Effective Population Size (N_e) and Parental Considerations

(doesn't get much more exciting than this)

Michael Stoehr

FIRM

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Ne = effective population size

- A theoretical concept that estimates deviation from an **ideal population**

- **Ideal population:** a randomly mating population with equal size of offspring (gametes) and no generational overlap

- **These populations do never exist**

Some properties of Ne

- The census population size (Nc) is always bigger than Ne
- Ne can b e different for different traits
- We use Ne as surrogate for genetic diversity

Ne Calculations

- $Ne = 1/(2f)$

- where f= inbreeding co-efficient
- 4 parents, unrelated, equal gamete contribution: f=.125
- f = average group co-ancestry

Average Group Co-ancestry

Parent	1	2	3	4
1	0.5	0	0	0
2	0	0.5	0	0
3	0	0	0.5	0
4	0	0	0	0.5

f = Sum of entries/ number of cells = 2/16=.125

So:

Ne = 1/(2*.125) = 4

Nc and Ne

- Ne is the size of a population that has inbreeding levels that are higher than the census population Nc:
- Nc=3, f = 1.5/9= 0.166

- So if Nc = 4, but its Ne = 3, that means that inbreeding in that population is 0.166 (like in an “ideal” 3 clone population)

Ne in Orchard Seedlots

- $Ne = 1/\Sigma p_i^2$
- where p_i = proportional gamete contribution of clone I

Clone	# gametes	proportion	prop^2
1	100	0.067	0.004
2	200	0.133	0.018
3	300	0.200	0.040
4	400	0.267	0.071
5	500	0.333	0.111
Sum	1500	1	0.24
		Ne=	4.1

Ne with SMP

Regno	L of Seed Cones	Male Gamete Estimate	SMP Mix (ml)	Prop. Female Contrib	Prop. Male Contrib.	SMP Contrib.	Total Male	Crop	Ne with SMP	Crop without SMP Calc	Ne
508	0.9	11.5	49	0.002	0.023	0.163	0.057	0.029	0.001	0.012	0.000
4503	0.0	1		0.000	0.002	0.000	0.002	0.001	0.000	0.001	0.000
4504	9.3	9.5	53	0.019	0.019	0.177	0.057	0.038	0.001	0.019	0.000
4507	0.0	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4508	65.8	109.5		0.136	0.218	0.000	0.165	0.151	0.023	0.177	0.031
4517	33.0	30.5		0.068	0.061	0.000	0.046	0.057	0.003	0.064	0.004
4518	116.5	126		0.240	0.250	0.000	0.190	0.215	0.046	0.245	0.060
4519	9.5	32.5	6	0.020	0.065	0.020	0.054	0.037	0.001	0.042	0.002
4520	78.2	50	21	0.161	0.099	0.070	0.092	0.127	0.016	0.130	0.017
4522	91.0	28.5	71	0.188	0.057	0.237	0.100	0.144	0.021	0.122	0.015
4523	77.0	101.5		0.159	0.202	0.000	0.153	0.156	0.024	0.180	0.032
4524	4.0	2.5		0.008	0.005	0.000	0.004	0.006	0.000	0.007	0.000
38	0.0	0	100	0.000	0.000	0.333	0.080	0.040	0.002	0.000	0.000
Sum	485.2	503.0	300.0	1.0	1.0	0.7	0.9	1.0	0.137	1	0.162

Ne: **7.008136** **6.164634**

0.76*Male contrib. + 0.24*SMP contrib.

Ne with 50% Contamination

Clone #	♀Contribution	♂Contribution	50% Cont	Crop	Crop^2
1	0.2	0.1		0.15	0.0225
2	0.2	0.1		0.15	0.0225
3	0.2	0.1		0.15	0.0225
4	0.2	0.1		0.15	0.0225
5	0.2	0.1		0.15	0.0225
x1			0.1	0.05	0.0025
x2			0.1	0.05	0.0025
x3			0.1	0.05	0.0025
x4			0.1	0.05	0.0025
x5			0.1	0.05	0.0025
Total	1	0.5	0.5	1	0.125

Ne= 8

Ne with contamination cont.

Clone #	♀Contribution	♂Contribution	50% Cont	Crop	Crop^2	
1	0.2	0.1		0.15	0.0225	
2	0.2	0.1		0.15	0.0225	
3	0.2	0.1		0.15	0.0225	
4	0.2	0.1		0.15	0.0225	
5	0.2	0.1		0.15	0.0225	
x1			0.01	0.005	0.00125	50*0.000025
x2			0.01	0.005		
:			:	:		
:			:	:		
x50			0.01	0.005		
Total	1	0.5	0.5	1	0.11375	

Ne= 8.791209

Ne in orchards with relatedness among clones

Relatedness will increase in advanced generation orchards under maximum gain

but

Relatedness in Orchards decreases Ne and increases inbreeding: decrease in genetic diversity

Ne in orchards with relatedness…..

Gamete Contribution [p]

	p	p^2
195	0.1	0.01
146	0.2	0.04
139	0.2	0.04
193	0.1	0.01
197	0	0
210	0.1	0.01
201	0	0
206	0.05	0.0025
196	0.15	0.0225
141	0.1	0.01
Sum	1	0.145
	Ne=	6.90

Co-ancestry Matrix

Co-Ancestry Matrix [C]

	195	146	139	193	197	210	201	206	196	141
195	0.5	0.0625	0	0.125	0	0	0	0	0.125	0.0625
146	0.0625	0.5	0	0.0625	0	0	0	0	0.0625	0.1875
139	0	0	0.5	0	0	0	0	0	0	0
193	0.125	0.0625	0	0.5	0	0	0	0	0.125	0.0625
197	0	0	0	0	0.5	0	0.125	0	0	0
210	0	0	0	0	0	0.5	0	0.125	0	0
201	0	0	0	0	0.125	0	0.5	0	0	0
206	0	0	0	0	0	0.125	0	0.5	0	0
196	0.125	0.0625	0	0.125	0	0	0	0	0.5	0.0625
141	0.0625	0.1875	0	0.0625	0	0	0	0	0.0625	0.5

average: 0.07375

Ne= 6.779661

Ne in orchards with relatedness……

Ne =1/2[p]’[C][p]

[p]'	**0.1**	**0.2**	**0.2**	**0.1**	**0**	**0.1**	**0**	**0.05**	**0.15**	**0.1**
[p]'[C]	**0.1**	**0.140625**	**0.1**	**0.1**	**0**	**0.05625**	**0**	**0.0375**	**0.11875**	**0.109375**
[p]'[C][p]	**0.104375**									
Ne=	**4.790419**									

Ne is also a reflection of genetic diversity (GD)

- GD= 1 - f = 1-1/(2Ne)

- A group with Ne=10 captures 95% of the GD found in the total population (where the individual were sampled from)
- That is why Ne = 10 is a minimum requirement for seedlot registration
- **GD = 1-1/(2*10) = .95 = 95%**