

**README: Grimm-Seyfarth, A., Harms, W., and Berger, A. 2021. Detection dogs in nature conservation: A database on their worldwide deployment with a review on breeds used and their performance compared to other methods.**

**Abstract**

Over the last century, dogs have been increasingly used to detect rare and elusive species or traces of them. The use of wildlife detection dogs (WDD) is particularly well established in North America, Europe and Oceania, and projects deploying them have increased worldwide. However, if they are to make a significant contribution to conservation and management, their strengths, abilities, and limitations should be fully identified. We reviewed the use of WDD with particular focus on the breeds used in different countries and for various targets, as well as their overall performance compared to other methods, by developing and analysing a database of 1220 publications, including 916 scientific ones, covering 2464 individual cases - most of them (1840) scientific. With the worldwide increase in the use of WDD, associated tasks have changed and become much more diverse. Since 1930, reports exist for 62 countries and 407 animal, 42 plant, 26 fungi and 6 bacteria species. Altogether, 108 FCI-classified and 20 non-FCI-classified breeds have worked as WDD. While certain breeds have been preferred on different continents and for specific tasks and targets, they were not generally better suited for detection tasks than others. Overall, WDD usually worked more effectively than other monitoring methods. For each species group, regardless of breed, detection dogs were better than other methods in 88.71% of all cases and only worse in 0.98%. It was only for arthropods that Pinschers and Schnauzers performed worse than other breeds. For mono- and dicotyledons, detection dogs did less often outperform other methods. Although every breed can be trained as a WDD, choosing the most suitable dog for the task and target may speed up training and increase the chance of success. Albeit selection of the most appropriate WDD is important, excellent training, knowledge about the target density and suitability, and a proper study design all appeared to have the highest impact on performance. Moreover, an appropriate area, habitat and weather are crucial for detection dog work. When these factors are taken into consideration, WDD can be an outstanding monitoring method.

**Methods**

We systematically searched for any publication using the following search terms in Google Scholar and ISI Web of Knowledge: wildlife detect\* dog, species detect\* dog, scat detect\* dog, [species] + detect\* dog, [author] + detect\* dog, [country] + detect\* dog, conservation (detect\*) dog, predator (detect\*) dog, protected species (detect\*) dog, den detect\* dog, roost detect\* dog, plant detect\* dog, canine detection, and tracking dog. We traced any potentially relevant cited publication and only included those in our review that we could check ourselves. We also collected publications if we got to know them otherwise and reviewed existing literature lists and compilations (Grimm-Seyfarth et al. 2021, Appendix S1.1). We focused mainly on scientific literature, including scientific papers, dissertations, and project reports. However, wildlife detection dogs were frequently used for conservation or management purposes without a scientific research project behind them. For a more comprehensive overview of their deployment and performance, we included popular science or newspaper articles when no scientific publication about the project was found. In addition, we used social media platforms to obtain many articles from different countries (Grimm-Seyfarth et al. 2021, Appendix S1.1). In order to avoid multiple

citations of the same study for which publications from different sources have been published, we compared each new entry with the entries in the database and preferably included scientific publications, followed by books, popular science and newspaper articles.

We compiled the data in a relational database (Microsoft Access 2013) consisting of five basic tables: literature, dog breeds, target species, target types and countries. We classified dog breeds into the ten FCI classification groups<sup>1</sup> and breeds not listed as “not classified”. We assigned mixed breeds to a main or first-mentioned breed or to the category “Mix” when they could not be assigned to a specific breed. We classified target species according to their Latin and English names, genus, family, order, class, phylum and kingdom, adding subspecies names if provided. If the dog detected species groups without further specification (e.g., bat or bird carcasses, rodents, weed), we retained this group only. Taxonomic changes due to splitting of taxa into several species were only made if the allocation to the new species was obvious from the geographic information provided or had already been done by other authors. We divided potential target types into: living or dead individuals; nests, dens, clutches, coveys, roosts; scat, urine, saliva, glandular secretion; spores, eggs; larvae; hair, feathers, pellets, shed skin; and different combinations thereof. Lastly, we classified countries according to the (sub-) continent into North, Central and South America, Europe, Asia, Africa, and Oceania, assigning Russia and Turkey to “Eurasia”. Furthermore, we assigned Australia, New Zealand, and all oceanic islands (including subantarctic islands) to “Oceania” and made no differentiation to Zealandia.

In a main table, we then assigned each breed-target species-country association per reference as a single “case”. We marked pure-breed dogs and added a second breed for mixed breeds (if provided), as well as the number of dogs per breed and reference (if not mentioned directly, “1” for mentioning “dog” and “2” for mentioning “dogs”). We also added specifications to the country (e.g. Islands). If available, we extracted results of the wildlife detection dog performance compared to other monitoring methods. We classified the performance into four categories: dogs were (i) better; (ii) equal; or (iii) worse than other methods tested; or (iv) mixed results. The factor in comparison was study-specific and could include speed per area or transect, area size, sample size, quality, detectability, specificity, sensitivity, accuracy, or precision. We relied on those conservative measures since different monitoring methods can hardly be compared otherwise. The category “mixed results” was given when the dogs were better at some factors but worse at others, or when the performance depended upon season, year, site, or dog.

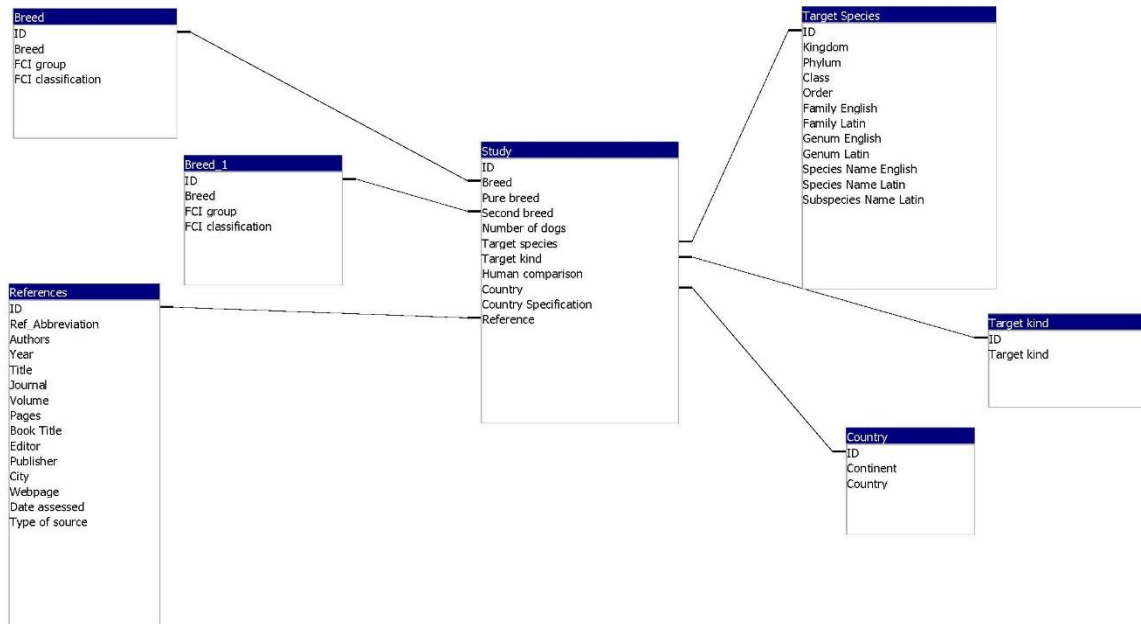
## Data Structure

This relational database was created in Microsoft Access 2013. It contains five basic tables (literature, dog breeds, target species, target types and countries) and one main table (Study). The basic tables and the main table are connected through unique identifier (IDs). Since we designed the database as a relational database, IDs among the five basic tables and the main table were linked together for quick searches and queries. The Relationship Report is shown in Fig. 1.

We will explain the different columns of the basic tables and the main table in the following.

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<sup>1</sup> <http://www.fci.be/en/Nomenclature/>, last assessed on 03/08/2019



**Figure 1. Relationship Report of the Database**

### Basic tables

#### References (= Literature)

Column name	Description
ID	Unique identifier of each literature entry
Ref_Abbreviation	Unique abbreviation of each literature entry
Authors	All authors of the publication
Year	Year of the publication
Title	Title of the publication
Journal	Journal or newspaper name
Volume	Volume of the journal; a date in case of web-publications
Pages	Pages within the volume; the number of pages for books or theses
Book Title	The title of the book for book publications or compilations
Editor	Editor in case of books
Publisher	Publisher in case of books or theses
City	City of publication for books, theses or conferences
Webpage	Link to webpage for web-publications
Date assessed	Last assessed date for web-publications
Type of source	Source type: scientific paper, scientific webpage, popular science magazine, popular science webpage, newspaper, book or conference proceedings

*Breed (= Dog breeds)*

Column name	Description
ID	Unique identifier of each breed entry
FCI group	Group number classified by FCI <sup>1</sup> ; “not classified” for breed not mentioned, mixed breeds, or not (yet) by FCI accepted breeds
Breed	Dog breed according to FCI <sup>1</sup> ; categories “Breed not mentioned” and “Mix” added for entries in the database where the breed was not mentioned or only mentioned as mix, respectively
FCI classification	Name of the FCI <sup>1</sup> group; “not classified” for breed not mentioned, mixed breeds or not (yet) by FCI accepted breeds

*Target species*

Column name	Description
ID	Unique identifier of each target species entry
Kingdom	Kingdom (Latin name)
Phylum	Phylum (Latin name)
Class	Class (Latin name)
Order	Order (Latin name)
Family English	Family (English name)
Family Latin	Family (Latin name)
Genum English	Genum (English name)
Genum Latin	Genum (Latin name)
Species Name English	Species (English name)
Species Name Latin	Species (Latin name)
Subspecies Name Latin	Subspecies (Latin name)

*Target kind (= target types)*

Column name	Description
ID	Unique identifier of each target type entry
Target type	All single target types and possible combinations thereof

*Country*

Column name	Description
ID	Unique identifier of each country entry
Continent	Continent or Sub-Continent; “Worldwide” added for publications mentioning a worldwide deployment
Country	Official country name; empty for entries mentioning the continent only

## Main Table

### Study

Please note that every target species – breed – country combination is recorded as a single case. That means that if a publication reports on dogs of several breeds searching for one target species, every breed is recorded into the table as a single case. Likewise, if one dog is searching for multiple target species, every target species is recorded as a single case. Also, if the study is explicitly mentioning several countries, cases per country are recorded as single cases.

Column name	Description
ID	Unique identifier of each case
Breed	ID of the breed mentioned in the study, or the first mentioned or main breed of a mixed dog; if not mentioned, “Breed not mentioned” selected; if no main breed mentioned, “Mix” selected
Pure breed	A tick if the breed is pure breed
Second breed	Only relevant in mixed breeds and only given if a second breed was mentioned; then, ID of breed
Number of dogs	Number of dogs mentioned in the study; if not given directly, “1” for mentioning “dog” and “2” for mentioning “dogs”
Target Species	ID of the target species mentioned in the study
Target kind	ID of the target kind (type) mentioned in the study
Human comparison	A comparison whether the dog was better, equal or worse than any other method used or referred to in the study; “mixed results” were given if the dog was better in some, but not all categories (see main text); “no comparison” was given if the study did not mention any comparison with other methods
Country	ID of the country mentioned in the study
Country Specification	Any important specification of the country, e.g. islands
Reference	ID of the reference where the study comes from

### Queries

We included a few simple pre-defined queries:

Query\_Breed\_Human\_comparison – A summary about which breed was better or not than any other method for which species

Query\_Number\_of\_dogs\_breed – A list of how many dogs have been used per breed

Query\_Target\_Species\_Publications – A list of all target species and the publications mentioning them

Query\_Type\_of\_Source\_Continent – A list of all publications by continent separated by type of source

Query\_Type\_of\_Source\_Year – A chronological list of all publications separated by type of source

Query\_Year\_Continent – A chronological list of all publications separated by continent

Note that double-mentioning of references is possible, e.g. when publications mention several continents.

The main query is called Target Species Query. It contains all 2465 single cases (based on the main table, *Study*) and all information connected to it. We also uploaded this table as Excel file for broader use.

We encourage re-use or extensions of the database but kindly ask to cite our original data properly.