Breed Health and Conservation Plan

Labrador Retriever

Evidence Base

CONTENTS

INTRODUCTION

The Kennel Club launched a new resource for breed clubs and individual breeders – the Breed Health and Conservation Plans (BHCP) project – in September 2016. The purpose of the project is to ensure that all health concerns for a breed are identified through evidence-based criteria, and that breeders are provided with useful information and resources to support them in making balanced breeding decisions that make health a priority.

The Breed Health and Conservation Plans take a complete view of breed health with consideration to the following issues: known inherited conditions, complex conditions (i.e. those involving many genes and environmental effects such as nutrition or exercise levels, for example hip dysplasia), conformational concerns and population genetics.

Sources of evidence and data have been collated into an evidence base which gives clear indications of the most significant health conditions in each breed, in terms of prevalence and impact. Once the evidence base document has been produced it is discussed with the relevant Breed Health Co-ordinator and breed health committee or representatives if applicable. Priorities are agreed based on this data and incorporated into a list of actions between the Kennel Club and the breed to tackle these health concerns. These actions and then monitored and reviewed on a regular basis.

DEMOGRAPHICS

The number of Labradors registered by year of birth between 1980 and 2018 are shown in Figure 1. The trend of registrations over year of birth (1980-2019) was+416.95 per year (with a 95% confidence interval of +311.702 to +522.19), reflecting the increase in registration trend during this time.

[Put simply, 95% confidence intervals (C.I.s) indicate that we are 95% confident that the true estimate of a parameter lies between the lower and upper number stated.]
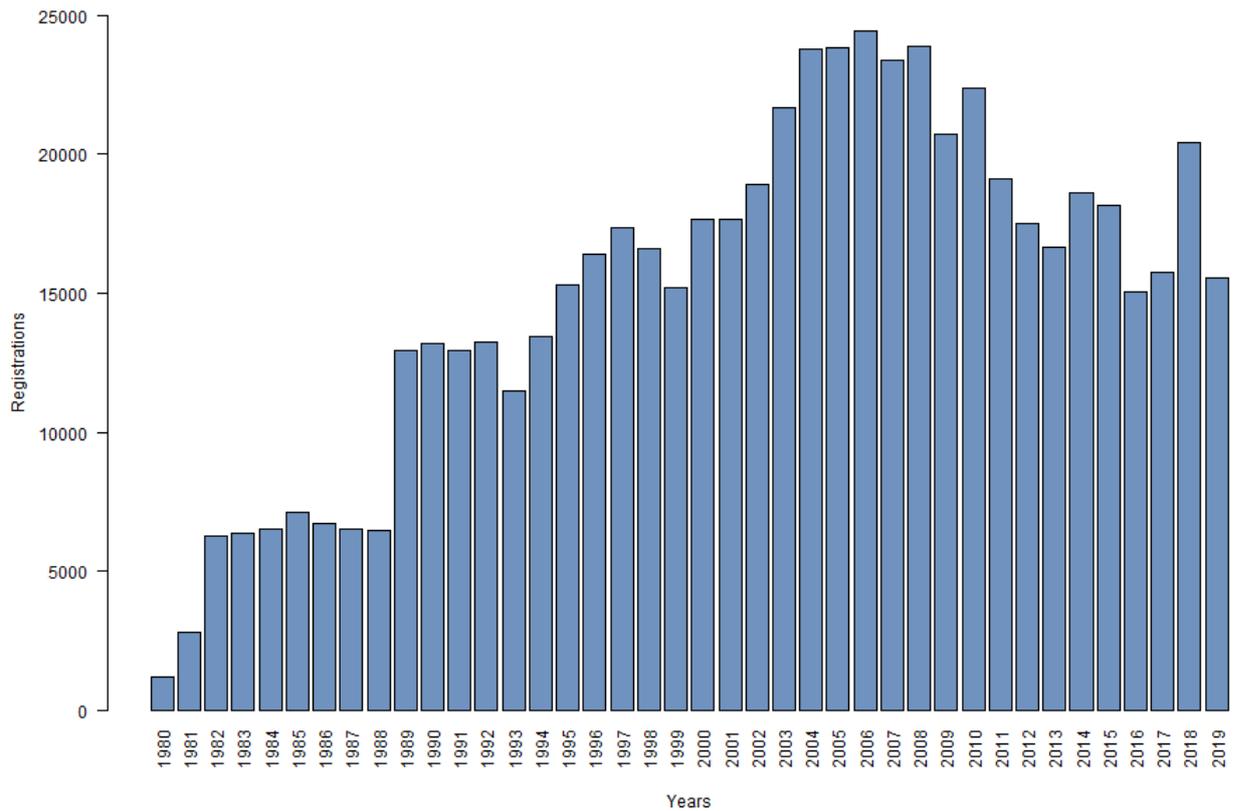
Figure 1: Number of registrations of Labradors per year of birth, 1980 - 2019

BREED HEALTH CO-ORDINATOR ANNUAL HEALTH REPORT

Breed Health Co-ordinators (BHCs) are volunteers nominated by their breed to act as a vital conduit between the Kennel Club and the breed clubs with all matters relating to health.

The BHC's Annual Health Report 2019 yielded the following response to 'please list and rank the three health and welfare conditions that the breed considers to be currently the most important to deal with in your breed':

1. Elbow dysplasia
2. Hereditary cataract
3. Cruciate ligament rupture

In terms of what the breed has done in the last year to help tackle these listed health and welfare concerns it was noted that the breed had requested elbow testing be added as a requirement to the Assured Breeder Scheme, liaised with the Animal Health Trust (AHT) to assist in providing DNA samples for hereditary cataracts, and a member of the Health Committee has been given responsibility to co-ordinate research into cruciate ligament rupture.

BREED CLUB HEALTH ACTIVITIES

The Labrador has a dedicated health sub-committee with comprehensive information regarding health issues in the breed on the Breed Council website.

BREED SPECIFIC HEALTH SURVEYS

Kennel Club Purebred and Pedigree Dog Health Surveys Results

The Kennel Club Purebred and Pedigree Dog Health Surveys were launched in 2004 and 2014 respectively for all of the recognised breeds at the time, to establish common breed-specific and breed-wide conditions.

2004 Morbidity results: Health information was collected for 1,340 live Labradors of which 902 (67%) were healthy and 439 (33%) had at least one reported health condition. The top categories of diagnosis were musculoskeletal (26.9%, 182 of 676 reported conditions), reproductive (13.0%, 88 of 676 reported conditions), dermatologic (8.3%, 56 of 676 reported conditions), ocular (7.1%, 56 of 676 reported conditions) and aural (5.5%, 37 out of 676 conditions). The most frequently reported specific conditions were cruciate ligament rupture (38 reports), hip dysplasia (29 reports), ear infection/ otitis externa (26 reports), lipoma (24 reports), and kennel cough/ infectious tracheobronchitis (22 reports).

2004 Mortality results: In total 574 deaths were reported. The median age at death for Labradors was 12 years and 3 months (min = 2 months, max = 19 years). The most frequently reported causes of death by organ system or category were cancer (31.2%, 179 of 574 deaths), old age (23.0%, 132 of 574 deaths including age combinations), cardiac (7.3%, 42 of 574 deaths), cerebral vascular (5.6%, 32 of 574 deaths) and combinations (5.1%, 29 of 574 deaths). The most frequently reported specific reasons for death were old age (84 reports), stroke/ cerebral vascular/ infarction (28 reports), cancer – unspecified (26 reports), heart failure (24 reports), and euthanasia due to old age (19 reports).

2014 Morbidity results: Health information was collected for 6,938 live Labradors, of which 4,576 (66.0%) had reported no conditions and 2,362 (34.0%) reported affected by at least one condition. The most frequently reported specific conditions were lipoma (10.27% proportion, 430 cases), arthritis (6.28% proportion, 263 cases), elbow dysplasia (5.73%, 240 cases), hypersensitivity (allergic) skin disorder (4.63%, 194 cases), and hip dysplasia (3.68%, 154 cases).

2014 Mortality results: In total 731 deaths were reported. The median age of death for Labradors was 11 years. The most common cause of death was old age (20.25% proportion, 148 cases), cancer – unspecified (10.67% proportion, 78 cases), old age combinations (6.43% proportion, 47 cases), unknown (5.75%, 42 cases), and cardiac/ heart failure (3.97%, 29 cases).

A survey was undertaken in 2017 and received responses representing 3,811 Labradors, of which 1,924 dogs were male (50.5%) and 1,868 females (49.0%). A total of 626 (16.4%) dogs had been bred from.

When asked to detail whether their dog had been affected by a health condition, 3,790 dogs were accounted for, of which 1,984 answered no health concerns (52.3%), and the remaining 47.7% had been affected by at least one condition. Whilst a split in sex presentation for the most common conditions by category are given below, these have not been tested to determine whether they are statistically significant. Conditions are listed where more than three cases have been reported and median/ age split given where cases exceed 10 dogs.

Musculoskeletal Conditions

The most commonly affected category for dogs participating in the survey was the musculoskeletal system, of which 654 dogs were reportedly affected, representing 33 conditions.

The most commonly reported conditions were arthritis affecting 5.0% of dogs in the survey, with a median age of 7.0 years (range 0.4 years to 13.0; 63.0% males), followed by elbow dysplasia/ osteochondrosis (OCD) of the elbow at 4.2% (median age 1.0 years, range 0.0 to 9.0 years; 61.0%), hip dysplasia affecting 2.4% of dogs (1.0, 0.4 – 10.0 years; 56.0% males), lameness lasting over a week in dogs over a year old, 1.9% (4.0, 0.3 – 3.0; 52.1% females), and cruciate ligament disease, 1.7% (4.0, 0.0 – 10.0; 64.6% females).

Count of Musculoskeletal Conditions

Conditions Reported for 3 or more Labradors
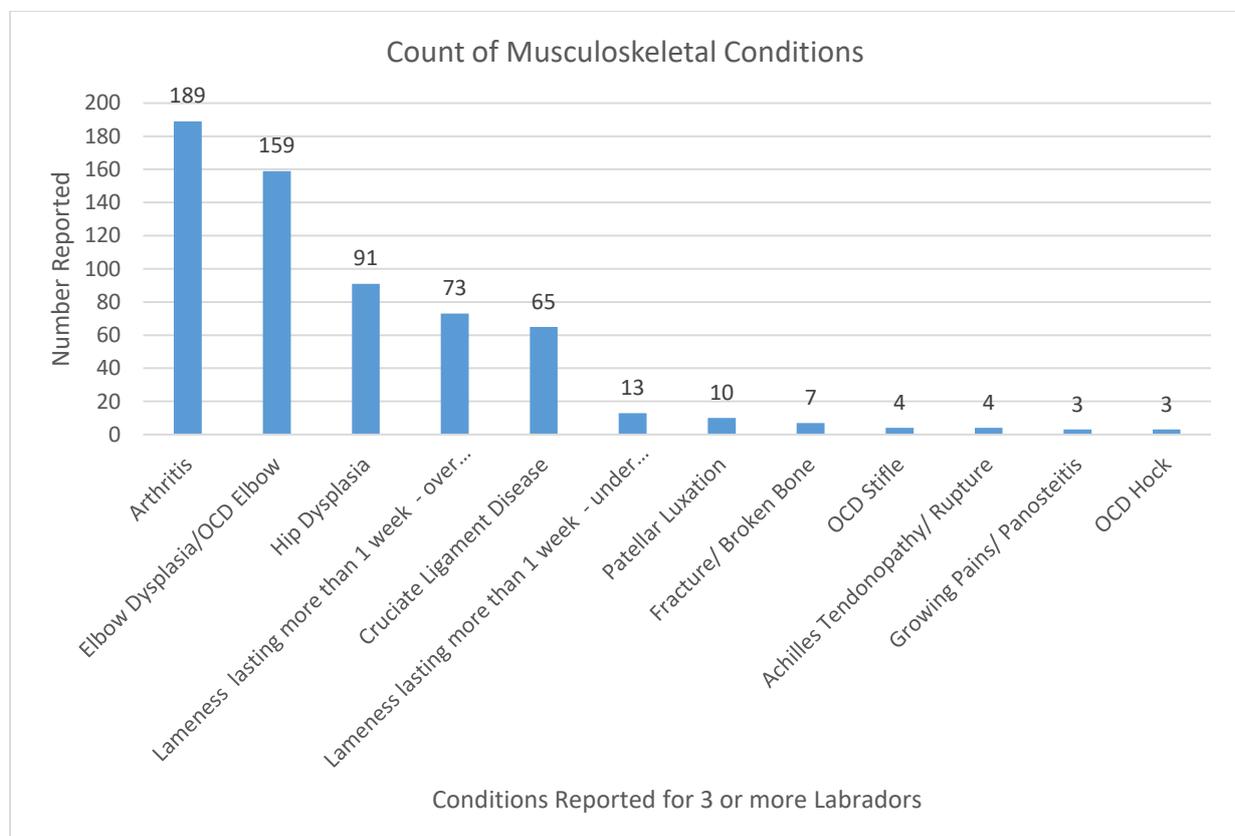
Overall, 11 of dogs affected were put down/ euthanised due to a musculoskeletal disorder with the top reasons being lameness lasting over a week in dogs over a year old (4 dogs), arthritis (3) and muscular disorders (3).

Dermatological Conditions

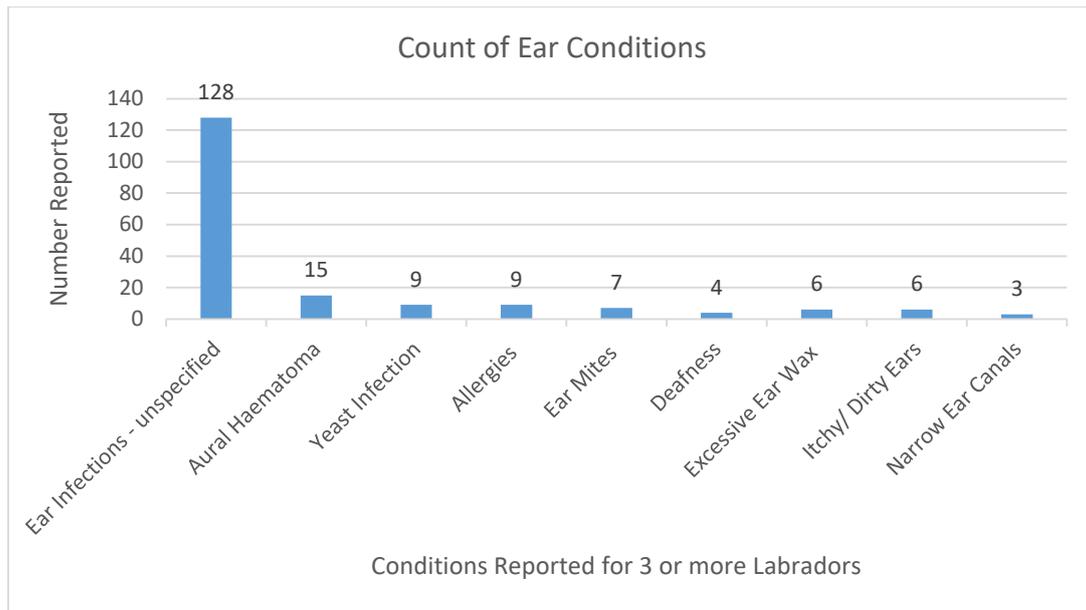A total of 300 dogs were reportedly affected by a dermatological condition, representing 19 conditions. The most common conditions were allergies affecting 4.4% of all dogs (median age 2.0 years, range 0.0 – 9.0; 52.4% females), dermatitis/ eczema/ itchiness, 2.2% (2.0 years, 0.0 – 11.0; 53.3% females), cysts 0.3% (2.0 years, 0.3 – 7.0 years; 71.4% males), and alopecia/ hairloss/ baldness (4.0 years, 2.0 – 8.0 years, 66.7% females).

Count of Dermatological Conditions
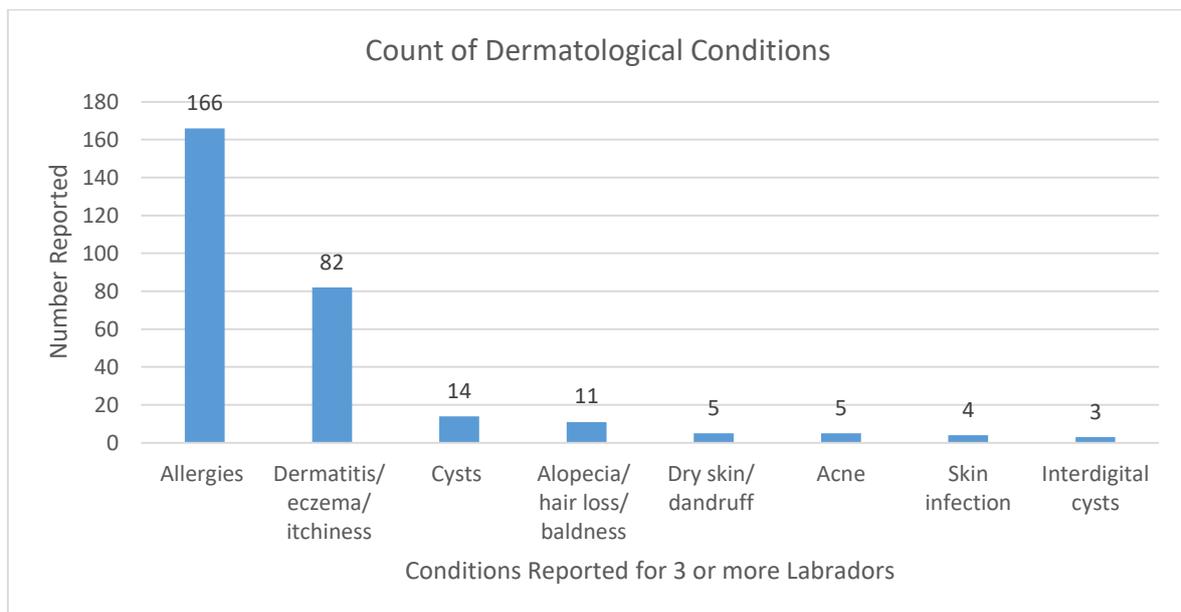
No dogs were put to sleep due to a dermatological condition.

Aural/ Ear Conditions

With regard to aural/ ear conditions, 258 dogs were reportedly affected, representing 16 conditions. The most commonly reported concerns were ear infections – unspecified, affecting 3.4% of dogs (2.0 years, 0.25 – 11.0 years; 60.3% males), aural haematoma 0.04% (6.0 years, 1.0 – 12.0 years; 53.3% females), yeast infection 0.02%, allergies 0.02%, and ear mites 0.02%.

Count of Ear Conditions

Conditions Reported for 3 or more Labradors

No dogs were put to sleep due to an ear condition.

Gastrointestinal Conditions

In total 219 dogs were reported to have been affected by a gastrointestinal condition, representing 21 conditions, with the most common condition being food intolerances/ allergies affecting 1.6% of dogs (1.0 years, 0.0 – 9.0 years; 56.5% males), colitis 0.7% (2.0 years, 0.3 – 11.0 years; 57.1% females), irritable bowel disease 0.6% (3.0 years, 0.1 – 12.0 years; 65.2% males), diarrhoea/ vomiting – unspecified 0.5% (2.0 years, 0.0 – 12.0 years; 68.8% males) and gastroenteritis 0.3% (3.3 years, 0.2 – 11.0 years; 61.5% females).

Count of Gastrointestinal Conditions

Conditions Reported in 3 or more Labradors
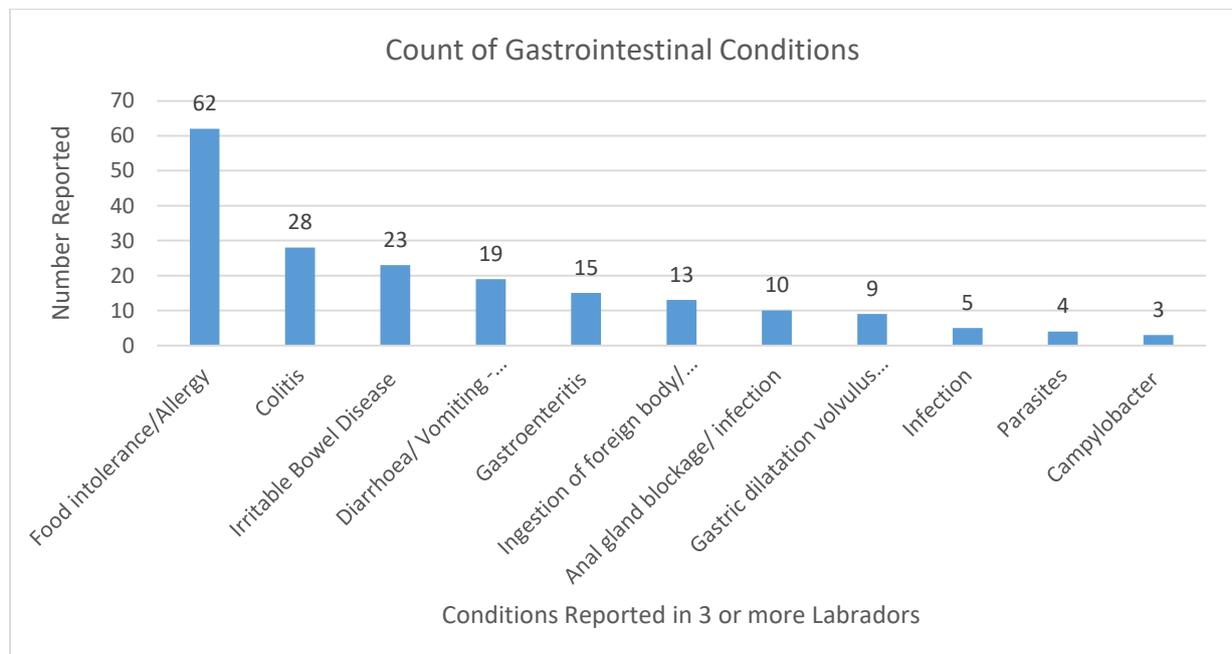
Five dogs were put to sleep due to a gastointestinal condition for five different conditions: reflux, catastrophic rupture, food intolerance/ allergy, megaoesphagus and haemorrhagic gastroenteritis.

Cancers/ Tumours/ Lumps

A total of 201 dogs were reported as having been diagnosed with a cancer/ tumour/ lump, with this encompassing 42 different types. The most commonly reported cancer in the breed were mast cell tumours, affecting 1.1% of dogs (5.0 years, 0.66 – 11.0 years; 60.5% females), skin 0.8% (6.0 years, 0.83 – 12.0 years; 51.6% males), unspecified abdominal mass 0.6% (8.75 years, 0.66 – 14.0 years; 66.7% males), lipoma 0.6% (6.0 years, 2.0 – 12.0 years; 71.4% males), and mammary 0.7% (of all females in survey, 7.0 years, 4.0 – 10.0 years).
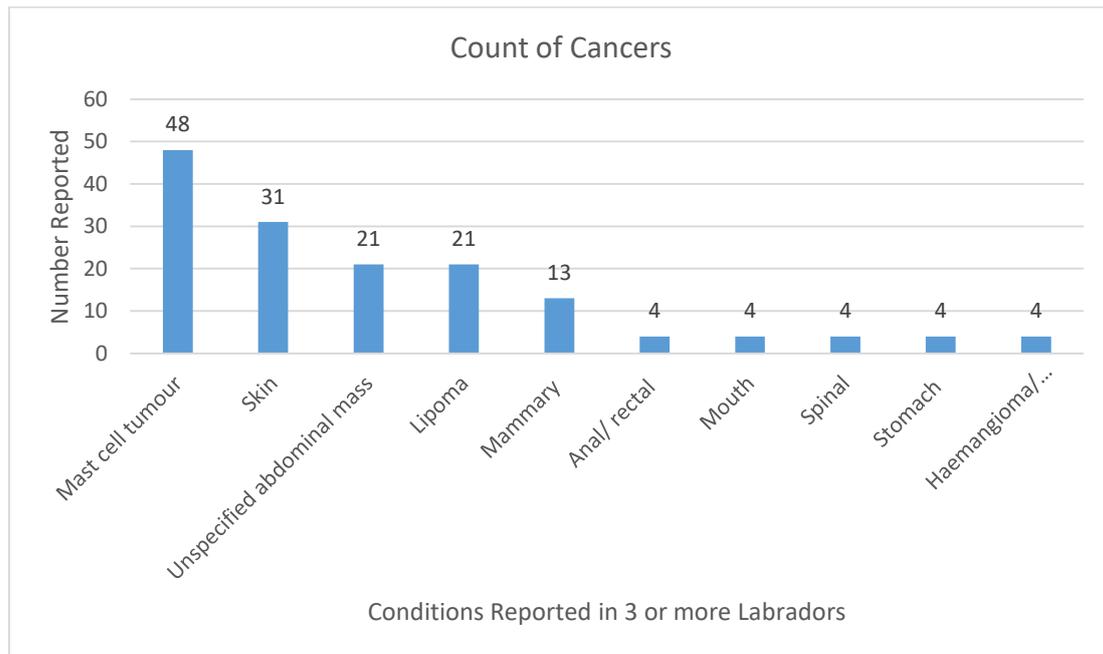
Overall, 41 dogs were put to sleep due to their cancer, with the most common being unspecified abdominal mass (10 dogs), lymphoma (3), stomach (3), spinal (3), mouth (2), and lung (2).

Neurological Conditions

When considering neurological conditions, 119 dogs were reportedly affected, with 22 conditions noted, the most commonly reported being epilepsy/ seizures, affecting 1.1% of dogs (2.0 years, 0.83 – 10.0 years; 61.0% males), followed by intervertebral disc disease 0.3% (7.0 years, 1.0 – 12.0 years; 61.5% dogs), spondylosis 0.3% (7.0 years, 4.0 – 12.0 years; 90% males), and dementia/ senile 0.1%.

Count of Neurological Conditions

Seven dogs were put to sleep due to their neurological condition, three due to epilepsy, and the others one each for intervertebral disc disease, unspecified, dementia/ senile, and myasthenia gravis.
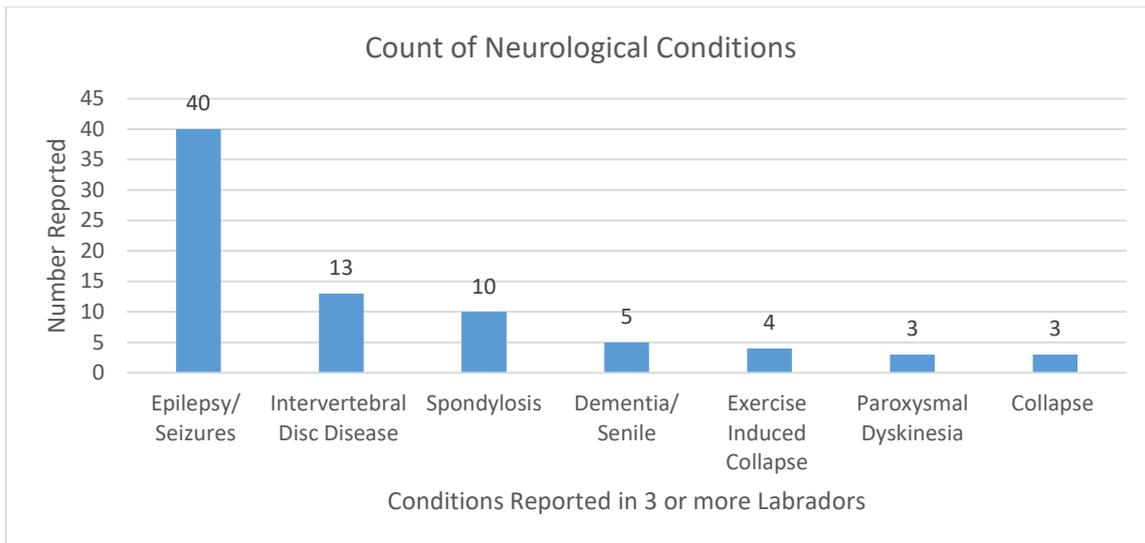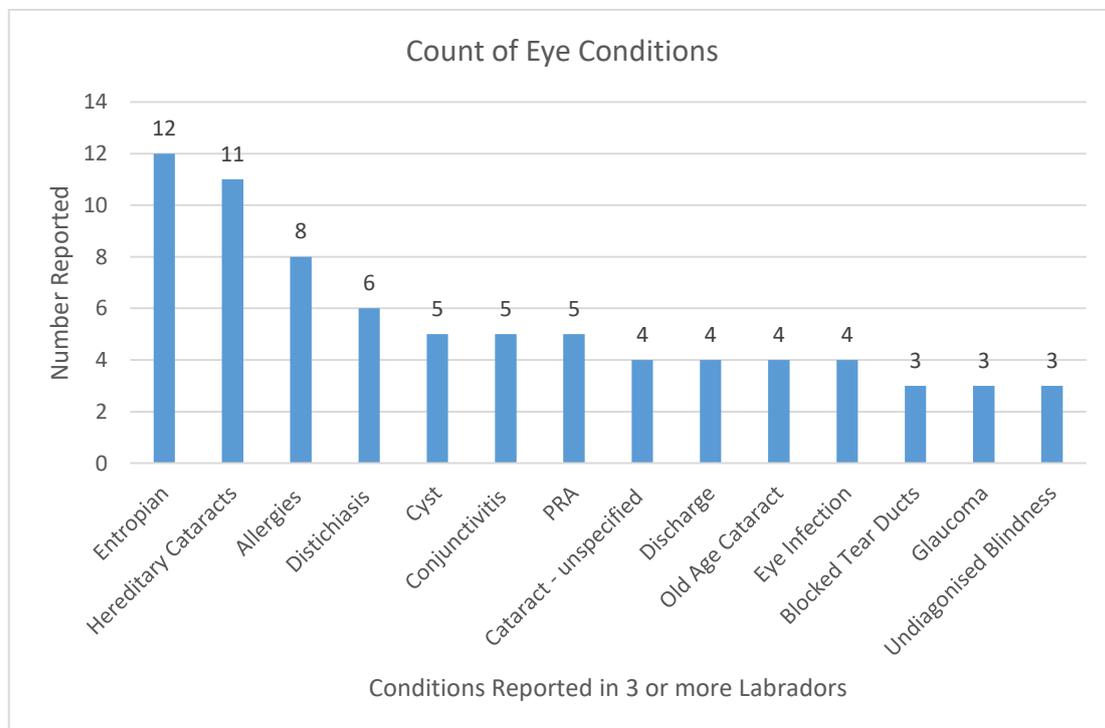
Ocular/ Eye Conditions

With regard to ocular/ eye conditions a total of 112 dogs were reportedly affected, representing 28 conditions, with the most common condition being entropion and affecting 0.3% of dogs included in the survey (1.0 years, 0.1 – 9.0 years; 58.3% females), followed by hereditary cataracts 0.3% (2.0 years, 0.0 – 2.0 years; 63.6% females), allergies 0.2%, and distichiasis (misplaced/ extra eyelashes) 0.6%.

Count of Eye Conditions

Two dogs were put to sleep due to an eye condition, one due to a benign tumour and the other as a result of diabetes-induced blindness.

Urological/ Kidney Conditions

A total of 80 dogs were reported to having been affected by a urological condition, representing 17 conditions. The most commonly reported condition was incontinence affecting 0.3% of the dogs surveyed (3.5 years, 0.25 – 12.0 years; 81.8% female), followed by incontinence following spaying 0.2%, kidney failure 0.2%, cystitis 0.2% and urinary infections 0.2%.
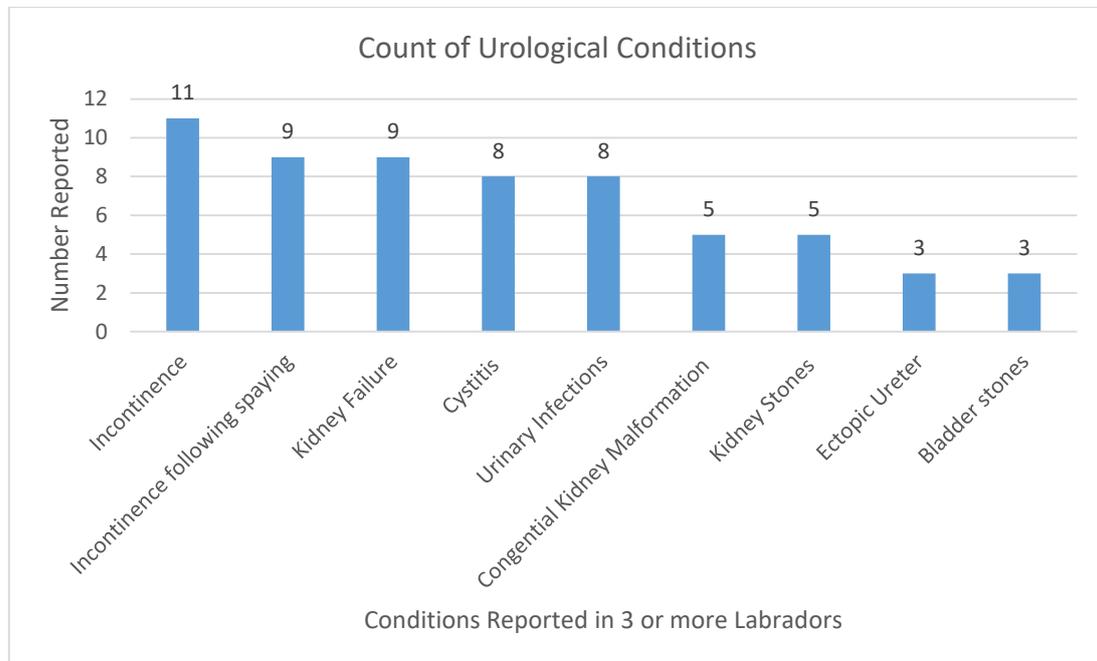
A total of six dogs were euthanised, four due to kidney failure, one as a result of a urinary infection, and the final due to an ectopic ureter.

Reproductive Conditions

Overall 73 dogs (male and females) were reported as having been affected by a reproductive condition, representing 18 conditions. With regard to females, the most common condition was pyometra affecting 1.1% of females included in the survey (5.0, 0.75 – 11.0 years), followed by false pregnancy 0.2%, caesarean section 0.2% and stillborn 0.08%. Regarding male dogs, 12 dogs, or 0.6% of males, were reportedly cryptorchid/ monorchid.
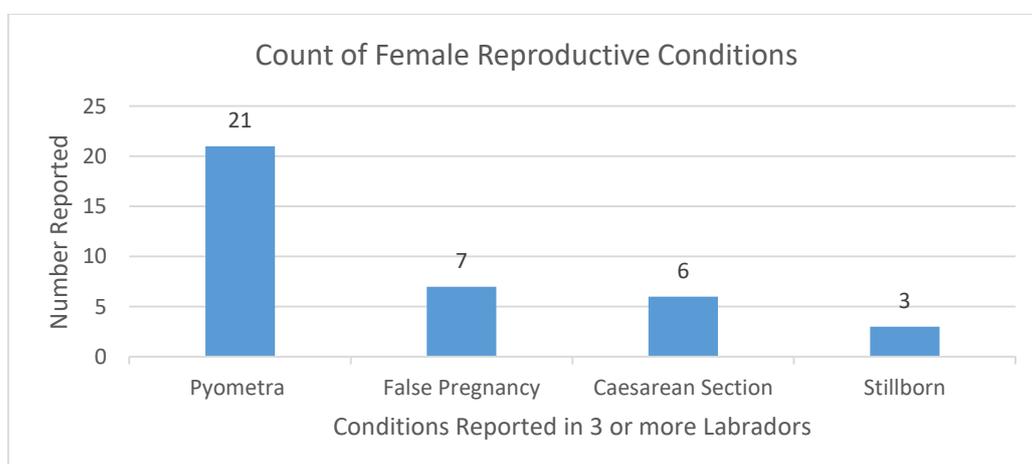
No dogs were put to sleep due to their reproductive condition.

Dental Conditions

Sixty-three dogs were reported to have had a dental concern in the survey, representing 14 conditions. The most common condition were broken teeth affecting 0.6% of dogs (5.0 years, 0.0 – 12.0 years), dental disease 0.2%, gum disease 0.2% and undershot bite 0.1%. No dogs were put to sleep due to a dental condition.

Count of Dental Conditions

Number Reported

	Broken Tooth	Dental Disease	Gum Disease	Undershot Jaw	Retained Puppy Teeth	Misaligned mandibular canines
	24	6	6	5	4	3

Conditions Reported in 3 or more Labradors

Hepatic/ Liver Conditions

A total of 43 dogs were affected by a hepatic condition, representing seven conditions. Pancreatitis was the most common condition, affecting 23 or 0.6% of dogs (6.0 years, 1.0 – 14.0 years; 51.2% females), followed by chronic liver disease 0.2%. Eight dogs were put to sleep due to their hepatic condition, five due to chronic liver disease, two due to pancreatitis and one due to fibrosis.

Cardiovascular Conditions

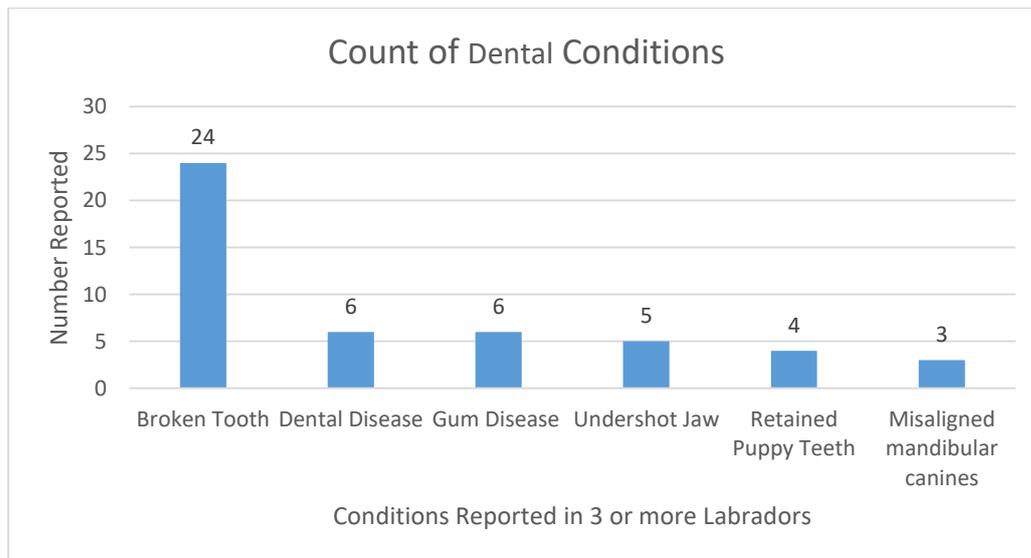Forty-two dogs were affected with a cardiovascular condition, representing 17 conditions. The most commonly reported condition were heart murmurs, of which 18 were affected (3.0 years, 0.2 – 11.0 years; 55.6% males), followed by congestive heart failure 0.2%, and heart rhythm disorder 0.08%. Seven dogs were euthanised due to their heart condition, three due to congestive heart failure, two due to heart murmurs and one each due to mitral valve disease, and unspecified condition.

Immune Conditions

Overall, 40 dogs were reportedly affected by an immune condition, with allergies to pollen/ mites/ fleas the most commonly reported in 10 dogs, 0.3% (4.0 years, 1.0 – 6.0 years), followed by auto-immune disease 0.2%, allergy – unspecified 0.1% and atopy – skin allergy 0.1%.

Count of Immune Conditions
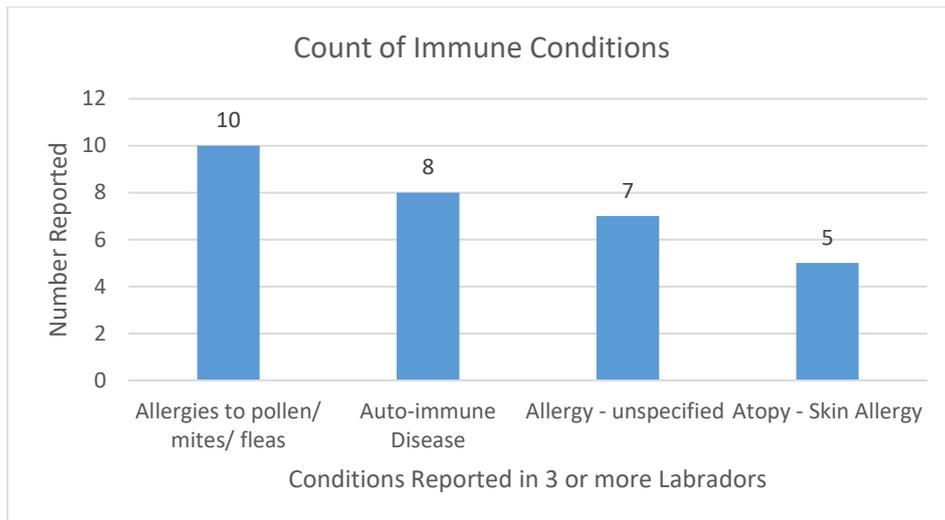
Respiratory Conditions

Thirty-two dogs were reported as affected by a respiratory condition, making up 17 conditions. The most common condition was Kennel Cough of which four dogs, or 0.1%, were affected. Similarly, there were four cases of laryngeal paralysis, and three pneumonia cases. One dog was put to sleep due to laryngeal paralysis.

Endocrine/ Hormonal Conditions

Thirty-two dogs were reported to having been affected by an endocrine condition, representing seven conditions. The most common were hypothyroidism which affected 11 dogs or 0.2% (5.0 years, 2.0 – 9.0 years; 54.5% females), followed by diabetes 0.1%, Addison's disease 0.1% and Cushing's disease 0.1%. One dog was put to sleep due to Cushing's disease.

Cerebral Vascular Conditions

Three dogs were reportedly affected under this category, with two put to sleep, one due to fits and the second as a result of a stroke.

Behaviour

Owners were also asked to complete questions focused on their dog's behaviour and the frequency in which particular behaviours were shown by their dog. These results are shown in the graph below.

Assessment of Behaviour
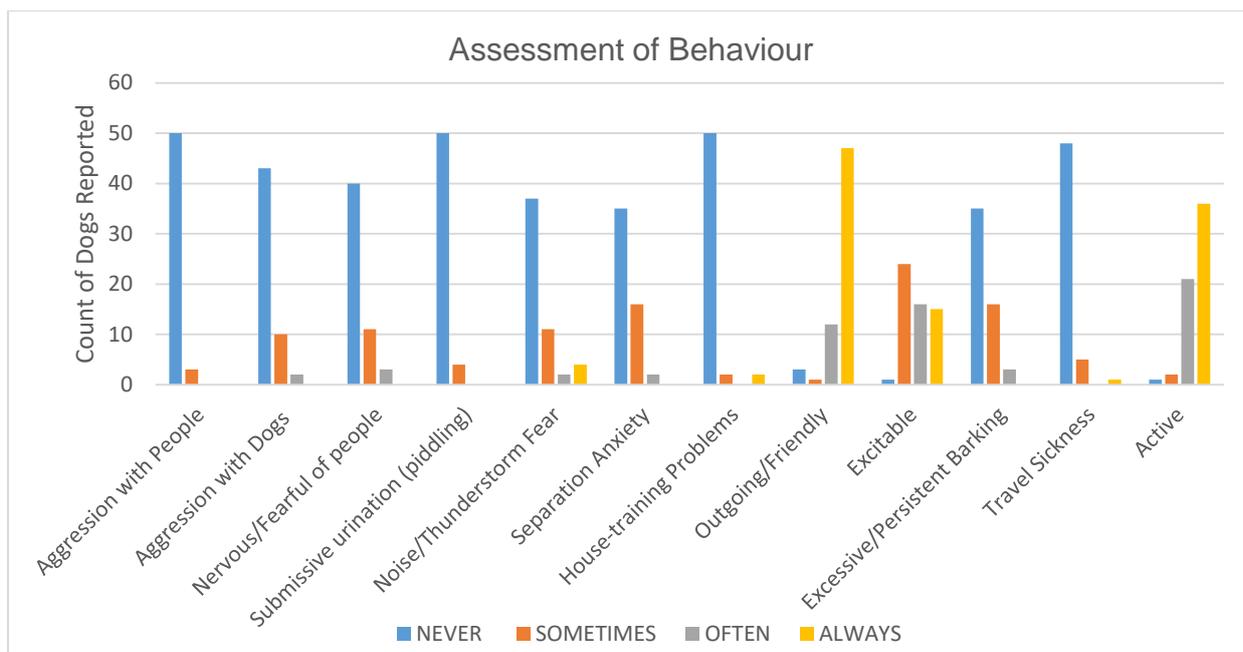
UK LITERATURE REVIEW

The literature review lays out the current scientific knowledge relating to the health of the breed. We have attempted to refer primarily to research which has been published in peer-reviewed scientific journals. We have also incorporated literature that includes dogs residing within the UK primarily, and literature that was released relatively recently to try to reflect current publications and research relating to the breed. It is important to note that whilst there are numerous studies detailed below, the vast popularity of the breed will mean they are more likely to be represented in a sample cohort. For example, in 2018 the breed accounted for 14.57% of the overall Kennel Club registered population.

Mortality: Analysis of the Kennel Club Purebred Dog Health Survey 2004 yielded 369 responses for dogs of the breed (Adams et al, 2010). These responses accounted for 574 Labrador deaths, with a median age of 12.25 years (range 0.17 to 19 years). Cancer was the most common cause of death, relating to 31.2% of deaths, followed by old age at 23.0%.

Cancers

Anal sac gland carcinoma: Of 810 dogs diagnosed with this form of cancer, 81 were Labrador Retrievers, making the breed the second most commonly affected breed (Polton et al, 2006). Whilst no breed-specific prevalence or odds ratios were established the authors noted that neutered males appeared to be more frequently affected, with a relative risk of 1.4.

General cancers: A paper researching cancer-related deaths in a range of breeds found that of 574 deaths for the breed, 179 (31.2%) were due to cancers, with a median age at death of 12.25 years (Dobson, 2013). The most common tumours reported to affect the breed, with a possible predisposition, were mast cell tumours.

The author noted that Labradors appear to often be affected by more aggressive cancers.

Limbal melanoma: Analysis of dogs affected by this form of cancer at the Animal Health Trust, and pedigree analysis of six dogs of the breed, established the Labrador Retriever as being a breed with a possible predisposition due to the disease through genetic mutations – however, further genetic analysis is needed to identify potential specific mutations (Donaldson et al, 2006). The breed was found to be three times more likely to be presented in the affected group, than those in the AHT's population, with an odds ratio of 3.0 (95% CI 1.3 -6.7).

Lymphoma: Interestingly, UK Labradors appear to be less predisposed to this form of cancer in comparison to dogs of the breed internationally (Comazzi et al, 2018). Whilst the breed were initially over-represented in the sample of affected dogs, this was not found to be significant, and instead, the study found that dogs originating from Switzerland had an odds ratio of 3.3. However, dogs that were affected appeared to be more commonly affected by a particular form of T-cell (immune cells involved in regulating the immune system) than other forms of lymphoma (odds ratio 2.74, 95% CI 1.61 – 4.67).

Similarly, a study on UK dogs established an odds ratio for this cancer of 0.64 (95% CI 0.28 – 1.46) suggesting again that the breed may be at a reduced risk of this form (Edwards et al, 2013).

Mast cell tumours: A recent paper used a number of methods to establish a variant in a gene, *DSCAM* which appears to have an association with development of mast cell tumours in the breed, accounting for 2% of the mast cell tumour trait in the breed, with dogs carrying this variant having an elevated risk (odds ratio of 1.67 (95% CI 1.24 – 2.24)) (Biasoli et al, 2019). Dogs heterozygous for the allele had a risk of MCT development of 1.66 x (equal to the ratio of the heterozygote odds: reference allele homozygote odds (95% CI 0.99-2.77)), and dogs homozygous for the allele 2.79 x (ratio of alternative homozygote odds: reference allele homozygote odds (95% CI 1.55 – 5.03)).

Cardiovascular Conditions

Dilated cardiomyopathy (DCM): Of 369 dogs diagnosed with this condition and referred to the Veterinary Cardiorespiratory Centre in England, 20 were Labrador Retrievers (Martin et al, 2009). There was variation between females and males affected, with a male: female ratio of 3:1. However, no breed-specific prevalence or odds ratio could be established. Subsequently to this study, the authors investigated prognostic factors, with the Labrador having a mean survival time of 35 weeks from diagnosis (range 3 – 82 weeks) (Martin et al, 2010).

Tricuspid valve dysplasia (TVD): An American study of 521 Labradors (345 with known phenotypes) was undertaken to establish a genetic basis of TVD in the breed (Famula et al, 2002). The authors found an apparently strong hereditary component for the disease, with a heritability of 0.71 (95% CI 0.60 – 0.82), and identified chromosome 9 as the potential source of the gene responsible, suggesting that this disease can be selected away from. However, they did note the importance in

developing clear diagnostic methods to identify TVD in dogs, due to the ambiguity of several dogs' results, before attempting to locate a particular gene.

A more recent paper originating on a population of 29 dogs from the UK found the Labrador to be the most common breed affected with TVD (n=7), although they were not significantly over-represented when compared to the total hospital population (Navarro-Cubas et al, 2017). Four of the dogs were diagnosed with mild TVD and three severe, with accompanying clinical signs of ascites (swollen abdomen), heart murmurs and pericardial effusion (fluid building around the heart). Three dogs were euthanised due to their condition.

Dermatological (Skin) Conditions

Hereditary nasal parakeratosis (HNPK): HNPK is characterised by crusting and fissures forming on the nose of affected dogs. A genome-wide association study (GWAS) was performed on 13 cases and 23 controls dogs, and determined a mutation in the gene *SUV39H2,* which is inherited in an autosomal recessive manner (Jagannathan et al, 2013). A DNA test was produced and is recognised by the Kennel Club (summary under DNA Test section on page 18).

Colour dilution alopecia (CDA): Whilst CDA has not been specifically identified in the Labrador with regard to scientific publication, there are papers to suggest that dilution can be associated with alopecia, and/ or follicular dysplasia in other breeds. The gene *MLPH* has been identified as a causative mutation for dilute phenotype, and established as required, but not sufficient, to develop clinical disease (Welle et al, 2009). The authors who identified this mutation noted that the risk of skin abnormalities due to dilute coat is breed specific. CDA and follicular dysplasia have been described in Weimaraners, a breed thought to be the cause of introduction of dilute coats into the Labrador population (Laffort-Dassot et al, 2002)

Endocrine (Hormonal) Conditions

Diabetes mellitus: A study of 253 UK dogs affected by diabetes were investigated to assess possible predisposing factors (Davison et al, 2005). Labradors contributed towards 17.4% of affected dogs, although this may be partly due to the popularity of the breed. Interestingly, three dogs diagnosed with the condition were under the age of six months and from the same litter, implying a potential genetic basis. However, a more recent VetCompass paper found the breed to be at a reduced risk (see under VetCompass section below).

Obesity: A study into the genetic components of obesity and diabetes mellitus in the breed investigated 61 non-diabetic Labradors and 57 affected, and identified a mutation in the *POMC* gene associated with obesity, but not with diabetes. *POMC* mutations are associated with obesity in humans, and play a part in regulation of food motivation in dogs (Davison et al, 2017).

Another study in the form of an online survey of UK dog owners received responses from 1,344 Labrador owners, and established an odds ratio of 1.47 for obesity in the breed (German et al, 2017). The authors found that obesity was associated with several negative behaviours, such as fearfulness of going outside/ reluctance to walk

(25.6% of all dogs in the study), guarding food (22.7%), stealing and scavenging (22.3%), and barking and/ or growling at familiar people (21.3%), or at strangers (18.7%).

A further study investigated the influence of obesity on musculoskeletal disease, specifically osteoarthritis/ degenerative joint disease (Marshall et al, 2009). Two groups of puppies were reared, with one group fed ad libitum, and the other fed 75% of the adlib group. Bodyweight was significantly higher in the adlib group. Dogs on the adlib diet had four times the incidence of osteoarthritis by the age of five and five times by the age of eight. Sixteen overweight/ obese dogs were also assessed to measure whether weight-loss had a positive impact on the individual. Following a controlled diet the dogs had a significantly improved gait, indicating reduced joint pain/ restriction in movement.

Hepatic (Liver) Conditions

Chronic hepatitis: Analysis of dogs attending the University of Cambridge diagnosed with chronic hepatitis in 2001 and 2008, established the Labrador as one of several breeds with a possible predisposition for disease (Bexfield et al, 2012). The median age for affected dogs was 8 years 3 months (range 2 years 8 months – 13 years). Female dogs of the breed were over-represented in comparison to males, with a ratio of 1.5:1 (63 females and 32 males). In both the 2001 and 2008 analysis the breed had an elevated odds ratio, with this being 2.1 (95% CI 1.7 – 2.7) and 2.0 (95% CI 1.6 – 2.5) respectively.

Copper toxicosis: Genetic studies undertaken on 235 dogs of the breed have established two genes that may play a role in disrupting normal copper metabolism, *ATP7A* and *ATP7B* (Fieten et al, 2016). Mutation in these genes lead to excessive accumulation of copper in the liver, and delayed excretion, and induces cirrhosis in middle-aged dogs. Previous studies have also found that the condition can be largely managed through an appropriate, low-copper high-zinc diet, as an alternative to drugs that can have significant side effects (Fieten et al, 2014). However, this diet was only tested in 16 dogs, four of which required further medication, and so further studies are needed to confirm this. Females appear to be at an increased risk, although this has not been statistically proven (Fieten et al, 2012b).

Musculoskeletal Conditions

Cruciate ligament disease: American studies have found the breed to be within the top five most commonly affected breeds (Witsberger et al, 1993), however studies within the UK have found lower levels of risk. An investigation into risk factors for disease established an odds ratio of 1.37 for the Labrador (95% CI 0.75 – 2.53), out of 14 cases and 85 controls (Adams et al, 2011). Median age of rupture was 8.08 years, with younger dogs, particularly under the age of two, having a significantly reduced risk of disease. A further VetCompass paper specific to the condition is shown under the VetCompass section on page 21.

Genome studies for the disease have been undertaken in the breed (Clements et al, 2010). A total of 20 candidate genes were identified, but no significant associations

could be established and due to the complex nature of this condition it will be difficult to isolate specific genetic regions.

Degenerative joint disease (DJD)/ hip dysplasia: A study of 6,277 Labradors measured potential risk factors for DJD, associated with hip and/or elbow dysplasia, including age, breed, sex, weight and distraction index (a measurement of joint laxity) (Smith et al, 2001). DJD was associated with age in the breed, with 3.0% affected between the age of 4 and 11 months, 5.6% between 12 and 23 months, and 20.5% in those over 24 months. Mean distraction index was also associated with disease, with this being highest in the youngest cohort of dogs, but also increased in dogs over the age of 24 months.

Elbow dysplasia: Elbow dysplasia is a well-acknowledged and serious condition in the breed. The BVA/ KC Elbow Dysplasia Scheme was launched in 1998, with dogs assigned a grade per elbow (0 – 3), with the highest score taken as the overall individual's score. Heritability of the condition has been estimated to be 0.19 ± 0.04, and has a genetic correlation of 0.41 ± 0.09 with hip dysplasia (Woolliams et al, 2011). As with hip dysplasia, the complex nature of this condition means use of EBVs is currently the best way to predict and select away from elbow dysplasia

With regard to accuracy of hip score when using EBVs and phenotypic factors, dogs that were born from parents with an available elbow EBV, compared to those based on phenotype alone, had a 13-fold more accurate elbow score (Lewis et al, 2010a; Lewis et al, 2013; Woolliams et al, 2011).

A Kennel Club paper investigating efficacy of screening schemes overtime investigated elbow dysplasia in several breeds, of which the Labrador was one (James et al, 2019). Between 2012-4, 5.57% of the registered population were scored under the BVA/KC Elbow Dysplasia Scheme, following an increase in 4.95% since 1998-2000. As of 2016-8, 41.15% of sires were scored, and 45.73% of dams, with 92.76% of scored sires a grade zero, and 91.66% of dams. The rolling mean of the percentage of total zero elbow grades in dogs born 2012-4 was 87.29% in the breed, with an increase in the percentage of zero grades by 0.4% per year. The mean total elbow grade for dogs born 2012-4 was 0.2732 in the breed following a decline overtime from 1998-2000. The standard deviation for elbow grades reduced overtime, with the 3-year rolling mean for the breed being 0.8581 in 2012-4, following a negative trend of -0.0136. The 3-year rolling mean EBV for the breed similarly reduced overtime, from 8.64 to -4.48, again suggesting an improvement in elbow health at a genetic level.

Hip dysplasia: Hip dysplasia has long been acknowledged a significant and prevalent condition in the breed and is a consequence of malformation in the hip joints, resulting in a loose fitting structure and eventual wearing of the joint over time, leading to osteoarthritis and degenerative joint disease. The British Veterinary Association (BVA)/ Kennel Club (KC) Hip Dysplasia Scheme was launched in 1965, and has been operating in its current from since 1983, with radiographic images taken of an individual to assess nine distinct features of each hip, and a final score established through the sum of the total score for both the left and right hip. These nine features have been demonstrated to have heritability of between 0.15 – 0.38

individually, but had genetic correlations of 0.71 – 1.0 amongst themselves, indicating significant genetic similarity, and value in being used as predictors of hip dysplasia (Lewis et al, 2010b). Due to the incredibly complex nature of the condition, and impact of external environmental factors, use of genomic selection instead of sourcing a specific marker is currently the strongest route to reduce disease prevalence in the breed (Sanchez-Molano et al, 2014).

An older UK study assessed hip scheme results for 29,610 Labradors to assess progress in hip health over time from 1980 to 1998 (Wood et al, 2002). The number of dogs tested increased during this period, with 0.95% of males and 1.08% of females tested in 1980, to 1.33% and 2.62% respectively for 1998. Similarly, the percent of progeny born from health tested parents has also increased, with no recorded litters born from two health tested parents in 1980, to 52.0% in 1998. The authors also investigated heritability of hip dysplasia in sires and dams, with a 0.41 heritability in sires, 0.30 in dams and 0.34 from two parents.

Estimated breeding values (EBVs) - values which are given for an individual dog to estimate its genetic risk for disease - have been available for the breed since 2014, and have been established as a more powerful method to select against hip and/ or elbow dysplasia than use of ancestral information and phenotypic traits (Lewis et al, 2010a; Lewis et al, 2013; Woolliams et al, 2019). In a study of Kennel Club registered Labradors, dogs that were born from parents with available EBVs, compared to those born from phenotype alone, had up to a 3-fold greater accuracy with their hip score than those without. The accuracy of EBVs were estimated to be between 1.16 and 1.34 times more accurate than use of phenotypes alone (Lewis et al, 2013).

A recent Kennel Club paper assessed hip score data for eleven breeds, of which the Labrador was included (James et al, 2019). Three year rolling means of median hip score were established, of which the Labrador has shown a significant reduction of -2.33 overtime (from 1990-2 to 2012-4), with the median score being 10.82 for 2012-4. Standard deviation of the mean 3-year rolling hip score has also reduced significantly in the breed by -4.83 (9.78 for 2012-4), as well as the percentage of dysplastic scores (in line with the FCI guidelines), reducing by 16.18% since 1990-4, with just 7.98% scored as dysplastic in 2012-4, implying a curtailing in severe scores and a general improvement in hip health. EBVs were also studied in the breed, with the 3-year rolling mean for dogs born 2016-8 being -4.34, after a reduction of -33.76 in mean EBV (from 1990-2).

Participation in the scheme appears to be very slightly declining in the breed (-0.68%), with 10.62% of dogs registered between 2012-4 scored. As of 2016-8, 56.2% of sires and 56.93% of dams were scored, with the proportion of dogs scored plateauing in the late 1990s/ early 2000s.

Patella luxation: Investigation into the risk to larger breeds established a relative risk of 3.3 for the Labrador, based on 70 dogs (Gibbons et al, 2006). Eleven of the 21 Labradors affected suffered from complications, of which five were minor (e.g. infection/ discomfort/ abnormal scar tissue) and the remaining six major (e.g.

relaxation/ implant failure). Males were also more commonly affected with a ratio of 1.8:1.

Skeletal dysplasia: This condition has been found to be heritable in the breed and results in mild disproportionate dwarfism, termed SD2 (Frischknect et al, 2012). Pedigree analysis was undertaken on 33 affected American Labradors, all of which appeared to be of working-type. A popular sire from 1966 was established as a potential source of the mutation, which was found to be inherited in an autosomal recessive manner with incomplete penetrance. A DNA test was produced and is recognised by the Kennel Club (summary under DNA Test section on page 18).

Ocular Conditions

Cataracts: A small scale study of 18 Labradors referred to an ophthalmologic centre in the UK assessed the number and outcome of cataracts in these dogs (Guerra et al, 2018). The most common type of cataracts in this group of dogs were nuclear and cortical (50.0%, 16 eyes affected), with subcapsular cataracts also frequent in the breed (n=10, 31.3%). Genetic aetiology was the most common cause in the breed (n=7).

An older UK paper measured 331 Labradors to investigate prevalence and age of onset of cataracts (Williams et al, 2004). The median age at which 50% of the population were affected by lens opacities was found to be 11.4 ± 2.2 years, however the authors noted that due to the high level of posterior polar subcapsular cataracts (PPSC) caution should be taken with this estimate.

Macular corneal dystrophy: This condition is a progressive disease that reduces vision in an affected individual, characterised by clouding of the eye and a grey/ white appearance. The gene *CHST6* was examined as a potential candidate in the breed, with a mutation in this gene established (Tetas Pont et al, 2016). The authors established that the mutant allele was present at a frequency of 0.017, with 3.3% of dogs being carriers and 0.028% affected, with an autosomal recessive of inheritance.

Progressive rod cone degeneration - Progressive retinal atrophy (prcd-PRA): PRA results in loss of vision in affected dogs and has been found to have several different mutations contributing towards disease (Downs et al, 2014). In the Labrador a mutation in the *CFA9* gene has been established as a causative factor for disease, inherited in an autosomal manner, and is available as a DNA Test (summary of dogs tested to date on page 18).

Stargardt disease: This condition leads to severe central visual impairment in affected animals, with currently no option for treatment (Makelainen et al, 2019). A pair of affected siblings, and their unaffected parents were genome sequenced, with the *ABCA4* gene established as the causative mutation. This was identified as being inherited in an autosomal recessive manner.

Neurological Conditions

Centronuclear myopathy (CNM): CNM is characterised by clinical signs such as general muscle weakness and muscle wastage, respiratory difficulty, and paralysis

of the muscles around the eyes (Maurer et al, 2012). Genetic analysis of the *PTPLA* gene in different Labrador populations worldwide identified this as a definitive mutation to be used in DNA testing. The group also found that the UK have the highest percentage of carriers at 19% for the mutation, and estimated that one in seven dogs will be a carrier. The quick dissemination of the mutation worldwide implies that the mutation occurred relatively recently (approximately 50 years) and probably occurred through use of a very popular sire. However, the high carrier rate is not reflected in the test results for UK dogs tested to date, which is much lower, at 0.6% (page 30).

Epilepsy: Out of a cohort of 1,260 epileptic dogs, 11.0% (n=139) were Labrador Retrievers, with the breed being established as one of four commonly affected pedigree breeds (Short et al, 2011). However, the authors did note that the breed's popularity may explain their apparent high incidence.

Exercise induce collapse (EIC): Dogs affected by EIC have normal behaviour at rest, but after 5-20 minutes of intense exercise, may develop incoordination/ ataxia and partial paralysis of the lower limbs, causing collapse (Minor et al, 2011). Labrador populations in the USA were investigated to estimate the frequency of a mutation in the *DNM1* gene, with pet dogs (n=743) appearing to have the highest frequency of being homozygous (26.9%). Throughout all populations, the frequency of homozygous for the wild-type (normal) allele was 52.9%, carriers or heterozygous 37.2%, and homozygous for the mutation 9.9%. A DNA test is available and recognised by the Kennel Club (further information under DNA Tests, page 18).

Laryngeal paralysis: Whilst there do not appear to be publications for the prevalence of this condition in the breed for the UK population, there are international data. An American study investigated owner perception on quality of life (QoL) of affected dogs by 76 owners (Sample et al, 2020). The mean age of onset of clinical signs was 10.3 ± 1.4 years, with dogs undergoing surgery being significantly younger (9.9 ± 1.3 years). The mean age at death for all dogs was 13.2 ± 1.6 years. The majority of owners (36%) felt that their dog's QoL was affected within a year of onset of clinical signs. Overall, 47% of owners reported that the condition was a large contributing factor to their dog's death.

An older Australian paper found the breed to be significantly more likely to have a higher laryngeal grade than other breeds (grade of 0 – 4), with a relative risk of 2.527 (95% CI 1.63 – 3.92) (Broome et al, 2000). Age, weight and body condition were also associated with the condition.

Paroxysmal dyskinesia: A cohort of 36 Labradors were assessed at referral centres in the UK, 29 males and seven females, with a median age of onset of 2 year and 3 months (range 9 months – 10 years 8 months) (Lowrie et al, 2016). Clinical signs incorporated under this condition included abrupt contraction of muscles (i.e. in the trunk and limbs) and involuntary movements. Episodes followed excitement in nine of the 36 Labradors, with a median frequency of one episode every three weeks (range one every six months to 12 per month). Fourteen of the dogs underwent spontaneous remission, with 22 of the other dogs having had a history of cluster

episodes which the authors suggested may be a factor for non-remission. Genetic studies for the condition in the breed have not yet been undertaken.

Urinary Conditions

Ectopic ureter: This congenital condition involves displacement of the ureter, resulting in incontinence. Following submission and analysis of 217 dogs to the University of Edinburgh, the Labrador Retriever was established as a breed at risk of disease, with 49 cases and 1,032 controls (Holt et al, 2000). The authors proposed an odds ratio of 2.43 (95% CI 1.71 – 3.41).

VetCompass Results

The Kennel Club work closely with VetCompass at the Royal Veterinary College. VetCompass is a broad welfare research programme that collects anonymised clinical information from more than 1800 UK veterinary practices and includes over 7.5 million dogs. VetCompass research can be used to identify common breed-specific conditions, or condition-specific concerns which affect a range of breeds. A breed specific VetCompass paper has been published for the Labrador which is shown below and, in addition, the Labrador is included in the condition-specific studies also detailed below (McGreevy et al, 2018).

Breed-specific study: The median longevity for the breed was 12 years (range of 0 to 16 years), however it did differ between colours, with non-chocolate dogs having a median longevity of 12.1 years and chocolates 10.7 years (range 3.8 years to 15.5 years). The top causes for death for the breed are shown in Table 1 below.

Table 1: Top causes for mortality in the Labrador Retriever as part of the breed-specific VetCompass paper

Cause of Death by Category	Overall Count (%)	Median Age at Death (years)
Musculoskeletal disorder	36 (24.5%)	13.4
Cancer/ neoplasia	31 (21.1%)	10.6
Mass lesion	11 (7.5%)	9.7
Brain disorder	8 (5.4%)	11.8
Liver disorder	8 (5.4%)	12.0
Renal disorder	8 (5.4%)	11.3
Endocrine disorder	7 (4.8%)	12.1
Enteropathy	5 (3.4%)	10.3
Heart disease	5 (3.4%)	9.1
Urinary disorder	4 (2.7%)	12.7

Of the dogs examined, 61.6% were reported to have at least one disorder. The most commonly reported conditions in the breed were otitis externa, overweight/ obesity, and degenerative joint disease (Table 2). Obesity was not statistically significantly associated with neutering in females, but was associated with this in males. Otitis externa, vomiting, diarrhoea, conjunctivitis, skin mass, pruritus, pyoderma, coughing, stiffness, alopecia, pododermatitis and pyotraumatic dermatitis were most prevalent in chocolate dogs.

Table 2: Top reported conditions in the Labrador Retriever, and prevalence split by colour, as part of the breed-specific VetCompass paper

Condition	Overall Count (%)	Black Prevalence	Chocolate Prevalence	Yellow Prevalence
Otitis externa	215 (10.4%)	12.8%	23.4%	17.0%
Overweight/ obesity	183 (8.8%)	13.0%	15.4%	16.7%
Degenerative joint disease	115 (5.5)	10.7%	6.7%	8.8%
Lameness	91 (4.4%)	6.9%	6.7%	7.7%
Periodontal disease	87 (4.2%)	7.6%	5.7%	6.9%
Lipoma	85 (4.1%)	7.2%	4.7%	8.0%
Vomiting	74 (3.6%)	6.0%	6.7%	4.0%
Diarrhoea	67 (3.2%)	5.4%	6.4%	4.2%
Conjunctivitis	57 (2.7%)	4.3%	5.0%	4.5%
Skin mass	51 (2.5%)	3.8%	4.7%	3.5%

Cancers

Mast cell tumours: The Labrador was one of several breeds that had a prevalence of mast cell tumours above what was expected with a breed prevalence of 0.72% (95% CI 0.58 – 0.85) and 106 cases, compared to the expected prevalence of 0.27% (Shoop et al, 2015). The authors also noted that the breed were over-represented in the cases compared to their representation of controls. Age was established as a risk factor for disease, with dogs the age of 8 – 10 years and 10 years plus with a higher much odds ratio, 38.3 (95% CI 15.1 – 97.4) and 41.3 (95% CI 16.7 – 102.5) respectively.

Endocrine (Hormonal) Conditions

Diabetes mellitus: Of 128,210 dogs attending veterinary practices between 2009 and 2012, 439 cases were studied to identify risk factors (Mattin et al, 2014). The Labrador appeared to have a reduced risk of disease, with an odds ratio of 0.54 (95% CI 0.25 – 1.18). Neutered males appeared to have an increased risk, with an odds ratio of 2.26 (95% CI 1.29 – 3.96).

Musculoskeletal Conditions

Osteoarthritis: A condition-specific VetCompass study investigated the prevalence, duration and risk factors for appendicular osteoarthritis in dogs, establishing the Labrador as a breed predisposed to this condition (Anderson et al, 2017). Of 455,557 dogs in the VetCompass database, 16,437 were defined as affected by arthritis, with a prevalence of 6.1% in the breed and an odds ratio of 2.47 (95% CI 2.25 – 2.72). Being older and overweight/ obese were also significant factors for disease, with an odds ratio of 12.58 – 53.89 for dogs aged between 6 to over 12 years, and 2.29 for overweight dogs.

Cranial cruciate ligament (CCL) disease: A sample of 621 dogs affected by this condition were selected from an overall cohort of 171,522 dogs attending primary-care veterinary practices within the UK (Taylor-Brown et al, 2015). The Labrador made up 54 (8.70%) of the total cases, of which 17 dogs were referred to a specialist practice for treatment. The authors proposed an odds ratio of 0.9 for the breed (95% CI 0.6 – 1.3), though this was not significant at the $p = 0.05$ level ($p = 0.478$). Risk factors such as bodyweight, age and sex were however found to be significant with the following odds ratios: high bodyweight 3.4 (95% CI 2.6 – 4.5), age of 9.0 – 11.9 years 4.4 (95% CI 3.2 – 6.1) and being a neutered female 2.1 (95% CI 1.6 – 2.9).

Elbow joint disease: A new VetCompass paper was very recently released, with the Labrador was established as the breed with the second highest risk in developing joint disease, with an odds ratio of 5.94 (95% CI 4.65 – 7.60), based on a population of 804 affected dogs, of which 2.54% were dogs of the breed (O'Neill et al, 2020). Dogs that had a bodyweight of 30 – 40kg had an odds ratio of 11.72 (95% CI 8.20 – 16.75) and 17.34 (95% CI12.04 – 24.97) for those over 40kg. Age was another risk factor, with dogs 9 – 12 years having an odds ratio of 5.34 (95% CI 4.16 – 6.84) and dogs over 12 years 5.69 (95% CI 4.36 – 7.41). Males appeared to have a relatively increased odds of disease, with this being 1.43 (95% CI 1.22 – 1.69) and being neutered was also found to have increased odds of 2.60 (95% CI 2.12 – 3.19).

Neurological Conditions

Epilepsy: A VetCompass study (Kearsley-Fleet et al, 2013) of 87,317 dogs established the Labrador as having a potentially higher risk of developing disease, with an odds ratio of 1.35 (95% CI 0.98 – 1.86). The breed did however represent 9.8% of the total dogs included in the study.

Dogslife Study

Dogslife is a longitudinal initiative launched by the Roslin Institute, University of Edinburgh, and follows the life of dogs from the time puppies arrive at their new home and then over the period of several years (Clements et al, 2013).

A total of 1,348 Labradors were recruited with the study between 2010 and 2011. The authors estimated that 80.4% of dogs (95% CI 75.5 – 84.3%) were affected by an illness before the age of 1 year, however overall 53.7% of dogs were taken to the vet for treatment of non-routine attention before the age of one, indicating many illnesses were naturally resolved.

Limber tail/ water tail/ dead tail: A study on this condition, characterised by a limp tail and localised pain, used data from Dogslife to identify potential risk factors and the incidence of disease in the breed (Pugh et al, 2016). Of 6,000 dogs enrolled with the study at the time, 53 were reportedly affected with a case of limber tail, giving an incidence of 0.7%, and a mean age of first being affected of 2.13 years (95% CI 1.75 – 2.50 years). A second part of the study consisted of a tail-specific owner questionnaire, with a resultant 43 cases and 93 controls, and an overall incidence of 9.7% (95% CI 4.5 – 17.6%). When asked to consider the effects of limber tail on quality of life and the amount of pain their dog was experiencing on a scale of 0 – 10, the mean pain score was six out of 10 and quality of life impact 4.1. The mean

duration of bouts was 3.5 days (95% CI 2.9 to 4.2 days). Swimming appeared to be a risk factor, with the authors proposing an odds ratio of 4.7 for this activity (95% CI 1.1 – 29.9). Another factor appeared to be breed type, with an odds ratio of 5.1 for working type dogs (95% CI 1.1 – 24.9), and also geographical location, with dogs at higher latitudes having an odds ratio of 1.47 (95% CI 1.12 – 1.98). The authors noted further genetic analysis is needed to determine any underlying genetic predispositions.

INSURANCE DATA

There are some important limitations to consider for insurance data:

- Accuracy of diagnosis varies between disorders depending on the ease of clinical diagnosis, clinical acumen of the veterinarian and facilities available at the veterinary practice.
- Younger animals tend to be overrepresented in the UK insured population.
- Only clinical events that are not excluded and where the cost exceeds the deductible excess are included

UK Agria data

Insurance data were available for Labradors insured with Agria UK (Table 3).

Full policies are available to dogs of any age. Free policies are available to breeders of Kennel Club registered puppies and cover starts from the time the puppy is collected by the new owner; cover under free policies lasts for five weeks from this time. A full exposure is equivalent to a whole year of cover. Between July 2017 and June 2018 there were 24,494 free exposures, 12,744 full exposures and 11,851 claims.

Table 3: Top 10 conditions and number of settlements for each condition between 1st July 2017 and 31st June 2018 for Labradors insured on full policies with Agria UK

Condition	Number of settlements
Hypersensitivity (allergic) skin disorder (unspecified)	724
Osteoarthritis (osteoarthrosis degenerative joint disease (DJD))(unspecified)	603
Elbow dysplasia (canine)	529
Atopy finding	447
Lameness finding	423
Cruciate ligament rupture - caudal and cranial	333
Gastroenteritis	297
Foreign body - gastric (stomach)	249
Hip dysplasia developmental	211
Elbow dysplasia (canine) - medial coronoid process disease fragment identified	48

Swedish Agria Insurance Data

Swedish morbidity and mortality insurance data were also available from Agria for the Labrador. Reported rates are based on dog-years-at-risk (DYAR) which take into account the actual time each dog was insured during the period (2011-2016). One DYAR is equivalent to a full year of cover. The number of DYAR for the Labrador in Sweden during this period was 50,000 < 100,000. It is important to consider that such a large population may result in the breed appearing over-represented for some conditions. The full Swedish insurance results are available through https://dogwellnet.com/, but key findings are reported below.

The most common specific causes of Veterinary Care Events (VCEs) for Agria-insured Labrador in Sweden between 2011 and 2016 are shown in Figure 3. The top five specific causes of VCEs were vomiting/ diarrhoea/ enteritis, otitis, symptoms of pain during locomotion, dermatitis/ pyoderma/ folliculitis, and skin tumours.

Figure 3: The most common specific causes of VCEs for the Labrador compared to all breeds in Sweden 2011 - 2016, from Swedish Agria insurance data.

The specific causes of VCEs ordered by relative risk for the Labrador are shown in Figure 4. In this analysis, the top five specific causes of VCEs ordered by relative risk were degeneration/ dystrophy/ dysplasia of the hock, osteochondrosis of the elbow, degeneration/ dystrophy/ dysplasia of the elbow, benign eye tumour, and

degeneration/ dystrophy/ dysplasia of the phalanx.
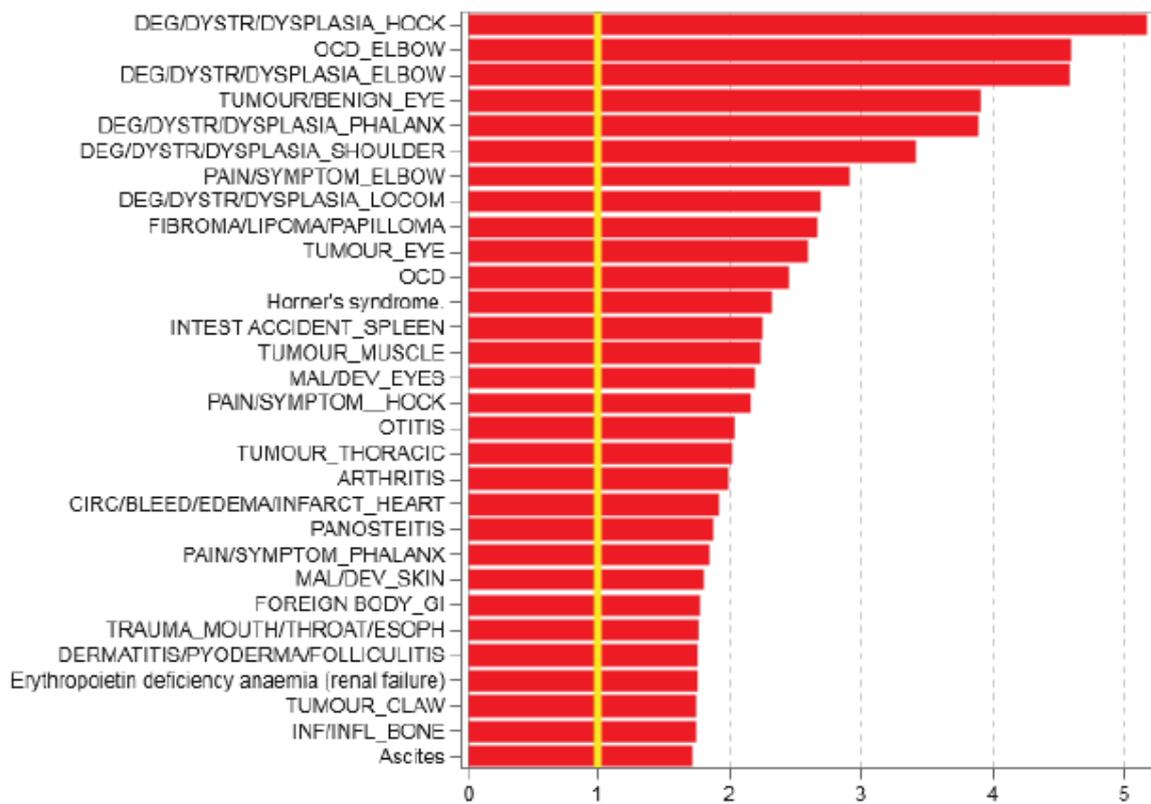
Figure 4: The specific causes of VCEs for the Labrador ordered by relative risk compared to all breeds in Sweden 2011 - 2016, from Swedish Agria insurance data.

Further analysis of locomotor disorders found the Labrador to be at an increased relative risk of elbow, hock, phalanx, shoulder, unspecified/ various skeletal and patellar (Figure 5).

Figure 5: Relative risk morbidity for locomotor disorders in the Labrador in Sweden between 2011 - 2016, from Swedish Agria insurance data.

The most common specific causes of death for the Labrador are shown in Figure 6, the top five causes were degeneration/ dystrophy/ dysplasia of the elbow, dead/ euthanised, epilepsy, knee trauma and osteochondrosis of the elbow.
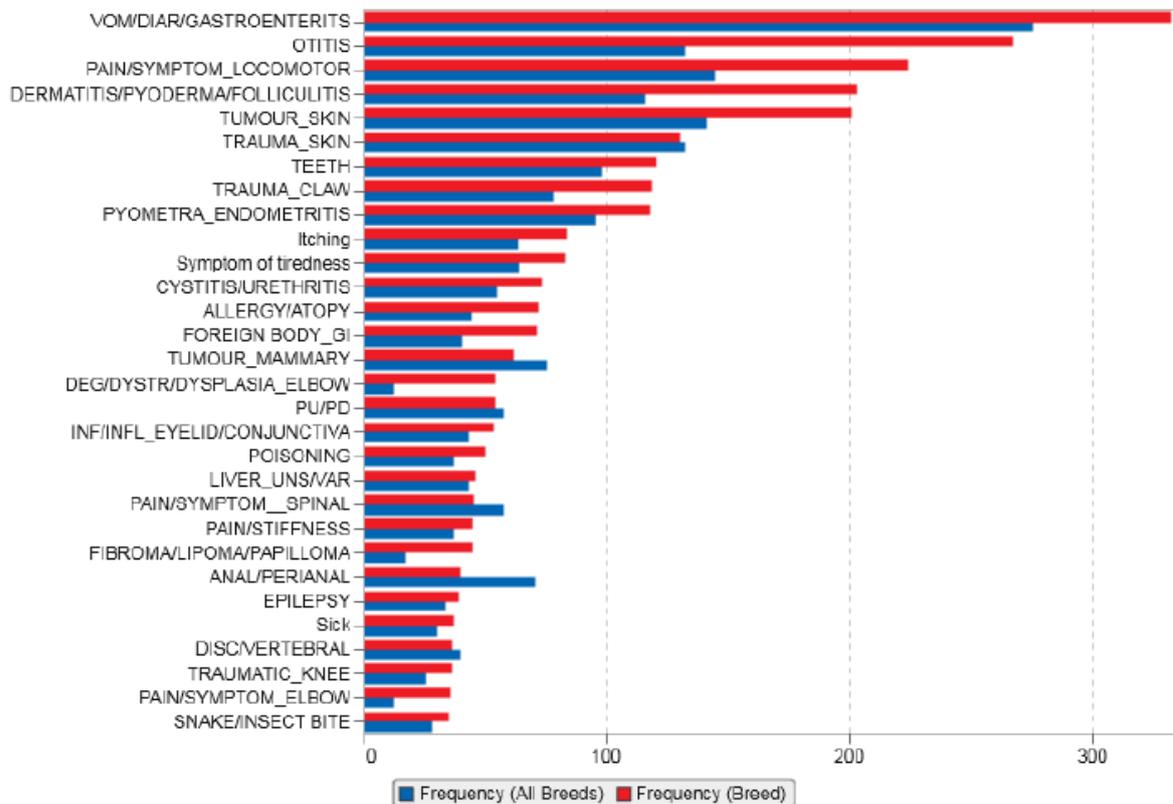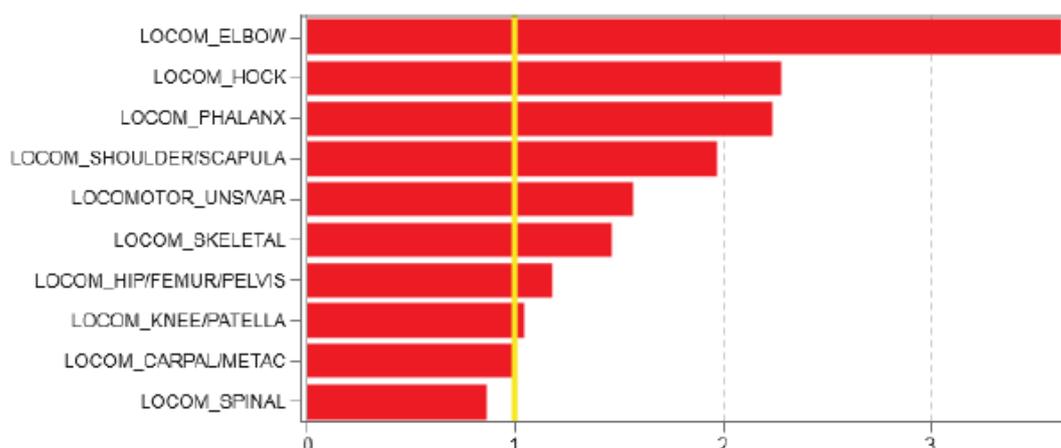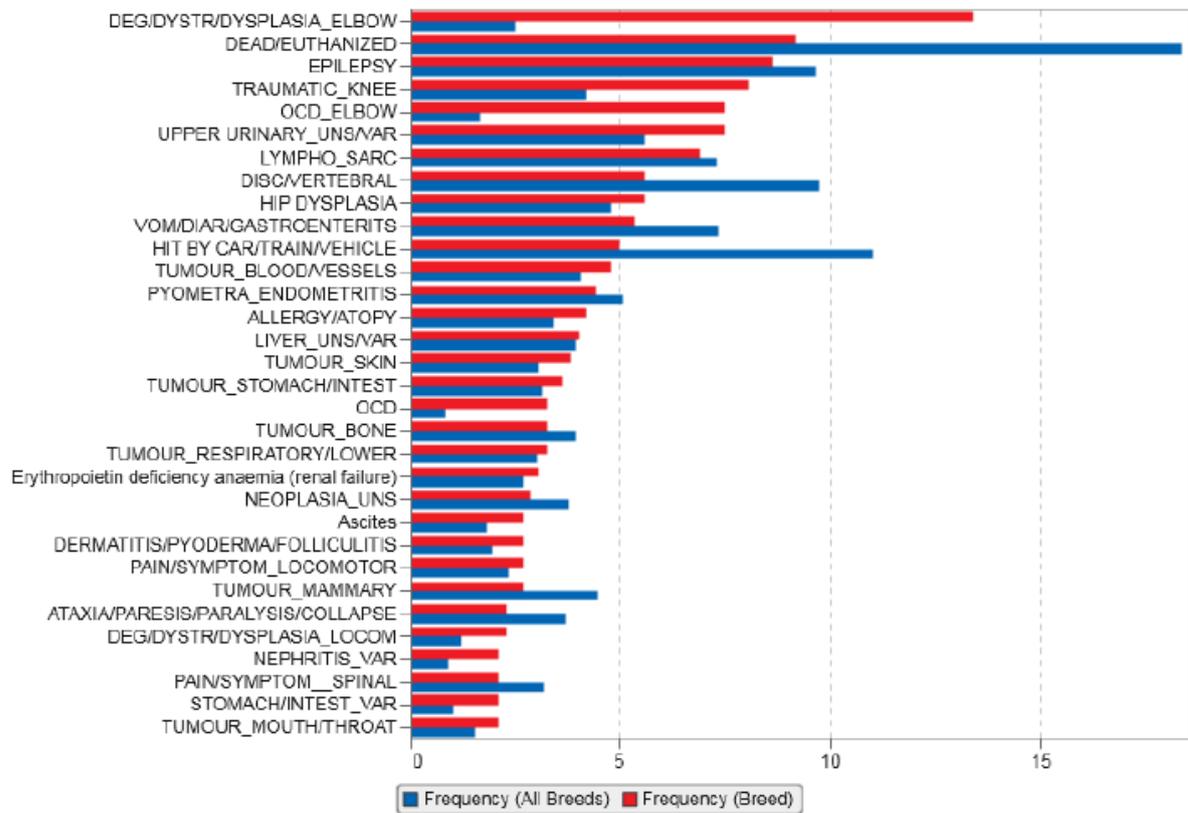

Figure 6: The most common specific causes of death for the Labrador compared to all breeds in Sweden between 2011 and 2016, from Swedish Agria insurance data.

BREED WATCH

As a category two breed judges' health monitoring forms are mandatory at championship show level to identify any visible points of concern affecting dogs in the show ring. It is possible that one dog could have been reported for a point of concern on more than one occasion.

Breed Watch reports for the last three years are shown in Table 4 below.

Table 4: Breed Watch points of concern reported between 2016 and 2019.

Point of Concern	2016	2017	2018	2019
Legs too short to depth of body	0.8%	1.8%	1.3%	1.4%
Significantly overweight	0.4%	0.6%	1.1%	1.2%
* Cow hocks	0.0%	0.0%	0.0%	0.1%
* Incorrect bite	0.1%	0.0%	0.0%	0.0%
* Incorrect dentition	0.0%	0.1%	0.0%	0.0%
* Overweight	0.3%	0.1%	0.0%	0.0%
* Nervous temperament	0.0%	0.0%	0.0%	0.1%
* Unsound movement	0.0%	0.1%	0.0%	0.0%
* Unsound movement from weak hind movement	0.0%	0.1%	0.0%	0.0%
Total of Dogs Shown	**7,852**	**6,405**	**6,339**	**4,680**

ASSURED BREEDER SCHEME

It is currently required that Assured Breeders complete the following on all breeding stock prior to mating:

- Hip test under the British Veterinary Association (BVA)/ Kennel Club (KC) Hip Dysplasia Scheme
- Eye testing under the BVA/KC/ International Sheepdog Society (ISDS) Eye Scheme
- Elbow tested under the BVA/KC Elbow Dysplasia Scheme

It is also recommended that the following are completed:

- DNA test for prcd-PRA

BREED CLUB BREEDING RECOMMENDATIONS

There are not currently any Breed Club breeding recommendations listed under the Kennel Club's Assured Breeder Scheme for the breed.

DNA TEST RESULTS

The following DNA tests are currently available and recognised for the breed:

- Prcd-PRA
- Prcd-PRA (linkage test)
- Exercise induced collapse (EIC)
- Centronuclear myopathy (CNM)
- Skeletal dysplasia 2 (SD2)

- Hereditary nasal parakeratosis (HPNK)

A list of laboratories that provide the test can be found through clicking here: https://www.thekennelclub.org.uk/worldwide-dna-tests/

Whilst other DNA tests may be available for the breed results from these will not be accepted by the Kennel Club until the test has been formally recognised; the process involves collaboration between the breed clubs and the Kennel Club in order to validate the test's accuracy.

As a note, as of January 2022 hereditarily clear status will no longer apply after two generations and dogs will need to be retested to confirm the status of that individual. This is to prevent the possibility of misclassification of status and therefore unintentional breeding of affected puppies. Where parentage is confirmed by DNA profile, the biggest contributor to mistaken status will be removed. Therefore, a less stringent restriction for HC status is applied where parentage is confirmed by DNA test.

To date (28/01/2020) 116,287 DNA test results have been received for the breed. The results of these test results are shown in Table 5 below.

Table 5: DNA test results for Labrador Retrievers received by the Kennel Club to date (28/01/2020)

DNA Test	Affected	Carrier	Clear	Hereditary Carrier	Hereditary Clear	Total
CNM	8 (0.02%)	232 (0.6%)	3259 (8.1%)	0 (0.0%)	36727 (91.3%)	**40226**
EIC	40 (0.2%)	435 (2.2%)	2703 (13.7%)	90 (0.5%)	16490 (83.5%)	**19758**
HNPK	10 (0.2%)	146 (3.1%)	1340 (28.8%)	53 (1.1%)	3109 (66.7%)	**4658**
prcd-PRA	37 (0.1%)	736 (1.6%)	3493 (7.4%)	99 (0.2%)	42911 (90.8%)	**47276**
prcd-PRA (linkage)	1 (2.3%)	3 (7.0%)	39 (90.7%)	0 (0.0%)	0 (0.0%)	**43**
SD2	21 (0.2%)	425 (3.6%)	2021 (17.2%)	42 (0.4%)	9246 (78.7%)	**11755**

Whilst it has not been formally recognised as a DNA test by the Kennel Club, the breed have been working with the AHT in developing a test for macular corneal dystrophy. To date, 82 dogs have been tested, of which 51 were clear (62.2%), five carriers (6.1%) and 26 affected (31.7%). However, it is important to note that at these early stages in research it is likely that affected cases will be submitted for analysis.

A DNA test has been launched by the AHT for *ABCA4* (Stargardt's) in February 2020 but has not yet been formally recognised by the Kennel Club.

CANINE HEALTH SCHEMES AND ESTIMATED BREEDING VALUES

All of the BVA/KC Canine Health Schemes are open to dogs of any breed with a summary given of dogs tested to date below.

<u>HIPS</u>

In the 15 years leading up to date (28/01/2020) 50,120 Labradors have been hip scored as part of the BVA/KC Hip Dysplasia Scheme. The 15 and five year median hip score were both 9 (15 year range 0 – 106, 5 year range 0 – 103).

As of 2016-8, 56.2% of sires and 56.93% of dams were scored, with the proportion of dogs scored plateauing in the late 1990s/ early 2000s (James et al, 2019).

Hip score categories received by Labradors which participated in the BVA/KC Hip Dysplasia Scheme between 1990 and 2016 are shown in five year blocks (which can be considered to approximate to a generation) in Figure 6 below. The categories correspond to those assigned under the FCI (Europe)'s hip grading scheme; for one hip, a 'normal' hip scores 0-3, borderline scores 4-8, mild HD scores 9-18, moderate HD scores 19-30 and severe HD represents scores greater than 30. Further information on these categories can be found here: https://www.bva.co.uk/uploadedFiles/Content/Canine_Health_Schemes/chs-comparison-of-hd-schemes.pdf . Over this time period there appears to be a definite reduction in the proportion of Labradors with severe and moderate hip dysplasia and an increase in those with borderline and normal scores.

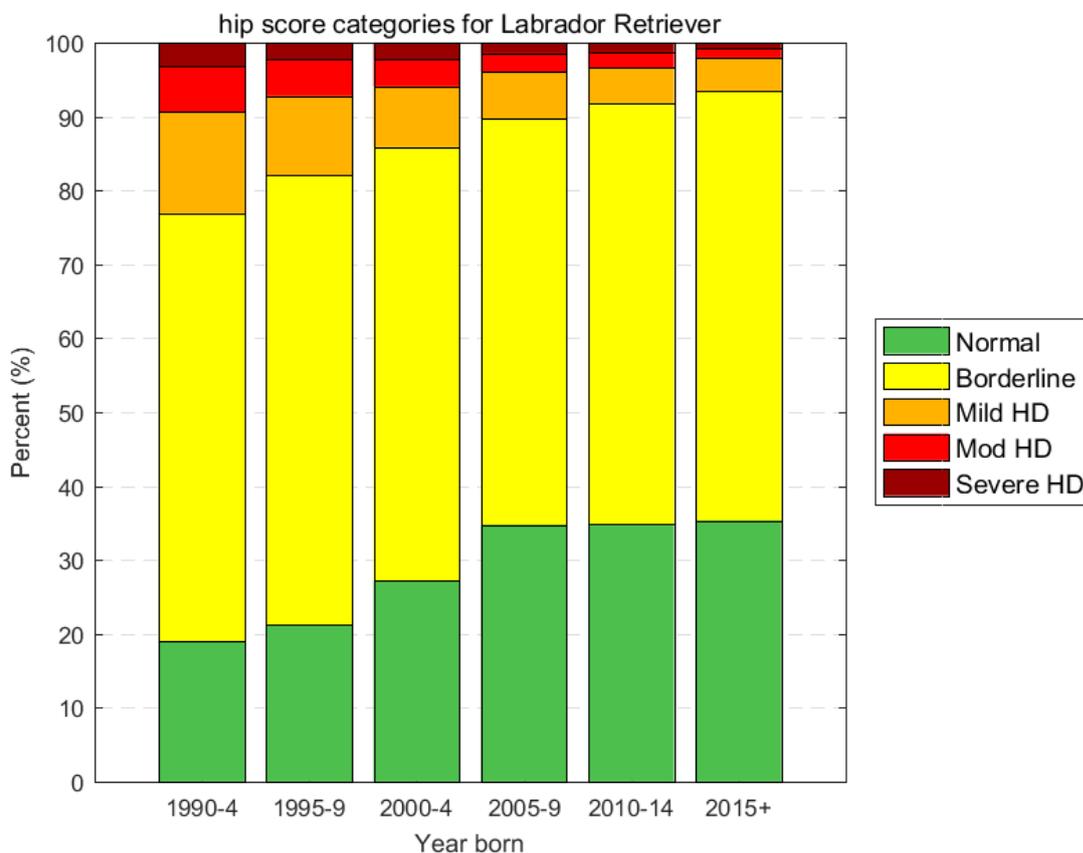hip score categories for Labrador Retriever

Figure 6: Hip score categories for Labradors which participated in the BVA/KC Hip Dysplasia Scheme between 1990 and 2016, in 5-year blocks.

Estimated breeding values (EBVs) are available for hip score for the Labrador. Figure 7 shows the five year rolling trend in EBVs by year of birth in the breed. It can clearly be seen that EBVs have decreased overtime which indicates an improving (lowering) genetic risk of hip dysplasia as determined by the BVA/KC hip score, most likely as a result of selection.
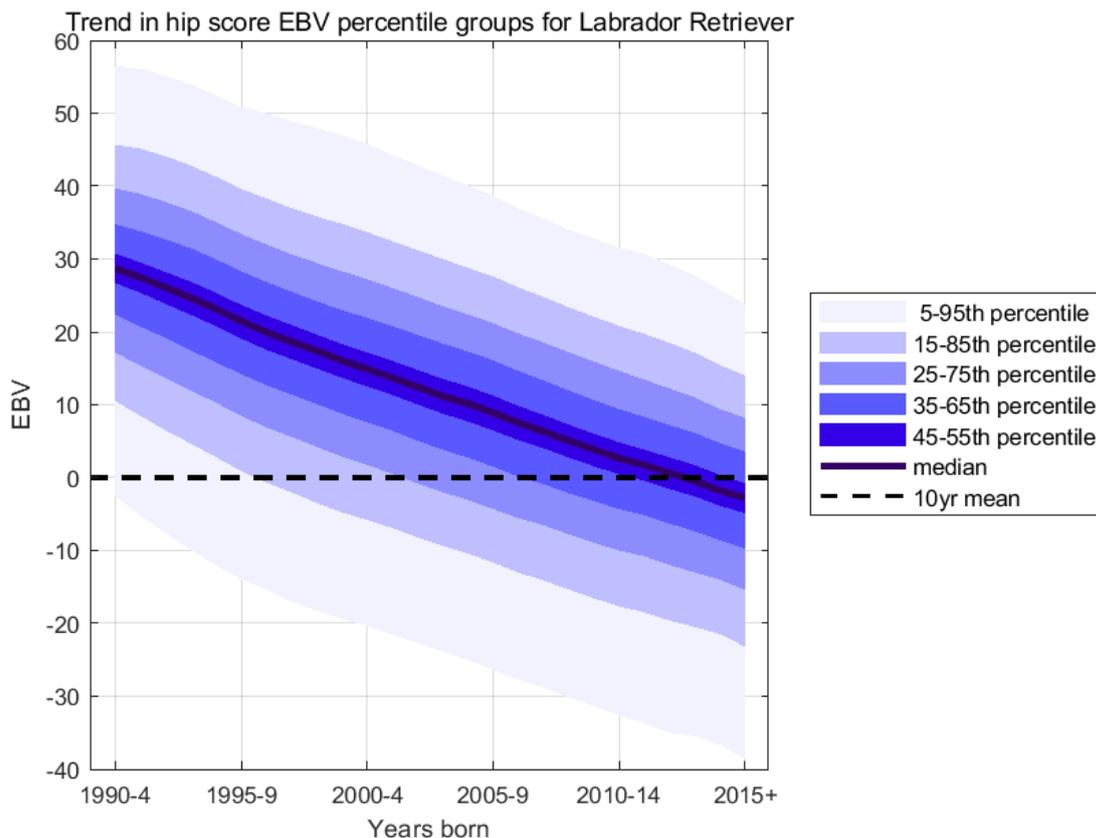
Figure 7: Trend in hip score EBV, with percentile groups, for the Labrador for years of birth since 1990.

ELBOWS

A total of 24,459 Labradors have participated in the BVA/KC Elbow Dysplasia Scheme in the past 15 years. As of 2020, 87.2% of those dogs were graded a 0, 9.1% a grade 1, 3.2% a grade 2 and 1.5% a grade 3. Figure 8 shows the categories of grades over five year blocks for the past 20 years. There appears to have been a gradual reduction in the number of moderate and severe grades (grade 2 and 3s) during this time, and increase in grade 0s.

As of 2016-8, 41.15% of sires were scored, and 45.73% of dams, with 92.76% of scored sires a grade zero, and 91.66% of dams (James et al, 2019).
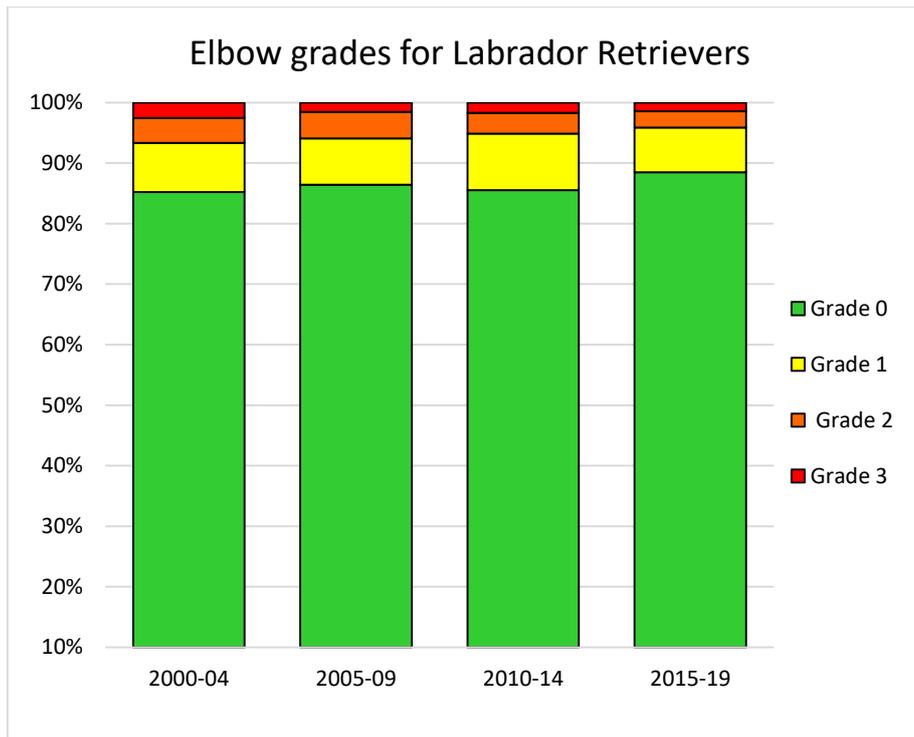
Figure 8: Elbow grade categories for Labradors which participated in the BVA/KC Hip Dysplasia Scheme between 2000 and 2019, in 5-year blocks.

Again, EBVs are available for elbows for the Labrador with Figure 9 showing the five year rolling trend in EBVs by year of birth in the breed. Since 1990 the trend has in EBVs have decreased overtime which indicates again an improving (lowering) genetic risk of hip dysplasia as determined by the BVA/KC elbow score.
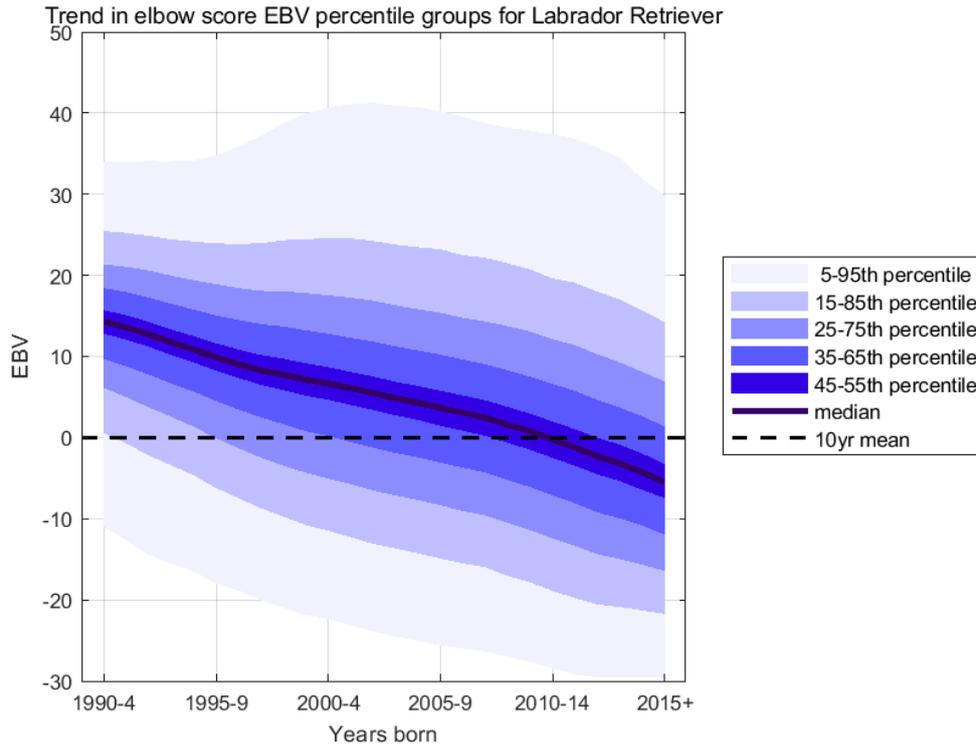
Figure 9: Trend in elbow score EBV, with percentile groups, for the Labrador for years of birth since 1990.

EYES

The Labrador is currently on the Known Inherited Ocular Disease (KIOD) list (formally Schedule A), under the BVA/KC/International Sheep Dog Society (ISDS) Eye Scheme, for:

- Multifocal retinal dysplasia (MRD)
- Total retinal dysplasia (TRD)
- Generalised progressive retinal atrophy (GPRA)
- Retinal pigment epithelial dystrophy (RPED)
- Hereditary cataracts (HC)

KIOD lists the known inherited eye conditions in the breeds where there is enough scientific information to show that the condition is inherited in the breed, often including the actual mode of inheritance and in some cases even a DNA test.

Schedule B no longer exists in its former state, and instead has been replaced with the sightings reports (shown in Table 4).

In the past 15 years, 67,777 Labradors have been tested and recorded by the BVA/KC/ISDS, with 97.3% of dogs recorded as unaffected by any condition. Results of these dogs are shown in Table 6 below.

Table 6: Eye test results for Labrador Retrievers tested under the BVA/KC/ISDS Eye Scheme in the past 15 years

Condition	Number Affected
AFFECTED – unspecified	2
AFFECTED RPED	1
AFFECTED CPRA and HC	2
AFFECTED GPRA	107
AFFECTED GPRA and HC	49
AFFECTED GPRA, CPRA and HC	1
AFFECTED HC	3241
AFFECTED HC and RD	1
AFFECTED RD	1
AFFECTED TRD	3
UNAFFECTED	96593
Total	**100000**

MRD results were stored on an open register and freely accessible on the Kennel Club's website, results of dogs tested prior to January 2020 can be found through clicking here: https://www.thekennelclub.org.uk/for-vets-and-researchers/mrd-eye-results/

As of January 2020 however, MRD results are no longer recorded in the open register and instead will be recorded as with other KIOD disorders, and published in the Breed Records Supplement and on the Health Test Results Finder.

The BVA also records the results of dogs which have participated in the scheme and are affected by any conditions that occur outside of the Schedules, and compile into an annual sightings report. The results of sightings reports for the Labrador since 2012 are shown in Table 7 on the following page.

Table 7: Reports on Labrador which have participated in the BVA/KC/ISDS Eye Scheme since 2012 (As = adults, Ls = litters).

Condition	2012		2013		2014		2015		2016		2017		2018	
	4824 As	5 Ls	4904 As	4 Ls	4316 As	11 Ls	4812 As	9 Ls	4876 As	8 Ls	5069 As	11 Ls	5127 As	8 Ls
APD	1													
Capsular cataract							34						6	
Chorioretinopathy							82				9			
Choroidal hypoplasia												1		
Corneal lipid deposition	60		46		22		44		21		23		15	
Cortical cataract													8	
Dermoid			1											
Diamond eye							5							
Distichiasis	43		54		47	1	37		35		28		55	
Ectropion	2		8		4				2		5			
Entropion	12		3		5		5		1		4		2	
Eyelid mass			1											
Focal retinopathy							8							
Goniodysgenesis	3													
GPRA-like appearance	3		3											
Hyaloid remnants			9		13		15							
Iris cysts	9		9				16							
Microphthalmos					1									
MRD-like appearance											1			1
Multi-ocular defects							1		1					
Nuclear cataract	12		9		8		5		20		8		23	
Optic nerve hypoplasia	2													
Other cataract	214		149		29	1	289		46					
Perinuclear cataract											1			
Persistent hyperplastic primary vitreous (PHPV)	44		14								8		8	
Persistent pupillary membranes (PPM)	73		61	1	16		64		27		39		10	
PLD grade (0)											2			
Post cataract													8	
Posterior post-subcapsular cataract (PPSC)	5		1				4				22		15	
Vitreal cyst					1									

AMERICAN COLLEGE OF VETERINARY OPHTHALMOLOGISTS (ACVO)

Results of examinations through ACVO are shown in Table 8 below. Between 2015 and 2019, 33,829 Labrador Retrievers were examined, of which 80.2% (27,117 of 33,829 dogs) were found to be unaffected by any eye condition. Whilst it is important to note that these data represent dogs in America, the organisation tend to examine a higher number of dogs than that in the UK, and therefore can be a valuable source of information.

Table 8: ACVO examination results for Labrador Retrievers, 1991 - 2019

Disease Category/Name	Percentage of Dogs Affected	
	1991-2014 (n=221,401)	2015-2019 (n=33,829)
Eyelids		
Distichiasis	1.0%	0.9%
Cornea		
Corneal dystrophy	1.0%	1.0%
Uvea		
Persistent pupillary membranes (iris to iris)	2.9%	3.8%
Lens		
Cataract (significant)	3.9%	4.0%
Retina		
Retinal dysplasia (folds)	2.2%	1.1%

Adapted from: https://www.ofa.org/diseases/eye-certification/blue-book

REPORTED CAESAREAN SECTIONS

When breeders register a litter of puppies, they are asked to indicate whether the litter was delivered (in whole or in part) by caesarean section. In addition, veterinary surgeons are asked to report caesarean sections they perform on Kennel Club registered bitches. The consent of the Kennel Club registered dog owner releases the veterinary surgeon from the professional obligation to maintain confidentiality (vide the Kennel Club General Code of Ethics (2)).

There are some caveats to the associated data;

- It is doubtful that all caesarean sections are reported, so the number reported each year may not represent the true proportion of caesarean sections undertaken in each breed.
- These data do not indicate whether the caesarean sections were emergency or elective.

The number of litters registered per year for Labradors and the number and percentage of reported caesarean sections in the breed for the past 10 years are shown in Table 9. Of 6,518 caesarean sections reported in 2019, 3.3% were Labrador Retrievers (213). Of 41,329 registered litters 11.9% were Labrador litters.

Table 9: Number and percentage of litters of Labradors registered per year and number of caesarean sections reported per year, 2009 to 2019.

Year	Number of Litters Registered	Number of C-sections	Percentage of C-sections	*Percentage of C-sections out of all KC registered litters (all breeds)*
2009	6145	1	0.02%	0.15%
2010	6425	12	0.19%	0.35%
2011	5795	35	0.60%	1.64%
2012	5263	206	3.91%	8.69%
2013	5086	231	4.54%	9.96%
2014	4891	218	4.46%	10.63%
2015	4785	241	5.04%	11.68%
2016	4781	238	4.98%	13.89%
2017	5037	229	4.55%	15.00%
2018	5122	327	6.38%	17.21%
2019	4911	231	4.70%	15.70%

GENETIC DIVERSITY MEASURES

The effective population size is the number of breeding animals in an idealised, hypothetical population that would be expected to show the same rate of loss of genetic diversity (rate of inbreeding) as the population in question; it can be thought of as the size of the 'gene pool' of the breed. In the population analysis undertaken by the Kennel Club in 2015, an estimated effective population size of 81.7 was reported (estimated using the rate of inbreeding over the period 1980-2014).

The rate of inbreeding has increased gradually and is below an effective population size of 100 (inbreeding rate of 0.50% per generation) which results in the rate of loss of genetic diversity in a breed/population increasing dramatically (Food & Agriculture Organisation of the United Nations, "Monitoring animal genetic resources and criteria for prioritization of breeds", 1992).

Although the breed is numerically strong, and therefore could be thought to have plentiful genetic diversity, there are two distinct types of Labrador (show and working) and geographic bottlenecks may occur, where a sire becomes popular locally – both acting to decrease genetic diversity in the breed.

Annual mean observed inbreeding coefficient (showing loss of genetic diversity) and mean expected inbreeding coefficient (from simulated 'random mating') over the period 1980-2014 are shown in Figure 10. The rate of inbreeding has been increasing, although may have begun to plateau since 2005.   For full interpretation

see Lewis et al, 2015 https://cgejournal.biomedcentral.com/articles/10.1186/s40575-015-0027-4.

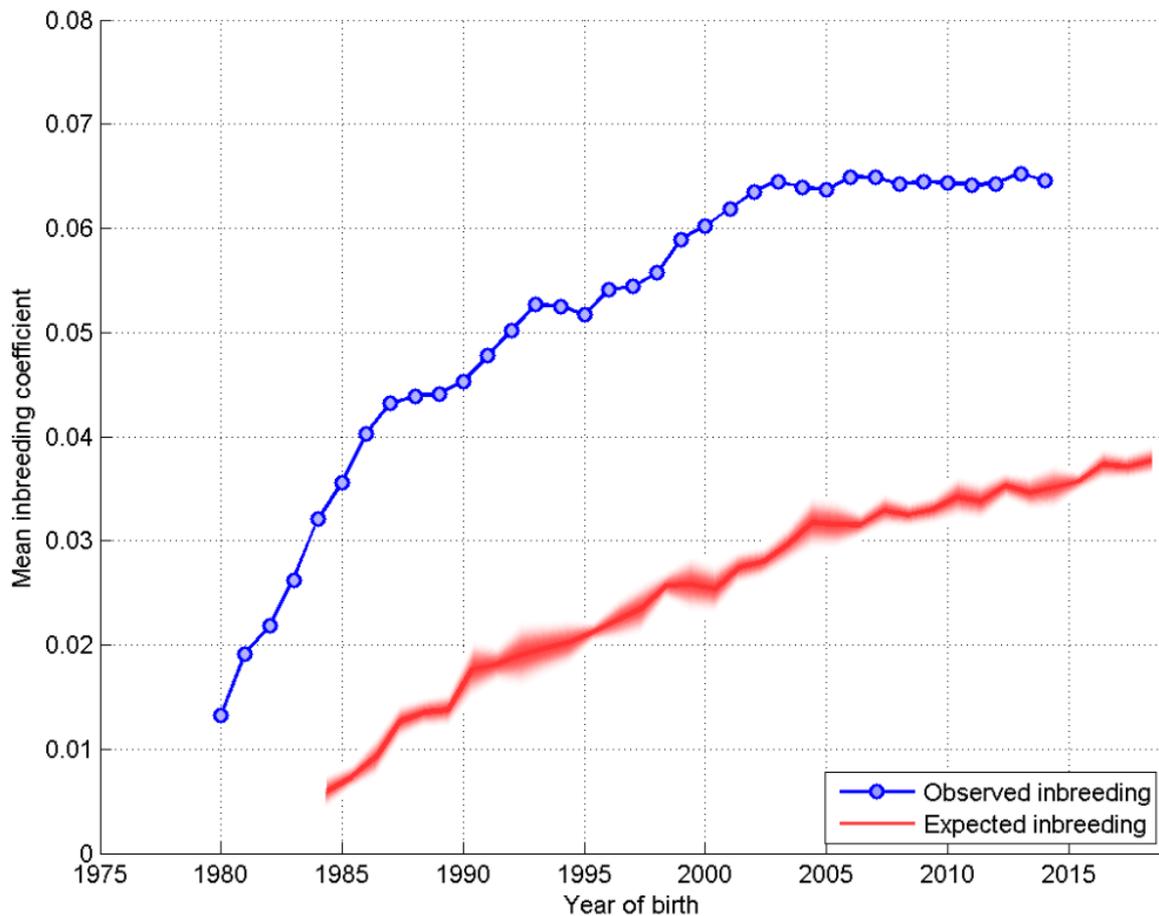The current annual breed average inbreeding coefficient is 6.5%.

Figure 10: Annual mean observed and expected inbreeding coefficients

Below is a histogram ('tally' distribution) of number of progeny per sire and dam over each of seven 5-year blocks (Figure 11). A longer 'tail' on the distribution of progeny per sire is indicative of 'popular sires' (few sires with a very large number of offspring, known to be a major contributor to a high rate of inbreeding).   It appears that the extensive use of popular dogs as sires has eased a little (the 'tail' of the blue distribution shortening in Figure 11), although there are still some dogs who have sired approximately 700 progeny between 2010 and 2014.
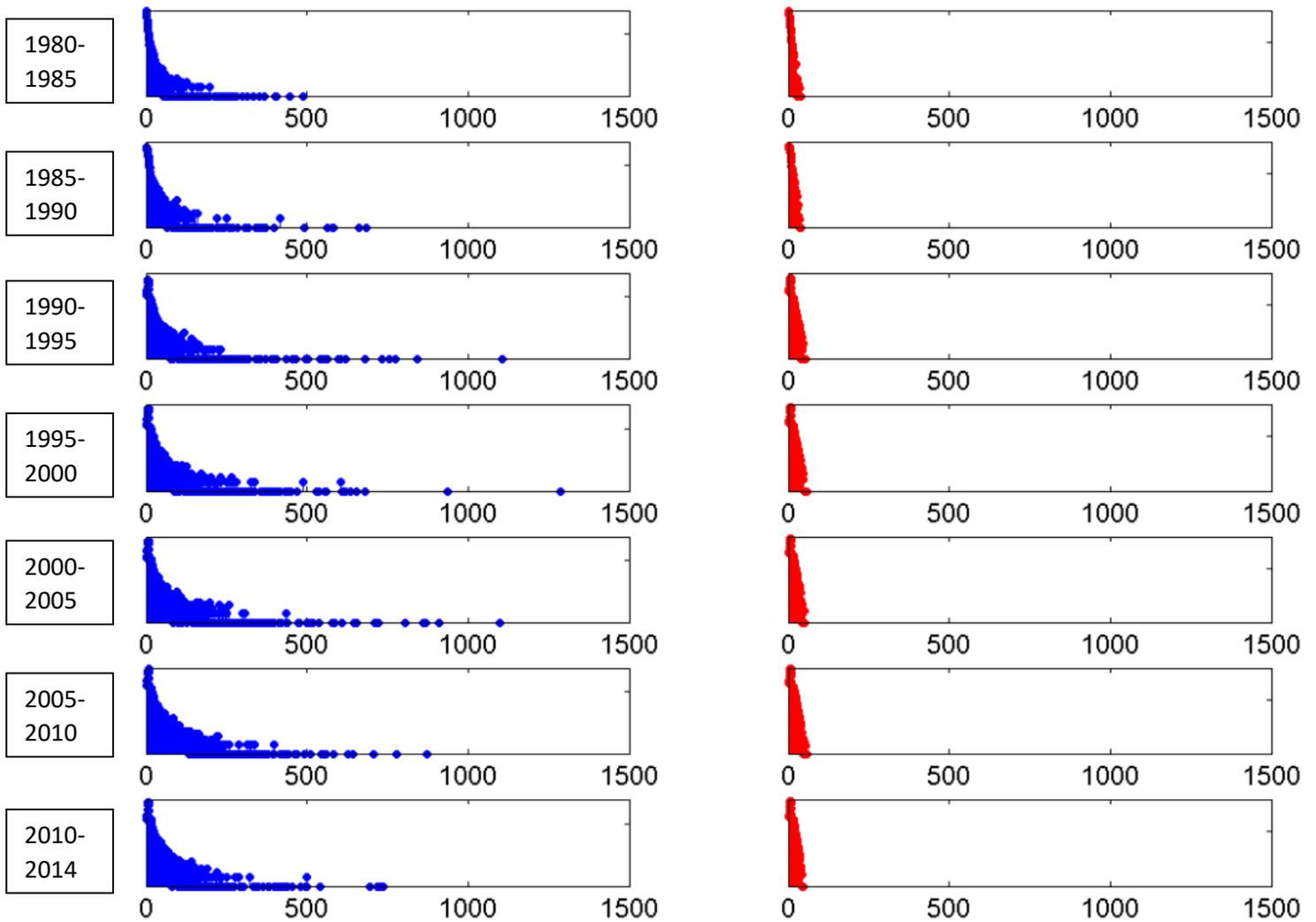
Figure 11: Distribution of progeny per sire (blue) and per dam (red) over 5-year blocks (1980-4 top, 2010-14 bottom). Vertical axis is a logarithmic scale.

CURRENT RESEARCH

The breed have been encouraging owners to complete a cancer survey which is being run by the University of Nottingham, investigating any breed-specific predispositions to cancers.

The breed have also continued to participate in the Dogs Life project to identify common diseases in the breed.

As well as this, participation with the Animal Health Trust (AHT) is ongoing, investigating mast cell tumours as well as collecting samples for hereditary cataracts.

The breed are also encouraging samples to be sent to the AHT to investigate cataracts and iris melanoma.

PRIORITIES

A meeting was held with the Labrador breed representatives on 4th January 2020 to discuss the breed's evidence base.

The group agreed from the evidence base and their own experience that the priorities for the Labrador are:

- Skin conditions and colour associated disorders
- Hereditary cataracts
- Cruciate ligament disease
- Elbow disease
- Heart conditions

ACTION PLAN

Following the meeting between the Kennel Club and the breed regarding the evidence base of the Breed Health & Conservation Plans, the following actions were agreed to improve the health of the Labrador. Both partners are expected to begin to action these points prior to the next review.

Breed Club actions include:

- The breed to document their concerns and suggestions for the BVA/KC Elbow & Hip Dysplasia Schemes via the Breed Health Co-ordinators to the Kennel Club, in order for these to be taken to the BVA

- The breed to monitor the incidence of macular dystrophy through collaborating with the AHT and consider making a proposal that this is formally recognised as a DNA test by the Kennel Club

- The breed to consider adding a Breed Watch point of concern regarding incorrect temperaments

- The breed to forward correspondence regarding research into ectopic ureters to the Kennel Club to see if this can be progressed

- The breed to continue to disseminate health information to owners and puppy buyers, covering areas such as husbandry and managing obesity

Kennel Club actions include:

- The Kennel Club to monitor cruciate ligament studies and inform the breed of any studies/ outcomes

- The Kennel Club to contact the AHT for an update on the Give a Dog a Genome Project

- The Kennel Club to take documented concerns regarding the BVA/ KC/ ISDS Eye Scheme to the Eye Panel Working Party

- The Kennel Club to request an update from the University of Cambridge GoDogs project

- The Kennel Club to develop a cruciate and elbow surgery survey, with the breed's input, and circulate to UK owners, to determine whether young dogs are having surgery under the age of one

- The Kennel Club to investigate research avenues for skin research and keep the breed updated

- The Kennel Club to remove the prcd-PRA linkage test due to the replacement of a definitive test

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