

Genomic selection of greenlip abalone for improved growth rate, limiting inbreeding & maintaining genetic diversity

Marie Lillehammer, Tom Hyde, Craig Marshall, Cameron Davidson & Nick Robinson



Abalone genetic improvement challenges

- High fecundity & low number of spawners
- Large potential for inbreeding & loss of genetic diversity
- Environmental variation
- Mate selected individuals in desired combinations

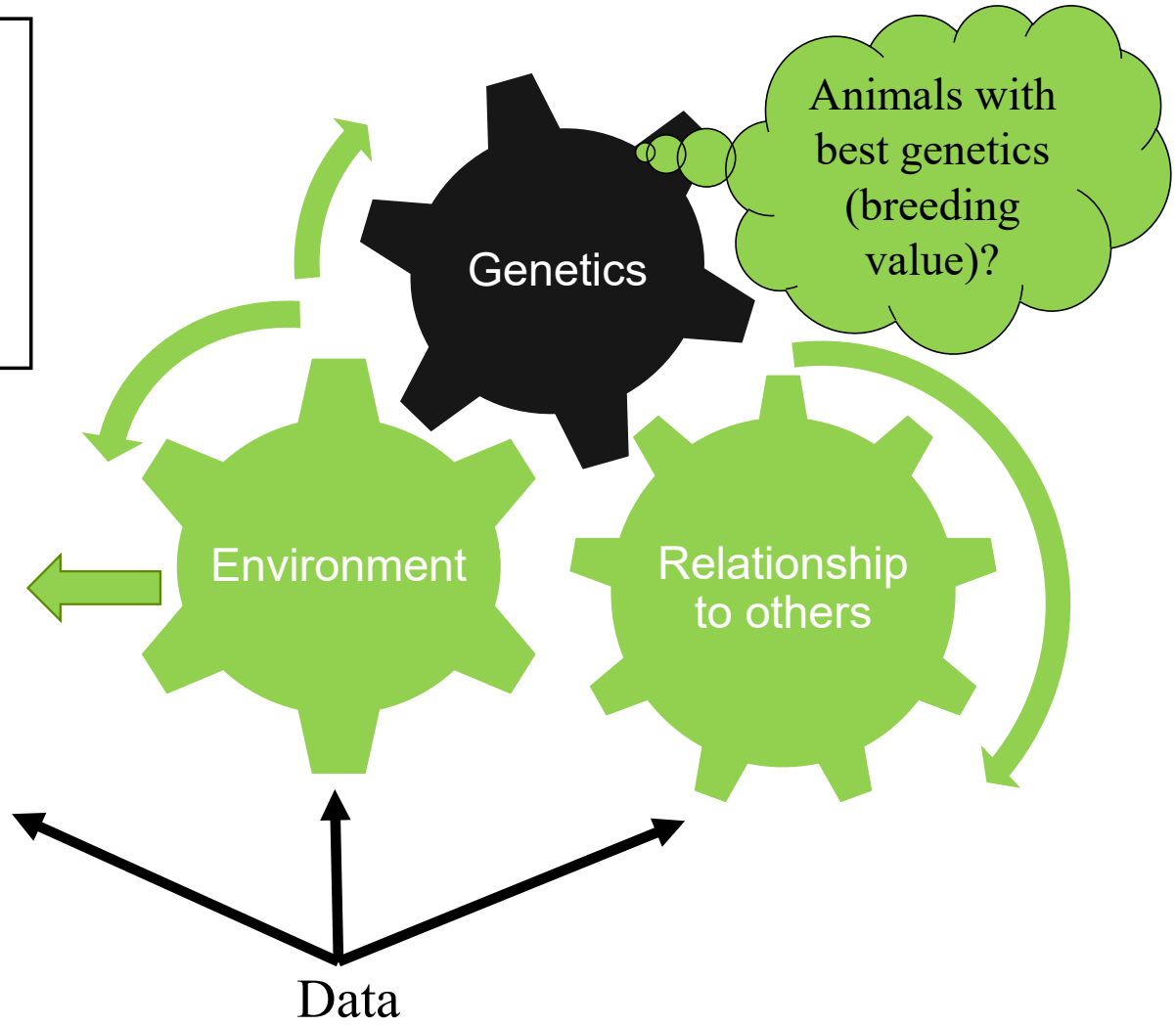
- Start with diversity
- Control who mates with who
- Potential breeders to select from → selection intensity
- Large number of contributors to each generation
- Equalise contribution (equal numbers of offspring)
- Common rearing environment & DNA to determine relationships
- Follow instructions!

Predicting breeding value

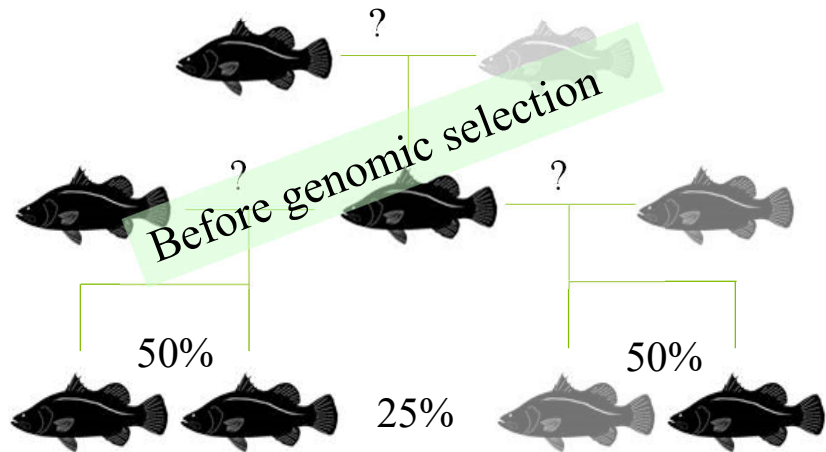
Objective: An abalone that performs well in culture environment



Whole abalone weight as a measure of performance



Relationships are **crucial** for predicting breeding value



Genomic selection

(Meuwissen et al. 2001)



Advantages:

- DNA sequence →
“true” genetic relationship
- Deep relationships
- High accuracy →
improve genetics, maintain
variability & limit inbreeding

Practical demonstration of genomic selection for growth rate

Genotyped with 29,556
SNPs (ddRADseq
GenomNZ)

Largest 2,455 (~5%) pre-
selected candidates, weighed,
sexed, tagged & transferred to
common tank when sampled for
DNA (April 2022)

Family matings pooled as larva
& grown in 16 tanks on farm
(Aug 2019)



Evaluation (h^2 , accuracy & ΔG)

Genomic predictions:

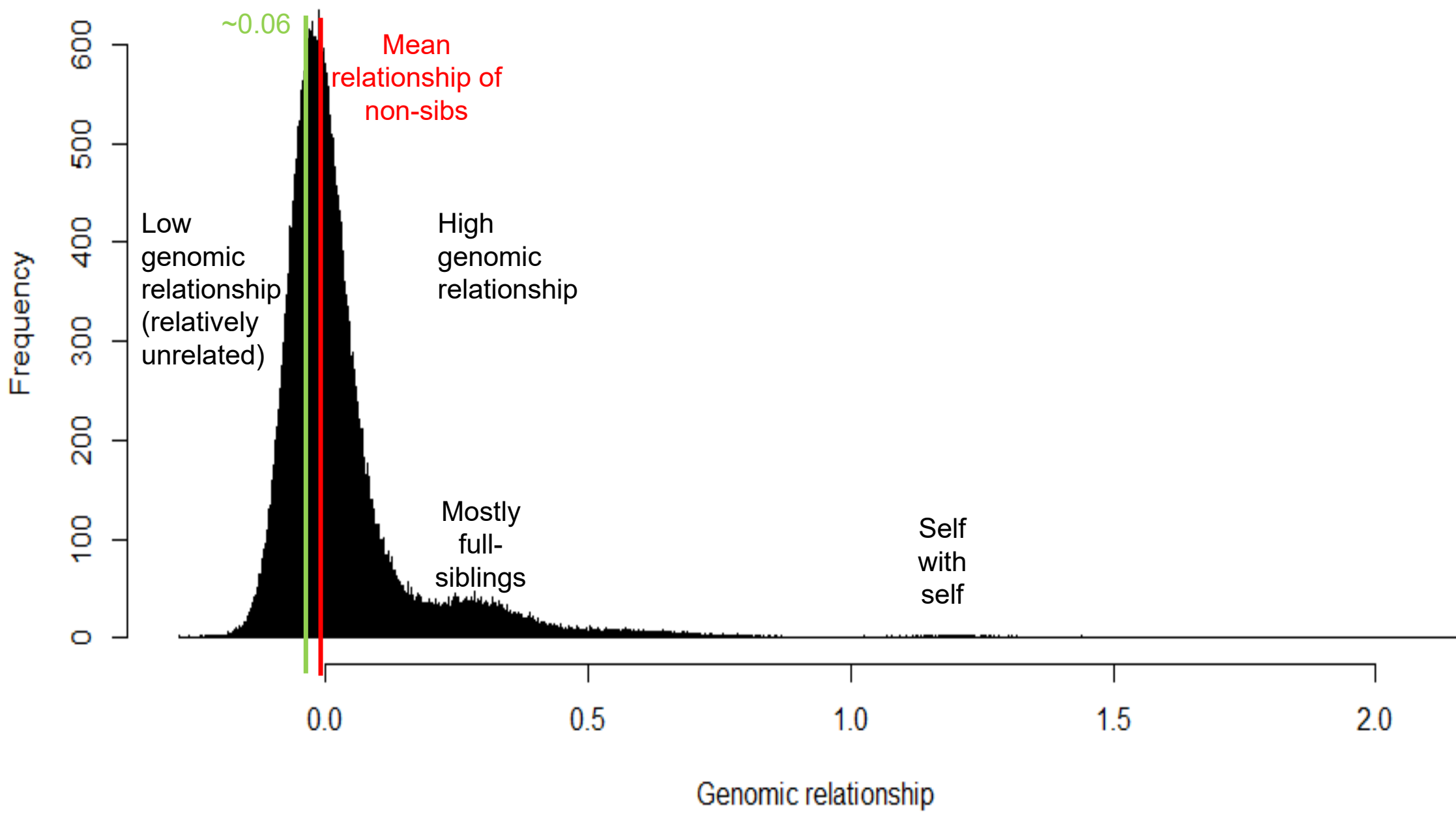
- breeding values (gEBV),
- relationships &
- tree of ancestry

Sex verification

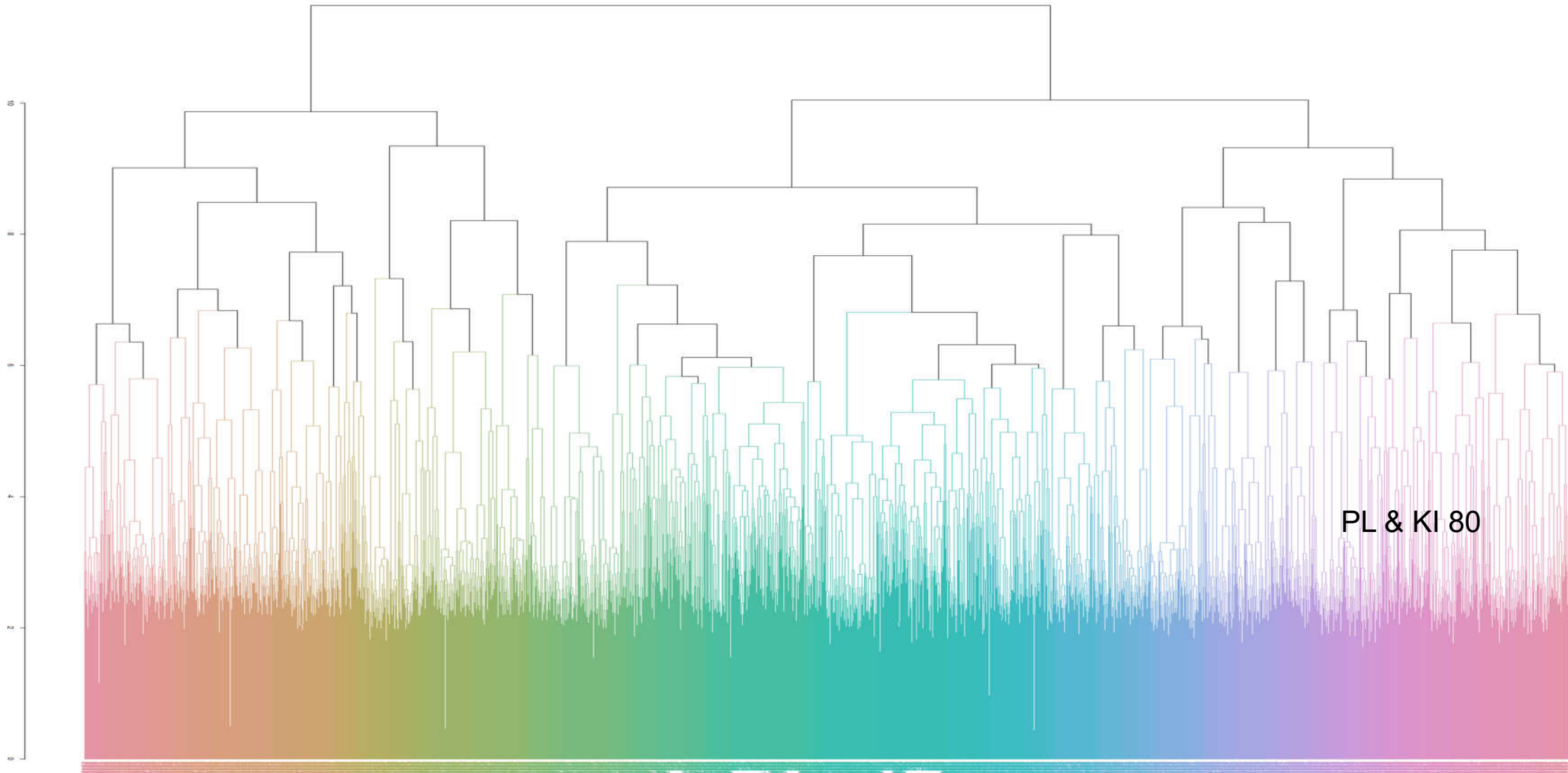
Mate prioritisations & “lookup
chart”

Spawn in individual tubs & pair
mate (60 pairs including some
half-sibs) (Sept 2022)

Combine equal numbers of
viable larvae



Colour coding the main (80) genetic groups detected

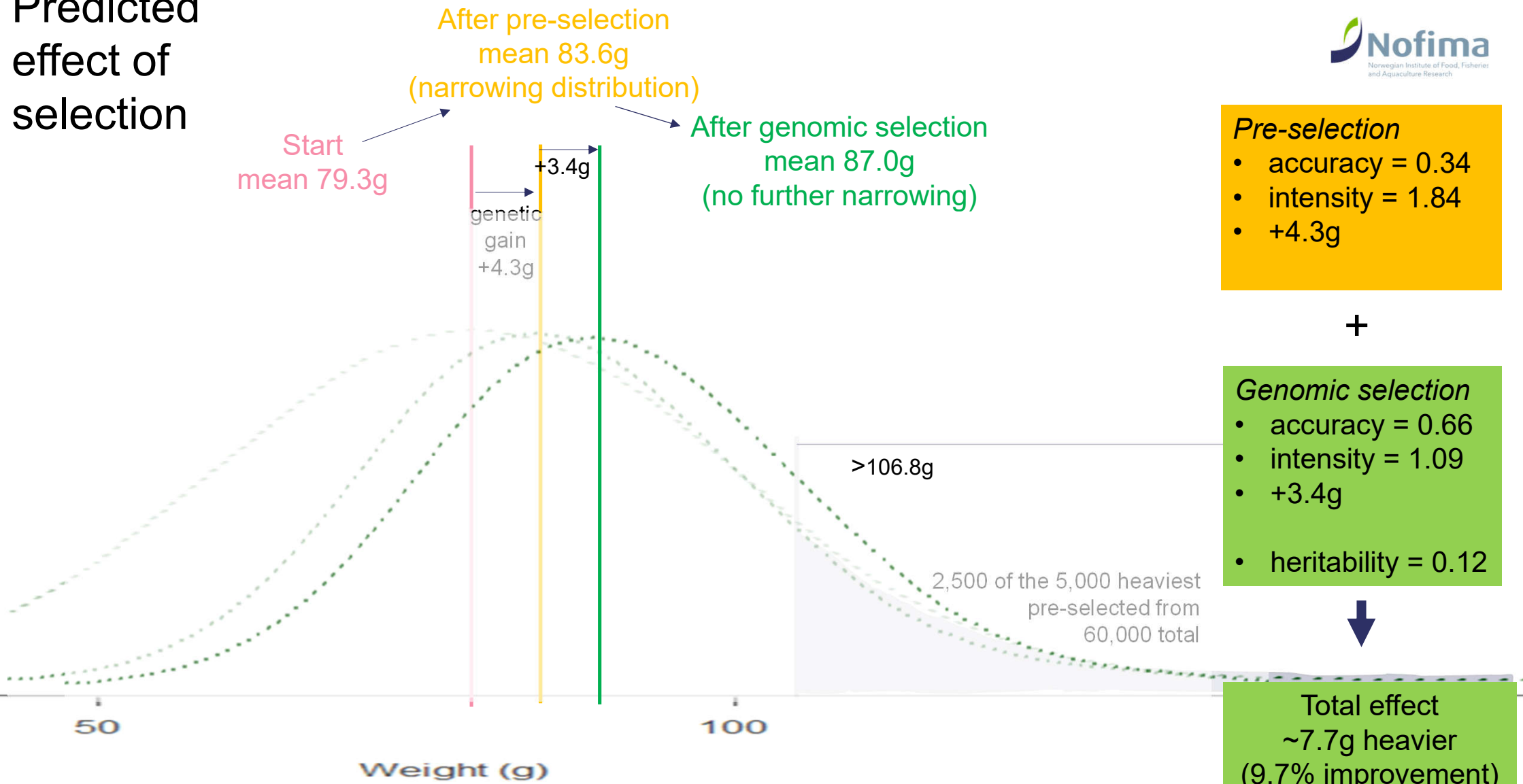


	Growout		Wt(g)	gEBV_Wt_WithoutK	GonadRating	Mortality	Selection_Index	ColorCode	E398	C250	B981	E464	D569	E386	E835	Female	Male	Tank		
	M TankNo	TrueSex																		
MatesPicked_Y	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	E398	C513	Tank1	0
GrowoutTankNo	0	0	0	0	0	0	0	0	6	8	6	5	8	6	5	2	C250	C516	Tank1	8
TrueSex	0	0	0	0	0	0	0	f	f	f	f	f	f	f	3	E464	E393	Tank1	f	
Wt(g)	0	0	0	0	0	0	0	0	156	121	159	127	162	135	144	4	D569	B984	Tank1	127
gEBV_Wt_WithoutK	0	0	0	0	0	0	0	0	21.61	18.12	15.01	14.83	14.74	12.95	12.82	4	D569	B984	Tank1	159
GonadRating	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	NA	5	E386	D247	Tank1	f	
Mortality	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	NA	6	C208	E519	Tank1	159	
Selection_Index	0	0	0	0	0	0	0	0	21.61	18.12	15.01	14.83	14.74	12.95	12.82	5	E386	E519	Tank1	159
ColorCode	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	C208	E479	Tank1	8
E253	1	m	128	15.48	2	15.48	D5A07B	0.597846	0.037103	0.000975	-0.01693	-0.00363	0.020302	0.597846	7	D057	E479	Tank1	539	
E457	1	m	135	14.99	3	14.99	40BEA8	0.108158	0.04669	0.001804	0.040582	0.046496	-0.02789	0.172	8	E523	E215	Tank1	257	
E490	3	m	143	14.95	3	14.95	E2979B	0.133871	-0.06746	-0.02524	-0.01406	-0.01298	-0.01757	0.288	9	E523	E215	Tank1	109	
D305	2	m	157	12.7	2	12.7	E2979B	0.297842	-0.03755	-0.03744	-0.05968	-0.07269	0.002571	0.288	10	E523	D507	Tank1	489	
C516	3	m	135	12.64	2	12.64	E2979B	0.194834	-0.07134	-0.05611	-0.02288	-0.05775	-0.0128	0.32	11	E579	C488	Tank1	026	
E523	3	m	138	12.47	2	12.47	CF98D7	-0.05566	0.014475	-0.04122	-0.0499	0.349552	0.050982	-0.02763	11	E525	E070	Tank1	048	
D625	2	m	149	12.45	2	12.45	CF98D7	-0.09735	0.005774	0.02629	-0.10983	0.342692	-0.03579	-0.00928	12	E958	C413	Tank1	288	
C052	3	m	116	12.33	2	12.33	5CB7D3	0.133772	0.349632	0.274067	-0.01431	-0.02347	0.123763	0.140071	12	E958	C413	Tank1	217	
E483	2	m	110	12.26	2	12.26	E396A0	0.087239	0.005598	0.034095	-0.03353	-0.09515	-0.03775	0.129326	13	C549	E234	Tank1	297	
D765	2	m	115	12.14	3	12.14	5CB7D3	0.127263	0.327572	0.263096	-0.03974	-0.02616	0.043785	0.078826	13	C549	E234	Tank1	829	
C477	3	m	119	12.05	3	12.05	78BA7E	-0.01547	0.232919	0.076934	-0.04751	-0.00727	0.017922	0.009458	14	E318	C476	Tank1	905	
E579	3	m	150	11.74	2	11.74	CB9ADA	-0.0053	-0.00544	0.032173	0.019626	0.335178	-0.02914	0.007426	15	E256	C477	Tank1	447	
E365	1	m	141	11.69	2	11.69	E396A0	0.031761	-0.00547	0.044323	-0.04828	-0.00646	-0.04647	-0.03265	16	E256	C477	Tank1	987	
C438	3	m	121	11.52	2	11.52	5CB7D3	0.05378	0.237044	0.28913	-0.01103	0.014707	0.076845	0.059837	16	E488	E217	Tank1	576	
C513	3	m	144	11.52	2	11.52	E393B7	-0.10089	-0.06035	-0.07363	0.3746	-0.0549	-0.07959	0.002659	17	B963	D680	Tank1	982	
D255	1	m	143	11.47	3	11.47	D5A07B	0.261405	0.064255	0.025073	-0.04143	0.00353	-0.02386	0.402697	18	E366	E508	Tank1	941	
E325	2	m	130	11.28	2	11.28	D297D5	-0.0176	-0.01335	-0.02823	0.340238	0.679846	0.042534	-0.06687	18	E366	E508	Tank1	186	
E211	1	m	131	11.25	2	11.25	D5A07B	0.498234	-0.02856	0.018632	0.010113	0.005649	-0.00554	0.497078	19	E513	C238	Tank1	179	
E489	3	m	151	11.21	3	11.21	D5A07B	0.350857	-0.03204	-0.01803	-0.04575	0.019749	0.051437	0.328833	19	E513	C238	Tank1	485	
E479	1	m	132	11.18	2	11.18	4BBE9E	0.055247	0.041037	0.014715	-0.00738	0.006468	-0.02658	0.030401	20	E356	E251	Tank1	026	
C549	2	m	137	11.09	2	11.09	39BEB1	-0.00323	0.010977	0.014819	-0.09264	0.079222	0.089809	-0.05203	21	D946	E357	Tank1	654	
E318	2	m	140	11	2	11	C29DDE	-0.06198	0.007844	0.091421	-0.02053	0.394865	8.19E-05	-0.08434	21	D946	E357	Tank1	827	
D111	2	m	137	10.84	3	10.84	D5A07B	0.582645	0.03092	-0.00455	-0.03866	-0.04573	0.069671	0.620567	22	E274	D582	Tank1	289	
E447	1	m	139	10.76	2	10.76	73B2DB	0.050095	-0.02132	-0.03547	-0.05919	0.034904	0.018439	0.01952	23	E505	C494	Tank1	763	
C203	2	m	145	10.61	3	10.61	5EBD90	0.016932	0.22273	0.290197	0.022687	-0.01745	0.105206	0.030173	23	E505	C494	Tank1	33	
D162	2	m	132	10.61	2	10.61	D297D5	0.009527	0.018042	-0.01398	0.272178	0.706284	0.023216	0.026403	24	C021	E447	Tank1	085	
C525	2	m	133	10.36	3	10.36	D5A07B	0.421811	0.019576	-0.03711	-0.00665	-0.01029	-0.01224	0.427095	25	E449	E566	Tank1	05	
B984	1	m	125	10.26	2	10.26	E19896	0.308339	-0.05764	-0.03655	-0.07428	-0.09915	-0.07755	0.247423	25	E449	E566	Tank1	511	
E492	3	m	151	10.25	2	10.25	C8A66D	0.335315	-0.05405	0.023353	-0.03853	-0.0293	-0.01568	0.189609	26	C057	D761	Tank1	603	
E321	2	m	135	10.22	2	10.22	42BB66	0.023245	0.083134	0.05824	0.028256	0.069507	0.018560	0.0823	0.026224	0.05827	0.02808	0.05032	0.014521	0.128474

Recommended mate pairs for the 8 conditioning tanks

Etc.....
(200 pairs = 400 animals total)

Predicted effect of selection



Summary, genomic selection strategy:

- Adds little cost if genotyping is required anyway
- Large potential benefits over conventional selection
 - Adds 4% genetic gain to pre-selection (→total ~10%)
 - Enabled inbreeding to be tightly limited
 - Genetic variation well maintained

Platform for continuous improvement of this & other traits

