



THE KENNEL CLUB  
DOG HEALTH

# Breed Health and Conservation Plan

## Gordon Setter Evidence Base

# CONTENTS

<b>INTRODUCTION</b> .....	3
<b>DEMOGRAPHICS</b> .....	3
<b>BREED HEALTH CO-ORDINATOR ANNUAL HEALTH REPORT</b> .....	4
<b>BREED CLUB HEALTH ACTIVITES</b> .....	5
<b>BREED SPECIFIC HEALTH SURVEYS</b> .....	5
<b>LITERATURE REVIEW</b> .....	6
<b>INSURANCE DATA</b> .....	8
<b>BREED WATCH</b> .....	11
<b>PERMISSION TO SHOW</b> .....	12
<b>ASSURED BREEDER SCHEME</b> .....	12
<b>BREED CLUB BREEDING RECOMMENDATIONS</b> .....	12
<b>CANINE HEALTH SCHEMES AND ESTIMATED BREEDING VALUES</b> .....	13
<b>REPORTED CAESAREAN SECTIONS</b> .....	17
<b>GENETIC DIVERSITY MEASURES</b> .....	18
<b>CURRENT RESEARCH</b> .....	20
<b>PRIORITIES</b> .....	21
<b>ACTION PLAN</b> .....	22
<b>REFERENCES</b> .....	23

## **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 raise awareness of current health and welfare concerns in their breed, and support them in making balanced breeding decisions.

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 representatives where 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 are then monitored and reviewed on a regular basis.

## **DEMOGRAPHICS**

The Gordon Setter is a vulnerable native breed, defined as a breed with fewer than 300 new registrations a year. The numbers of new registrations of the breed have been consistently below this threshold since 2011, but have been relatively stable since this time, as shown in Figure 1 below.

The trend of registrations over year of birth (1980-2019) was -7.60 per year (with a 95% confidence interval of -5.37 to -9.82), reflecting the general decrease seen over this time period.

[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.]

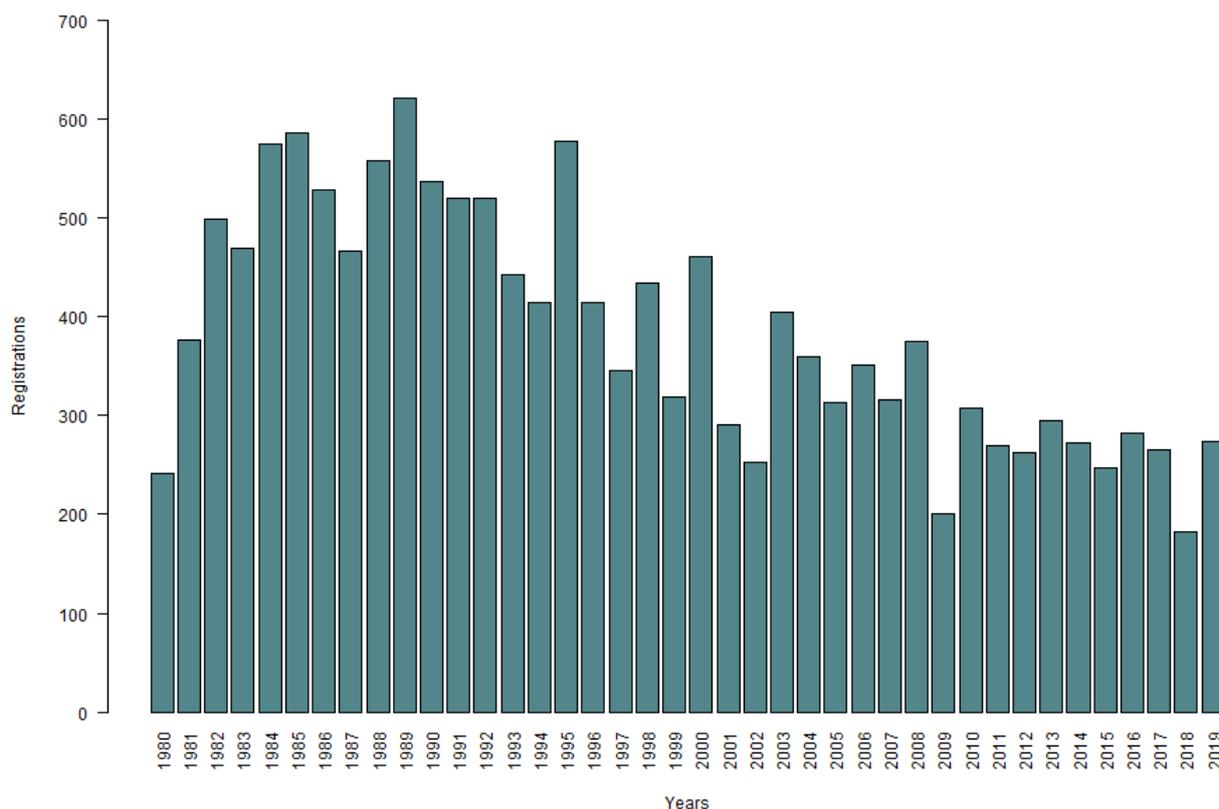


Figure 1: Number of registrations of Gordon Setters per year of birth, 1980 – 2019

## 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 Breed Health Coordinators' 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. Progressive retinal atrophy (PRA)
2. Heart condition concerns

In terms of what the breed has done in the last year to help tackle this listed health and welfare concern, they have been continuing to encourage the use of the PRA-rcd4 DNA test and routine eye testing, with two eye clinics held in the year. The breed have also been working with the University of Nottingham following concern raised over heart conditions.

## **BREED CLUB HEALTH ACTIVITIES**

The breed has an active BHC, dedicated health sections on the breed clubs' websites and each breed club has a health representative. The BHC continues to monitor emerging conditions within the breed, with reports of inflammatory bowel disease (IBD) having been reported recently.

## **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 293 live Gordon Setters, of which 155 (53%) were healthy and 138 (47%) had at least one reported health condition. The top categories of diagnosis were musculoskeletal (20.0%, 49 of 245 reported conditions), reproductive (11.8%, 29 of 245 reported conditions), dermatologic (9.0%, 22 of 245 reported conditions), immune-mediated (9.0%, 22 of 245 reported conditions) and respiratory (7.8%, 19 of 245 reported conditions). The most frequently reported specific conditions were pyometra (4.4% prevalence, 8 cases in the 182 females in the survey), kennel cough (4.1% prevalence, 12 cases), otitis externa (3.1% prevalence, 9 cases) and lipoma (3.1% prevalence, 9 cases).

**2004 Mortality results:** A total of 157 deaths were reported for the breed. The median age at death for Gordon Setters was 11 years and 1 months (min = 4 months, max = 16 years and 3 months). The most frequently reported causes of death by organ system or category were cancer (29.3%, 46 of 157 deaths), old age (16.6%, 26 deaths) and cardiac (14.6%, 23 deaths). The most frequently reported specific cause of death behind old age and cancer was heart failure (9.6%, 15 deaths).

**2014 Morbidity results:** Health information was collected for 173 live Gordon Setters of which 103 (59.5%) had no reported conditions and 70 (40.5%) were reported affected by at least one condition. The most frequently reported specific conditions were skin (cutaneous) cyst (15.6% prevalence, 27 cases), lipoma (6.9%, 12 cases), otitis externa (6.4%, 11 cases), mammary lump (5.8% prevalence, 10 cases) and hypothyroidism (4.1%, 7 cases).

**2014 Mortality results:** A total of 54 deaths were reported for the breed. The median age at death for Gordon Setters was 12 years (min = 4 years, max = 15 years). The most frequently reported causes of death were old age (20.4%, 11 deaths) and skin tumours (9.3%, 5 deaths).

## Rolling Health Survey

A rolling breed health survey was launched in 2017, which allows Gordon Setters to report health conditions in their dogs as they arise. A report on the forms received will be provided at a later date.

## **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 attempted to acknowledge possible limitations of the studies reported, including when the research involved dogs in other countries. Whilst there are often strong links between populations of a breed in different countries, there are also often differences between the populations and issues seen in one country may not be seen (or may have a different prevalence) in another.

### **Dermatological conditions**

*Black hair follicular dysplasia*: This condition has been reported in Gordon Setters in Norway. Antinuclear antibodies were found in five of the 13 affected dogs, suggesting an autoimmune basis for the disease (Øvrebø Bohnhorst et al, 2001). The findings of that study led the authors to suggest that this condition may share a common genetic predisposition with symmetric lupoid onychodystrophy.

*Canine juvenile cellulitis ('puppy stranglers', juvenile pyoderma)*: This uncommon condition, which usually onsets at one to four months of age, was reported to affected 24.4% of Gordon Setter litters in the UK between 1985 and 1988 (Mason and Jones, 1989). However no more recent reports of the condition in the breed, nor prevalence estimates, were found in the literature.

*Symmetrical lupoid onychodystrophy (SLO, symmetrical onychomadesis)*: The Gordon Setter is reported to be at increased risk of this autoimmune condition in which several, and eventually all, claws separate and slough from the claw beds (Wilbe et al, 2010). It was first reported in a Norwegian paper which suggested an autoimmune basis due to the presence of antinuclear antibodies in three of 10 affected dogs (Øvrebø Bohnhorst et al, 2001). Dog leucocyte antigen (DLA) class II alleles have been shown to be associated with risk of developing the disease in Gordon Setters, supporting the hypothesis that it is an immune-mediated disease (Wilbe et al, 2010). It has been suggested that SLO is a complex condition, affected by both genetics and environmental factors. A recent genome-wide association study of Setters in Norway and Sweden identified a single, approximately 3.3 megabase region on chromosome 12 strongly identified with SLO in Gordon Setters (Dahlgren et al, 2016).

## **Endocrine conditions**

*Hypothyroidism:* The Gordon Setter was first described as being at increased risk of hypothyroidism in a case series at the University of Montreal, Canada (1987-1988) with 20% of cases whilst only representing 0.1% of the hospital population, giving a relative risk of 200.0 (Scott and Paradis, 1990). In a Norwegian study of 291 eight-year-old Gordon Setters in 2012, 2.7% (8 dogs) had developed hypothyroidism (Ziener, 2015). In that study, particular DLA haplotypes and alleles were associated with hypothyroidism, with one DLA haplotype which may protect against hypothyroidism appearing to be associated with SLO. Further to this, genome-wide association analysis was undertaken on the breed and identified a risk locus on chromosome 12 with three genes that could contribute to development of disease (Bianchi et al, 2015). However, these genes have not been identified in genomic studies in the past and therefore further investigation between their association with disease is needed to confirm this.

## **Gastrointestinal conditions**

*Gastric dilatation/volvulus syndrome (GDV, 'bloat'):* Gastric dilatation-volvulus syndrome (GDV) is an acute, life-threatening condition featuring rapid accumulation of air in the stomach, malposition of the stomach to a varying degree and a rise in intragastric pressure, frequently leading to the development of cardiogenic shock (Glickman et al, 2000). The Gordon Setter was found to be at increased risk of GDV in an American case series based on data from the Veterinary Medical Data Base between 1980-1989, with an odds ratio of 4.1 (95% C.I. 1.8-9.3) compared to mixed breed dogs (Glickman et al, 1994).

## **Musculoskeletal conditions**

*Elbow dysplasia:* The Gordon Setter was reported to be at elevated risk of fragmented coronoid process (FCP), a form of elbow dysplasia, with a breed-associated odds ratio compared to mixed breeds of 19.8 (95% C.I. 9.2-42.8), based on dogs which had attended veterinary teaching hospitals in the USA between 1986 and 1995; however this result was only based on 7 cases and 11 non-cases in the breed (LaFond et al, 2002).

*Hip dysplasia:* The Gordon Setter was reported to be at elevated risk of hip dysplasia, with a breed-associated odds ratio compared to mixed breeds of 2.0 (95% C.I. 1.4-3.0), based on dogs which had attended veterinary teaching hospitals in the USA between 1986 and 1995; however this result was only based on 53 cases and 41 non-cases in the breed (LaFond et al, 2002). A study of radiographs submitted for screening by the French Kennel Club, comparing the 1993-1999 with the 2000-2006 period, reported a 25% decrease in hip dysplasia prevalence In the Gordon Setter (Genevois et al, 2008).

## Neurological conditions

*Cerebellar degeneration*: This condition was first observed in six to 24 month old Gordon Setters in America in the late 1970s, with affected dogs showing a slowly progressive ataxia, and an apparent autosomal recessive mode of inheritance (de Lahunta et al, 1980). An A to C single nucleotide polymorphism (SNP) located at position 113 in exon 1 of an autophagy gene, *RAB24*, has been shown to segregate perfectly with the phenotype in the Gordon Setter suggesting that this mutation may contribute to the condition (Agler et al, 2014).

*Lethal astrocytosis*: This fatal condition which affects puppies from three to four weeks of age has been described in Gordon Setters in America. Pedigree analysis of 10 litters with a total of 84 pups, including 27 affected puppies, suggested an autosomal recessive mode of inheritance (Yaeger et al, 2000).

## Ocular conditions

*Progressive retinal atrophy (PRA)*: PRA is the collective name for a group of inherited and progressive retinal diseases characterised by gradual retinal degeneration resulting in initial night blindness and progressing to total vision loss. A late onset form, now known as rod-cone degeneration 4 (*rcd4*), has been described in the Gordon Setter, and a single-base insertion mutation in *C2orf71* has been identified which is a major susceptibility locus for late-onset PRA in the breed (Downs et al, 2013). A DNA test is available for the mutation. It is possible that other genetic forms of PRA may also exist in the breed.

A recent paper looking at trends in DNA testing for specific breeds overtime included the Gordon Setter and the PRA-*rcd4* test (Lewis and Mellersh, 2019). Overall, the proportion of dogs affected by the condition has significantly reduced from 2000-2017, as has the mutation frequency for the condition, with this having dropped from 28.44% (before the test was available) to 10.84%. Conversely, the proportion of dogs with a known genotype had increased overtime, with significant evidence that breeders had selected away from the condition using genotyping, resulting in a reduction in the prevalence of disease in the breeding population.

*Retinopathy (cone-rod dystrophy)*: This condition, which presents as day blindness, was first described in two related Gordon Setters which were referred to the Ophthalmology Service of the University of California, Davis Veterinary Medical Teaching Hospital (Good et al, 2016). They were free of all known mutations associated with canine retinal disease, including *rcd4*. No further reports of the condition or prevalence estimates have been published to date.

## 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 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 Gordon Setters insured with Agria UK. 'Exposures' are equivalent to one full policy year; in 2017 there were 19 free exposures, 224 full exposures and 220 claims, in 2018 these figures were 15, 198 and 233 respectively. 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. It is possible that one dog could have more than one settlement for a condition within the 12-month period shown.

The top 10 conditions by number of settlements, for authorised claims where treatments started between 1<sup>st</sup> July 2017 and 31<sup>st</sup> June 2018 for the Gordon Setter are shown in Table 1 below.

Table 1: Top 10 conditions and number of settlements for each condition between 1<sup>st</sup> July 2017 and 31<sup>st</sup> June 2018 for Gordon Setters insured with Agria UK

Condition	Number of settlements
Otitis externa chronic	14
Addison's disease (primary hypoadrenocorticism)	14
Cruciate ligament rupture - caudal and cranial	13
Cardiomyopathy - unclassified or class undetermined	10
Atopy finding	9
Cardiomyopathy - Canine dilated cardiomyopathy	9
Wound - laceration	8
Skin (cutaneous) disorder (unspecified)	7
Lameness finding	7
Otitis externa	6

### Swedish Agria insurance morbidity data

Swedish morbidity insurance data were available from Agria for the Gordon Setter. 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) e.g. 1 DYAR is equivalent to one whole year of insurance. The number of DYAR for the Gordon Setter in Sweden during this period was between 1,000 and 2,500, so the results should be interpreted with caution.

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 episodes (VCEs) for Agria-insured Gordon Setters in Sweden between 2011 and 2016 are shown in Figure 2. The top specific causes of VCEs were and skin tumours, pain on locomotion, vomiting/ diarrhoea/ gastroenteritis, claw trauma, and mammary tumours.

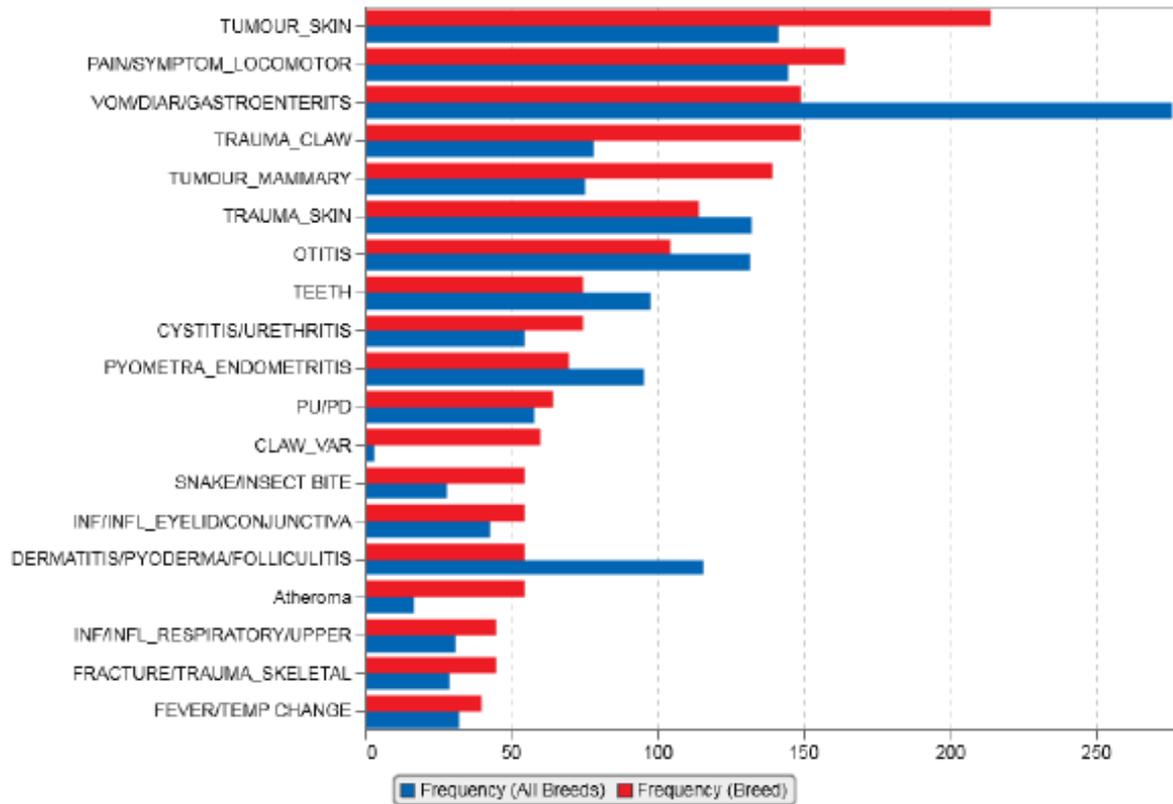


Figure 2: The most common specific causes of VCEs for the Gordon Setter compared to all breeds in Sweden between 2011 and 2016, from Swedish Agria insurance data.

The specific causes of VCEs ordered by relative risk for the Gordon Setter are shown in Figure 3. In this analysis, the top specific causes of VCEs ordered by relative risk are claw disorders - various, atheroma (degeneration of artery walls), snake/insect bite, claw trauma and mammary tumours. Rare conditions that occur sporadically may appear as a high relative risk; given that a number of the conditions in Figure 3 do not appear in Figure 2, this caveat may well apply to these conditions.

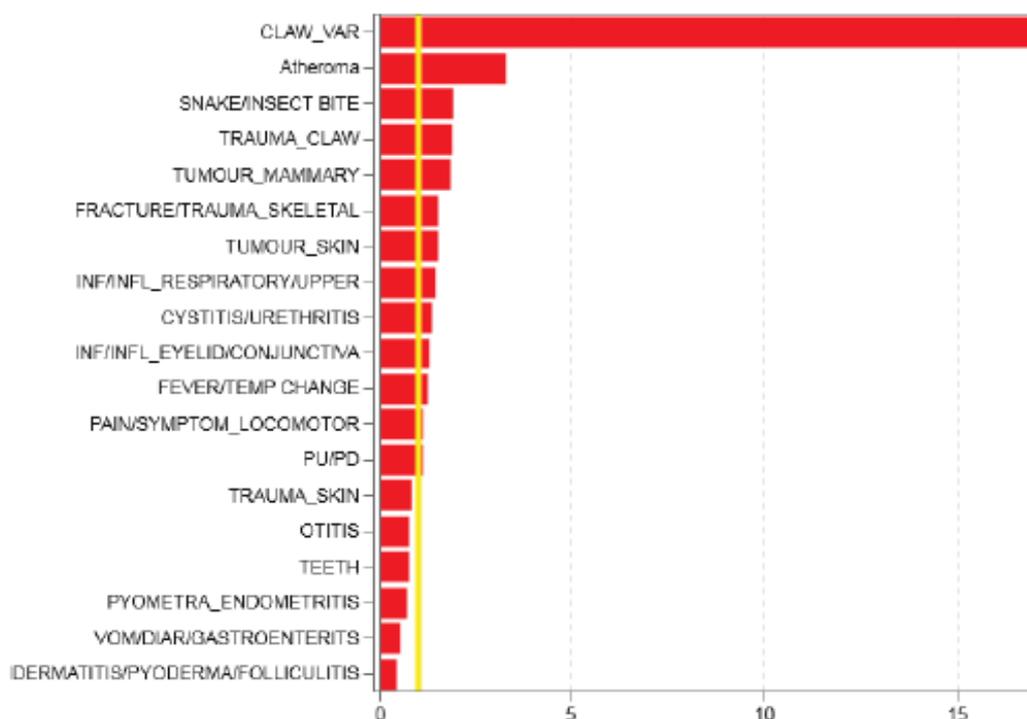


Figure 3: The specific causes of VCEs for the Gordon Setter ordered by relative risk compared to all breeds in Sweden between 2011 and 2016, from Swedish Agria insurance data. The yellow line indicates the baseline risk for all breeds.

## BREED WATCH

The Gordon Setter is a category 2 breed on Breed Watch, meaning judges are required to complete a mandatory monitoring form following a judging appointment at Championship Certificate level. The points of concern judges are required to monitor and the percentage of dogs reported to be affected are shown in Table 1.

Table 2: Judges' health monitoring reports for 2017 to 2019. Those marked with a \* indicate newly reported points of concern.

Point of concern	2017	2018	2019
Excessive hind angulation	0.60%	0.23%	0.24%
Excessively thick woolly coat	0.22%	0.29%	0.08%
Overlong hip to hock	0.82%	0.17%	0.24%
Sickle hock	0.38%	0.17%	0.24%
* Incorrect dentition	0.16%	0.00%	0.24%
* Nervous temperament	0.00%	0.25%	0.00%
* Other	0.05%	1.05%	0.00%
* Overweight	0.00%	0.00%	0.24%
* Unsound movement	0.05%	0.00%	0.00%
<b>Total dogs reported for</b>	<b>1981</b>	<b>1717</b>	<b>1233</b>

NB: As of quarter 3 in 2019 judges are no longer reminded to complete monitoring forms following their judging appointments, which is reflected in a reduced number of reports received across all breeds.

## PERMISSION TO SHOW

As of the 1<sup>st</sup> January 2020 exhibits for which permission to show (PTS) following surgical intervention has been requested will no longer be published in the Breed Record Supplement and instead will be detailed in BHCPs, and a yearly report will be collated for the BHC. In the past five years 14 PTS have been sought (excluding neutering) for the breed, with these shown in Table 3 below.

Table 3: PTS granted for Gordon Setters in the past five years.

<b>Surgical alteration</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>	<b>2020</b>
Cruciate Ligament (rupture)			1	1	
Operation to repair damage of elbow	1			1	
Removal of cysts	1	1	1		1
Removal of teeth/tooth - Due to Trauma.				1	
Removal of toe				1	
Removal of tumours			1		
Tail Amputated due to Trauma	1				
Tail Partially Amputated		1			
Umbilical Hernia		1			

## ASSURED BREEDER SCHEME

Currently within the Kennel Club (KC)'s Assured Breeders Scheme (ABS) it is required that Assured Breeders:

- Hip score all breeding stock under the British Veterinary Association (BVA)/KC Hip Dysplasia Scheme
- DNA tested for PRA (rcd4)

The following recommendations also apply:

- Eye tested under the BVA/KC/International Sheepdog Scheme (ISDS) Eye Scheme
- Bitches under 21 months not to produce a litter

## BREED CLUB BREEDING RECOMMENDATIONS

The breed clubs recommend that bitches under 21 months are not to produce a litter.

## DNA TEST RESULTS

There is currently one recognised DNA test for this breed, which is:

- PRA (rcd4)

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 of which involves collaboration between the breed clubs and the Kennel Club in order to validate the test's accuracy.

Laboratories that test for these DNA tests and the methods through which the Kennel Club accept results can be found through:

<https://www.thekennelclub.org.uk/worldwide-dna-tests/>

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 major contributor to erroneous status will be removed. Therefore, a less stringent restriction for HC status is applied where parentage is confirmed by DNA test.

Results of the PRA (rcd4) DNA test have been recorded since May 2011 and it was made an ABS requirement in January 2012. The results for dogs which had been DNA tested up to July 2020 are shown in Table 4.

Table 4: PRA (rcd4) DNA test results held by the Kennel Club for Gordon Setters up to July 2020.

<b>Total number of results</b>	<b>Clear</b>	<b>Carrier</b>	<b>Affected</b>	<b>Hereditarily clear</b>	<b>Hereditarily carrier</b>	<b>Hereditarily affected</b>
1,882	333 (17.7%)	318 (16.9%)	73 (3.9%)	932 (49.5%)	220 (11.7%)	6 (0.3%)

The DNA test for the rcd4 mutation became available in 2011, and the apparent mutation frequency for Kennel Club registered Gordon Setters born in that year was approximately 27%. As shown in the paper by Lewis and Mellersh (2019) in the literature review above, the mutation frequency has since reduced and the proportion of dogs genotyped per year increased, implying selection against the disease is resulting in good progress.

## CANINE HEALTH SCHEMES AND ESTIMATED BREEDING VALUES

All BVA/KC Health Schemes are open to dogs of any breed, and the results for Gordon Setters which have been presented for assessment under the schemes are shown below.

## HIPS

In total 1,222 Gordon Setters have participated in the BVA/KC Hip Dysplasia Scheme in the past 20 years to date (July 2020), with the 15-year median hip score being 11 (range 0-101) and 5-year 10 (range 0-101) implying improvement has been made.

The graph below (Figure 4) shows the 5<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup>, 75<sup>th</sup> and 95<sup>th</sup> percentiles for hip scores in the breed between 2000 and 2018. Percentiles are the score at which a certain percent of the known population are at or below that point, e.g. in 2018 75% of scored dogs were below a score of 18. It is important to remember that the 95<sup>th</sup> percentile will include the dogs with the highest score, and so may contain outliers. Over this period, there is a notable decrease in the 95<sup>th</sup> and 75<sup>th</sup> percentiles, implying a curtailing in the most severe and moderate hip scores, with the remaining percentiles staying relatively level.

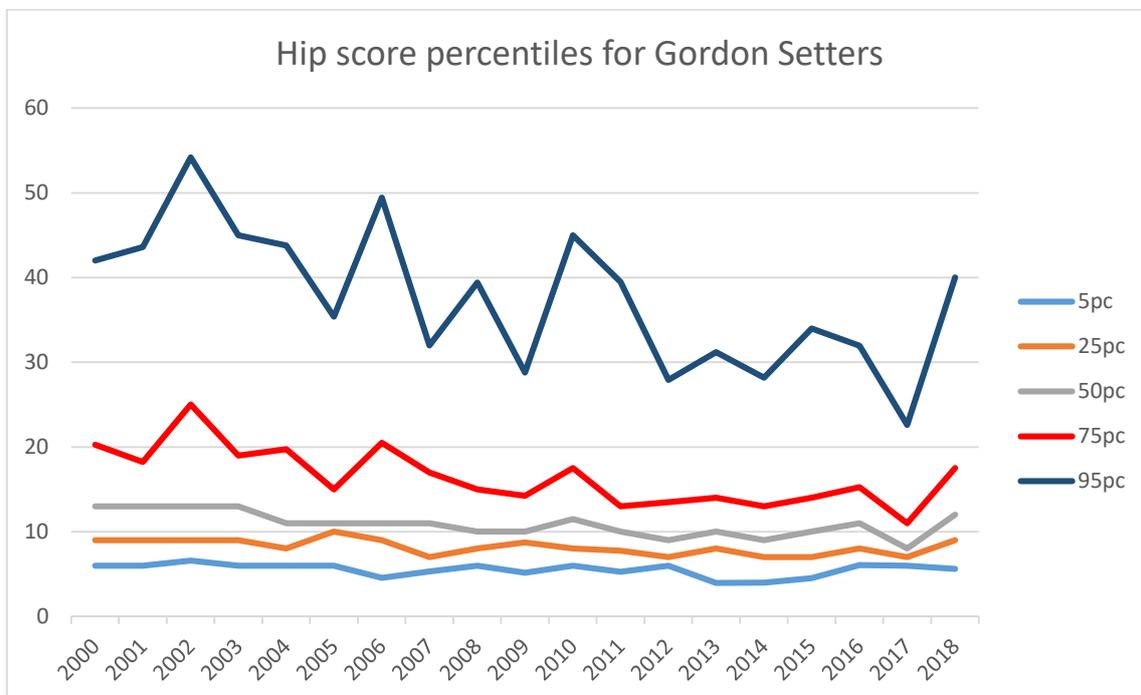


Figure 4: 5<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup>, 75<sup>th</sup> and 95<sup>th</sup> percentiles for hip scores of Gordon Setters from 2000 to 2018.

Estimated Breeding Values (EBVs) are available for hip scores in this breed. Figure 5 shows the five year rolling trend in EBVs by year of birth in the Gordon Setter. The mean EBVs have generally decreased since 1990, indicating a generally improving (lowering) genetic risk of hip dysplasia as determined by the BVA/KC hip score, most likely as a result of selection. However, the trend has begun to plateau since 2012 indicating no improvement in the most recent years.

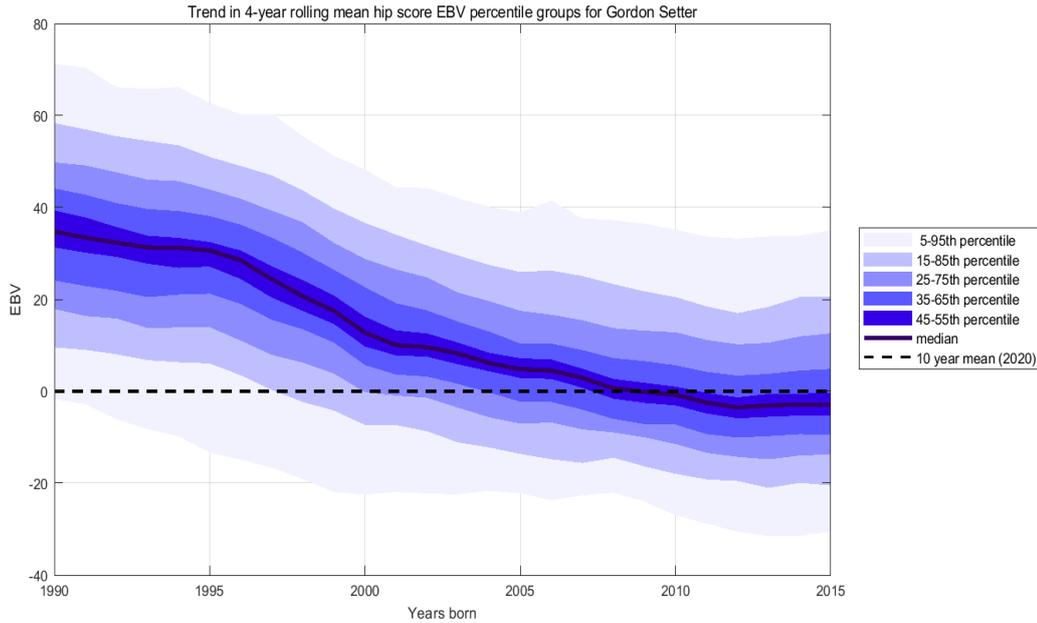


Figure 5: Trend in hip score EBV, with percentile groups, for the Gordon Setter for years of birth since 1990.

## ELBOWS

Elbow scores received by the 21 Gordon Setters scored since the Scheme launched in 1998 are shown in Table 5. Some 33.3% (7 of 21) of the dogs tested to date were diagnosed with some degree of elbow dysplasia, however the numbers involved are very small.

Table 5: Elbow scores and number of dogs receiving those scores since 1998 for the 19 Gordon Setters which have participated in the BVA/KC Elbow Dysplasia Scheme.

<b>Elbow score</b>	<b>Number of dogs</b>	<b>Proportion</b>
0	14	66.7%
1	5	23.8%
2	1	4.8%
3	1	4.8%

## EYES

The Gordon Setter is currently on the BVA/KC/ISDS Known Inherited Ocular Disease (KIOD) list (formally Schedule A) for:

- Progressive retinal atrophy (PRA)

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.

Of the 350 results held for the breed to date, 346 were unaffected for the condition (98.9%) and just four found to be affected.

Schedule B has been incorporated into an annual sightings reports, which records the results of conditions not listed on KIOD for dogs which have participated in the scheme. Results of Gordon Setters examined since 2012 are given in Table 6 below.

Table 6: Reports on Gordon Setters which have participated in the BVA/KC/ISDS Eye Scheme since 2012

<b>Year</b>	<b>Number seen</b>	<b>Comments</b>
2012	25 adults 0 litters	2 – entropion 1 – nuclear cataract 1 – other cataract
2013	35 adults 0 litters	1 – entropion 1 – Persistent hyperplastic primary vitreous (PHPV) 1 – other cataract
2014	27 adults 0 litters	1 – Posterior polar subcapsular cataract (PPSC) 1 – chorioretinitis 1 – macropalpebral fissure
2015	26 adults 0 litters	1 – PPM 4 – PHPV 1 – nuclear cataract 2 – chorioretinitis
2016	56 adults 0 litters	2 – GPRA affected
2017	52 adults 0 litters	1 – PPM 2 – PHPV 2 – post cataract 1 – nuclear cataract 4 – chorioretinopathy
2018	61 adults	2 – anterior cortical cataract
2019	<i>Awaiting report</i>	

### **AMERICAN COLLEGE OF VETERINARY OPHTHALMOLOGISTS (ACVO)**

Between 2015 and 2019 371 dogs of the breed were examined by the ACVO and prevalence data are shown in Table 7 alongside data from previous years for conditions affecting over 1% of the examined population. Overall, 72.2% (268 of 371) of dogs of the breed examined during 2015 and 2019 had healthy eyes unaffected by any disease conditions. However, it is important to consider that the sample was quite small and the dogs were from America.

Table 7: ACVO examination results for the Gordon Setter, 1991-2019

Disease Category/Name	Percentage of Dogs Affected	
	1991-2014 (n=2,125)	2015-2019 (n=371)
<b>Eyelids</b>		
Ectropion	2.4%	1.1%
Distichiasis	2.0%	0.8%
<b>Uvea</b>		
Uveal cyst	0.1%	1.7%
Persistent pupillary membranes (iris to iris)	5.1%	8.6%
Persistent pupillary membranes (lens pigment foci/ no strands)	0.5%	4.6%
<b>Lens</b>		
Cataract (significant)	3.4%	6.2%
<b>Vitreous</b>		
Persistent hyaloid artery/ remnant	0.4%	1.6%
<b>Retina</b>		
Retinal dysplasia (folds)	1.5%	1.9%

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.
- In all breeds, there was an increase in the number of caesarean sections reported from 2012 onwards, as the Kennel Club publicised the procedure to vets.

The number of litters registered per year for the breed and the number and percentage of reported caesarean sections in the breed for the past 10 years are shown in Table 8.

Table 8: Number and percentage of litters of Gordon Setters 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	31	0	0.00%	0.15%
2010	45	1	2.22%	0.35%
2011	32	0	0.00%	1.64%
2012	32	4	12.50%	8.69%
2013	43	11	25.58%	9.96%
2014	32	3	9.38%	10.63%
2015	37	4	10.81%	11.68%
2016	32	6	18.75%	13.89%
2017	33	3	9.09%	15.00%
2018	25	2	8.00%	17.21%
2019	33	6	18.18%	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 **125.2** was reported (estimated using the rate of inbreeding over the period 1980-2014). An effective population size of less than 100 (inbreeding rate of 0.50% per generation) leads to a dramatic increase in the rate of loss of genetic diversity in a breed/population (Food & Agriculture Organisation of the United Nations, "Monitoring animal genetic resources and criteria for prioritization of breeds", 1992).

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 6. As with most breeds, the rate of inbreeding was at its highest in this breed in the 1980s and 1990s. This represents a 'genetic bottleneck', with genetic variation lost from the population. However, since 2000 the rate of inbreeding has been negative, implying moderate restoration of genetic diversity (possibly through the use of imported animals).

It should be noted that, while animals imported from overseas may appear completely unrelated, this is not always the case. Often the pedigree available to the Kennel Club is limited in the number of generations, hampering the ability to detect true, albeit distant, relationships. For full interpretation see Lewis et al, 2015 <https://cgjournal.biomedcentral.com/articles/10.1186/s40575-015-0027-4>.

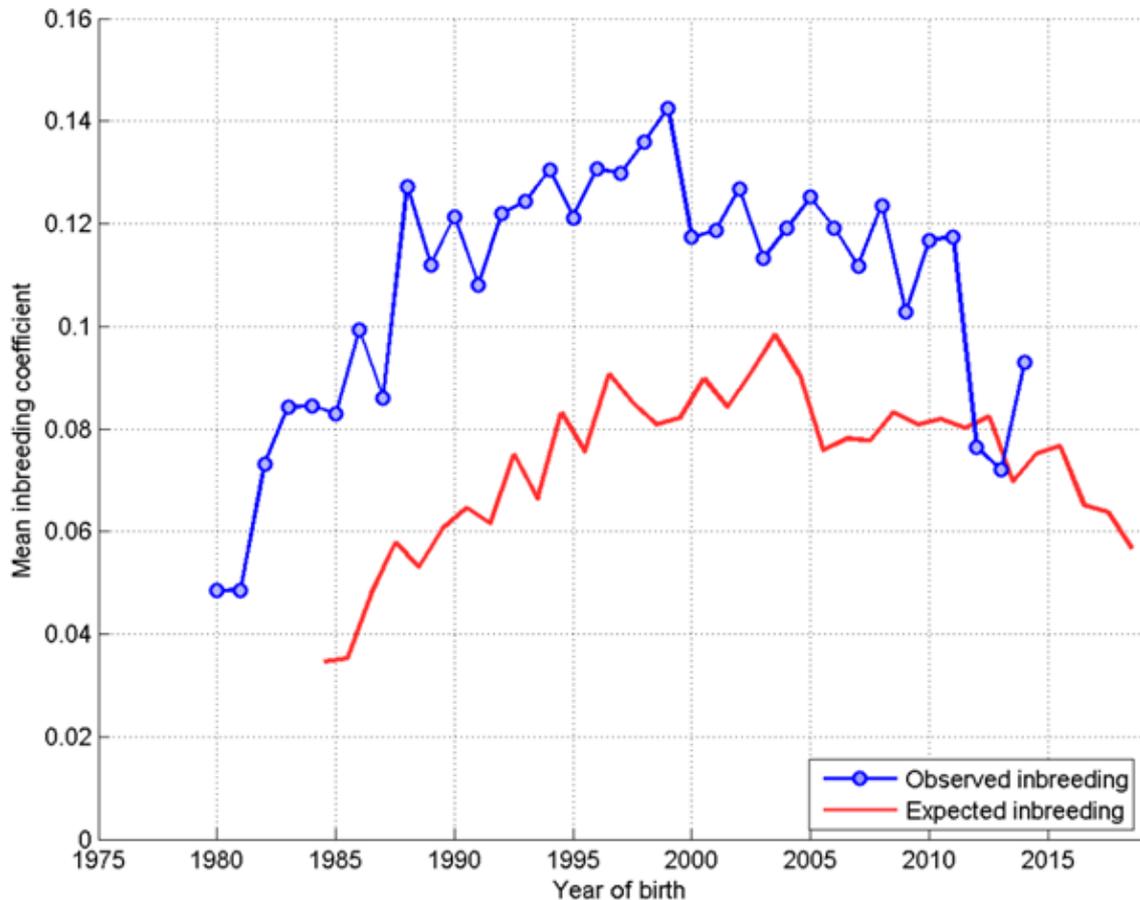


Figure 6: Annual mean observed and expected inbreeding coefficients.

Below is a histogram ('tally' distribution) of number of progeny per sire and dam over each of seven five-year blocks (Figure 7). 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 7).

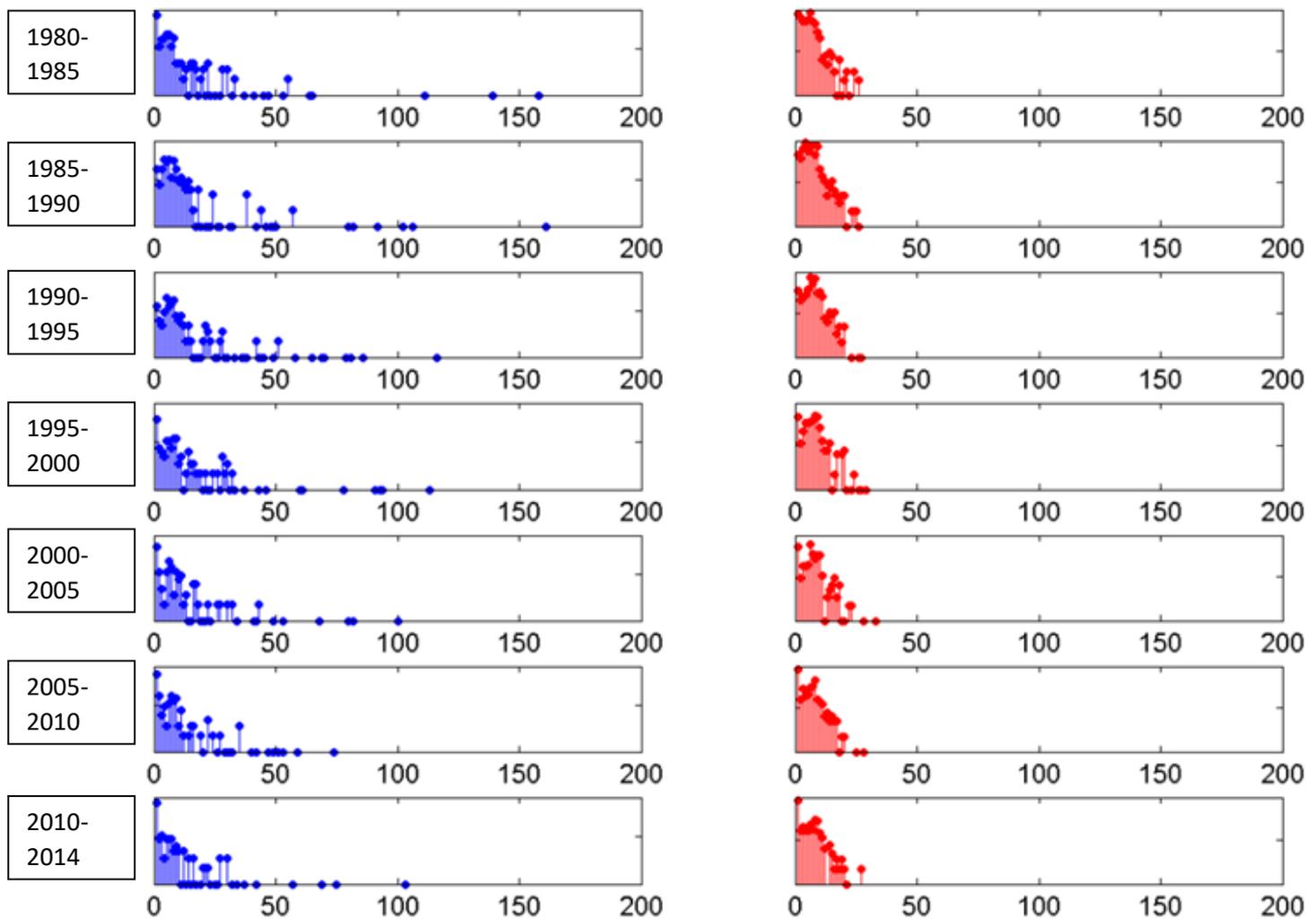


Figure 7: Distribution of progeny per sire (blue) and per dam (red) over 5-year blocks (1980-4 top, 2010-14 bottom). Vertical axis is a logarithmic scale.

## CURRENT RESEARCH

The Gordon Setter is one of the breeds in the Animal Health Trust (AHT)'s Give a Dog a Genome project; the health condition given as concerns in the breed was PRA. An affected individual with PRA has been sequenced.

Discussions are underway between the BHC and the University of Nottingham regarding a survey investigating heart conditions in the breed, with the analysis to begin in the summer of 2019.

The breed have also been involved with IBD/protein losing enteropathy(PLE) research in America, and are currently awaiting publication of the study.

## **PRIORITIES**

A remote review was held with the Gordon Setter breed club representatives in July 2020 to discuss advancements in the action plan (see next page) for the BHCP and review the priority issues for the health of the breed.

The group agreed from the information provided and their own experience that the priority for the Gordon Setter was:

- PRA

Whilst continuing to monitor emerging conditions and not losing focus on hip dysplasia and genetic diversity.

## **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 Gordon Setter. Both partners are expected to begin to action these points prior to the next review.

### **Breed Club actions include:**

- The breed clubs to continue encouraging uptake of the BVA/KC Hip Dysplasia Scheme and use of the associated EBVs
- The breed clubs to continue encouraging uptake of the BVA/KC/ISDS Eye Scheme
- The breed clubs to continue encouraging uptake of the PRA (rcd4) DNA test
- The breed clubs to continue to monitor eye conformation in the show ring

### **Kennel Club actions include:**

- The Kennel Club to investigate the progress with the research into heart conditions at Nottingham University
- The Kennel Club and breed clubs to monitor the PRA genomic research – **ON HOLD**
- The Kennel Club to repeat population analysis of the breed
- The Kennel Club to share the breed's reporting survey on the Breed Information Centre
- The Kennel Club and the breed clubs to monitor the heart research being undertaken at the University of Nottingham

## REFERENCES

- Agler, C., Nielsen, D.M., Urkasemsin, G., Singleton, A., Tonomura, N., Sigurdsson, S., Tang, R., Linder, K., Arepalli, S., Hernandez, D., Lindblad-Toh, K., van de Leemput, J., Motsinger-Reif, A., O'Brien, D.P., Bell, J., Harris, T., Steinberg, S. and Olby, N.J. (2014) Canine hereditary ataxia in Old English Sheepdogs and Gordon Setters is associated with a defect in the autophagy gene encoding *RAB24*. *PLoS ONE* **10** (2): e1003991. doi:10.1371/journal.pgen.1003991
- Bianchi, M., Dahlgren, S., Massey, J., Diestchi, E., Kierczak, M., Lund-Ziener, M., Sundberg, K., Istre Thoresen, S., Kämpe, O., Andersson, G., Ollier, W.E.R., Hedhammar, Å., Leeb, T., Lindblad-Toh, K., Kennedy, L.J., Lingaas, F. and Rosengren Pielberg, G. (2015) A multi-breed genome-wide association analysis for canine hypothyroidism identifies a shared major risk locus on CFA12. *PLoS ONE* **10** (8): e0134720. doi:10.1371/journal.pone.0134720
- de Lahunta, A., Fenner, W.R., Indrieri, R.J., Mellick, P.W., Gardner, S. and Bell, J.S. (1980) Hereditary cerebellar cortical abiotrophy in the Gordon Setter. *Journal of the American Veterinary Medical Association* **177** (6): 538-541
- Downs, L.M., Bell, J.S., Freeman, J., Hartley, C., Hayward, L.J. and Mellersh, C.S. (2013) Late-onset progressive retinal atrophy in the Gordon and Irish Setter breeds is associated with a frameshift mutation in *C2orf71*. *Animal Genetics* **44**: 169-177
- Genetics Committee of the American College of Veterinary Ophthalmologists (2015) Ocular disorders presumed to be inherited in purebred dogs, Eighth Edition <http://www.acvo.org/new/diplomates/resources/ACVOBlueBook20158thEdition.pdf> [Accessed 27/03/2018]
- Genevois, J.-P., Remy, D., Viguier, E., Carozzo, C., Collard, F., Cachon, T., Maitre, P. and Fau, D. (2008) Prevalence of hip dysplasia according to official radiographic screening, among 31 breeds of dogs in France. *Veterinary and Comparative Orthopaedics and Traumatology* **21**: 21-24
- Glickman, L.T., Glickman, N.W., Pérez, C.M., Schellenberg, D.B. and Lantz, G.C. (1994) Analysis of risk factors for gastric dilatation and dilatation-volvulus in dogs. *Journal of the American Veterinary Medical Association* **204** (9): 1465-1471
- Glickman, L.T., Glickman N.W., Schellenberg, D.B., Raghavan, M. and Lee, T.L. (2000) Incidence of and breed-related risk factors for gastric dilatation-volvulus in dogs. *Journal of the American Veterinary Medical Association* **216** (1): 40-45
- Good, K.L., Komáromy, A.M., Kass, P.H. and Ofri, R. (2016) Novel retinopathy in related Gordon setters: a clinical, behavioral, electrophysiological, and genetic investigation. *Veterinary Ophthalmology* **19** (5): 398-408
- LaFond, E., Breur, G.J. & Austin, C.C. (2002) Breed Susceptibility for Developmental Orthopedic Diseases in Dogs. *Journal of the American Animal Hospital Association* **38**: 467-477

Lewis, T.W., Abhayaratne, B.M. and Blott, S.C. (2015) Trends in genetic diversity for all Kennel Club registered pedigree dog breeds. *Canine Genetics and Epidemiology* **2**:13 <https://doi.org/10.1186/s40575-015-0027-4> [Accessed 18/08/2017]

Lewis, T.W., Mellersh, C.S. (2019) Changes in mutation frequency of eight Mendelian inherited disorders in eight pedigree dog populations following introduction of a commercial DNA test. *PLOS one* **14**(1): e0209864. <https://doi.org/10.1371/journal.pone.0209864>

Mason, I.S. and Jones, J. (1989) Juvenile cellulitis in Gordon Setters. *The Veterinary Record* **124** (24): 642

Øvrebø Bohnhorst, J., Hanssen, I. and Moen, T. (2001) Antinuclear antibodies (ANA) in Gordon Setters with symmetrical lupoid onychodystrophy and black hair follicular dysplasia. *Acta Veterinaria Scandinavica* **42**: 323-329

Scott, D.W. and Paradis, M. (1990) A survey of canine and feline skin disorders seen in a university practice: Small Animal Clinic, University of Montréal, Saint-Hyacinthe, Québec (1987-1988). *Canadian Veterinary Journal* **31**: 830-835

Wilbe, M., Lund Ziener, M., Aronsson, A., Harlos, C., Sundberg, K., Norberg, E., Andersson, L., Lindblad-Toh, K., Hedhammar, Å., Andersson, G. and Lingaas, F. (2010) DLA Class II alleles are associated with risk for canine symmetrical lupoid onychodystrophy (SLO). *PLoS ONE* **5** (8): e12332. doi:10.1371/journal.pone.0012332

Yaeger, M.J., Majercik, K., Carter, M. and Rothschild, M. (2000) An autosomal recessive, lethal, neurologic disease of Gordon Setter puppies. *Journal of Veterinary Diagnostic Investigation* **12**: 570-573

Ziener, M.L., Dahlgren, S., Thoresen, S.I. and Lingaas, F. (2015) Genetics and epidemiology of hypothyroidism and symmetrical onychomadesis in the Gordon setter and the English setter. *Canine Genetics and Epidemiology* **2**: 12 DOI: 10.1186/s40575-015-0025-6 <https://cgejournal.biomedcentral.com/articles/10.1186/s40575-015-0025-6>