 eggs → 50 fry → Smolt/MJ

50 fry ↓ 5 fry length and weight

All fry placed in a common tank and reared together from March to April of the next year

BY 2014 Sampling Completed

<u>Number</u>

1,254 - smolts sampled April 2016

459 - PIT tagged April, sacrificed Sept 2016

1,414 - smolts with data for both 11-KT + genotypes

57 - full sib progeny groups with both parents of known age, (n=1,170; average = 21 males/progeny group)

BY 2014, 2015, 2016

- All factorial crosses made
- Smolts were sampled April
- 11-KT and genotype analyses completed

BY 2016

- All factorial crosses made
- Smolts were sampled April 2018
- 11-KT and genotype analyses completed by Fall 2018

Fry Samples
parents of known age, sex, length, body wt, egg wt

BY 2014

Number

370 - NO fry sampled March 2015

BY 2015

Number

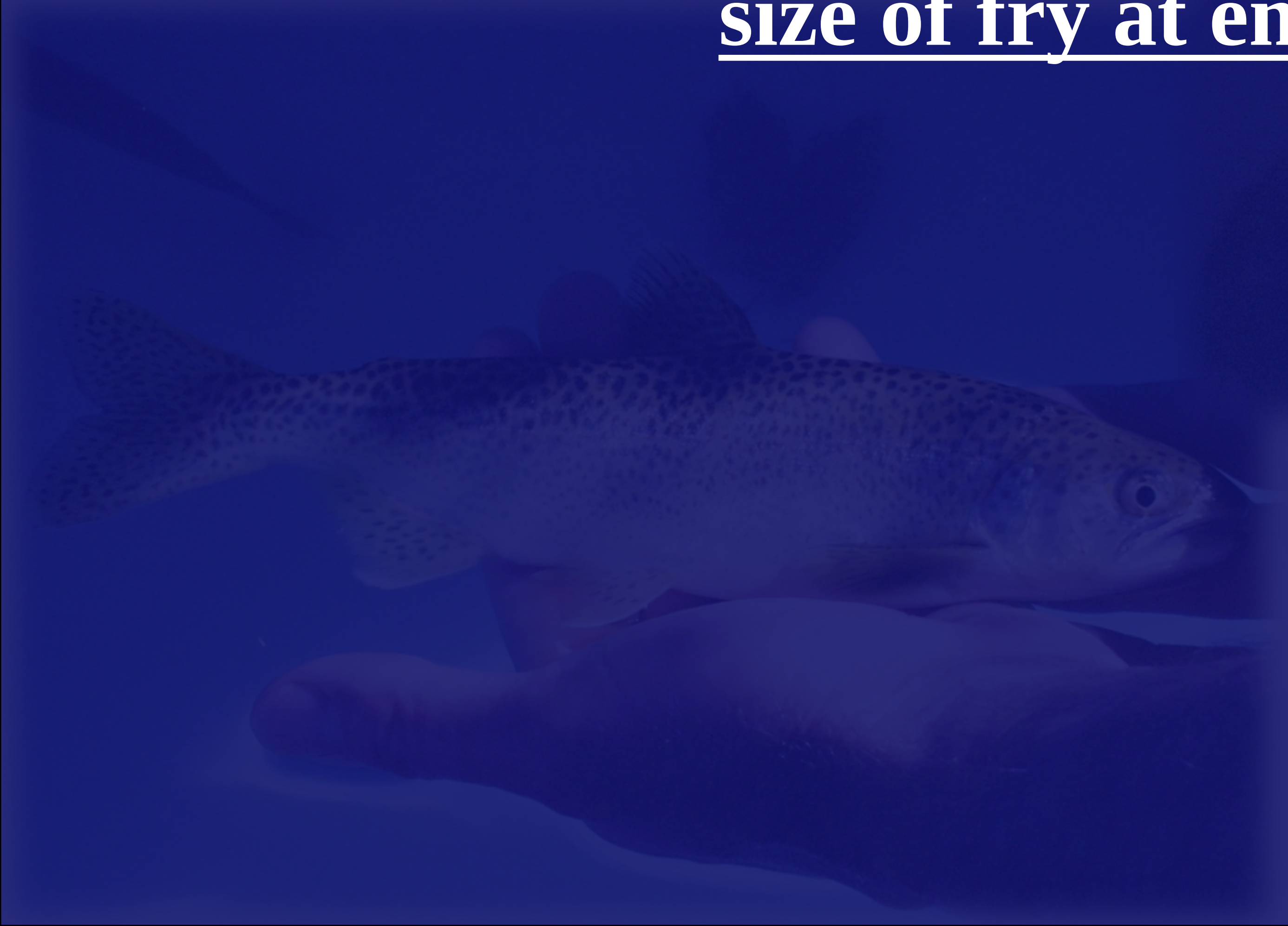
305 - NO fry sampled March 2016

BY 2016

Number

285 - NO fry sampled March 2017

Do parental traits have significant effects on size of fry at emergence?



Linear Mixed-Models for Fry Analyses:

Fry Body wt ~

Fixed effects

Female Age + Male Age + ln(Egg wt) + ln(Female Length) + ln(Female Body wt) + (ln(Female Body wt) *Fem Age)

Random effects

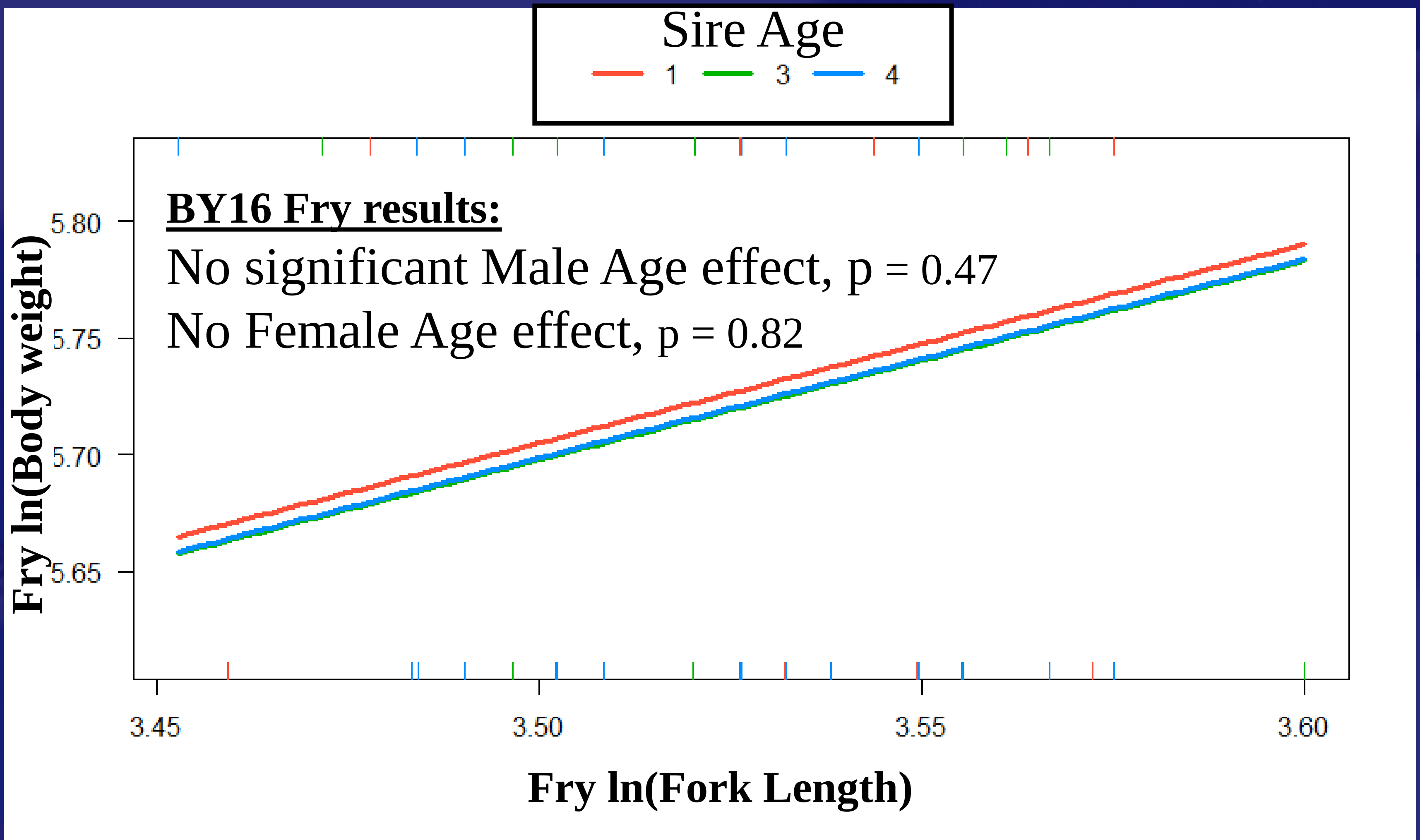
(1 | Female)　　　(1 + Female | Cross)

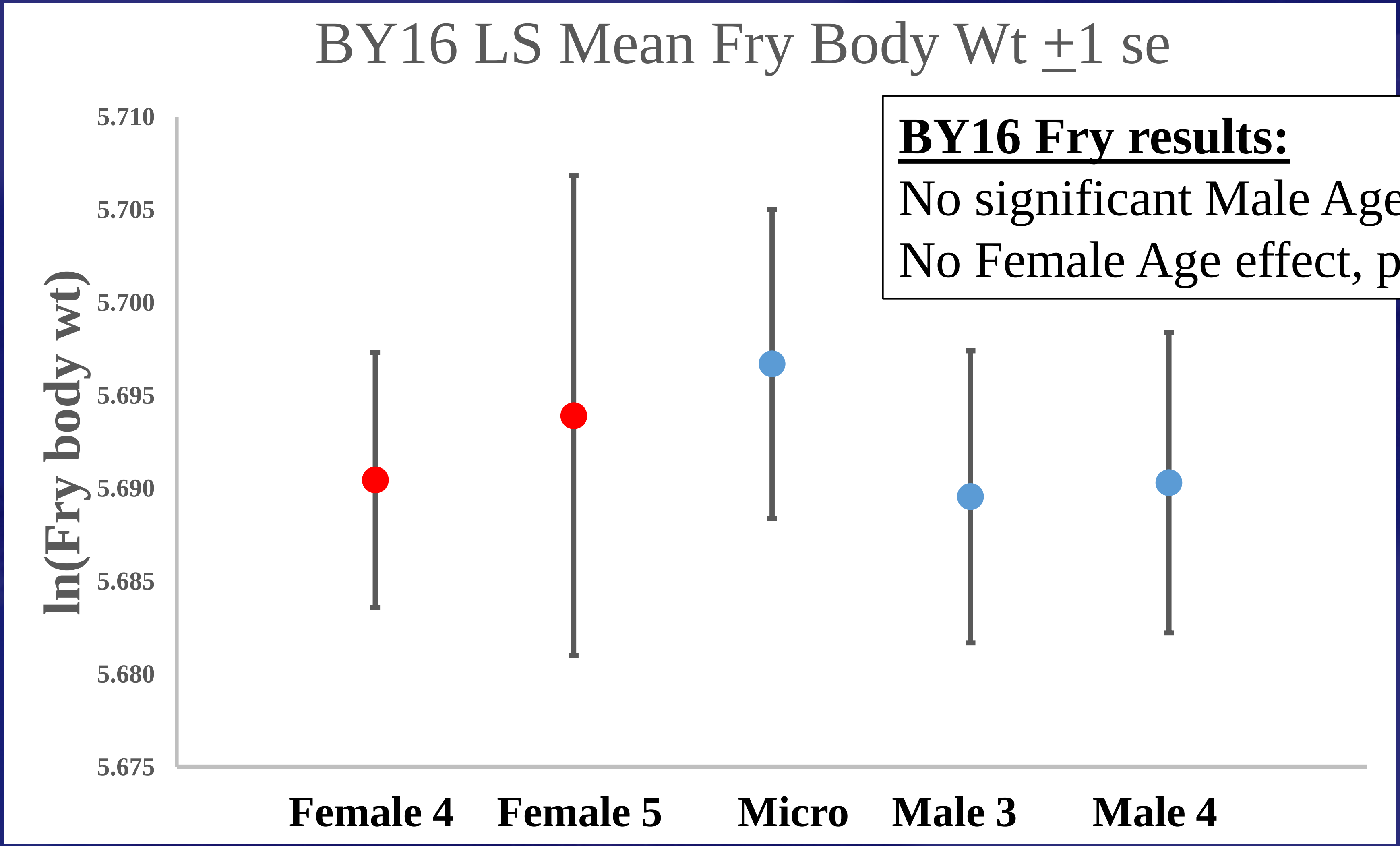
(1 | Male)

(1 | Cross)

Fry Mixed Model

ln(Fry BW) ~ FemAge + MalAge + Fry FL + EggWt + FemBW + (1 | FemID)


Sire Age
1
3
4
BY16 Fry results:
No significant Male Age effect, p = 0.47
No Female Age effect, p = 0.82
5.80
5.75
5.70
5.65
Fry ln(Body weight)
3.45
3.50
3.55
3.60
Fry ln(Fork Length)



BY16 Fry results:

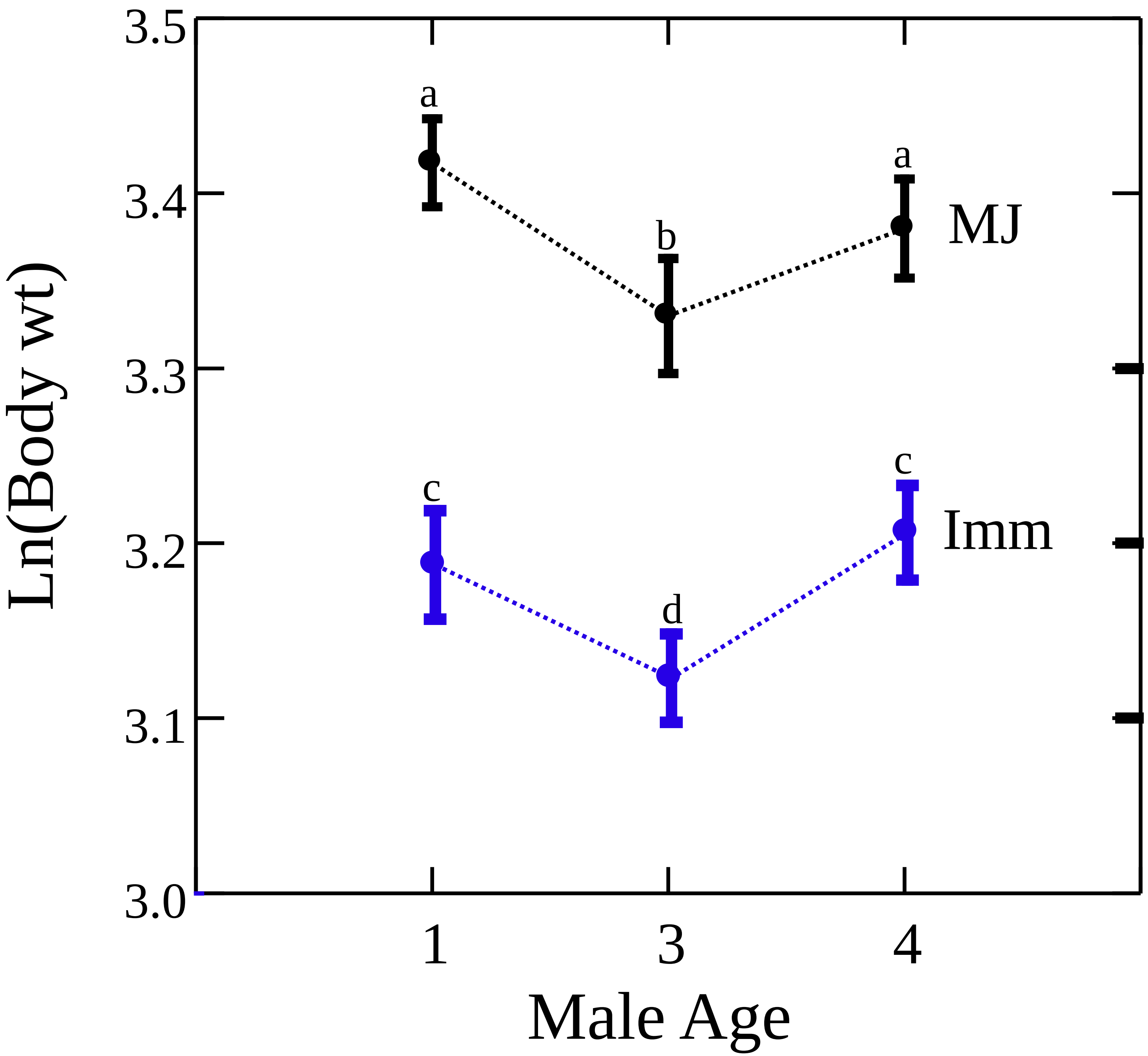
No significant Male Age effect, p = 0.47

No Female Age effect, p = 0.82

Fry Results:

- No significant male Age effect.
- No significant Female Age effect.
- Egg wt has a very significant effect on Fry size.
- Random effect of FemaleID was significant.

Do parental traits have significant effects on **size of juveniles in April** at release?



BY15 Size at release

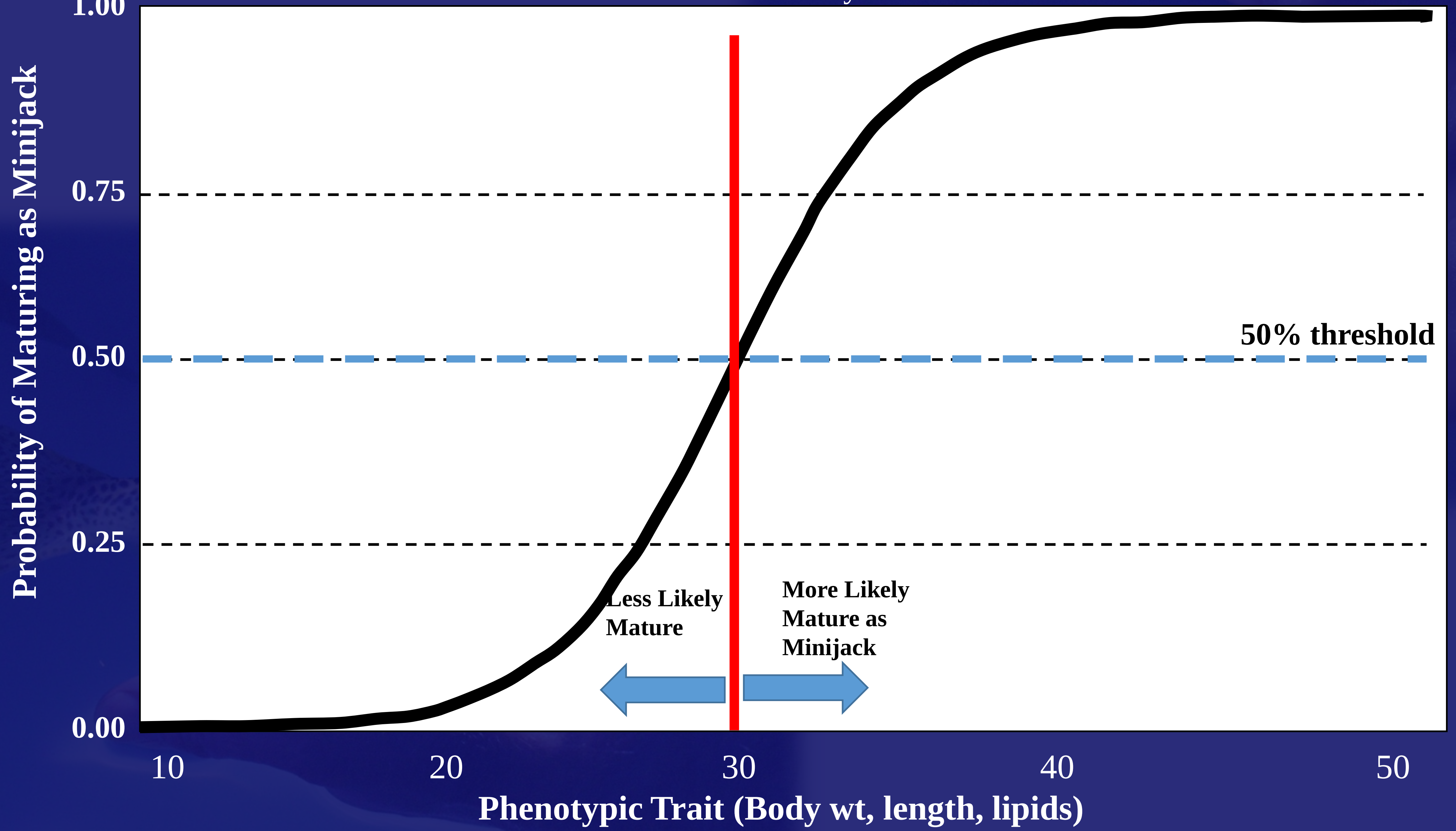
- **Age 3 progeny grew slowest (smallest)** both as MJ and Immature

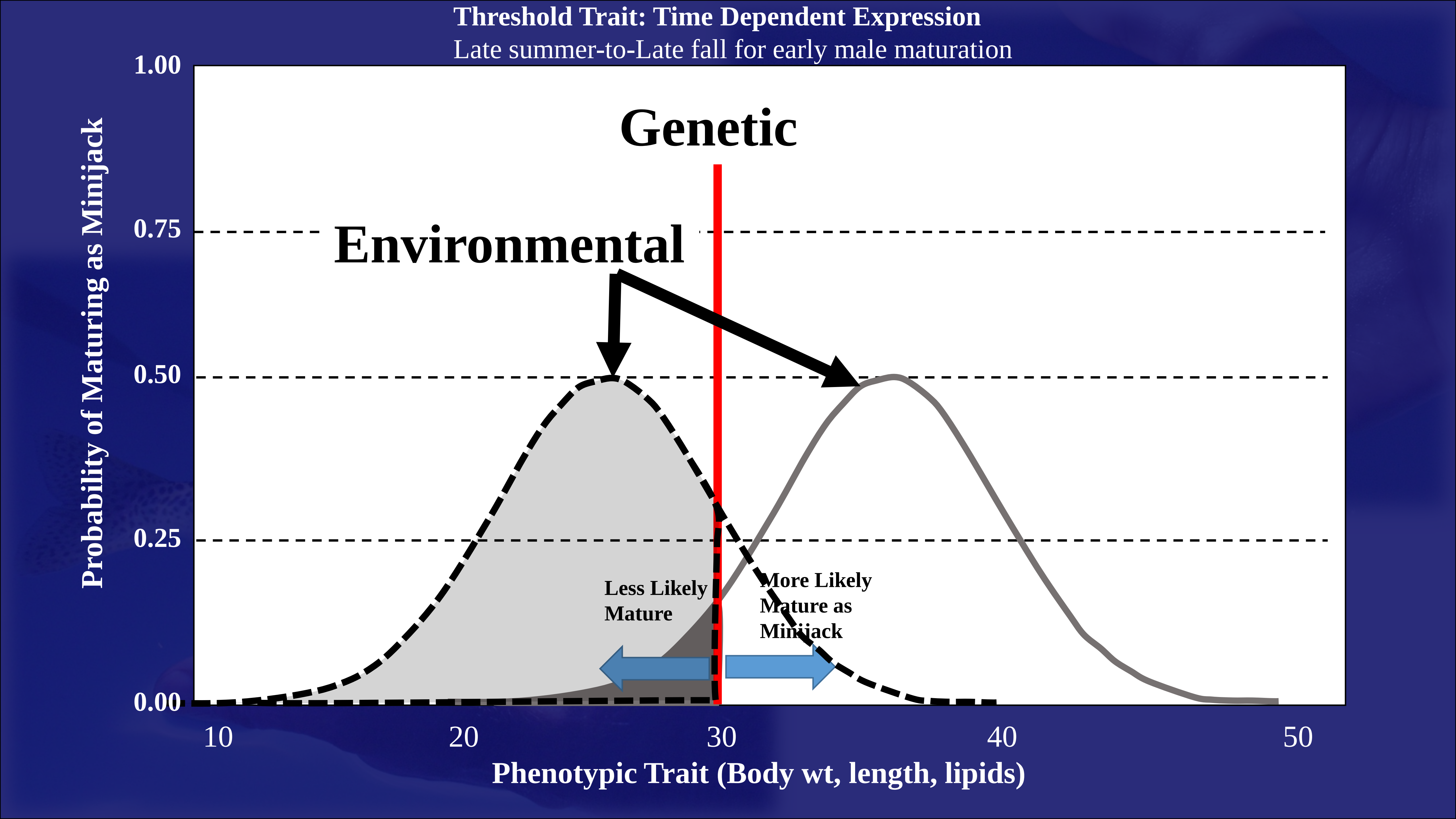
- Age 1 and 4 progeny grew fastest and were not significantly different as MJ or Immatures

Do parental traits have significant effects on **<u>maturation reaction norms</u>** (maturation threshold)?

Threshold Trait: Time Dependent Expression

Late summer-to-Late fall for early male maturation




Threshold Trait: Time Dependent Expression
Late summer-to-Late fall for early male maturation
Genetic
Environmental
Less Likely
Mature
More Likely
Mature as
Minijack
1.00
0.75
0.50
0.25
0.00
10
20
30
40
50
Probability of Maturing as Minijack
Phenotypic Trait (Body wt, length, lipids)

Logistic Regression often used to estimate Threshold Traits

Prob(Mature) ~ fixed effects + random effects

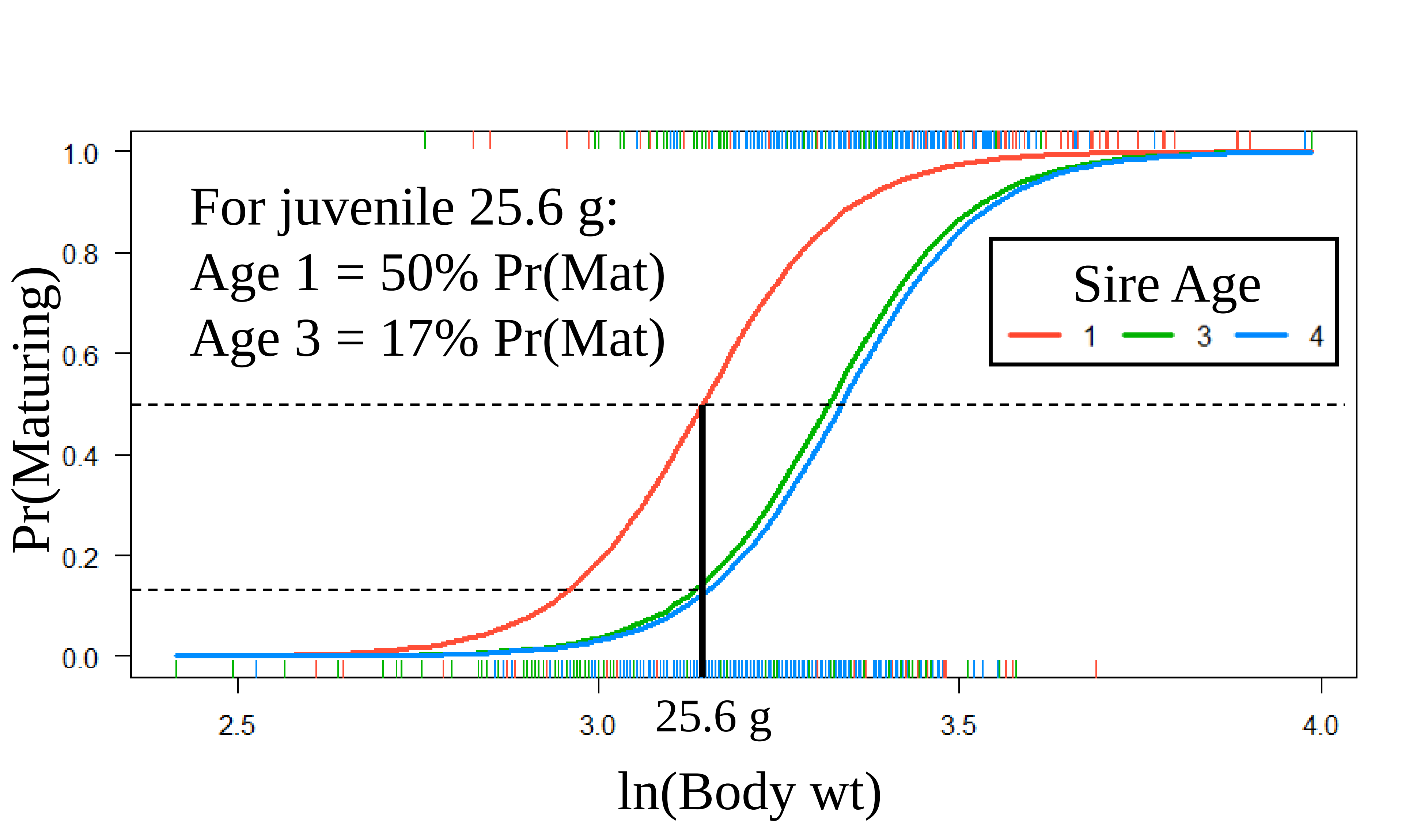
BY2015 Logistic Regression:

Pr(Mature) ~ Sire age + Juv FL + Juv BW + Sire length + Dam BW + Egg wt

Coefficients:

Variable	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-9.15	17.44	-0.53	0.600
Sire age 3	-1.79	0.48	-3.68	<0.001***
Sire age 4	-1.97	0.56	-3.52	<0.001***
ln(Smolt FL)	-6.95	4.31	-1.61	0.107
ln(Smolt BW)	10.23	1.41	7.25	<<0.001***
ln(Sire POHP)	0.911	0.30	3.02	0.003**
ln(Dam BW)	2.44	0.48	5.06	<<0.001***
ln(Egg weight)	-2.58	0.76	-3.40	0.001***

BY15 April Samples

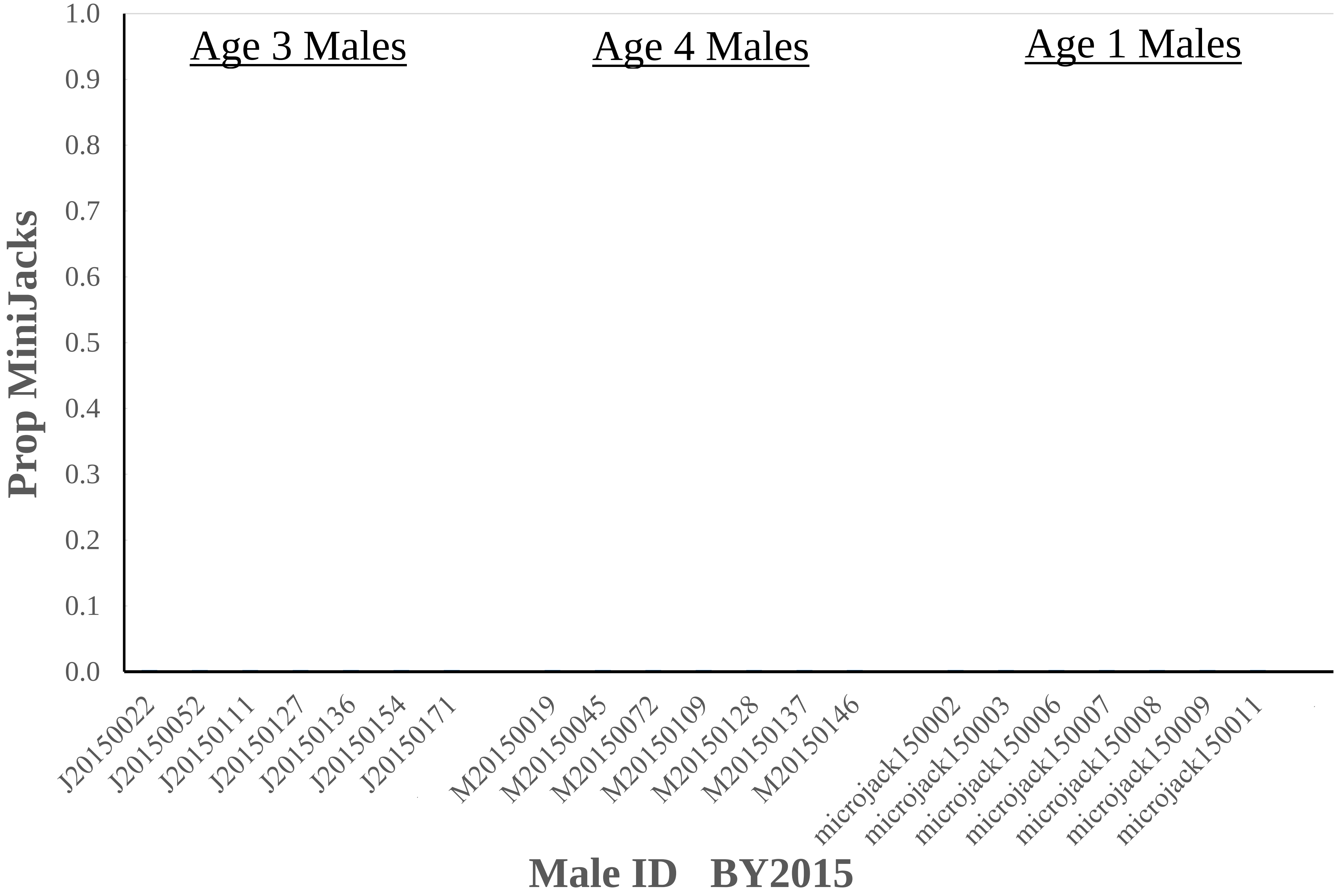


Male Age does significantly effect maturation thresholds for BY15:

- Age 1 males had a significantly lower 50% maturation threshold (mature at smaller size) than both Age 3 and 4 males.

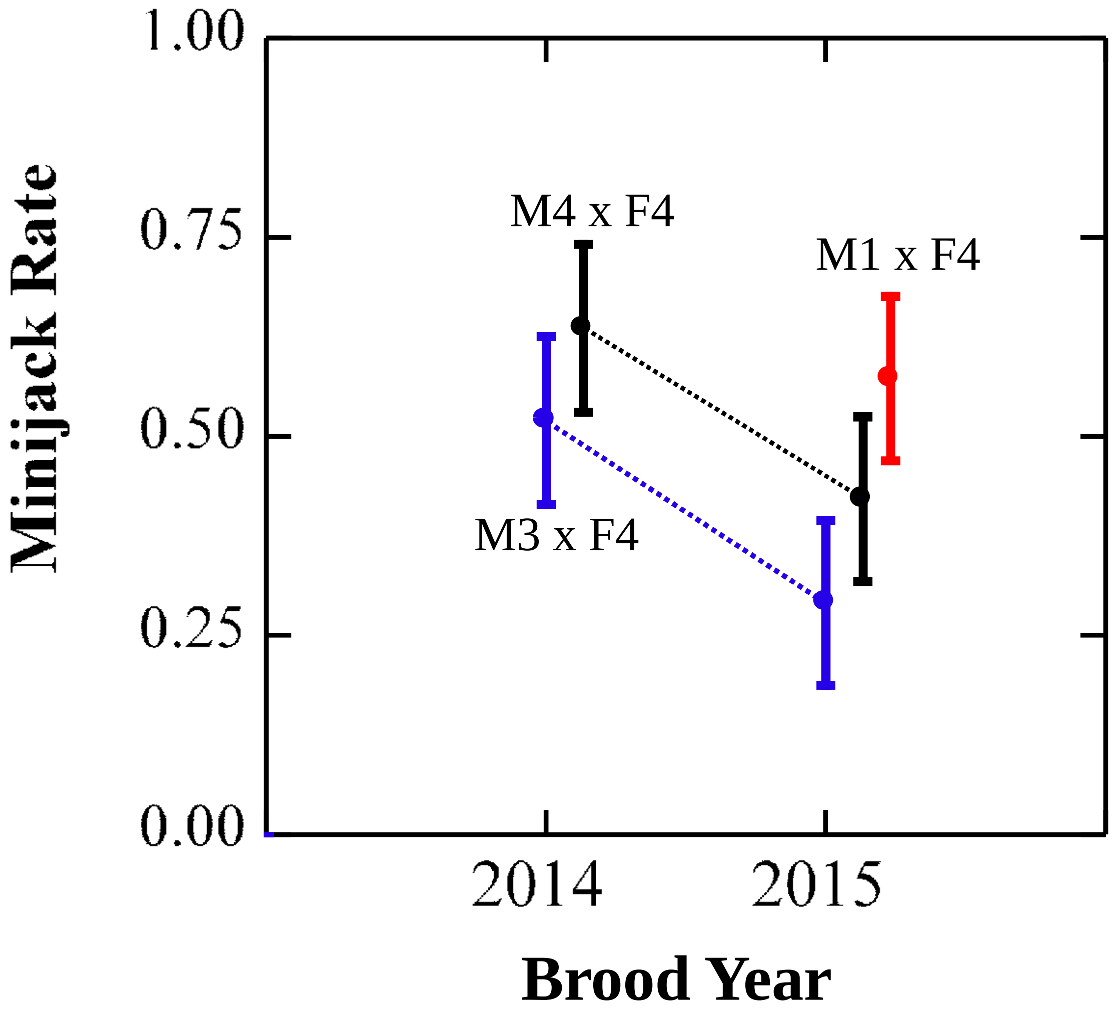
- Age 3 and 4 males were not significantly different.

Does Male Age significantly effect maturation rates?



Age 3 Males
Age 4 Males
Age 1 Males
Prop MiniJacks
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
J20150022
J20150052
J20150111
J20150127
J20150136
J20150154
J20150171
M20150019
M20150045
M20150072
M20150109
M20150128
M20150137
M20150146
microjack150002
microjack150003
microjack150006
microjack150007
microjack150008
microjack150009
microjack150011
Male ID BY2015

Least Squares Means ±1 se



Age 3 and 4 Males Only

Source	Type III SS	df	Mean Squares	F-ratio	p-value
BY	1.033	1	1.033	17.057	<0.001
Male Age	0.319	1	0.319	5.259	0.024
BY * Age	0.001	1	0.001	0.018	0.894
Error	4.846	80	0.061		

Age 3 males x Age 4 females (**blue**)
Age 4 males x Age 4 females (**black**)
Age 1 males x Age 4 females (**red**)

Results To Date

- Size of fry at emergence
  - **No male of female age effects**
- Size of juveniles in April at release
  - **Progeny of age sires 3 grew slower (smaller) both as MJ and Immature compared to age 3 and 4 males**
- Thresholds (maturation reaction norms)
  - **Age 1 males had a significantly lower 50% maturation threshold (mature at smaller size) than both Age 3 and 4 males.**
- Maturation rates in April
  - **Age 1 males with the fastest growth and lowest maturation threshold and produced the largest proportion of minijacks**
  - **Age 4 males grew more slowly than MJ, but had a higher MT resulting in medium MJ production**
  - **Age 3 male progeny grew slowly and had a high MT resulting in lowest MJ production**

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