Glossary of Elk Genetics

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To be an elk farmer is to be involved in genetics. Good breeding, along with good management, is a prerequisite for the best elk. Breeding is about genetics, whether it is the technical process of performance recording and DNA testing, or simply the experience of a stockman. Whatever the level of genetic management, there are an increasing number of technologies and tests available and with this technology comes jargon. This article provides explanation of some genetic terms relevant to the elk farmer and breeder.

Breeding Value (estimated breeding value, EBV, BV): An animal's genetic worth. To calculate the breeding value of an elk, you need performance and pedigree records. To compare the breeding values of animals on different farms, some genetically related animals (e.g. progeny by the same sires) must be raised on both farms. These related animals act as a sort of benchmark for comparison. Analysis of this data allows animals of highest genetic merit, within and between farms, to be identified. The best estimates of breeding value use BLUP (best linear unbiased prediction) to combine performance records from all the relatives. Even if an animal has no performance records, BLUP calculates the value from its parents, progeny and other relatives. For example, the antler breeding value of females is calculated from the records of their male relatives.

DNA: (DeoxyriboNucleic Acid): The chemical "paper" on which the "blueprints" of an animal are written. Every elk embryo has two sets of blueprints, one derived from its sire and one derived from its dam. Both contain detailed, coded instructions that enable the embryo to grow into a mature adult animal. As an elk grows, these DNA blueprints are copied into every new cell. DNA is stored in the cell nucleus, coiled and wound into packages called chromosomes. DNA is a remarkably stable chemical, able to withstand boiling and freezing. It can be chemically extracted for analysis from most tissues: skin, muscle, blood and even bone. However, if samples are not preserved or frozen, tissue enzymes or bacteria can degrade the DNA very quickly so that the "blueprints" are lost.

DNA Marker or Genetic Marker: A piece of DNA that can be easily analyzed in the laboratory. Usually, genetic markers are chosen because they show up differences between individual elk. Depending on the method of analysis used, these "DNA types" may be revealed as a different arrangement of bands on a film or colored peaks on a computerized output. Some DNA markers have a large variety of different DNA types within a herd of elk. These "polymorphic" markers (meaning many forms) are the most useful for testing pedigrees. The challenge for researchers is to find DNA markers that are associated with the key traits (for example, antler weight or pharmacological activity) and use these to assist in selecting the best elk for breeding.

DNA Profile: A database record of the animal's results for a standard set of DNA markers. The set of markers used by NAEBA produces a highly complex profile for each elk. The chance of finding another elk with an identical DNA profile is less than 1 in 1,000,000! These unique profiles provide the potential to confirm the identity of an elk by sending in a second sample of animal tissue (antler, blood, hair, and semen). DNA profiles are compared electronically during parentage testing.

DNA Parentage Test: Correct pedigrees are needed to establish breeding values for elk. DNA markers provide a powerful and independent check of elk pedigree records. If a DNA type is found in a calf that does not occur in the parents, the calf is "excluded". This means it is impossible for this calf to have come from the recorded parents; the true parents must be elsewhere. If, on the other hand, the calf DNA is compatible with the recorded parents, it is said to "qualify" or "match". For AgResearch's Genomnz parentage test, which is used by NAEBA, the chance that a calf will have a "DNA match" with an incorrect set of parents is very small, less than 1 chance in 100 on most farms.

Elk Test: Blood proteins, which differ between elk and red deer, were discovered at AgResearch Invermay, New Zealand. The test derived from this discovery is sometimes referred to as the "Dratch Test," after its discoverer and proponent, Dr. Peter Dratch. The protein test has been refined and extended in North America and used to identify hybrids between red deer and elk. While many hybrids have been identified, the test gives no indication of the proportion of elk and red deer genes in the hybrid. More recent developments at Invermay have identified DNA markers that differ between elk and red deer. These are currently used within New Zealand to assess the percentage of elk and red deer genes in a hybrid. The results are presented as a Genometer(tm). However, this technology requires validation before it is applicable to North American elk herds.

Heritability: The degree to which a particular characteristic or trait is passed on to progeny. There are two influences on the development of an animal: its genetics (DNA) and its environment. In some traits, such as maternal ability or incidence of disease, environmental variables like feeding and season will often play the major role. In these traits the genetic value of an animal may be masked or exaggerated by environment, so it is particularly important to also examine data from the relatives of the animal to estimate its genetic worth. Other traits, such as 3-year-old velvet antler weight, tend to be influenced less by environment (and therefore, have higher heritability), so there is a good chance that a high-performing elk in these traits will have high-performing offspring.

Gene: A specific region of DNA containing the instructions for a function, for example, the design of a specific protein or enzyme. (There are an estimated 100,000 genes in an elk!) DNA of unknown function, sometimes called "junk DNA" separates these genes.

Gene Map: A gene map describes the location and order of genes on the elk DNA. Currently, only about 500 of the 100,000 genes in elk have been mapped. However, research has shown that the arrangement of elk genes is very similar to the pattern of genes found in cattle and sheep. Therefore, the location of many more elk genes can be predicted by comparison with the cattle gene map.

Genetic variation: The genes of every elk are slightly different. This is because, over thousands of years, many mutations create slight differences in the DNA codes inherited by each new generation of elk. Mutations can give rise to positive (e.g., increased fertility), neutral or negative (e.g., susceptibility to a disease) effects. Over generations, the mixing (or recombination) of these mutations ensures that every elk has a unique DNA blueprint. The particular set of genetic mutations inherited determines the genetic value of an elk. Breeders aim to select the few individuals with the best combination of "genes" and mate them as widely as is practical.

Genotype: The "genetic type" of an animal. Genotype can refer to the DNA of a whole animal, or to a DNA profile consisting of a few markers, or to a single DNA marker.

Mutations: Random errors that occur in DNA during the lifetime of an animal. In order to grow, an elk must constantly copy its DNA from old cells to new cells. Sometimes this copying process does not work perfectly and the copied DNA differs from the original blueprint DNA. These differences are called mutations. Very occasionally, mutations give rise to more effective genes and, in some cases, these are passed to the elk's offspring.

Trait: A characteristic of an elk that can be measured. For example: velvet antler weight, weaning weight or whether a cow produced a calf in 1998. Trait measurements form the base data for any genetic improvement program.