

## **Issues requiring consideration in developing a strategy for outcrossing.**

### 1) What is meant by 'outcrossing'?

The term is used to describe various degrees of genetic admixture of sub-populations of a species. With specific reference to dogs I have heard the term 'outcrossing' used to describe scenarios from the migration of a single animal into a line, through to the creation of an F1 generation (crossbreed).

### 2) What is the objective?

Why is an outcross being considered? A clear understanding of the objective(s) will inform of the most appropriate strategy.

### 3) Variation can mean unpredictability.

A lack of genetic (and so phenotypic) variation delivers predictability, and vice versa. If considering using migration as a way of increasing genetic and phenotypic diversity it is difficult to predict which traits may see increased variation and to what degree.

### 4) Change in allele frequencies.

In genetically small populations alleles are more likely to drift to fixation than in large populations. Migration is a way of changing the allele frequencies, but we have no way of predicting the magnitude or consequences of these changes.

### 5) Heterosis/hybrid vigour and recombination loss

Heterosis is the opposite of inbreeding depression, i.e. the improvement in performance of a trait in a cross that was previously reduced in inbred parental lines. Both inbreeding depression and heterosis are a function of dominance of alleles at loci affecting the trait, and occur due to the varying proportions of heterozygotes in inbred parental and F1 generations. As a result, heterotic effects are maximal in the F1 generation and deteriorate thereafter (i.e. in F2 or backcross generations). Furthermore, the F2 and backcross generations may experience an additional decline in trait performance due to recombination loss in the production of gametes in the F1 generation.

### 6) Physical compatibility of crosses.

Thought must be given to the physical resemblance of the lines and specific dogs to be crossed to ensure as far as possible of no impact on welfare during mating and parturition (e.g. dystocia).

## 7) Widespread and ongoing health testing.

Effecting an outcross does NOT mean one no longer needs to worry about either the management of genetic diversity or the incidence of genetic disease. There will be deleterious alleles in the crossed generation, albeit perhaps at a lower frequency than in the parental generations. These are at risk of drifting to a high frequency. Selection for a specific trait risks a return to a consequential disease (e.g. BOAS), or rapid increase in the frequencies of deleterious alleles in linkage disequilibrium with genes for the desired trait.

***Glossary******Drift***

The random fluctuation in allele frequencies, which is seen to a greater degree in smaller populations resulting in a higher chance of fixation of one allele in the population.

***F1***

The generation produced from 'crossing' two distinct and separate parental lines (breeds).

***F2***

The generation produced from the interbreeding of the F1 generation. This generation will have the same proportion of the original parent lines/breeds as the F1, but different heterotic and recombination loss effects.

***Heterosis / hybrid vigour***

The complement of *inbreeding depression*, where the progeny of crossed inbred lines show an increase in those traits that previously suffered from inbreeding depression.

***Inbreeding depression***

The reduction of the mean phenotypic value shown by traits connected with reproductive capacity or physiological efficiency. It occurs due to a change in the allelic frequencies of selected lines towards fixation resulting in a decline in the proportion of heterozygote individuals in the population. It is a function of the degree of dominance of an allele.

***Recombination Loss***

The decline in performance beyond that expected in F2 or back cross generations due to the deterioration of heterotic effects. It has been explained as the break-up of breed specific epistatic (interaction) effects, which are maintained in the F1 generation (which possess entire chromosomes from either parent breed) but which occur during recombination of the gametes of the F1 generation.