Genetic status of purebred dogs in the UK

9/21/2015

By Carol Beuchat PhD

Just published today in Canine Genetics and Epidemiology is a study of the population statistics and genetic diversity of all 215 breeds registered by the Kennel Club, using data from the pedigree database from 1980-2014. The paper is a welcome addition to the literature, updating and eclipsing the earlier (and epic at the time) study by Calboli et al in 2008.

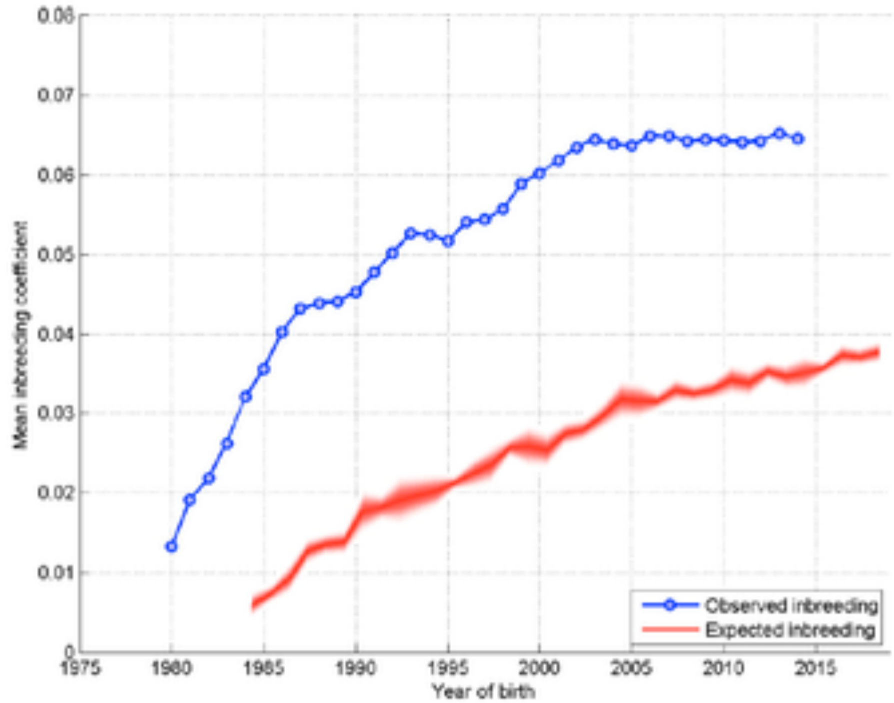
If you've been wondering if you should take a course in population genetics, this paper will convince you. (Check out the courses that ICB offers here.) The health of the dogs we breed depends fundamentally on the quality of the gene pool, and assessments of the genetic health of the gene pool are necessarily based on population-wide analyses. So there is much here about effective population size (Ne), which is determined by the rate of change in the average level of inbreeding in the population.

At the core of the paper are data for inbreeding over the years since 1980. Unfortunately, the data for individual breeds are not in the paper, or even in the supplementary documents available from the publisher (where they would be available in perpetuity), but instead are available as individual pdf documents on the Kennel Club website. If the address to that web page should ever change (and surely it will), the link published in the manuscript will be useless. So, download your favorite breed now, just to be safe.

Summarizing their findings about inbreeding, they say:

"The trend over all breeds was for the rate of inbreeding to be highest in the 1980s and 1990s, tending to decline after 2000...to sustainable levels, with some modest restoration of genetic diversity in some cases."

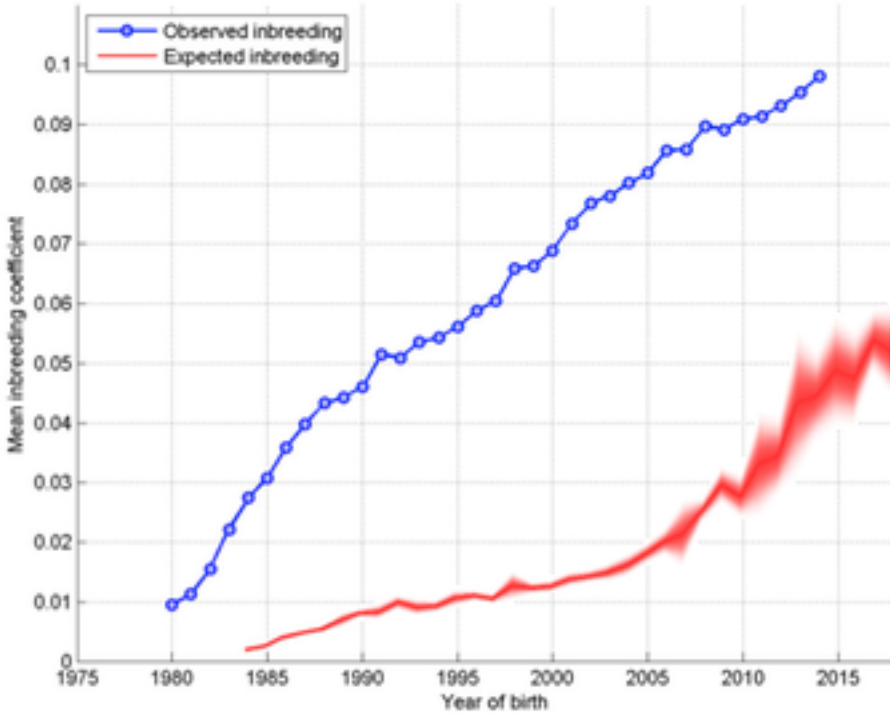
While there are breeds in which inbreeding does stabilize (e.g., the Labrador Retriever; figure on the right), it is certainly not the case that this is a general pattern across all breeds.



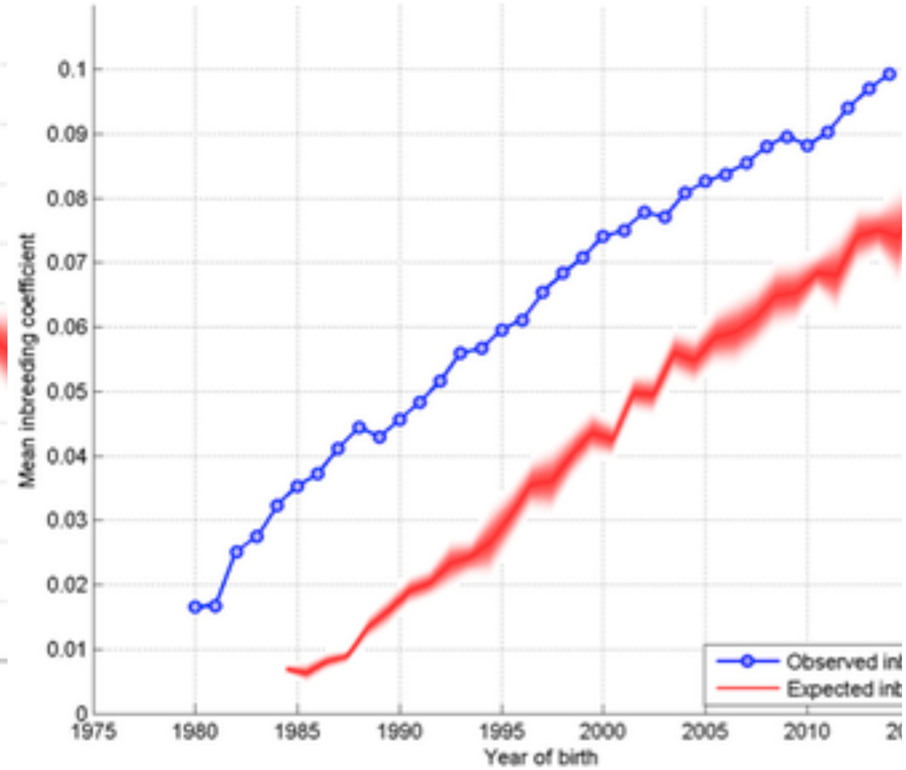
LABRADOR RETRIEVER

Below are some examples of breeds in which inbreeding doesn't stabilize after 2000, but increases continuously over the period of the study. Perhaps these are breeds that didn't benefit from a surge in imports after 2000 (wish we could see the data for imports), but there is no evidence that breeders have been adjusting breeding strategies to reduce the level of inbreeding. If that was happening, it would be evident in the distance between the observed and expected inbreeding lines in these graphs. The expected level of inbreeding assumes that breeding is random; the higher observed level indicates that the animals being bred together that are more closely related than the population average. This also indicates the potential magnitude of the reduction in inbreeding that could be achieved by a change in breeding strategy.

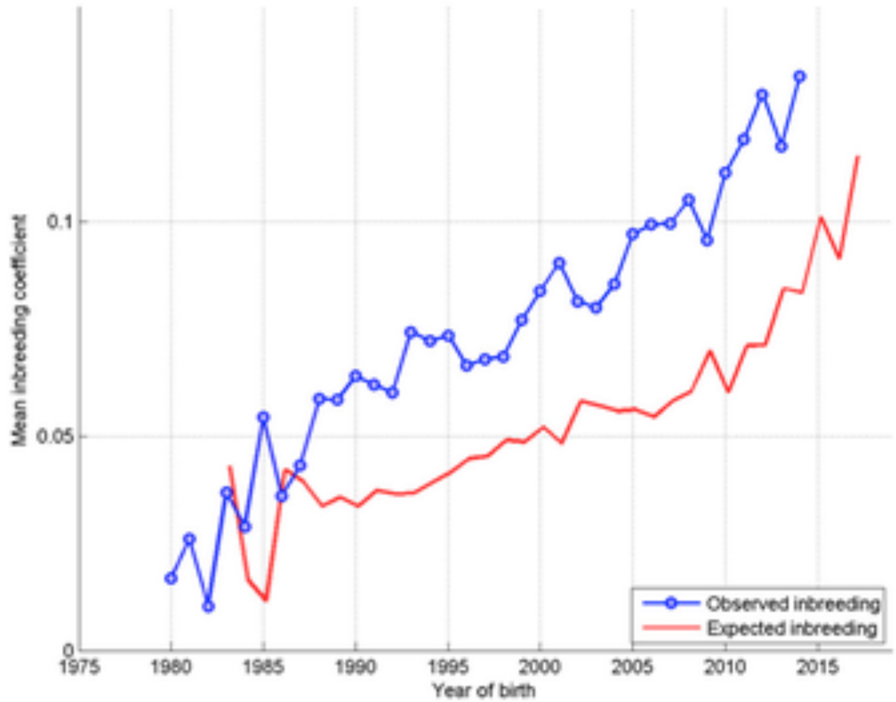
Average inbreeding coefficient over 1980-2014
Upper: English Cocker (left), English Springer (right)
Lower: Akita (left) , Bull Terrier (right)



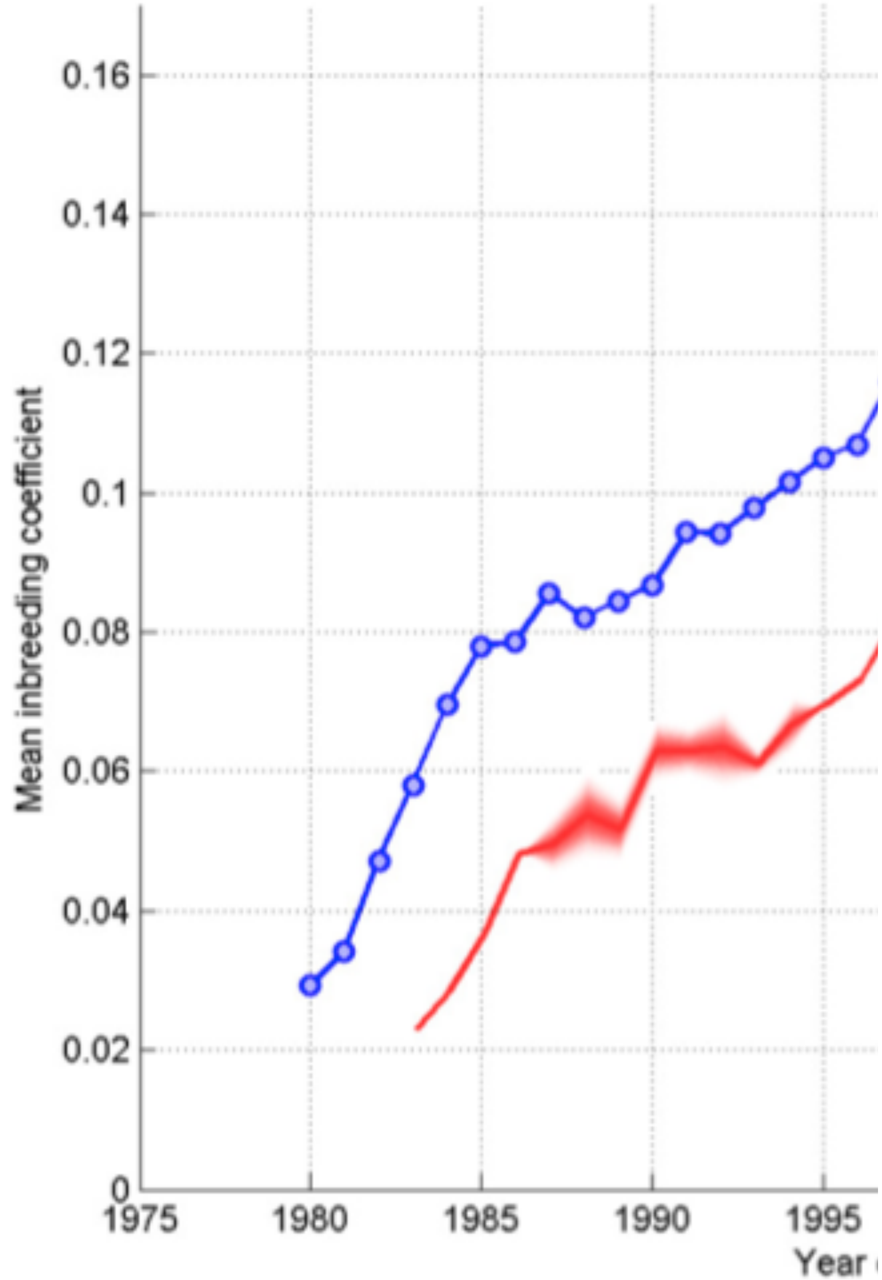
English Cocker



English Springer

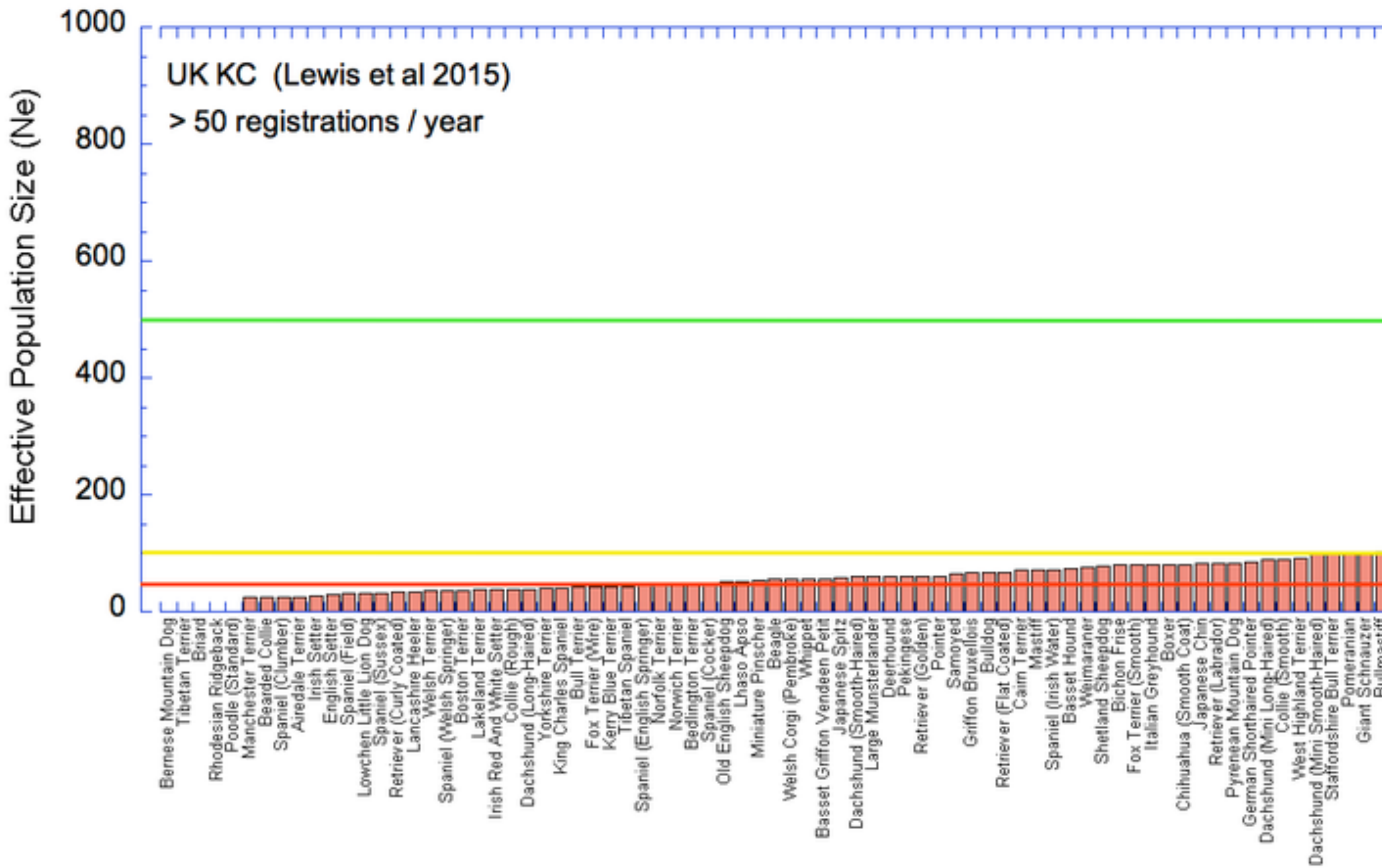

Mean inbreeding coefficient
0.1
0.05
0
1975
1980
1985
1990
1995
2000
2005
2010
2015
Year of birth
Observed inbreeding
Expected inbreeding

Akita


Mean inbreeding coefficient
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
1975
1980
1985
1990
1995
Year

As I noted above, the effective population size (Ne) is determined by the rate of inbreeding in the population. The rule of thumb used by conservation biologists as the minimum Ne necessary to maintain a sustainably breeding population has risen over the last few years from 50 unrelated, randomly breeding animals to 100, and even more recently 500, as biologists reassess the realities of both in situ and captive animal management (you can read about the latest argument over revision here). That aside, it is useful to look at some of the data on Ne from the present study.

Below I have graphed the data for Ne (from the Supplementary documents) for those breeds in which there were more than 50 registrations per year; that is, the more populous breeds. I have superimposed lines at Ne = 50 (red), Ne = 100 (yellow), and Ne = 500 (green), to correspond with the various rules of thumb under debate.



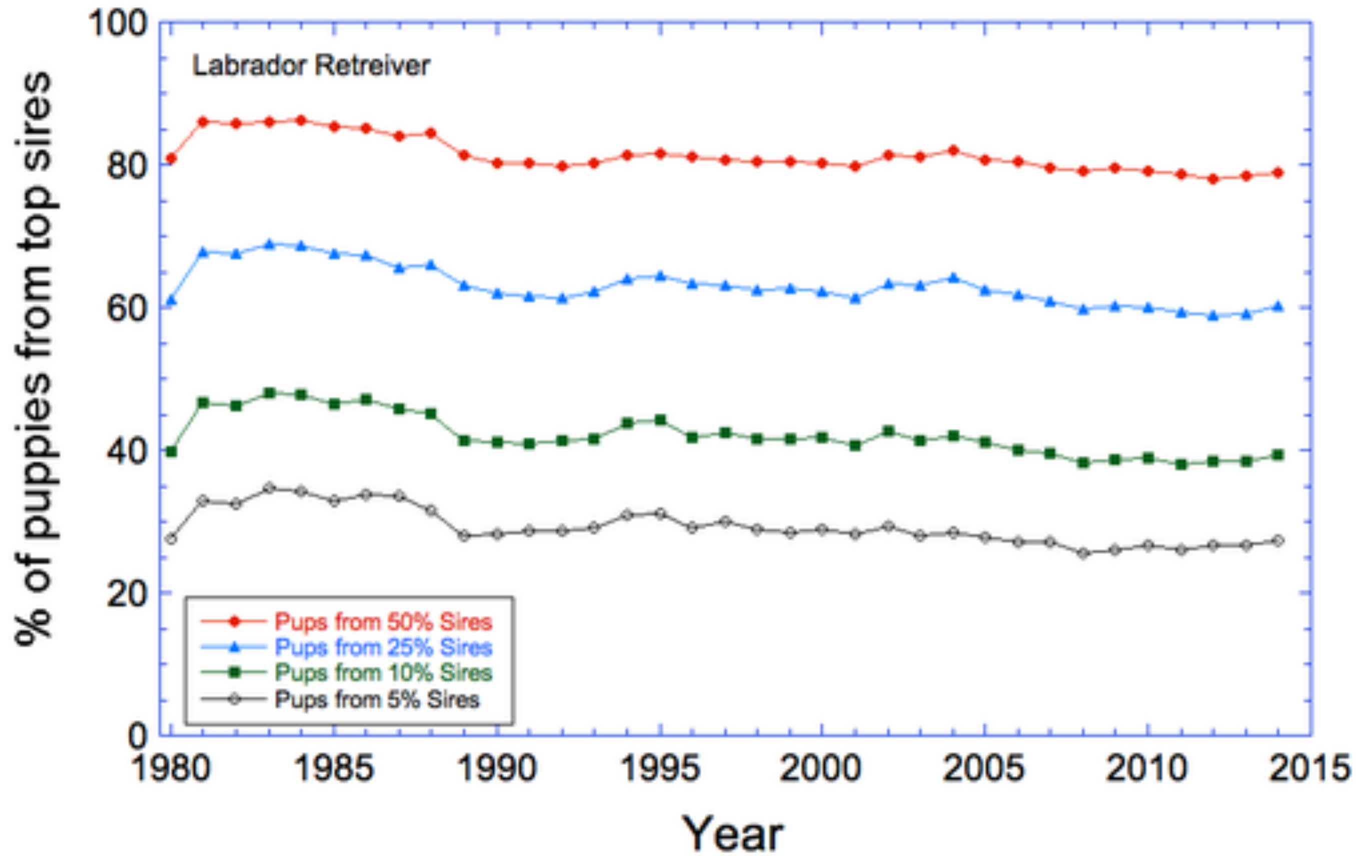
Effective Population Size (Ne)
UK KC (Lewis et al 2015)
> 50 registrations / year
1000
800
600
400
200
0
Bernese Mountain Dog
Tibetan Terrier
Briard
Rhodesian Ridgeback
Poodle (Standard)
Manchester Terrier
Bearded Collie
Spaniel (Clumber)
Airedale Terrier
Irish Setter
English Setter
Spaniel (Field)
Lowchen Little Lion Dog
Spaniel (Sussex)
Retriever (Curly Coated)
Lancashire Heeler
Welsh Terrier
Spaniel (Welsh Springer)
Boston Terrier
Lakeland Terrier
Irish Red And White Setter
Collie (Rough)
Dachshund (Long-Haired)
Yorkshire Terrier
King Charles Spaniel
Bull Terrier
Fox Terrier (Wire)
Kerry Blue Terrier
Tibetan Spaniel
Spaniel (English Springer)
Norfolk Terrier
Norwich Terrier
Bedlington Terrier
Spaniel (Cocker)
Old English Sheepdog
Lhaso Apso
Miniature Pinscher
Beagle
Welsh Corgi (Pembroke)
Whippet
Basset Griffon Vendeen Petit
Japanese Spitz
Dachshund (Smooth-Haired)
Large Munsterlander
Deerhound
Pekingese
Retriever (Golden)
Pointer
Samoyed
Griffon Bruxellois
Bulldog
Retriever (Flat Coated)
Cairn Terrier
Mastiff
Spaniel (Irish Water)
Basset Hound
Weimaraner
Shetland Sheepdog
Bichon Frise
Fox Terrier (Smooth)
Italian Greyhound
Boxer
Chihuahua (Smooth Coat)
Japanese Chin
Retriever (Labrador)
Pyrenean Mountain Dog
German Shorthaired Pointer
Dachshund (Mini Long-Haired)
Collie (Smooth)
West Highland Terrier
Dachshund (Mini Smooth-Haired)
Staffordshire Bull Terrier
Pomeranian
Giant Schnauzer

Download a larger version of this figure:

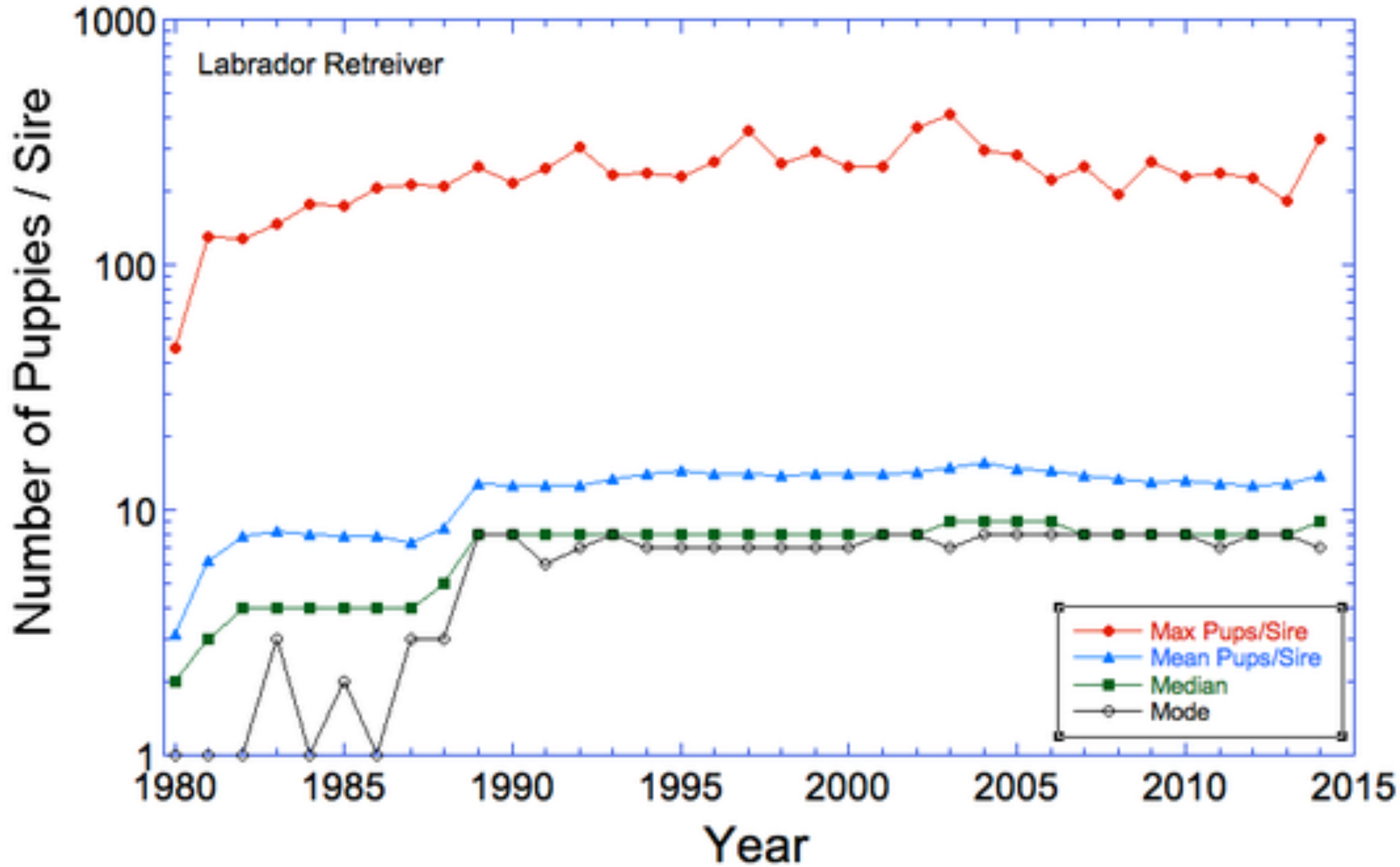
If we wanted to conservatively go with the minimum Ne of 500, only 2 breeds would make the grade, and only about half of the breeds with registrations higher than 50/year would make the Ne = 100 cutoff. There are a good number of breeds for which Ne is <50 on this graph, and I haven't looked at it yet but I would wager that the majority of breeds with fewer than 50 registrations per year will be below the red line as well. (If there were 50 dogs in the population, half male and half female, and all animals bred, the Ne would be 50. Breeds with fewer than 50 registrations per year would be cutting it mighty close.)

There is much more that could have been done with the data available to the authors than they presented in the paper and supplements. Just for fun, I have pulled the data for Labrador Retrievers from the paper and supplements and (quickly) put together some graphs that might be useful for breeders. (Similar analyses can be done for the other breeds on request.)

For instance, below is a graph of the fraction of puppies produced each year by top-ranking sires. You can see that about 30% of the pups born yearly were produced by only the top 5% of sires.



The impact of top-ranked popular sires is even more obvious in this figure of the maximum number of pups produced by a single sire in a year compared to the population average. Note that the y axis is logged, otherwise the data for the averages would all be to low to see.



(You can see more of the analyses of the Labrador data here.)

I would have to say that, after a few hours of fiddling with the available data, the paper's summary is rosier than the actual picture. The statement that levels of inbreeding are looking much better since 2000 is quite misleading - it could simply be an artifact of the importation of unrelated dogs, and there are plenty of breeds in which the rate of inbreeding has stayed on the same trajectory for decades and could very well continue. The number of breeds with effective population sizes well into the danger zone should be a heads up for breeders, especially in those breeds that could increase Ne with the simple strategy of breeding a larger fraction of available dogs and balancing the ratio of males to females (as I discuss here).

The caveat here is that these data are for an artificial population - the dogs registered with The Kennel Club. Before 2000, it was effectively a closed population, and since then has the addition of imports with only 3 generations of pedigree information, which makes them appear in analyses like this to be new, unrelated founders. At least The Kennel Club should be congratulated for including geneticists on their staff who have access to the pedigree data and the expertise necessary for these analyses. What a pity that the AKC does not do the same.