

3.6 Effective population size

Every new generation inherits half its genes from the sires and half from the dams. This is very important in, for instance, cattle breeding, where the possibility of artificial insemination is used. The number of bulls can here be very low compared to the number of cows.

In case of uneven numbers of the two sexes the effective population size (N_e) can be calculated according to this formula:

$$4/N_e = 1/N_{\text{sires}} + 1/N_{\text{dams}} \text{ or solved for } N_e$$

$$N_e = (4N_{\text{sires}} * N_{\text{dams}}) / (N_{\text{sires}} + N_{\text{dams}})$$

Example 1) 10 sires and 10 dams

$$4/N_e = 1/10 + 1/10 \text{ correspond to } N_e = 20$$

Example 2) 1 sire and 10 dams

$$4/N_e = 1/1 + 1/10 \text{ correspond to } N_e = 3,7$$

Example 3) 100 sires and 100000 dams

$$4/N_e = 1/100 + 0 \text{ correspond to } N_e = 400$$

The variance of the gene frequency in next generation corresponds to what is calculated by use of N_e , see section 3.5. If the number of males and females are the same (example 1), N_e equals the sum. If the number of females is infinite compared to the number of males, N_e equals 4 x the number of males. The sex which has the lowest number of individuals determines the effective size of the population.

The effective population size and increase in inbreeding.

The effective size of the population is important in relation to accumulation of inbreeding in a population. In populations with few animals all the animals will be closely related to each other within a few generations. Inbreeding occurs when the parents of an individual are related, see chapter 4. Inbreeding leads to several negative effects, which are directly proportional to the coefficient of inbreeding. According to the formula the increase in inbreeding is inversely proportional to the effective size of the population:

$$\Delta F = 1/(2*N_e)$$

In a population where $N_e = 20$ the increase in inbreeding is 2.5% per generation.