# Developments in dog genetics – a UK perspective

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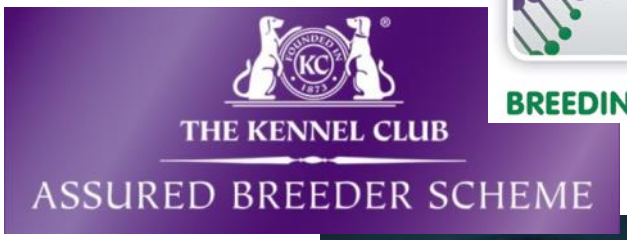
THE KENNEL CLUB
DOG HEALTH

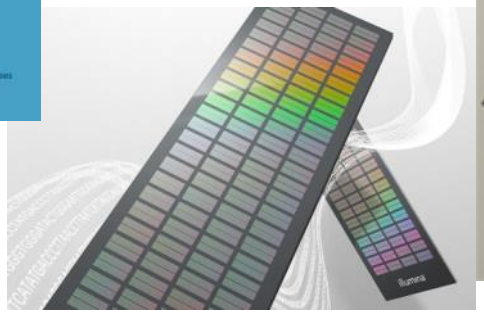
The University of Nottingham

# From a late start, things have moved quickly…









# DNA tests for many diseases in many breeds…

## CANINE DNA TESTING

**About the Animal Health Trust DNA Testing Service**
The Animal Health Trust (AHT) was one of the first laboratories in the world to offer DNA testing to dog owners. Our first test, rcd1 progressive retinal atrophy in Irish Setters, was introduced in 1995. We are proud that our scientists working in the Kennel Club Genetics Centre at the Animal Health Trust have identified the mutations and developed the DNA tests for many of the disorders listed below.

A full list of the canine DNA tests we offer can be found below using the alphabetical index to select tests by breed. Click on the DNA test name for more information, or click 'Buy Online' to order a test. All prices are exclusive of VAT at 20%.

The average turnaround time for canine DNA disease testing is 8 - 10 working days. For further information about canine DNA testing submissions and results, please view our FAQs.

**Newly Available**
A DNA Test for primary open angle glaucoma (POAG) in the Petit Basset Griffon Vendeen is now available to order from our Webshop.

**Discount offers**
We offer a 10% discount to breed clubs when more than 20 samples are ordered through our Webshop in a month. Please email dnatesting@aht.org.uk for more details. For all special offers, discounts will be applied at the Check Out from the Webshop.

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

**All breeds**

- Canine DNA Profiling ISAG2006 (£25 +VAT- contact dnatesting@aht.org.uk)
- Canine Parentage testing (£25 + VAT- contact dnatesting@aht.org.uk)

**A**

**American Staffordshire Terrier**

- Urate Stones – Uric Acid Excretion (Canine Hyperuricosuria) (£40 +VAT- Buy Online)

**Australian Cattle Dog**

- Primary Lens Luxation (PLL) (£35 +VAT– Buy Online)

**Australian Shepherd**

- Hereditary Cataract (£40 +VAT– Buy Online)
- Urate Stones – Uric Acid Excretion (Canine Hyperuricosuria) (£40 +VAT- Buy Online)
- Multidrug Resistance Gene: mdr1 mutation (Ivermectin Sensitivity) (£50 +VAT- Buy Online)

**B**

**Beagle**

- Musladin- Lueke Syndrome (£40 +VAT– Buy Online)
- Coagulation Factor VII Deficiency (£25 +VAT– Buy Online)
- Neonatal Cerebellar Cortical Degeneration and Coagulation Factor VII Deficiency (£40 +VAT– Buy Online)

**Bedlington Terrier**

- Copper Toxicosis (£40 +VAT– Buy Online)

OPTIGEN for the genetic advantage

FAQ GLOSSARY CONTACT

SEARCH: GO

HOME ABOUT US NEWS RESEARCH INSTRUCTIONS & INFORMATION TESTS ORDER TEST CLINIC SCHEDULE

## Tests

* **Cheek swabs not accepted for these tests**

Alaskan Malamute - OptiGen® CD test
American Bulldog - OptiGen® CMR test
American Eskimo Dogs - OptiGen® prcd-PRA & PLL tests
American Hairless (Rat) Terrier - PLL test
American Pit Bull Terriers - OptiGen® crd2 & NCL-A tests
American Staffordshire Terriers - OptiGen® NCL-A test
Australian Cattle Dogs - OptiGen® prcd-PRA & PLL & rcd4-PRA tests
Australian Shepherds - OptiGen® CEA/CH , CD, CMR, HSF4-2 & prcd-PRA tests
Australian Shepherds, Miniature - OptiGen® CEA/CH, CD, CMR, HSF4-2 & prcd-PRA tests
Australian Shepherds, Toy - OptiGen® CEA/CH, CD, CMR, HSF4-2 & prcd-PRA tests
Australian Stumpy Tail Cattle Dogs - OptiGen® prcd-PRA test
Basenjis - OptiGen® Bas_PRA & PK tests
Beagle - OptiGen® POA Glaucoma test
Bearded Collies - OptiGen® CEA/CH test
Berger des Pyrenees - OptiGen® IC test
Boerboel - OptiGen® CMR test
Bolonka Zwetna - OptiGen® prcd-PRA test
Border Collies - OptiGen® CEA/CH ,* CL, I-GS & TNS tests
Boston Terrier - OptiGen® HSF4-1 test
Boykin Spaniels - OptiGen® CEA/CH test
Briards - OptiGen®* CSNB test
Bullmastiffs - OptiGen® Dominant PRA & CMR tests
Cane Corso - OptiGen® CMR test
Cardigan Welsh Corgis - OptiGen®* rcd3-PRA test
Chesapeake Bay Retrievers - OptiGen® prcd-PRA test
Chinese Cresteds - OptiGen®* rcd3-PRA, prcd-PRA & PLL tests
Chinese Foo Dog - OptiGen® PLL test
Cockapoos - OptiGen® PFK test & prcd-PRA test
Cocker Spaniels (American) - OptiGen®* PFK & prcd-PRA tests
Collie - OptiGen® CEA/CH & rcd2-PRA tests
Coton de Tulear - OptiGen® CMR test
Dachshunds - OptiGen® NARC test
Doberman Pinschers - OptiGen® NARC & WDP/OCA tests
Dogue de Bordeaux (French Mastiff) - OptiGen® CMR test
Dwarf Poodles - OptiGen® prcd-PRA test

Prices
Discounts
Patents and Licenses
OptiGen's Health Registry Reporting Policies
Mars Wisdom Panel Breed Heritage Test

LABOKLIN
LABORATORY FOR CLINICAL DIAGNOSTICS

Home
News and offers
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Identity / Parentage
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Order Online
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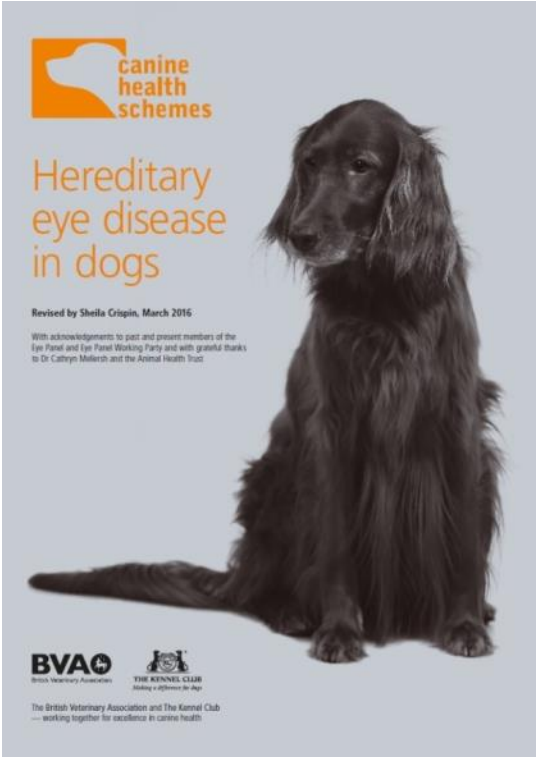
## Genetic Diseases in Dogs

Quick Find
By Breed: Select your breed
By Test: Select test from the list
Back
prices in Pounds change currency

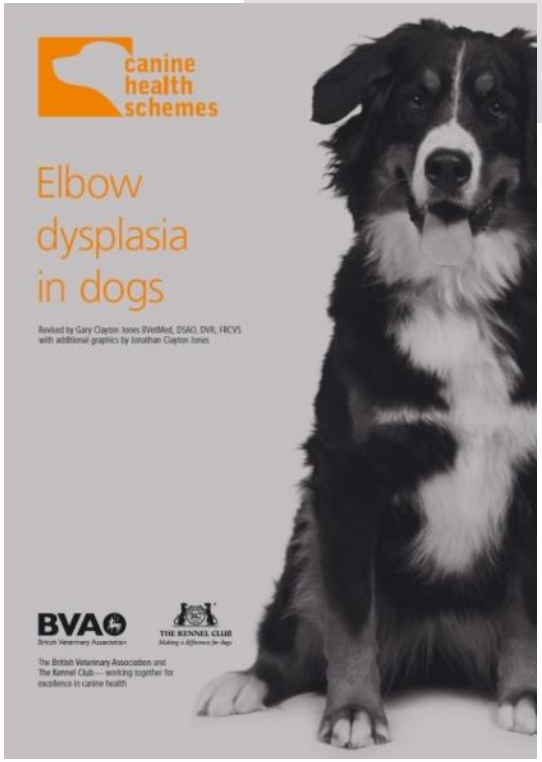
| Disease or Condition Name | Turnaround | Cost (including VAT) |
|---|---|---|
| Adult Onset Neuropathy * (AON) NEW<br>Breeds : English Cocker Spaniel , Cocker Spaniel , Field Spaniel . | within 3-5 weeks | £ 89.95 |
| Alaskan Malamute Polyneuropathy (AMPN / IPAM / HPAM) NEW<br>Breed : Alaskan Malamute .<br>This test is part of the Official UK Kennel Club DNA Testing Scheme in Alaskan Malamute. | Within 1-2 weeks | £ 55.00 |
| Brachyury (Bobtail Gene / Short Tail)<br>Breeds : Australian Shepherd , Australian Stumpy tail cattle Dog , Brittany Spaniel , Jack Russell Terrier , Austrian Pinscher , Bourbonnais Pointer , Brazilian Terrier , Croatian Sheepdog , Danish Farm Dog , Swedish Farm Dog , Karelian Bear Dog , Mudi , Polish Lowland sheepdog , Pyrenean Shepherd , Savoy Sheepdog , Schipperke , Spanish Waterdog , Swedish Vallhund . | within 1 - 2 weeks | £ 55.00 |
| Brittle Bone Disease (Osteogenesis Imperfecta)<br>Breeds : Miniature Smooth Haired Dachshund , Miniature Wire haired Dachshund , Standard Wirehaired Dachshund , Standard Smooth Haired Dachshund . | within 1 - 2 weeks | £ 55.00 |
| CLAD (Canine Leukocyte Adhesion Deficiency)<br>Breeds : Irish Setter , Irish Red and White Setter<br>This test is part of the Official UK Kennel Club DNA Testing Scheme in Irish Setter. | within 1 - 2 weeks | £ 55.00 |
| CMSD (Canine Multiple System Degeneration) NEW<br>Breeds : Chinese Crested , Kerry Blue Terrier . | Within 2 weeks | £ 55.00 |
| CSNB (Congenital Stationary Night Blindness)<br>Breed : Briard .<br>This test is part of the Official UK Kennel Club DNA Testing Scheme in Briard. | within 1 - 2 weeks | £ 55.00 |

# Health

# Screening:






# Mate Select Estimated Breeding Value

Retriever (Labrador)

## Haretor Abel Of Bellever

An Estimated Breeding Value (EBV) evaluates the genetic value of an individual dog, in relation to the whole of the dog's breed. These EBVs are intended to help breeders reduce the prevalence of hip and/or elbow dysplasia by more accurately evaluating genetic risk.

| | Score | EBV | Confidence | |
|---|---|---|---|---|
| Elbow | - | **-17** | 38% | 120 100 80 60 40 20 -20 -40 -60 -80 -100 -120<br>Higher Risk — Breed Average — Lower Risk |
| Hip | - | **-40** | 84% | 120 100 80 60 40 20 -20 -40 -60 -80 -100 -120<br>Higher Risk — Breed Average — Lower Risk |

Search again in this breed  Change breed

EBV calculations are using data last updated on the 10th July 2014.

EBVs are computed using available hip and/or elbow scores for the dog and all its relatives. Pedigree information is used to determine the relationships among dogs. This allows the genetic risk of individuals to be evaluated, stripping away any environmental effects. Using EBVs to make mating decisions will be more accurate than using the observed hip or elbow score and will lead to faster progress in reducing the prevalence of disease.

A dog's EBV allows it to be placed on a scale of liability, identifying those individuals at highest risk of passing on the condition and those at lowest risk.

### Go

Mate Select Home

New Calculation

Change Breed

### More Information

How to use EBVs

Frequently Asked Questions (FAQs)

### Other services

Breed Information Centre

Health Test Results Finder

# Health Information

You may be aware that some breeds of dog and their crosses can be susceptible to inherited disease. Of course you want to be sure that the dog you choose is as healthy as possible, and you would like to know that it has not inherited any undesirable disease-causing genes from its parents. There is some help in that DNA tests for diseases in purebred dogs are available for some conditions in some breeds, but there are not very many such tests just yet! There are also, however, a number of clinical veterinary screening schemes that dog breeders can use to increase the probability of producing healthy puppies.

Details of the various screening schemes, both veterinary and DNA, that are available to breeders in the UK can be found at www.thekennelclub.org.uk/doghealth

Potential dog owners should be aware that, at present, the application of various health screening results to breeding programmes is not always straightforward, and breeders may make choices for various reasons. A responsible breeder though, will always be willing to discuss relevant health issues with you. Breed clubs are often useful sources of breed-specific information.

## Schemes or advice relevant to this breed

The following schemes, tests and/ or advice are mandatory requirements for Kennel Club Assured Breeders. All other breeders are strongly advised to use these schemes, tests and/ or advice.

- BVA/KC Hip Dysplasia Scheme
- BVA/KC/ISDS Eye Scheme

It is strongly recommended that both Kennel Club Assured Breeders and non-Kennel Club Assured Breeders should use the following schemes, tests and/ or advice.

- BVA/KC Elbow Dysplasia Scheme
- DNA test - prcd-PRA

The following other schemes, tests and/ or advice are available and should also be considered.

- DNA test - CNM
- DNA test - EIC
- DNA test - SD2
- DNA test - HNPK

The list above is not necessarily comprehensive, other available health tests can be found at http://www.thekennelclub.org.uk/health/breeding-for-health/dna-screening-schemes-and-results/ or for further advice please contact your local breed club.

Gundog Group

More information on this breed

### Go

Breeding Restrictions
Assured Breeders
Breed Standard
Accepted Registration Colours
Pictures
Breed Watch

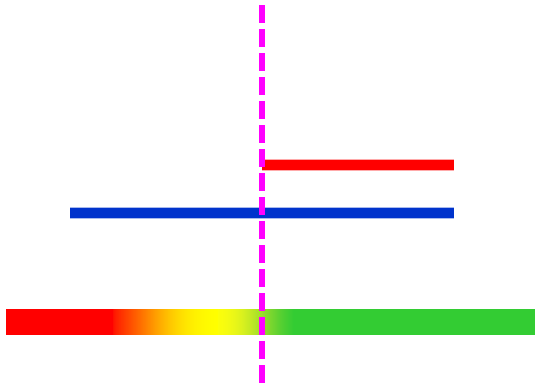
### Tools

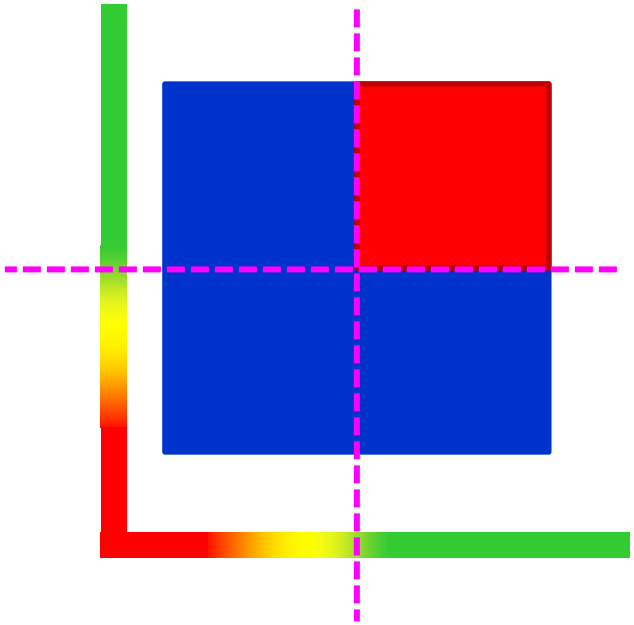
Breed Information Pack (PDF)
Find A Puppy
Find A Rescue Dog
Find A Dog Club

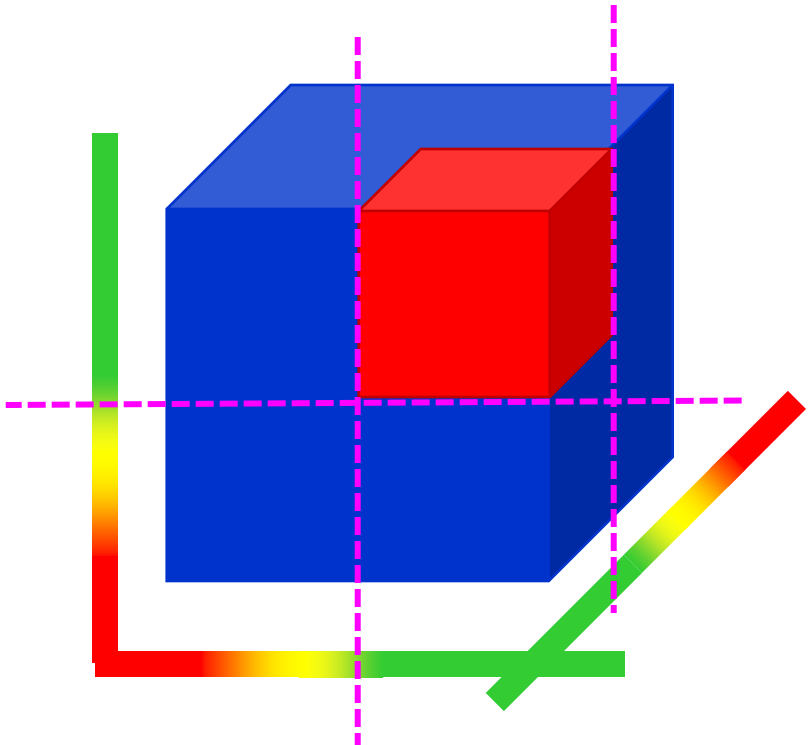
### More

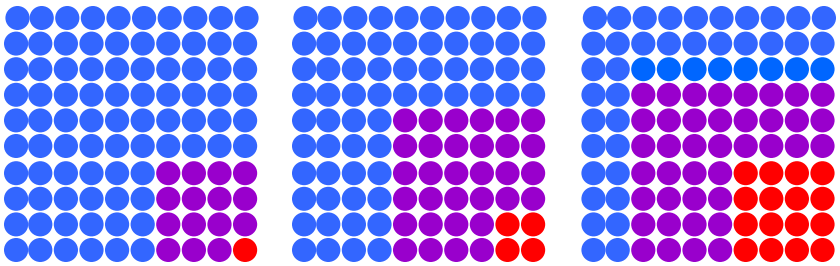
Other Breeds
Other Breeds in this group

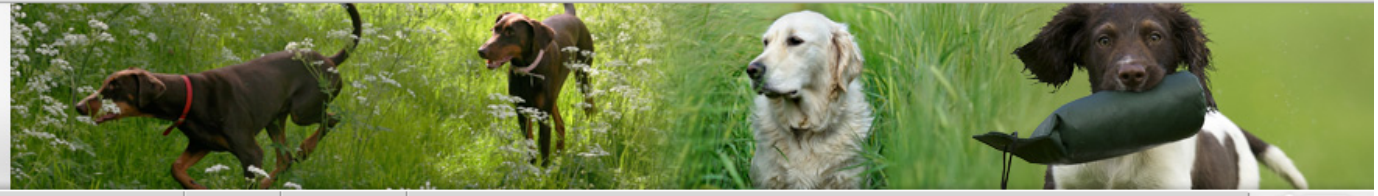
# ‘cumulative’ high selection intensities













# Mate Select — Mating Inbreeding Coefficient Prediction

## Result

**Retriever (Labrador)**

The Annual Breed Average inbreeding coefficient for this breed is

6.5%

♂ Racmic Black Bramble | ♀ Racmic Elli

Any puppies from this mating would have a coefficient value of

4.1%

**More information**

Health Tests | Health Tests

## How to use this information

### Using this result to help make Breeding decisions

The current Kennel Club breeding guidelines state that, where possible, breeders should produce puppies with an inbreeding coefficient which is at, or below, the annual breed average (shown above) and ideally as low as possible.

Breeders should be aware that the inbreeding coefficient is a measurement of risk and does not guarantee that puppies produced will, or will not, have any health related issues. There are other equally important factors to also consider when deciding whether two dogs should be mated together, such as temperament, available health test results, the general health of the dogs etc. Your decision should be well balanced between the inbreeding coefficient and the good qualities of the sire/dam that you are considering.

### Go

Mate Select Home

### Tools

All results for this session

New mating

Change breed

Health summary for this mating (PDF)

### Other services

Breed Information Centre

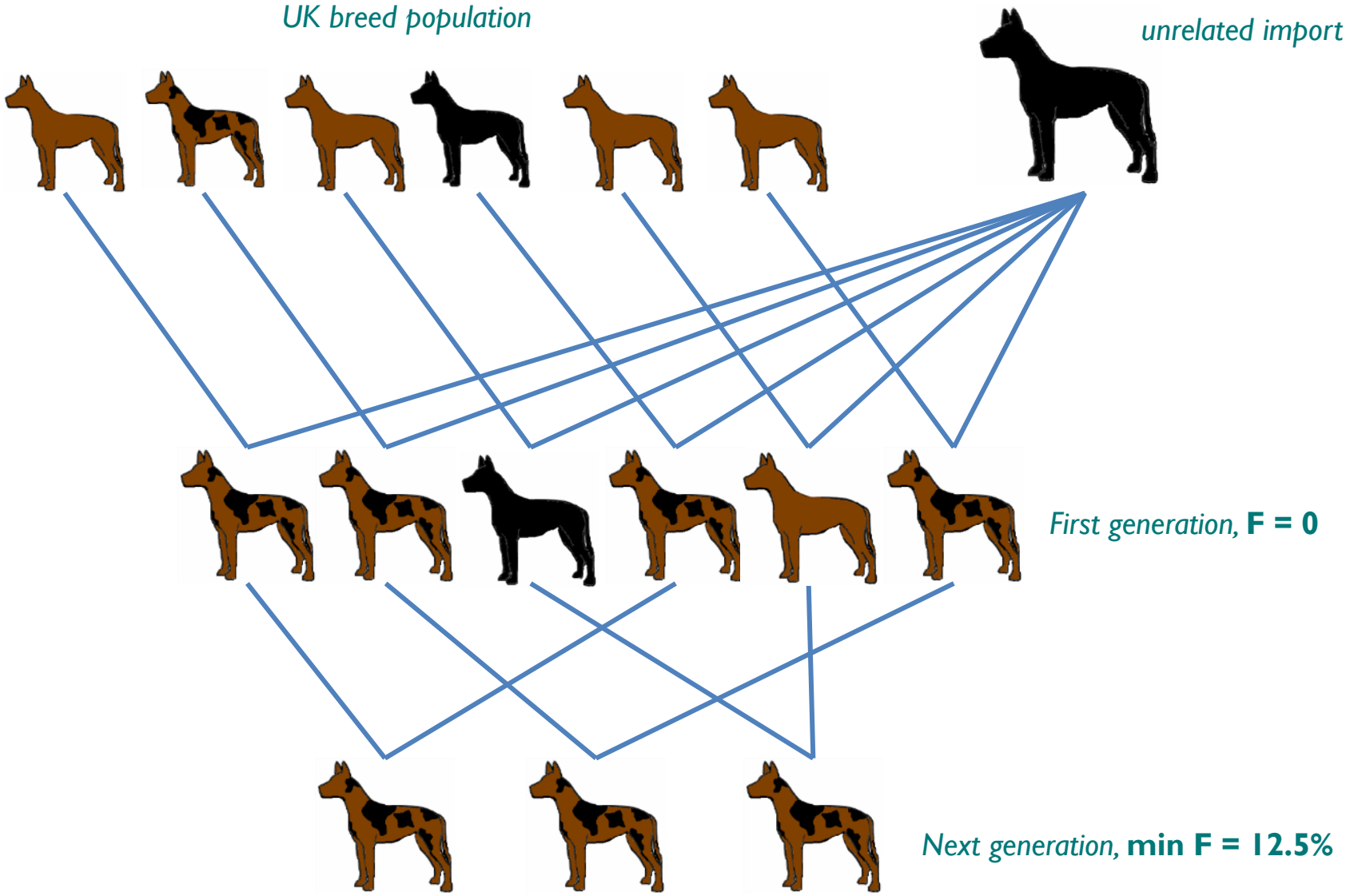
Health Test Results Finder

### About this calculation

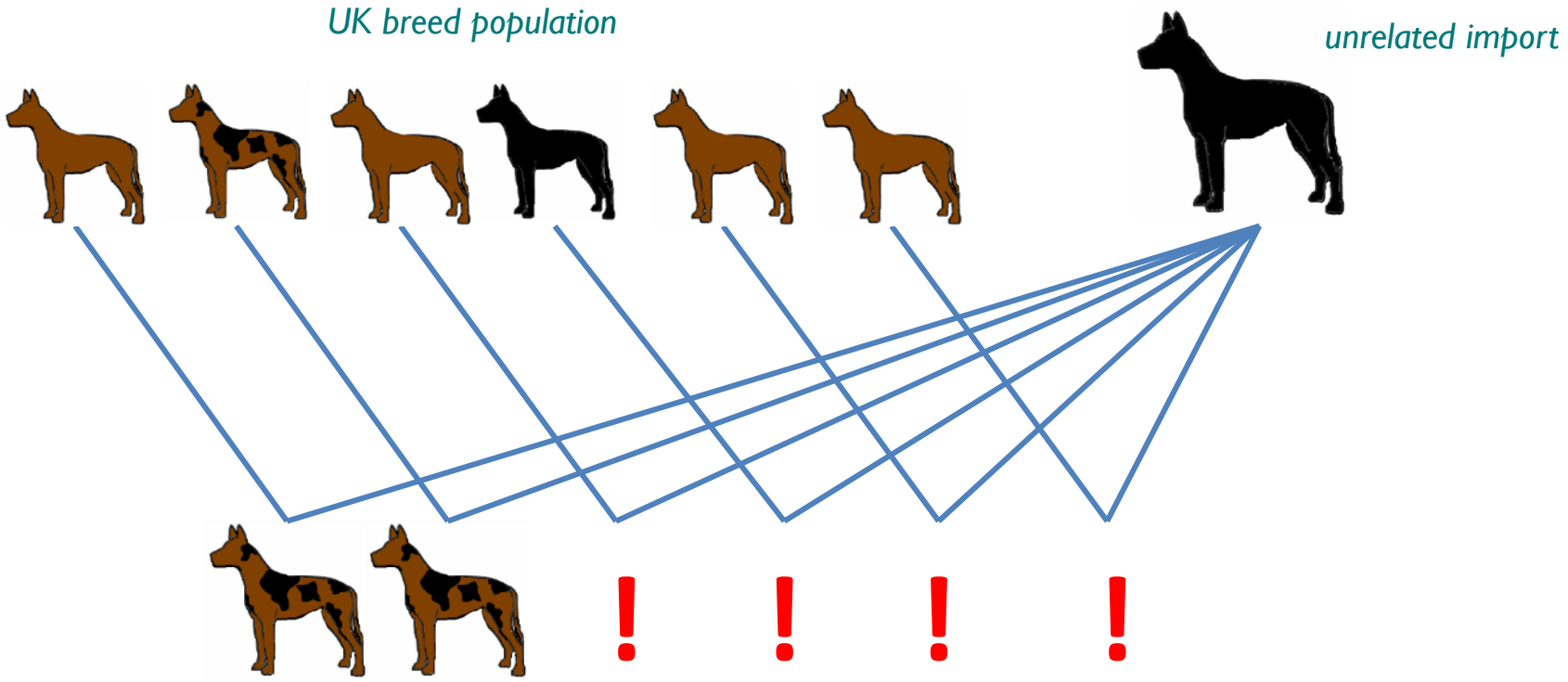
The pedigree data used to calculate this result extended back as far as 11 generations with the first 5 generations being fully complete.

The Mate Select computations are based upon data compiled from pedigree records and data submitted from breeders. As such all information and/or data on the site is provided on an 'as is' basis. Every effort has been made to report information accurately, but the Kennel Club assumes no responsibility for the content or the use or interpretation of the information published.

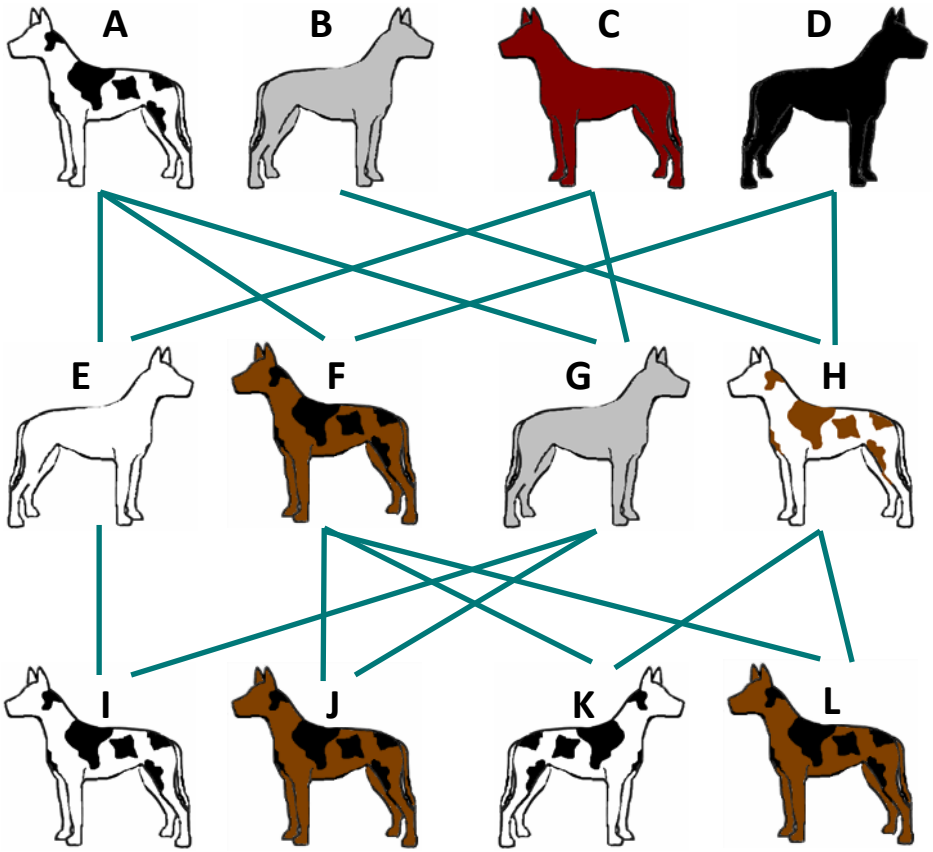
# BUT doesn't address over-use of individuals…



# want to flag up over-use in real time…



# Genetic Contributions a potential solution




| | A | B | C | D |
|---|---|---|---|---|
| E | ½ | 0 | ½ | 0 |
| F | ½ | 0 | 0 | ½ |
| G | ½ | 0 | ½ | 0 |
| H | 0 | ½ | 0 | ½ |

| | A | B | C | D |
|---|---|---|---|---|
| I | ½ | 0 | ½ | 0 |
| J | ½ | 0 | ¼ | ¼ |
| K | ¼ | ¼ | 0 | ½ |
| L | ¼ | ¼ | 0 | ½ |

| | | | | |
|---|---|---|---|---|
| Mean genetic contribution | 3/8 | 1/8 | 3/16 | 5/16 |

# Summary of major issues:

Multiplicity of health objectives (screening schemes, DNA tests, EBVs)

Excluding all animals with less than perfect results

→ bottleneck → impact on genetic diversity (vicious circle)

# Existing solutions – 1) selection index

Selection objectives ($H$) – e.g. hip score, elbow score, atopy

Selection criteria *(I)* - can be the same as $H$

$a$ = relative weights of selection objectives *(H)*

$$\boldsymbol{b = P^{-1}_{II} G_{IH} a}$$

$b$ = optimum selection coefficients for all traits in $I$

**BUT** – weighting of objectives may vary from breeder to breeder

# Existing solutions – 2) optimisation

Both rate of inbreeding (ΔF) and genetic gain (ΔG) related to genetic contributions (r):

$$\Delta F = \tfrac{1}{4} \Sigma \, r_i^2$$

Wray & Thompson, 1990

$$\Delta G = \Sigma \, r_i \, a_i$$

Woolliams & Thompson, 1994

Algorithms produce a mating list delivering maximum genetic gain within a specified rate of inbreeding (e.g. Meuwissen, Kinghorn etc).

**BUT** – requires breed-wide control to effect

# Summary of major issues:

Multiplicity of health objectives (screening schemes, DNA tests, EBVs)

Excluding all animals with less than perfect results → bottleneck → impact on genetic diversity (vicious circle)

Effective solutions exist, but rely on small number of stakeholders controlling a large proportion of the population

Need to provide breeders with means to *prioritise* and *balance* breeding objectives

# Breed Health & Conservation Plans

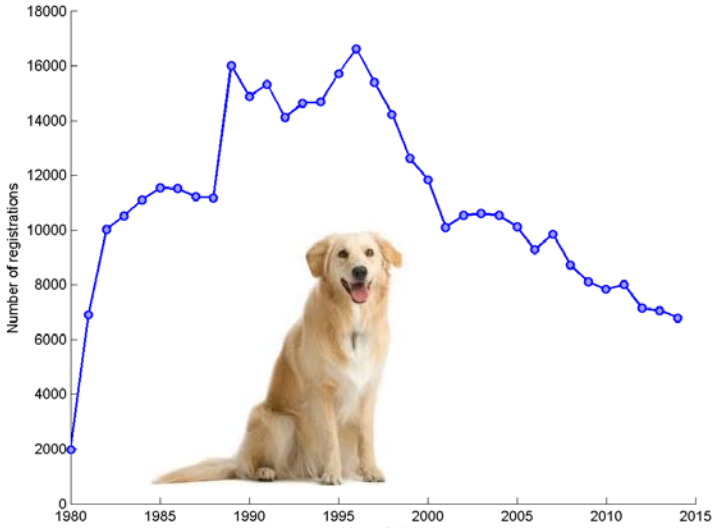
Provide epidemiological data on most prevalent & severe diseases (VetCompas, KC survey, GISID)

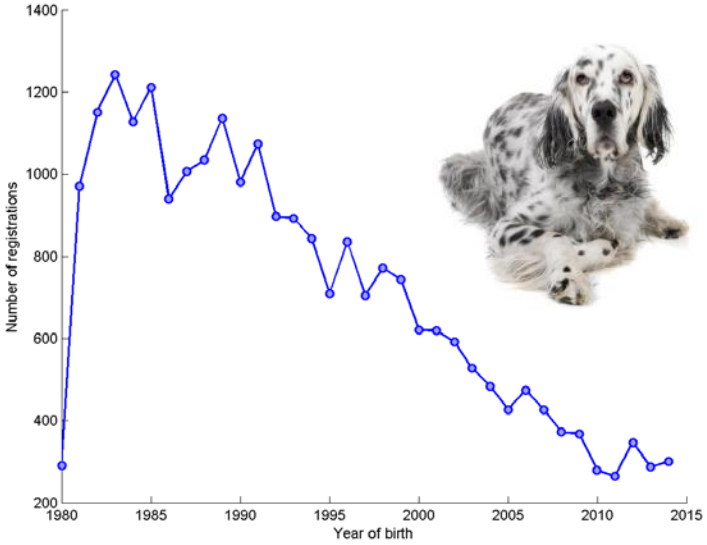
Detail numbers of DNA tests undertaken, proportion of clear/carrier/affected and estimated allele frequencies

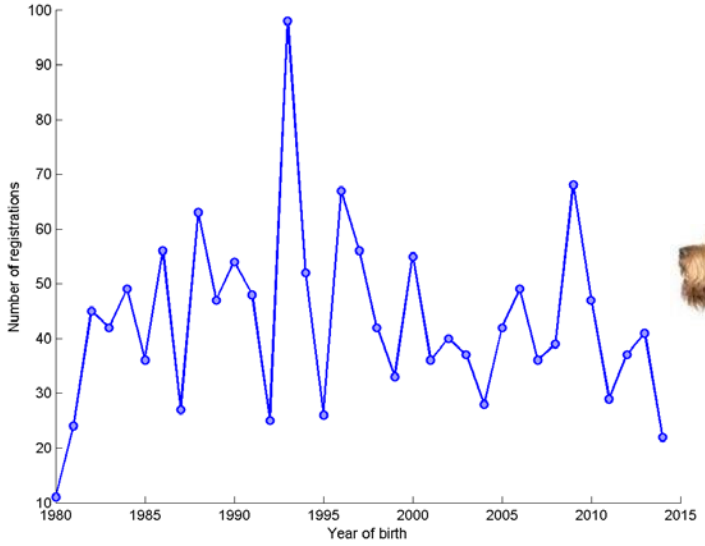
Genetic trends in traits for which EBVs are available

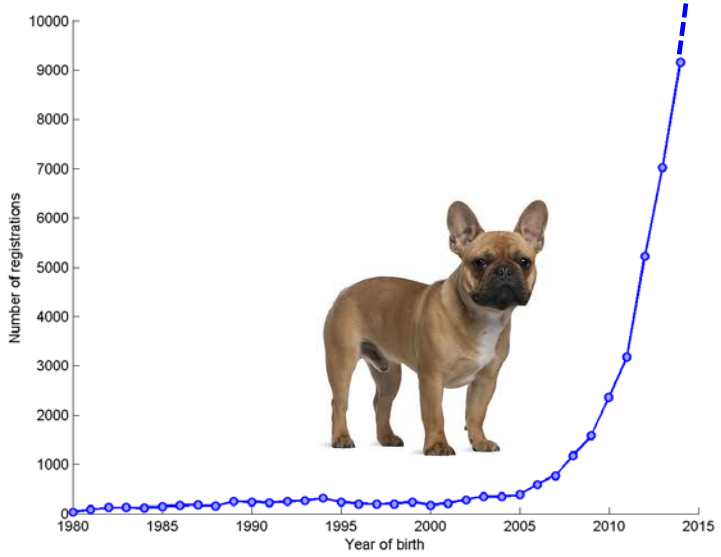
Population parameters – actual size, effective population size.

# Proposed content – *actual* population size



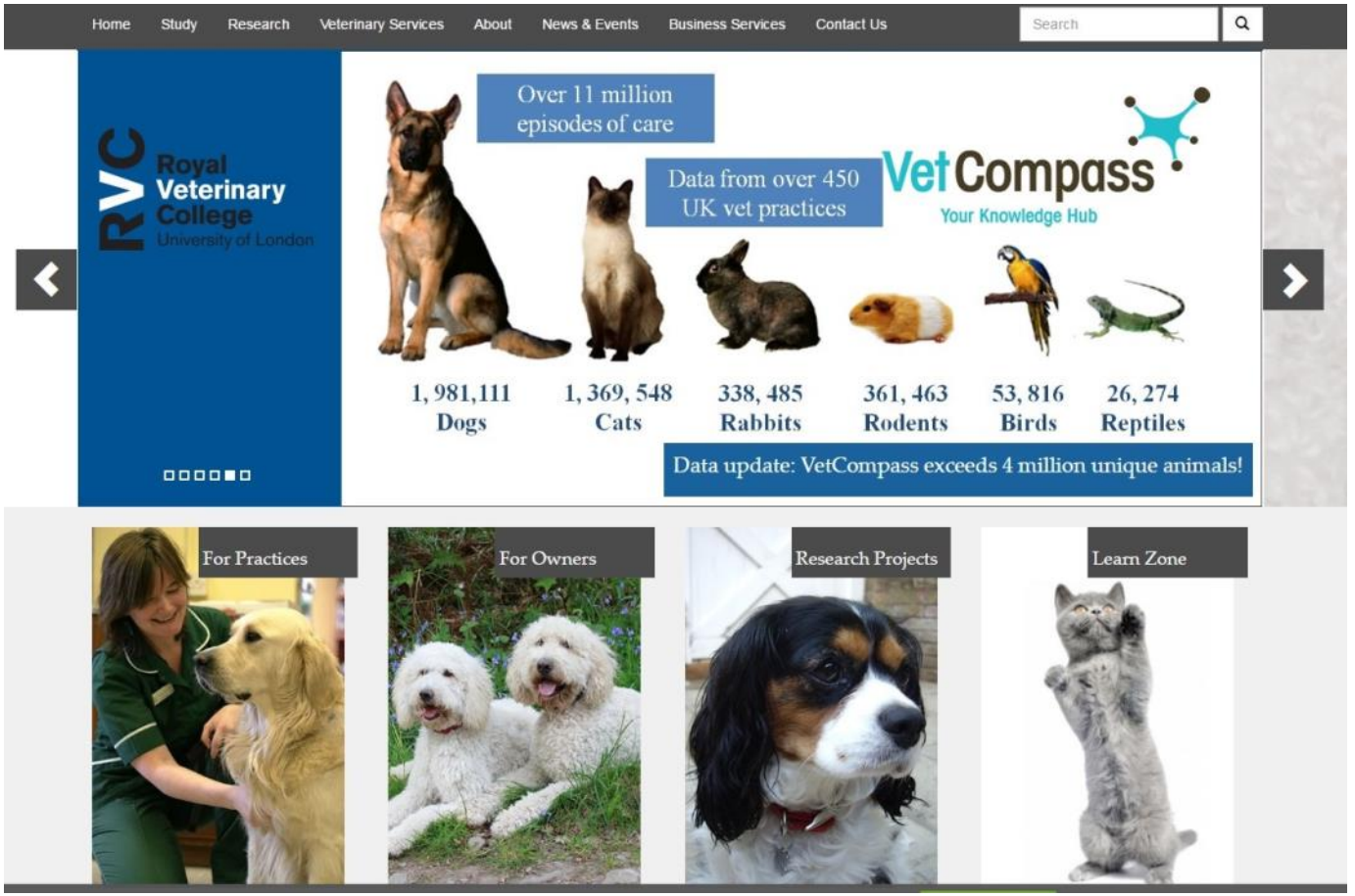



# Assessment of prevalence of disease/breed

Primary practice data (VetCompass)



# Assessment of prevalence of disease/breed

## Kennel Club owner surveys

| Condition | Boxer | Bull Terrier | Bulldog | Cocker Spaniel | English Springer Sp | French Bulldog | Staffordshire Bull Terrier | Tibetan Terrier | Weimaraner | West Highland Terrier | Whippet | Across breed prev |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hypersensitivity (allergic) skin disorder | | | | | | | | | | | | 2.63% |
| Dermatitis | | | | | | | | | | | | 1.08% |
| Food Allergy | | | | | | | | | | | | 0.85% |
| Colitis | | | | | | | | | | | | 0.79% |
| Inflammatory bowel disease (IBD) | | | | | | | | | | | | 0.34% |
| Flea allergic dermatitis | | | | | | | | | | | | 0.16% |

# Assessment of severity of disease

## Generic Illness Severity Index in Dogs (GISID)

Asher et al, 2009
TVJ, 182: 402-411

| Score | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| **Prognosis** | Short isolated bout & complete return to normal | Medium length isolated bout or successive short bouts & return to normal | Extended bout & return to normal or successive short bouts and minor long-term impairments | Unremitting or chronic illness of bout(s) with major long term impairment | Imminent death as a direct result of condition or condition-related euthanasia |
| **Treatment** | None required or not necessary as there is minimal impact on health | Medical – immediate curative &/or<br>Surgical – single curative minor surgery (not intra cavity)<br>Side Effects – none or very minor, short term | Medical – short term curative or medium term manageable &/or<br>Surgical – single curative intracavity surgery/repeated minor surgery<br>Side Effects – minor | Medical – long term curative or long term manageable &/or<br>Surgical – deep intracavity surgery<br>Side Effects – manageable pain or moderate | None available, or<br>Medical – prolonged palliative treatment &/or<br>Surgical- major deep intracavity surgery<br>Side Effects – chronic intractable pain or major |
| **Complications** | No linked disorders | Predisposition to minor secondary condition | Predisposition to moderate secondary condition | Predisposition to major secondary condition | Predisposition to catastrophic secondary condition |
| **Behaviour** | None disturbed | One disturbed | Two disturbed | Three disturbed | Four or more disturbed |

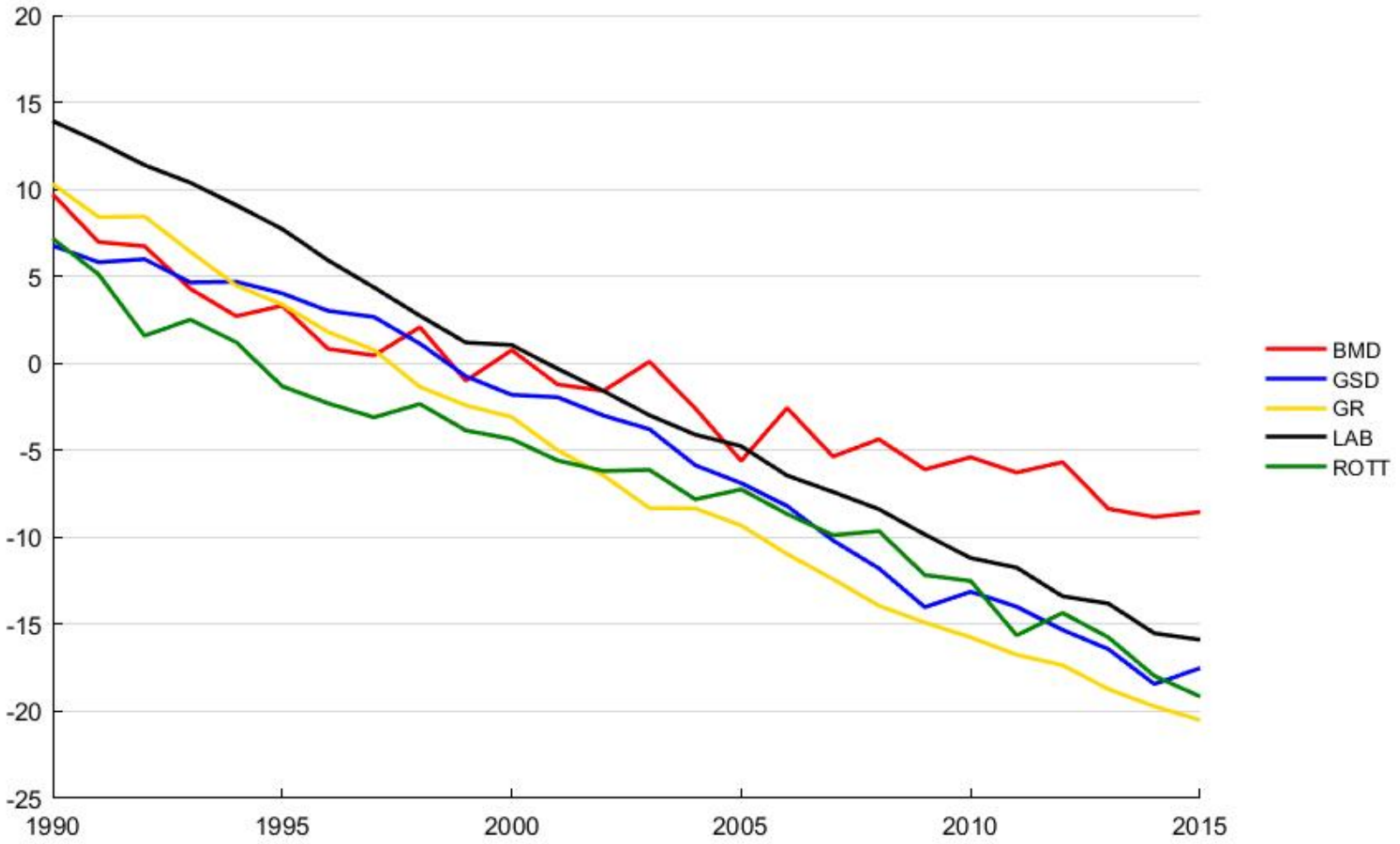
# DNA test statistics

For each DNA test available for each breed:

- Number tested per year, for last few years
- Proportion of breeding animals tested
- Number clear / carrier / affected
- Estimated disease allele frequency and extrapolation to number of carriers in breed
- Advice on use of carriers

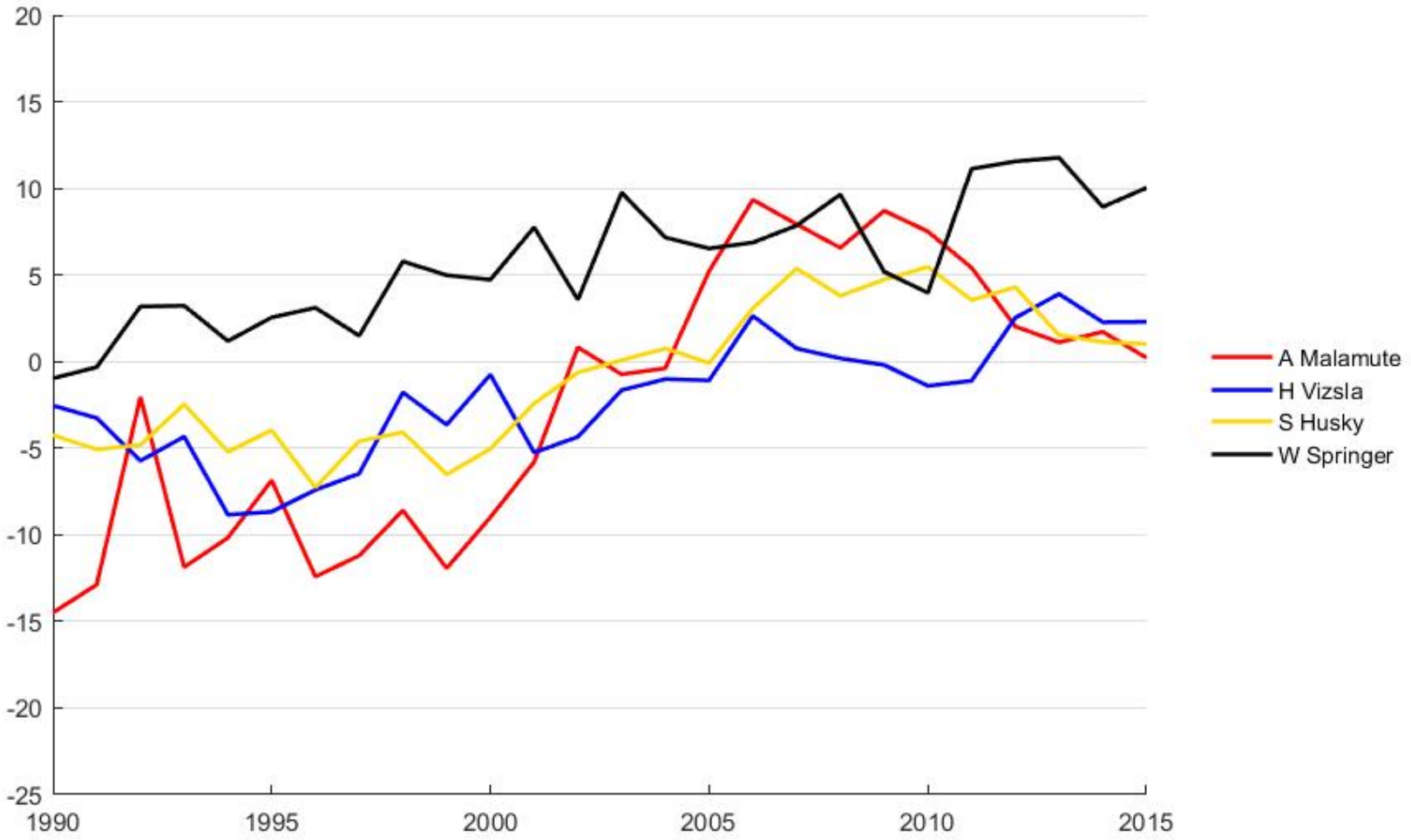
# Genetic trends (where available)

Improving trend for HD in most breeds…

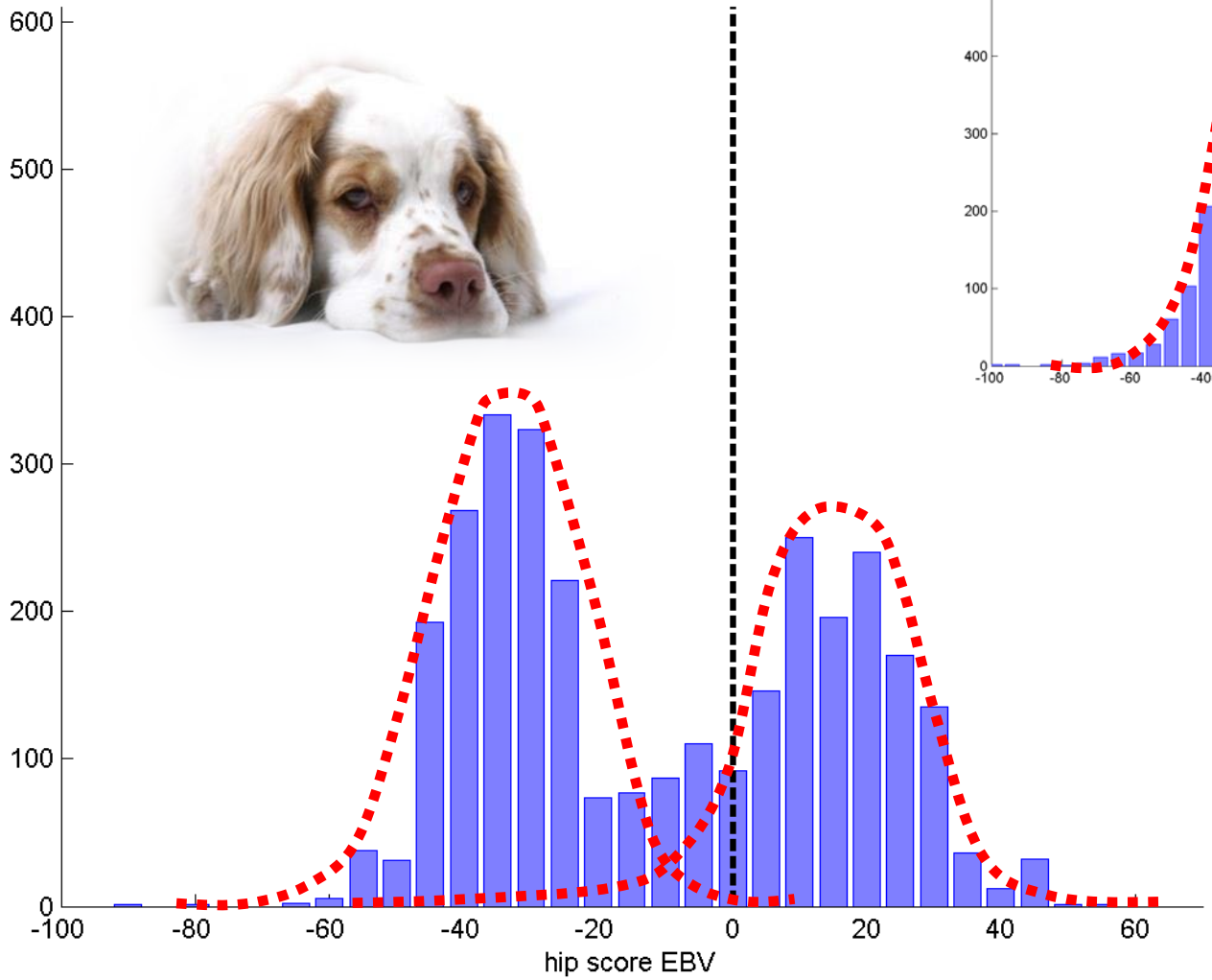


# Genetic trends (where available)

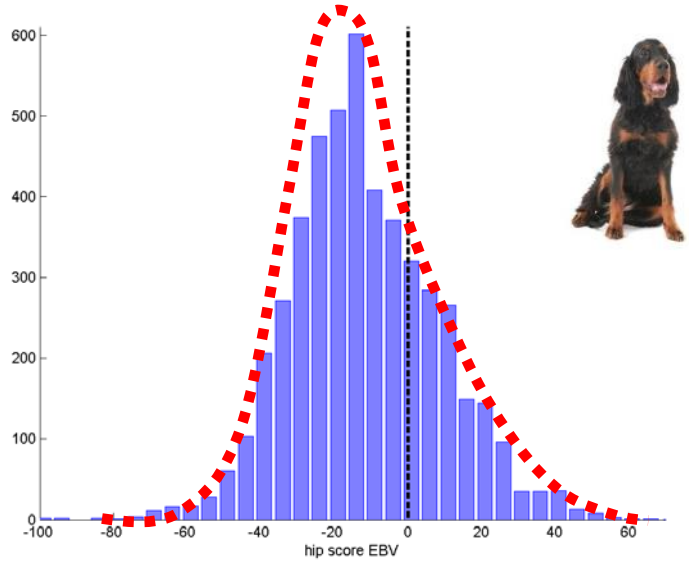
But a worsening trend in some breeds…



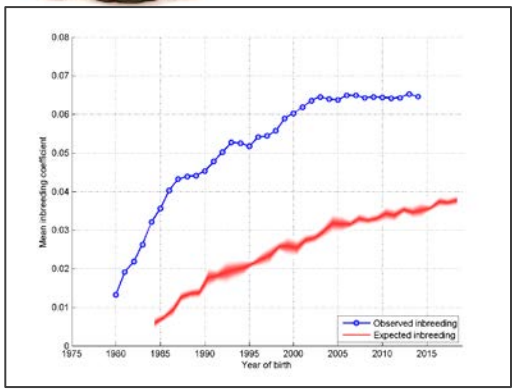
# EBVs may provide evidence of ‘sub-structure’

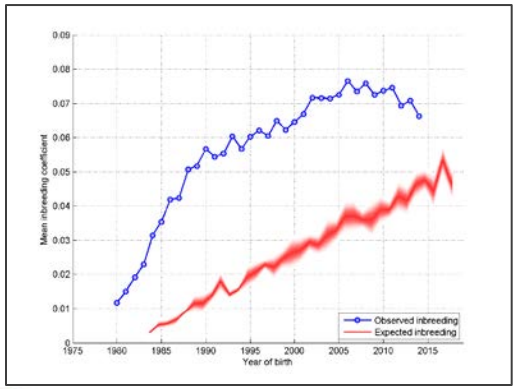


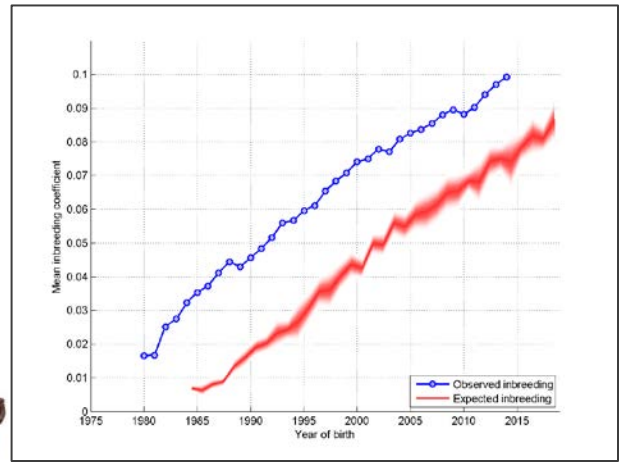


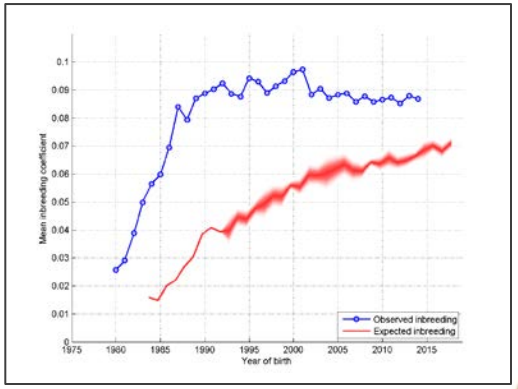



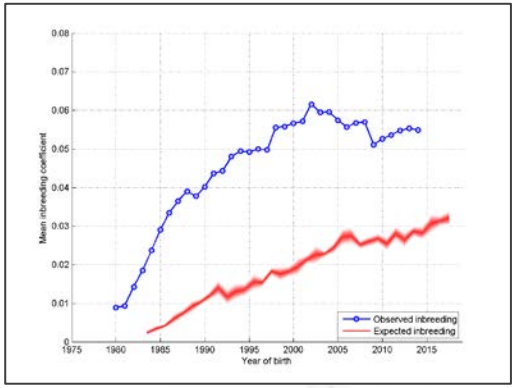
# Evaluate the historical trend in ΔF/Ne

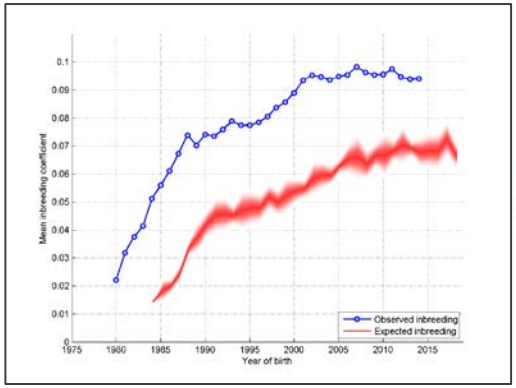


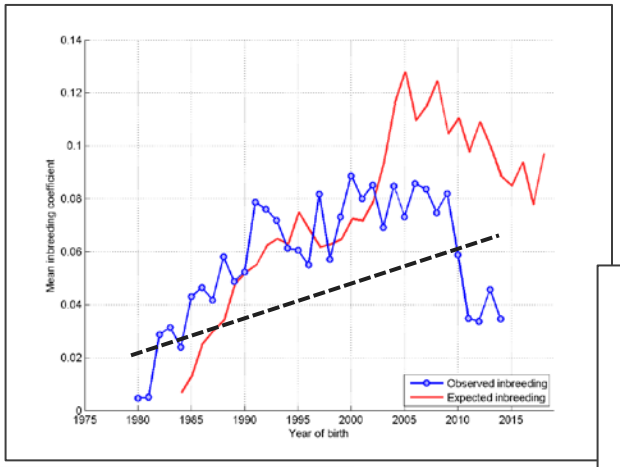



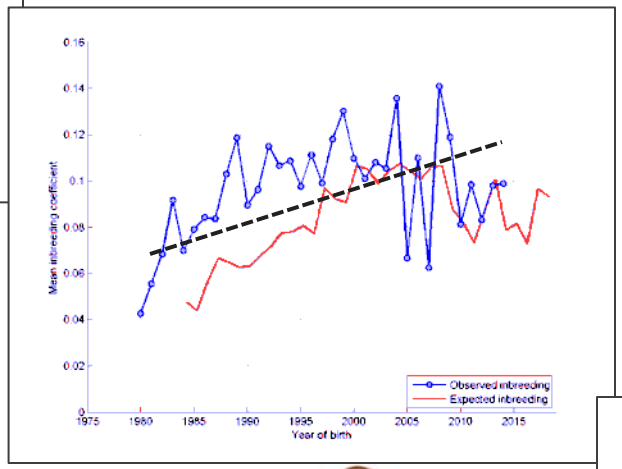



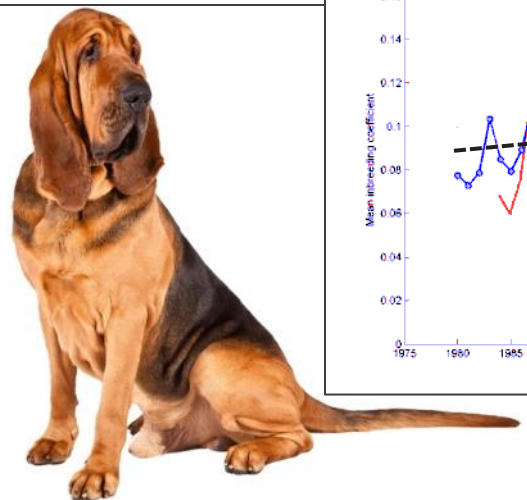



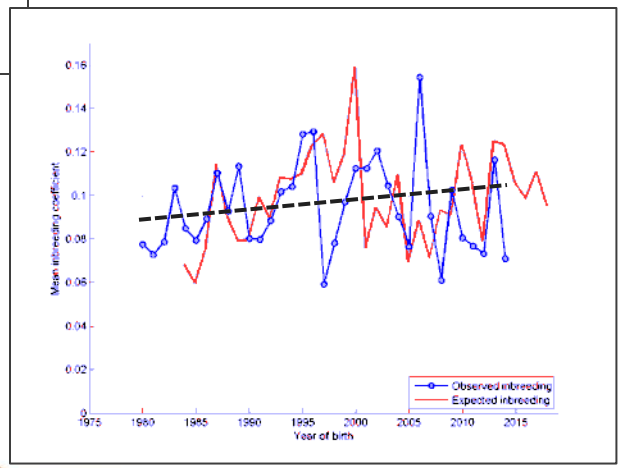

Lewis et al, 2015
CGE, 2:13
**DOI:** 10.1186/s40575-015-0027-4

# Some rarer breeds are conserving diversity…

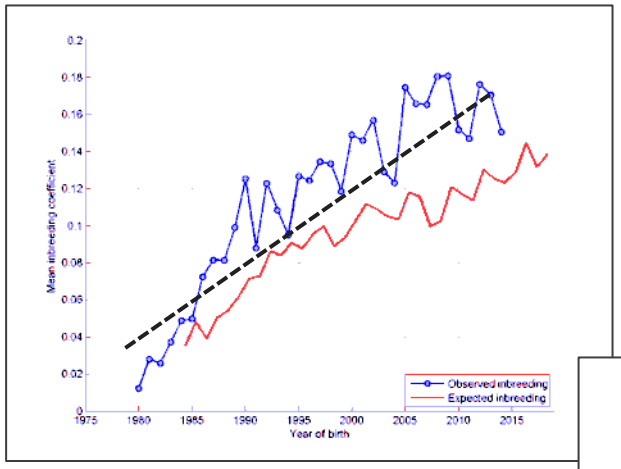


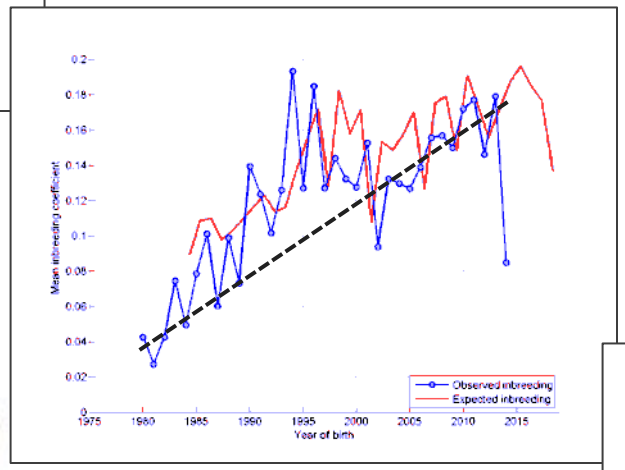



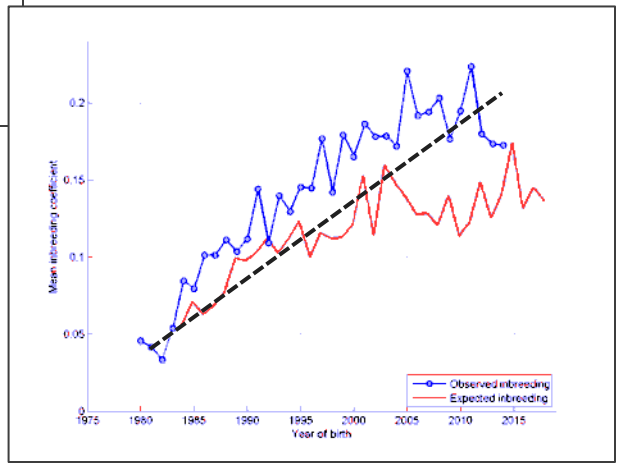





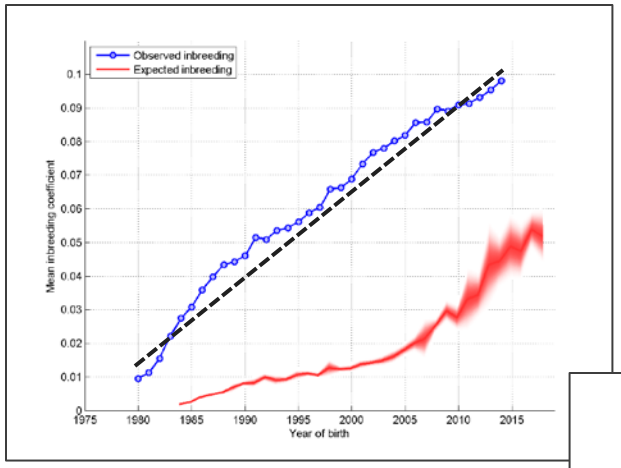
# …but others are really struggling…

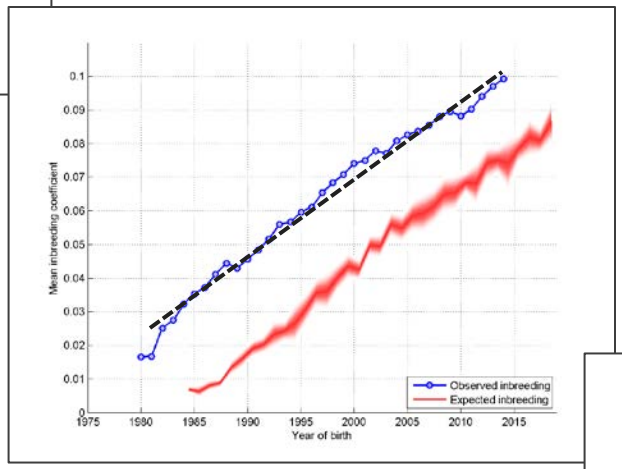


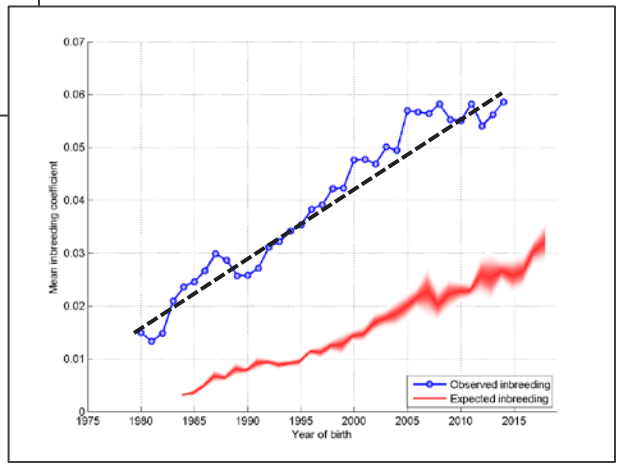



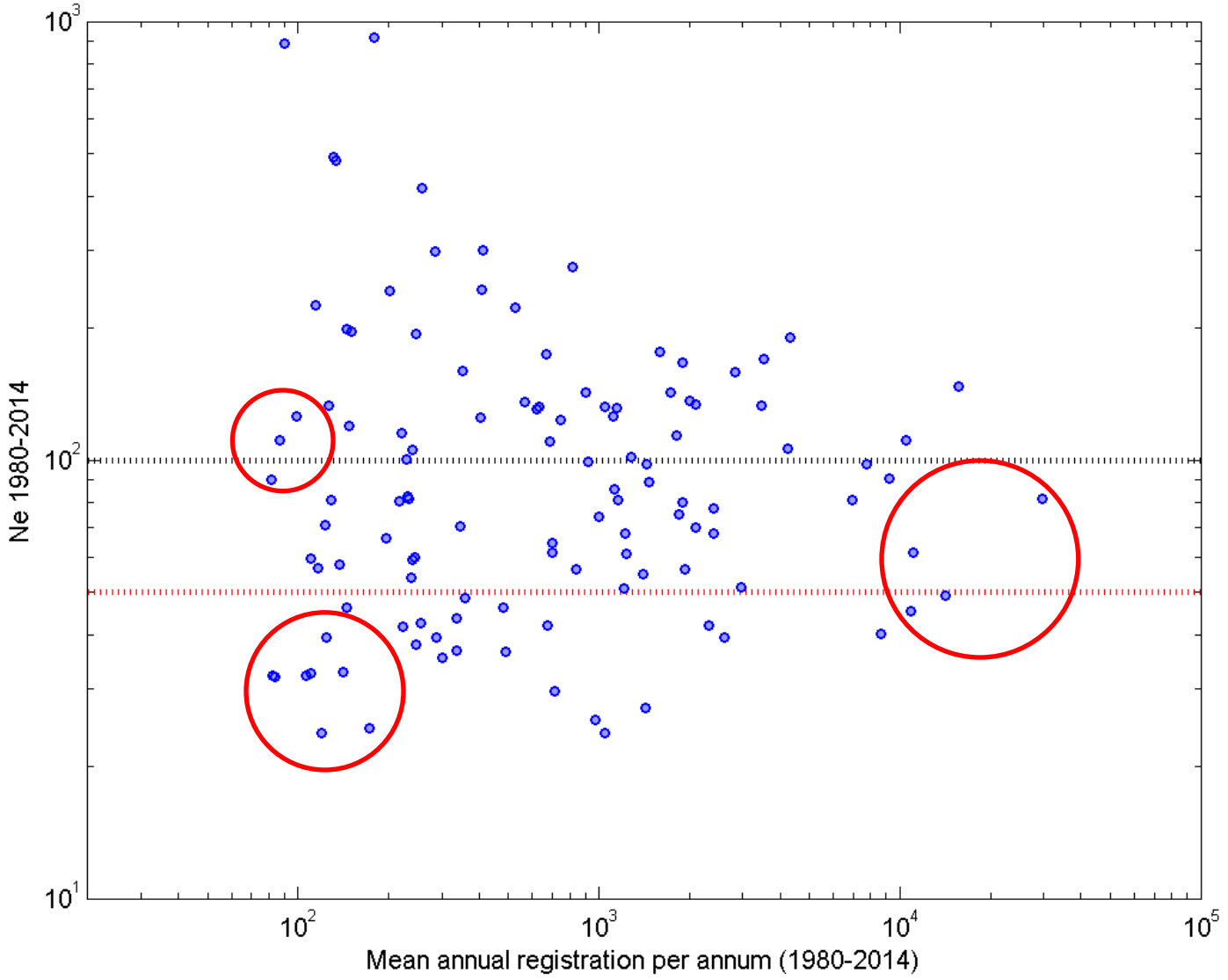
# Some common breeds have high ΔF



# Effective and actual pop$^{n}$ size appear unrelated



# Summary

Individual breeds require individual solutions / strategies

Dog breeding is dominated by individuals – but health should be a common aim

## Thank you – and any questions?

BHCPs may provide opportunity to get breeders to collaborate and change culture of individualism

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