

Evolution of *C. virginica* breeding in Chesapeake Bay, USA: from mass selection to family selection

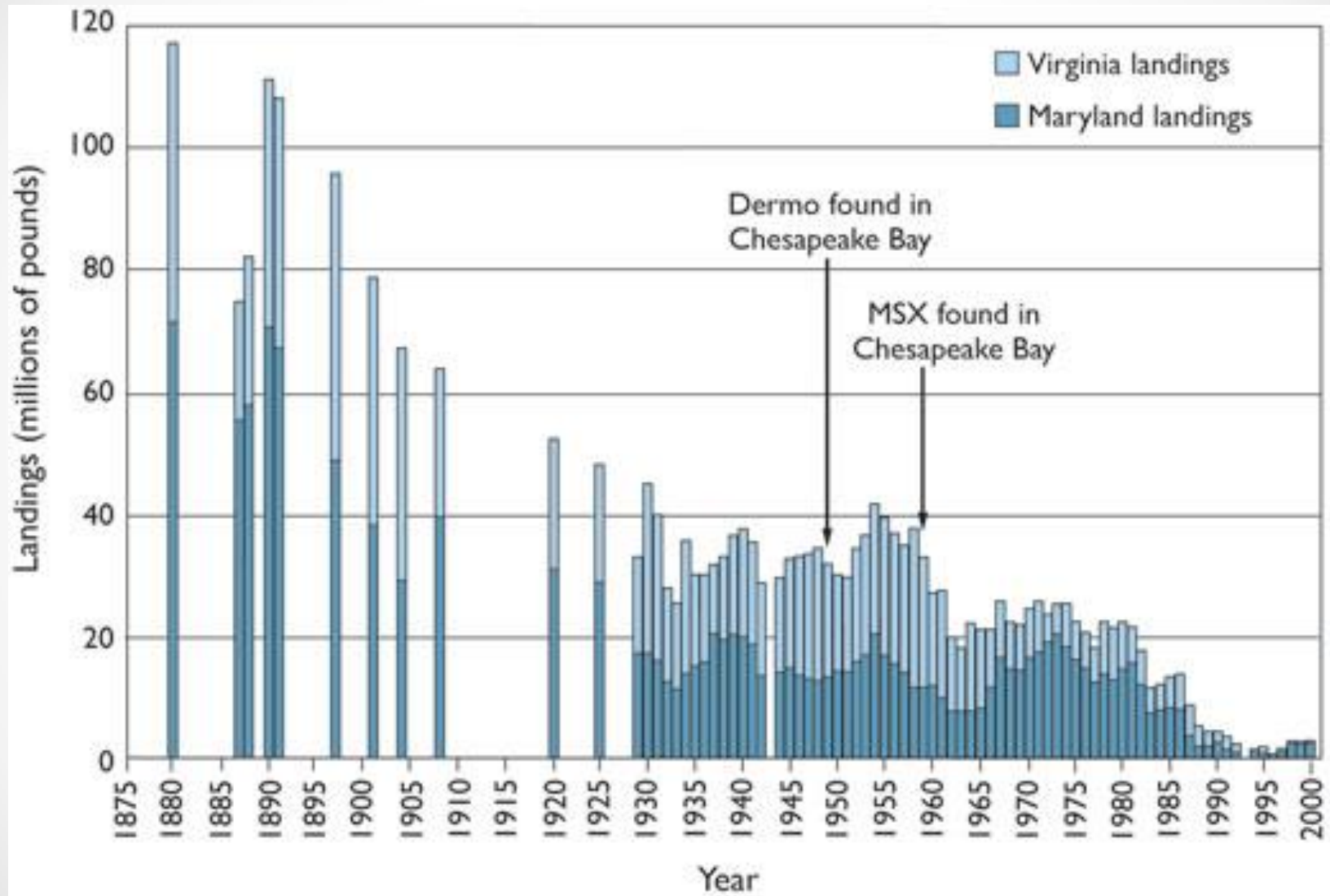
Jessica Moss Small, Peter Kube and Stan Allen



Background

...

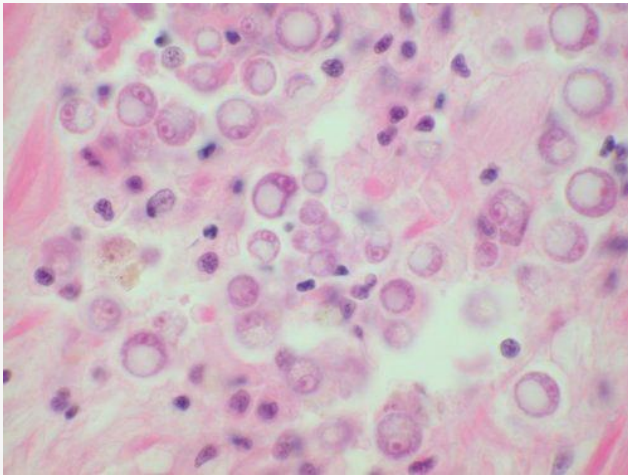
Virginia's Industry – ca. 1995



Diseases

Dermo

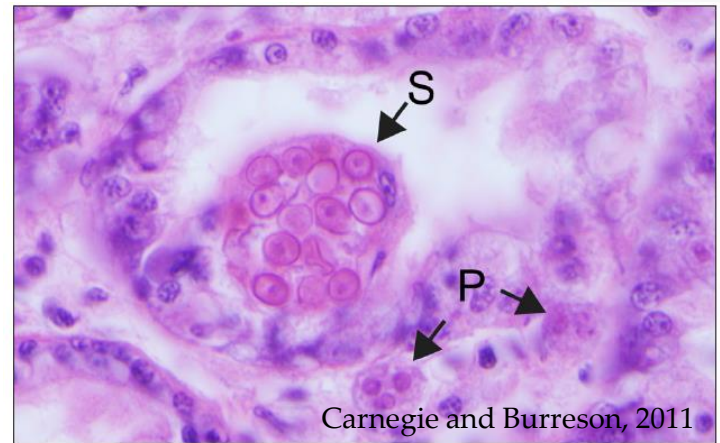
Perkinsus marinus



- directly transmitted
- $>20^{\circ}\text{C}$ and $>12\text{-}15\text{ppt}$

MSX

Haplosporidium nelsoni



- not directly transmitted
- range $\sim 5\text{-}20^{\circ}\text{C}$ and $15\text{-}20\text{ppt}$

Birth of ABC



- 1997 – VA General Assembly initiative
 - “Do something about the oyster problem...”
- Need to address endemic problems associated with MSX and Dermo?
 - domesticated lines
 - non-native disease resistant oysters

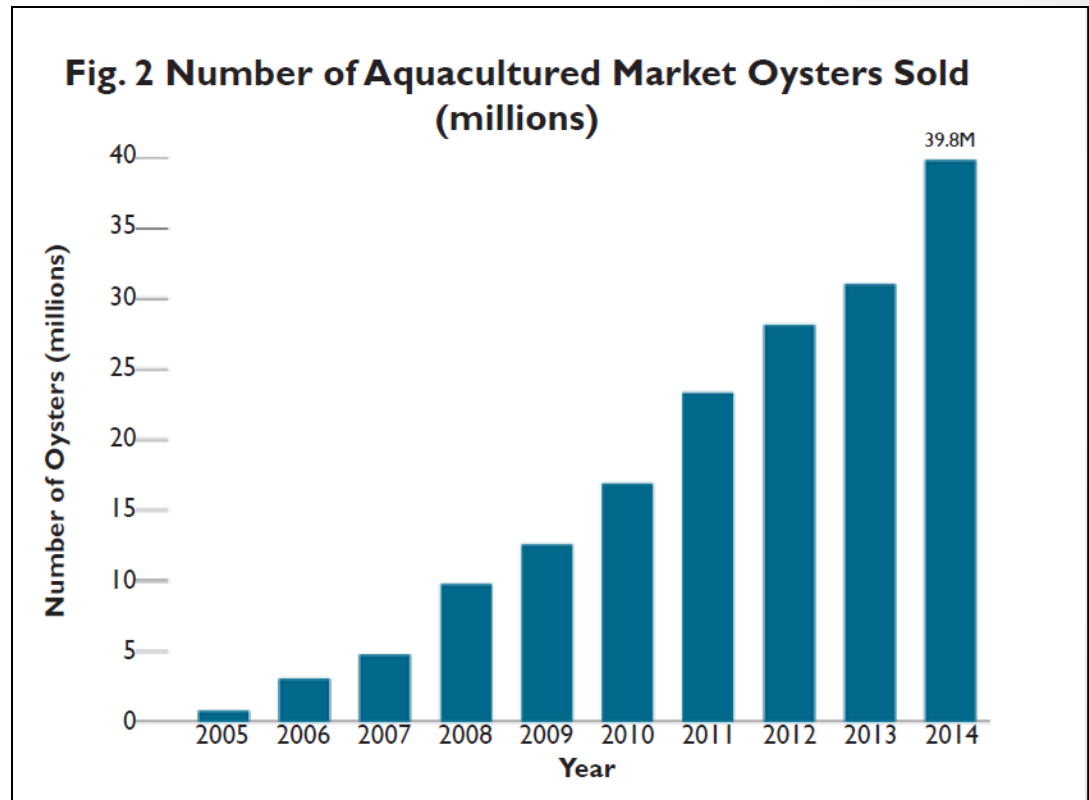
ABC Today

- Most extensive breeding program for oysters in the U.S.
 - 2 hatchery sites
 - 5 field locations
 - 12+ staff, post-docs, students and trainees
 - quantitative genetics collaboration with CSIRO



Virginia's Industry - Today

- 2014 – VA leads East coast oyster production – 39.8M sold
 - 91% triploid
- 2015 – forecasted 57M



Evolution

...



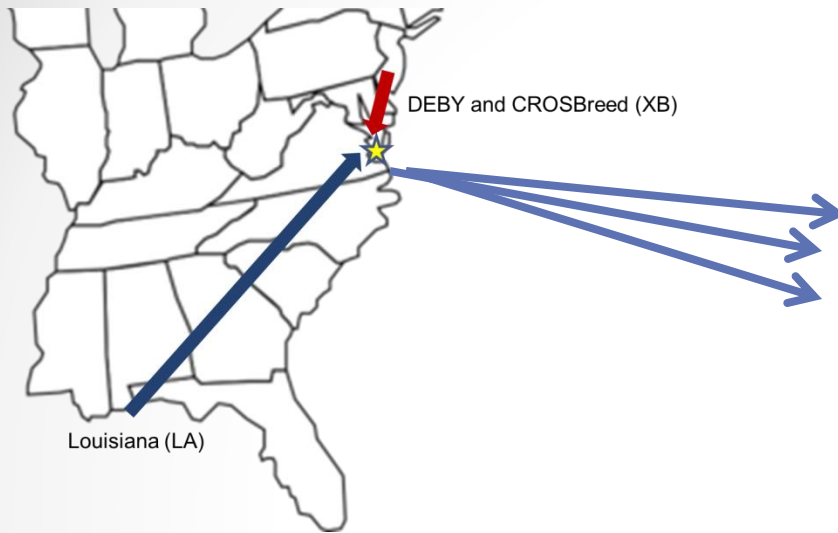
The Evolution: Disease Resistance



Building Genetic Stocks



Building Genetic Stocks

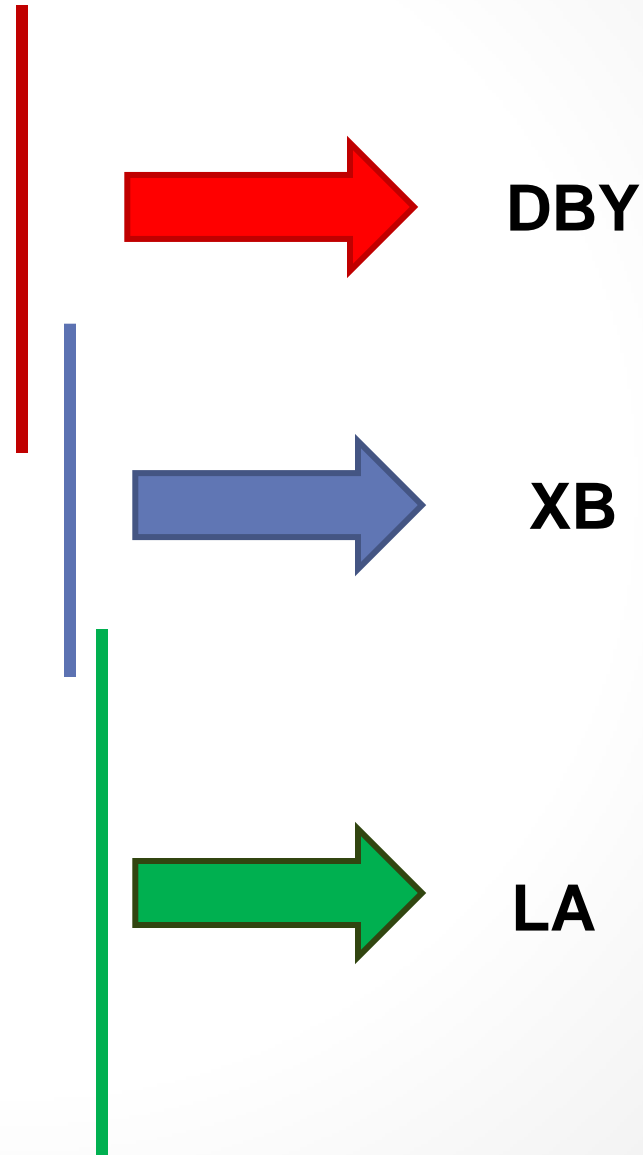


LINE	ORIGIN	GENES
DDBY	DEBY	D
FBST	DEBY	D,X
ADMO	DEBY	D,W
ADMOW	DEBY	D,W
ADXB	DEBY,XB	D,X
ADXBW	DEBY,XB	D,X
BXB	XB	X
BXBW	XB	X
CAMX	XB,CAM	X,L
ZOBOY	OBOY	L
ZOBOYX	OBOY	L
ZLGT	LGT	L
ZLGTK	LGT	L
ZLGTW	LGT	L
YDBLA	DEBY,LGT	D,L

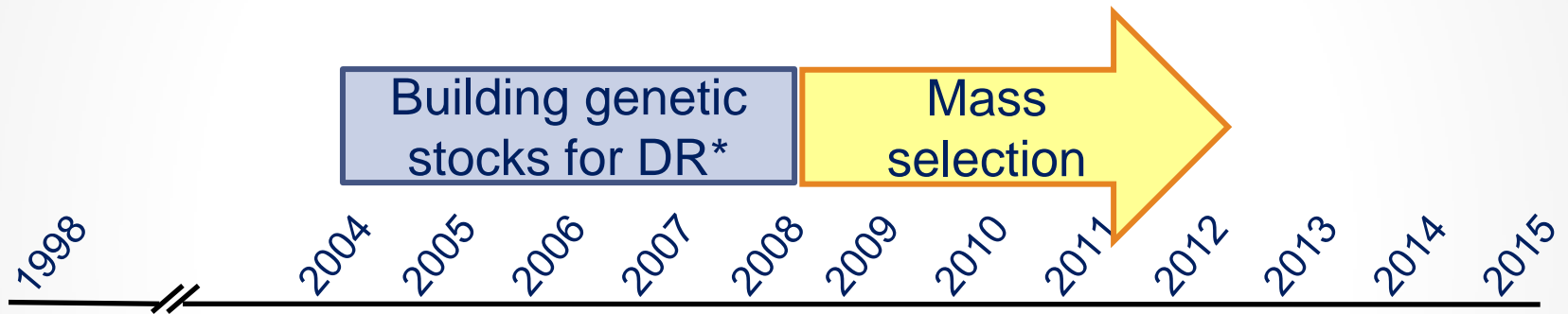


Lines to Superlines

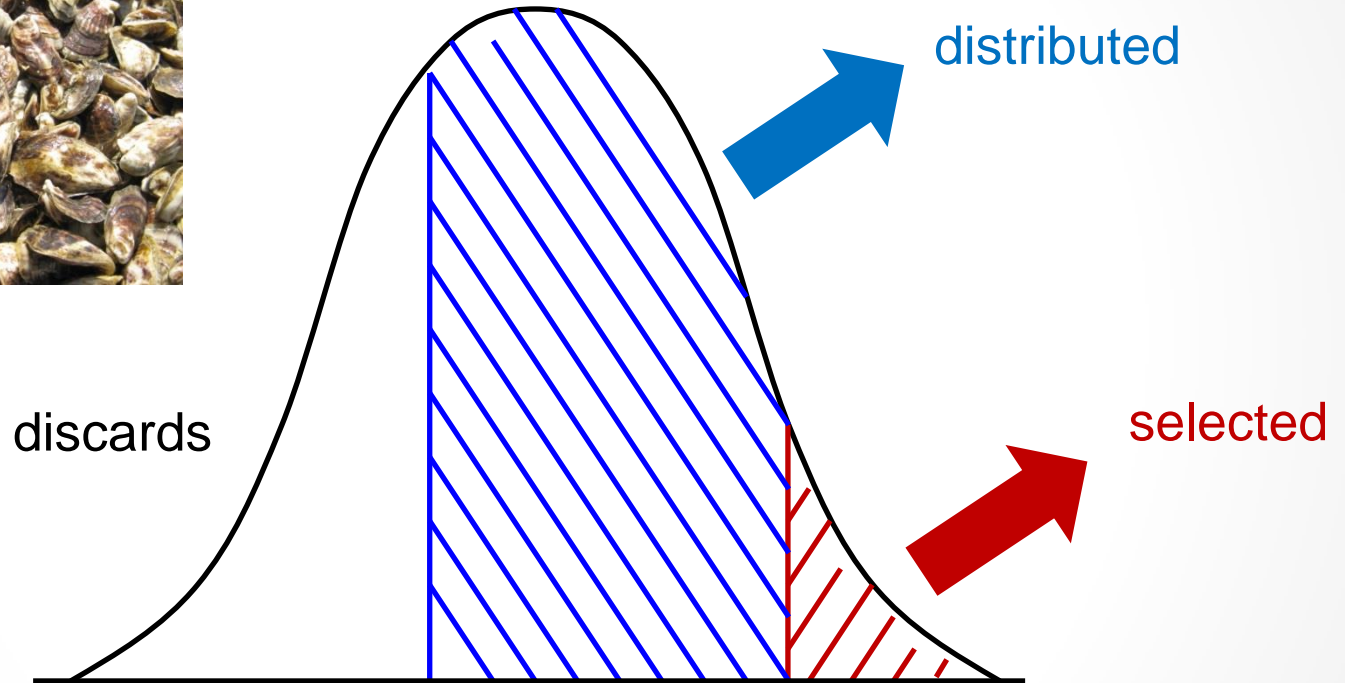
LINE	ORIGIN	GENES
DDBY	DEBY	D
FBST	DEBY	D,X
ADMO	DEBY	D,W
ADMOW	DEBY	D,W
ADXB	DEBY,XB	D,X
ADXBW	DEBY,XB	D,X
BXB	XB	X
BXBW	XB	X
CAMX	XB,CAM	X,L
ZOBOY	OBOY	L
ZOBOYX	OBOY	L
ZLGT	LGT	L
ZLGTK	LGT	L
ZLGTW	LGT	L
YDBLA	DEBY,LGT	D,L



The Evolution: Growth

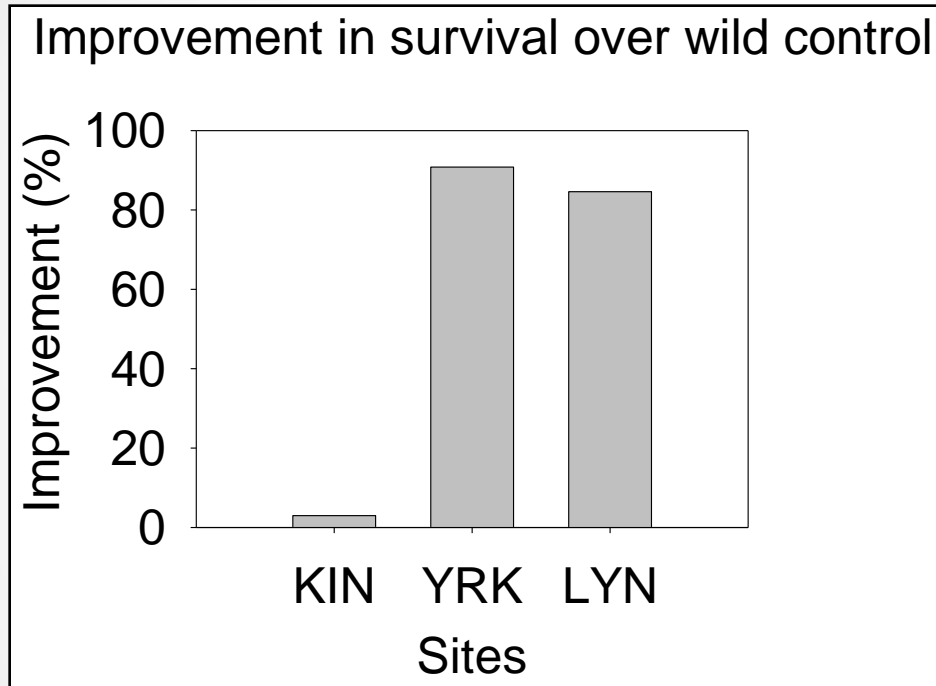


Mass Selection



Success of Mass Selection

Disease Resistance

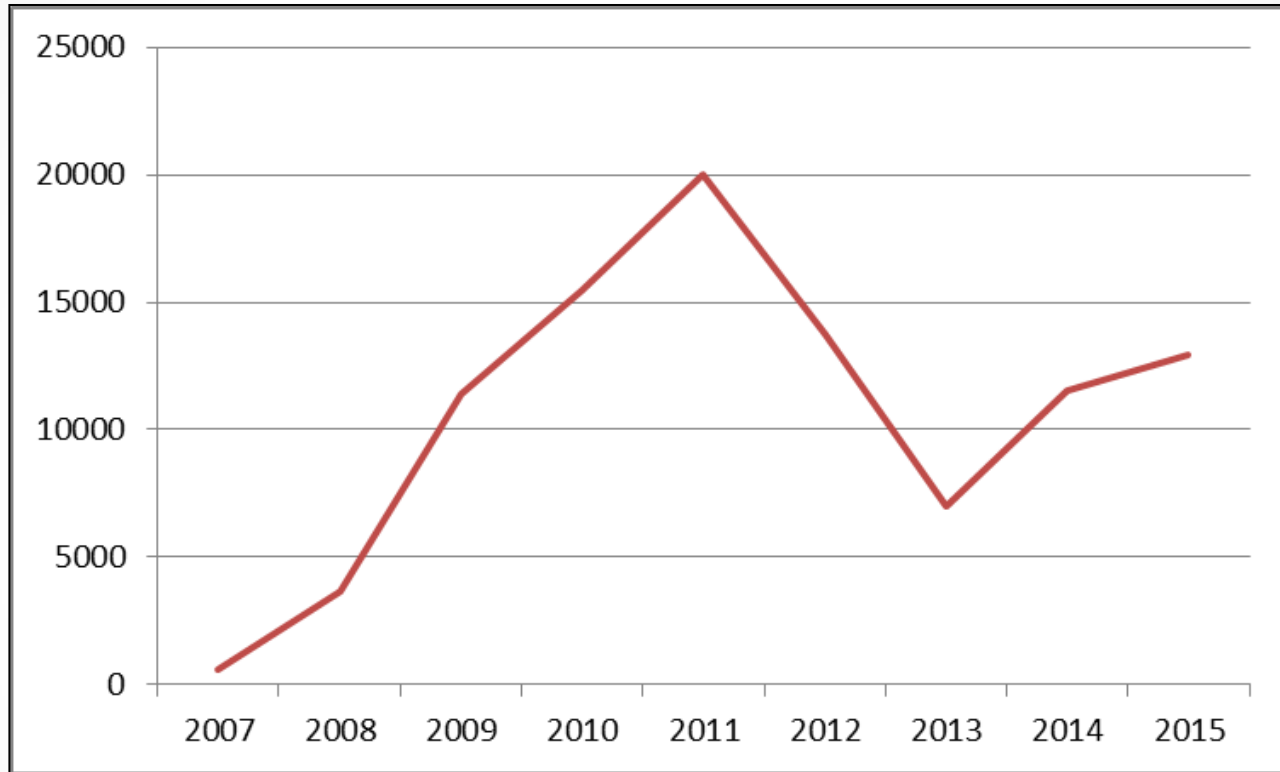


Growth

↓ time to harvest by 50% compared to unselected stocks

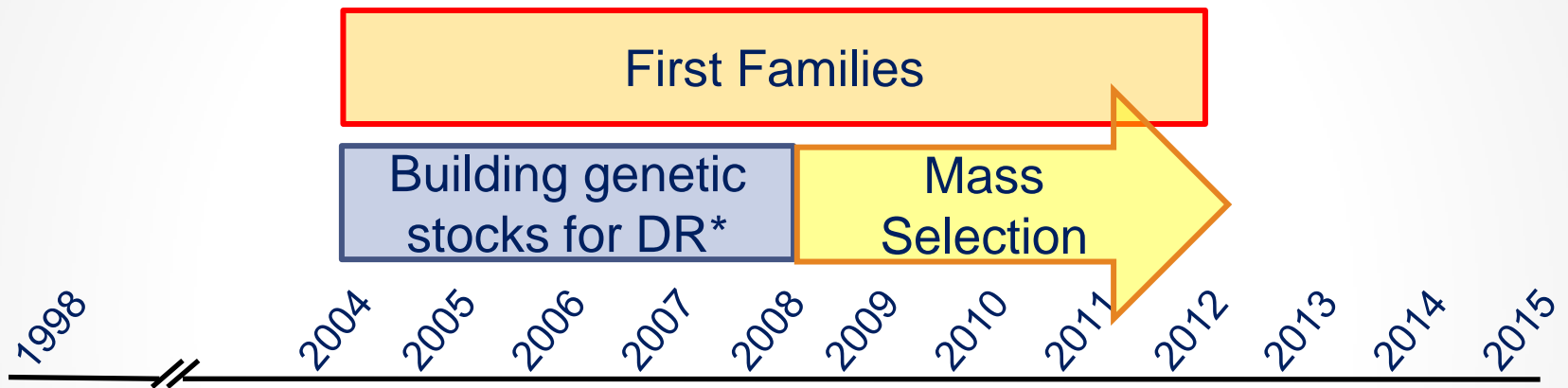


Products to Industry



diploid brood stock distribution 2007-2015

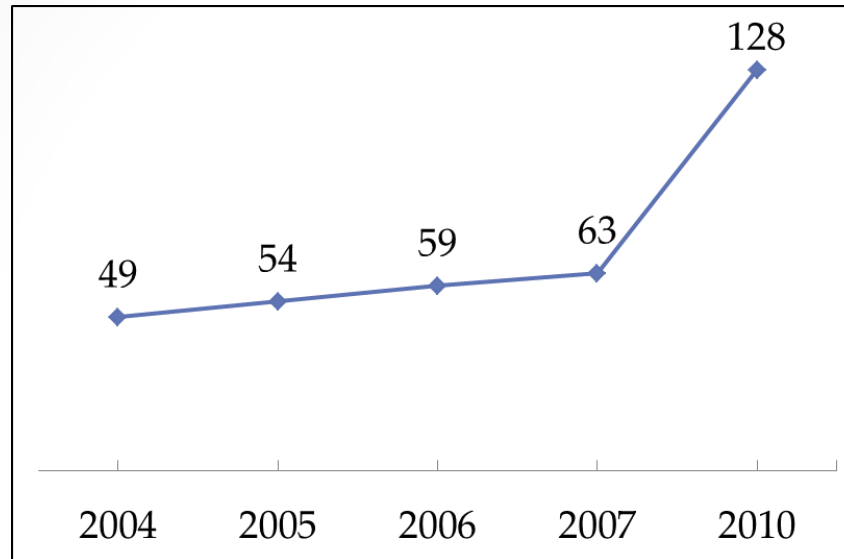
The Evolution: genetic parameters



Dr. Lionel Degremont

Dr. Anu Frank-Lawale

Heritability & Correlation of Traits



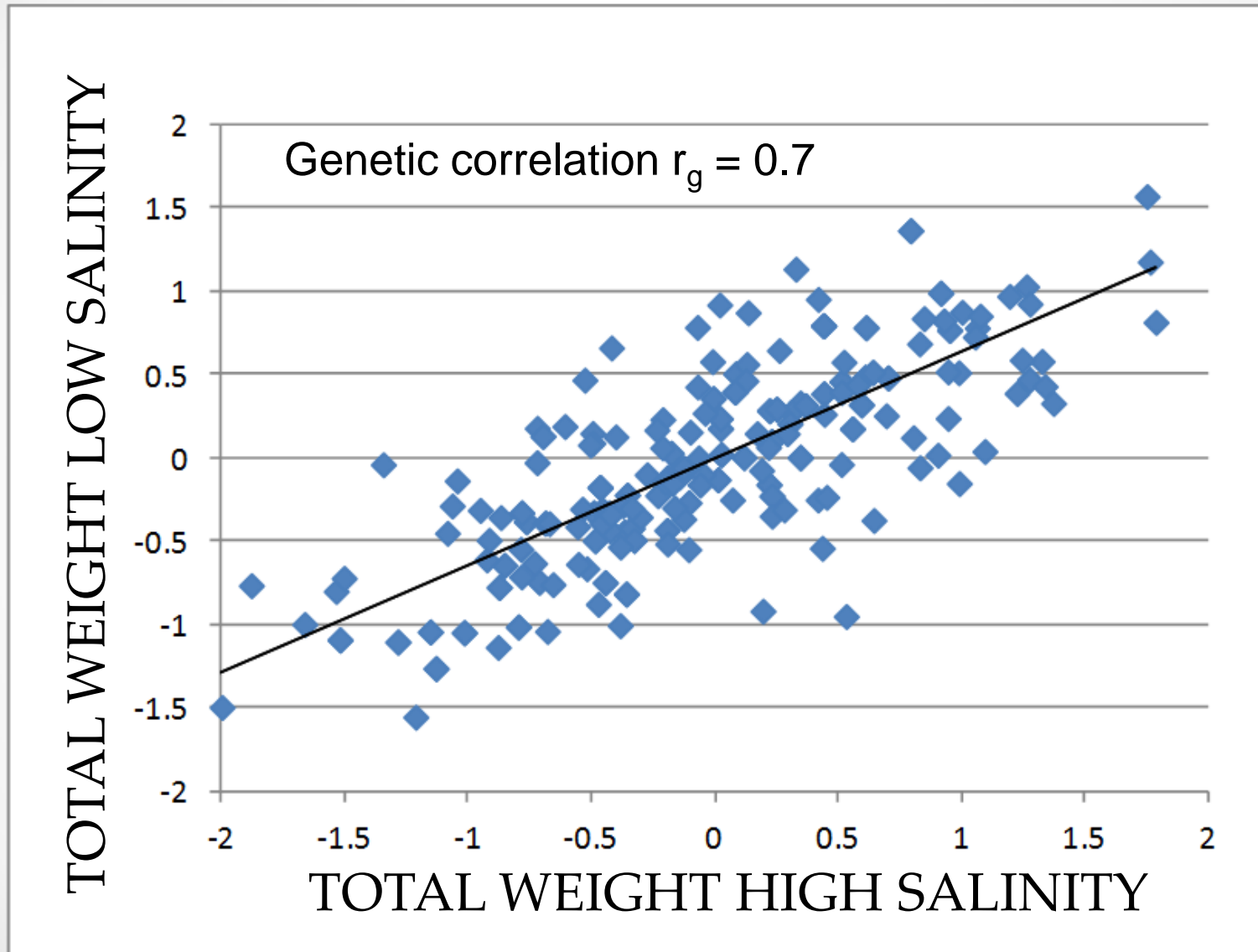
- 225 families
- > 51,000 individuals
- > 610,000 ind. measurements*

* 18 & 30 months only

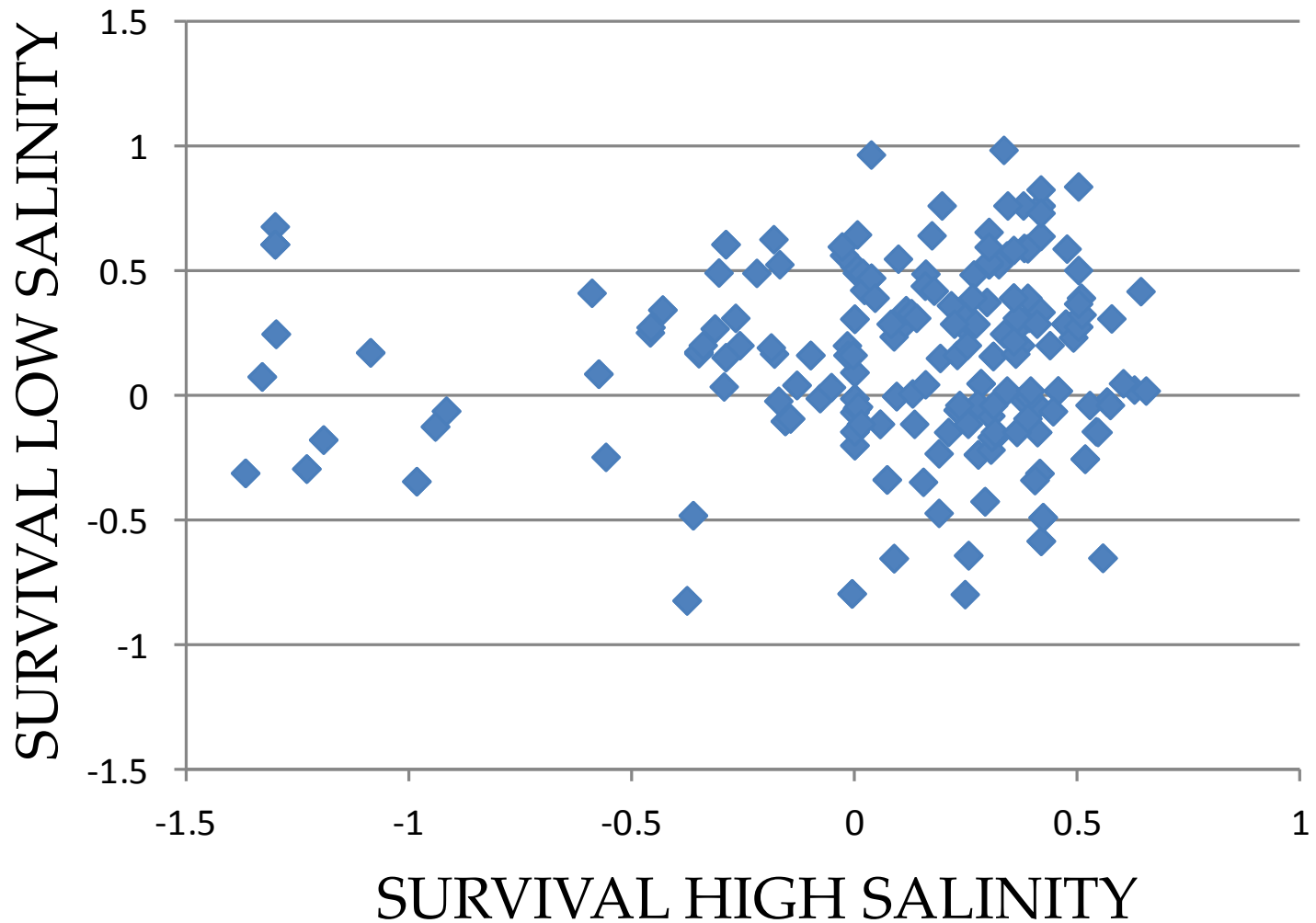
Age/Age Correlation

TRAIT	r_g age 18-30 months
Total weight	0.99 ± 0.05
Length	0.99 ± 0.05
Width index	0.99 ± 0.07
Height index	0.99 ± 0.05
Meat yield	0.99 ± 0.05
Meat weight	0.98 ± 0.10
Survival low salinity	0.73 ± 0.04
Survival high salinity	0.82 ± 0.03

Low vs. High Salinity Correlations – total wt.



Low vs. High Salinity Correlations -- survival



Heritability – low and high salinities*

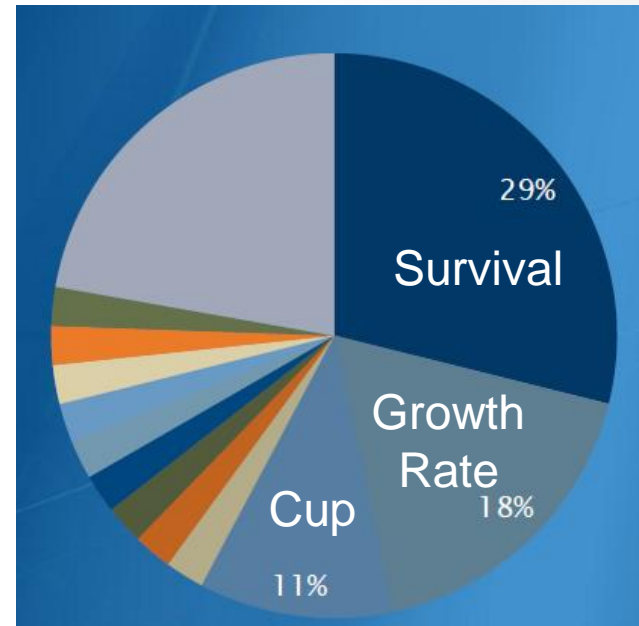
TRAIT	h^2 low salinity	h^2 high salinity
Total weight	0.23 ± 0.04	0.15 ± 0.03
Length	0.21 ± 0.04	0.14 ± 0.04
Width index	0.10 ± 0.02	0.07 ± 0.02
Height index	0.14 ± 0.03	0.13 ± 0.03
Meat yield	0.12 ± 0.04	0.14 ± 0.04
Meat weight	0.12 ± 0.03	0.12 ± 0.03
Survival	0.24	0.21

* 18 months

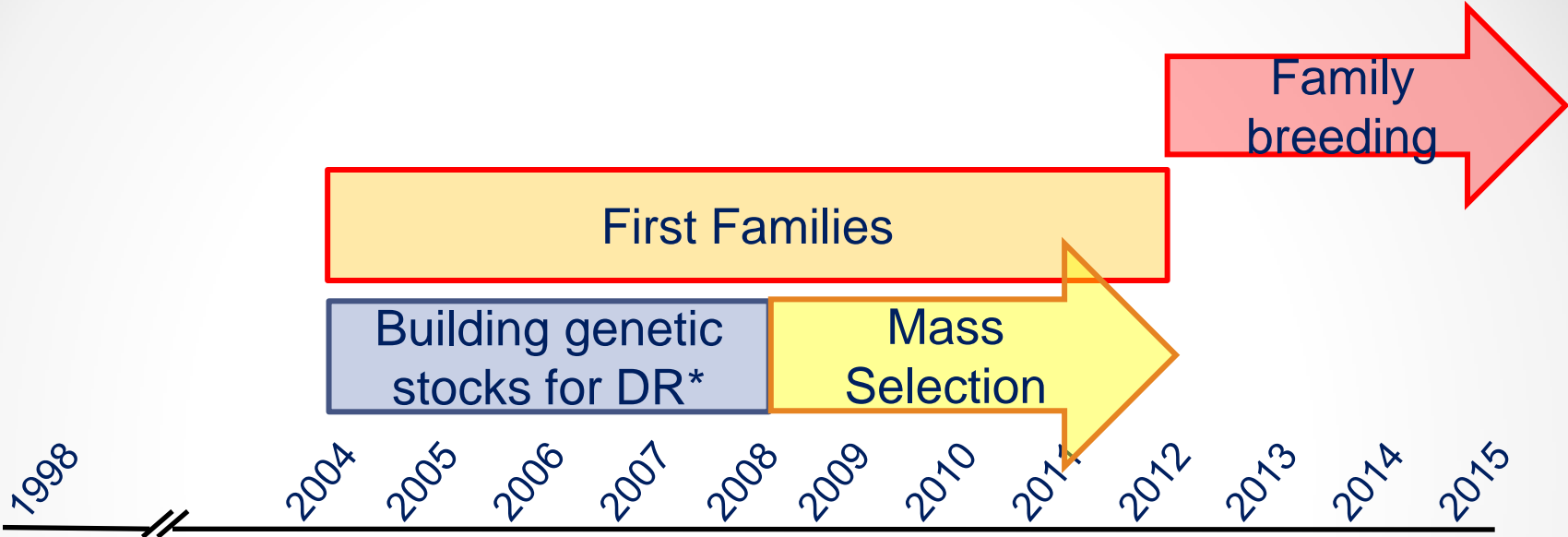
Economic Weights

What is important?

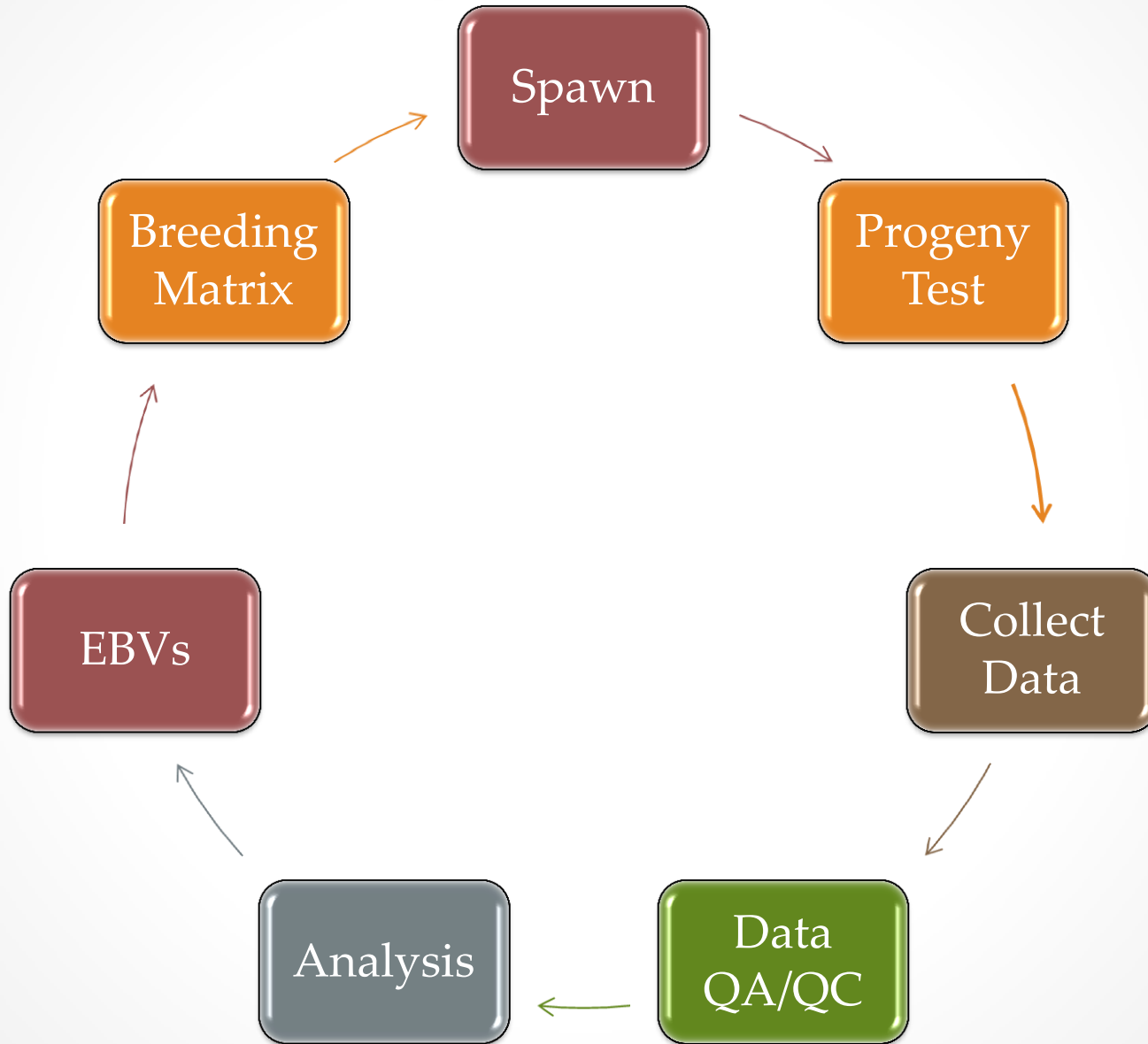
- survey to growers (297)
- traits of importance defined
 - growth rate
 - survival
 - shape
 - uniformity
 - seed acceptability
- traits + crop budget = **economic weight of traits**



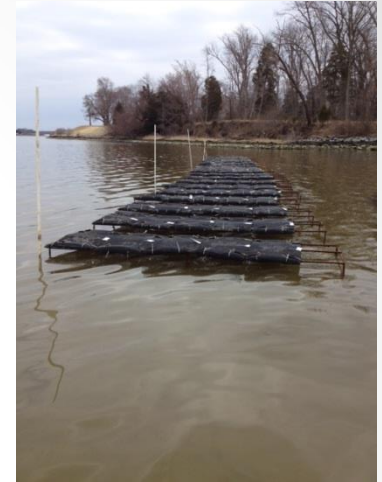
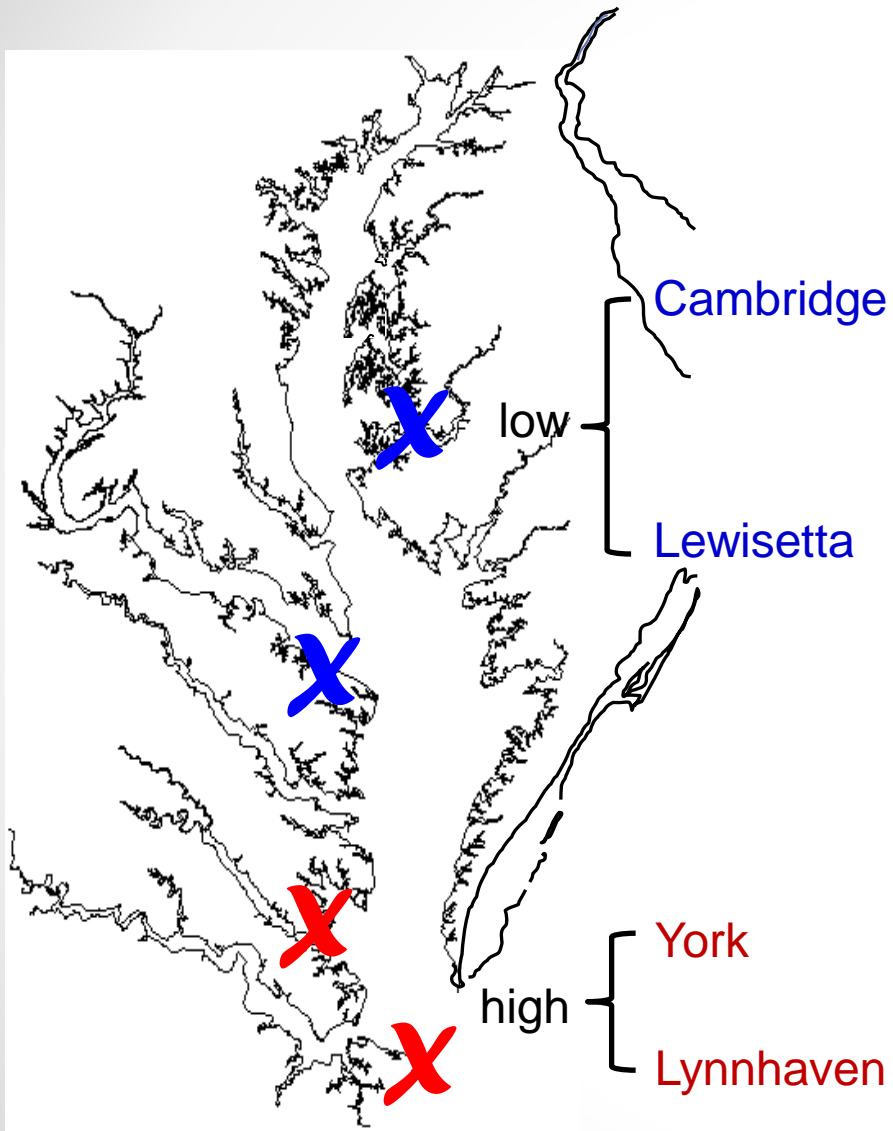
The Evolution: index selection



Family Production

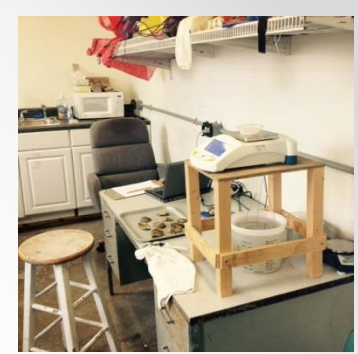


Families - Progeny Test



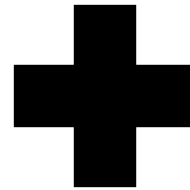
- 2013 – 126 families
- 126,000 oysters

Families - Data

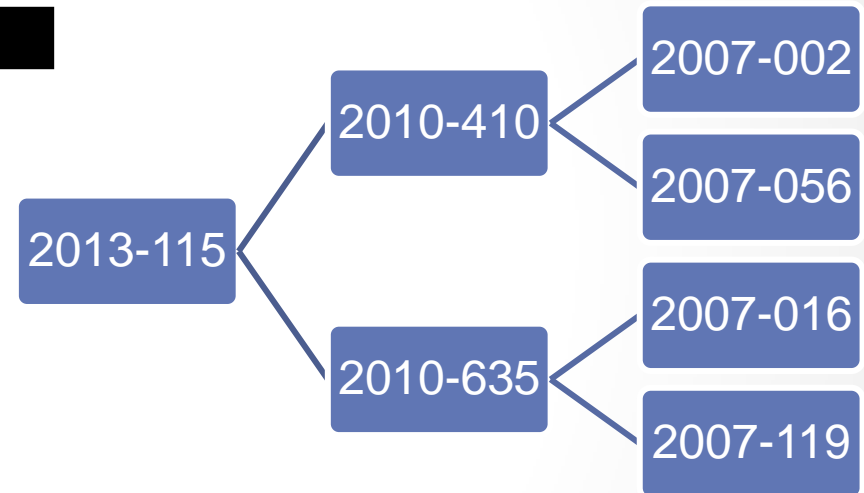


DATA

- YC2013 – 126 families
- 10,680 oysters
- 38,880 measurements
 - survival
 - length
 - width
 - height
 - meat weight
 - total weight



PEDIGREE



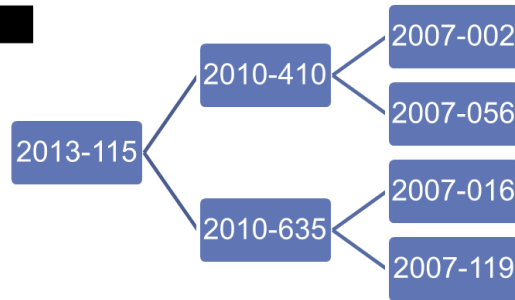
Family Data - Analysis

DATA

- YC2013 – 126 families
- measured 10,680 oysters
- 38,880 measurements
 - survival
 - length
 - width
 - height
 - meat weight
 - total weight



PEDIGREE



**Estimated
Breeding
Values**

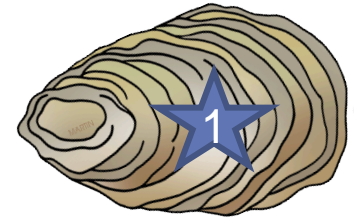


Families – Who to Spawn Next?

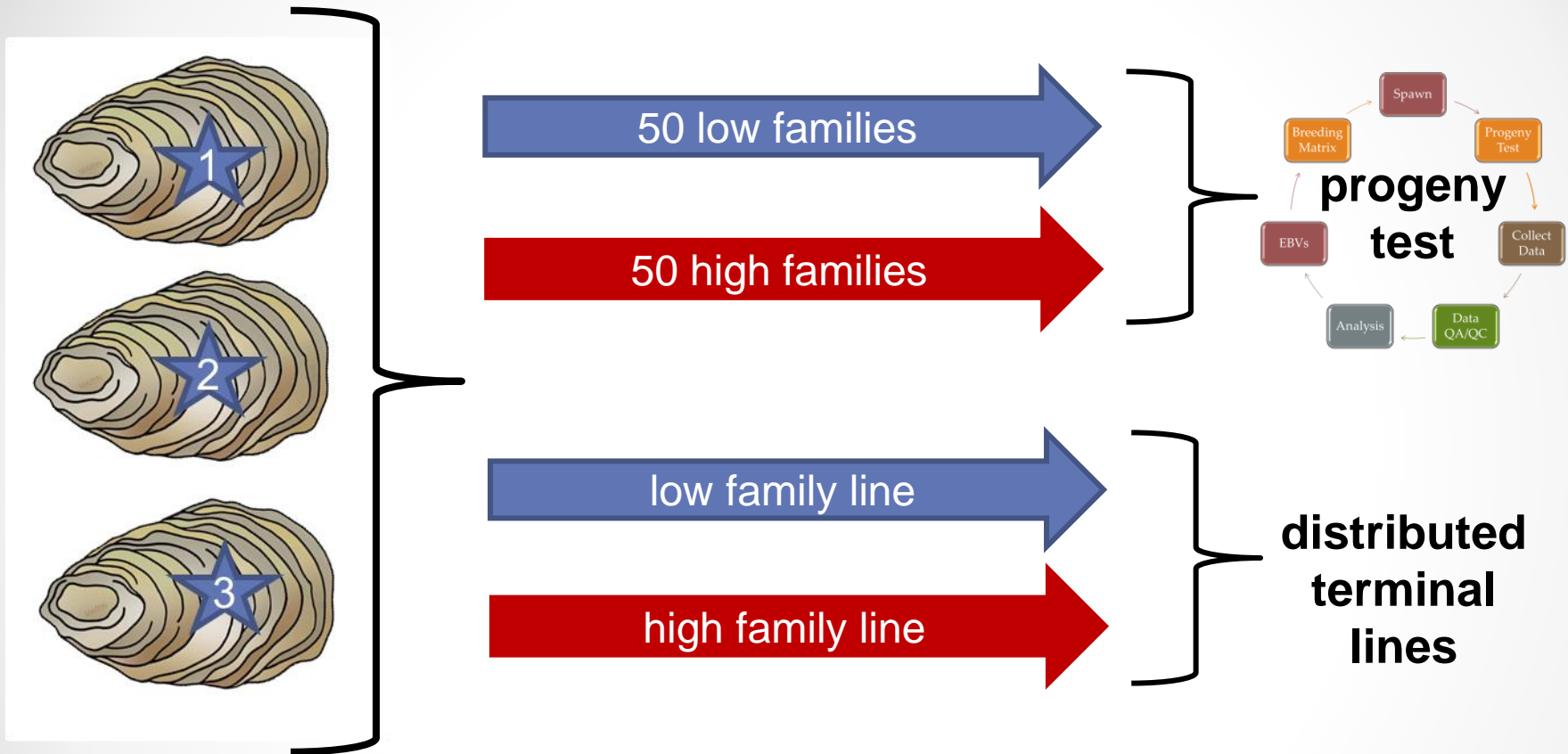
**Estimated
Breeding
Values**



Index
(sum of
weighted trait
EBVs)



Family - Production SOP



Acknowledgements

- ABC staff – past and present
- Horn Point Lab - UMCES
- CSIRO
- Virginia Sea Grant



