# ARE WE MAKING A DIFFERENCE?

ICAM

INTERNATIONAL COMPANION ANIMAL MANAGEMENT COALITION

## A Guide to Monitoring and Evaluating Dog Population Management Interventions

GARC rabiesalliance.org

RSPCA

HUMANE SOCIETY INTERNATIONAL

IFAW

WORLD ANIMAL PROTECTION

WSAVA Global Veterinary Community

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# Preface



Almost every country invests in dog population management (DPM) in some form; however there is no agreed measure to establish whether an intervention is successful. Through this guidance document, the International Companion Animal Management (ICAM) Coalition aims to provide encouragement and advice on impact assessment of DPM. Our aim is to enable academics, practitioners and funders to track progress, learn and subsequently improve their DPM impact through the use of measurable objective indicators. Indeed, for us to achieve our long term goals in DPM we need an evidence base for our future decisions, in other words "success depends on knowing what works" Bill Gates, cited by Savedoff et al. (2006), *pp* iv.

Our focus is on applying scientific solutions to real world problems and encouraging an increase in scientific research on DPM. Our scope is international, with a particular interest in simple methods and meaningful indicators for communities searching for cost-effective impact assessment. We do not pretend to have identified the 'gold standard' for impact assessment; instead we have *recommended* the best of current practice and also *suggested* adaptations of indicators and methods used in other contexts. We therefore strongly encourage innovation and testing of this guidance and would welcome all feedback through our website www.icam-coalition.org.

In this guidance, we have defined DPM as an intervention that includes activities directly involving dogs; for example sterilisation, vaccination, parasite control, sheltering, adoption or euthanasia. We also recognise that it may include targeted education or campaign activities to enhance dog owner knowledge and alter their behaviour.

This guidance does not tell you how to plan or run an intervention; for information in designing and implementing interventions see our previous publication 'Humane management of dog populations' (ICAM Coalition, 2008). Instead, this guidance aims to complement the previous publication by focussing on how to measure the impact of a DPM intervention, whatever activities it may include. DPM interventions are not driven by a single common desired impact; rather each intervention may have one or more of a range of impacts. We have included guidance on measuring and evaluating eight of the most common impacts which we feel are relevant to most DPM interventions.

The ICAM Coalition is grateful for the many people who have been involved in developing this guidance. Not least our collaborating partners at the Boyd Orr Centre for Population and Ecosystem Health at the University of Glasgow, the Jeanne Marchig International Centre for Animal Welfare Education (JMICAWE) at the University of Edinburgh, the Animal Welfare and Behaviour group at University of Bristol, and the Department of Veterinary Tropical Diseases at University of Pretoria. In addition, our thanks goes to the many experts and hardworking DPM implementers in the field who gave up their time and knowledge so willingly to help others; many but not all of whom are listed in the acknowledgements. Through your insights we hope to help others make the world a better place for dogs and the communities amongst which they live.

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# Background



## AIM OF THE GUIDANCE

The International Companion Animal Management (ICAM) Coalition was formed in 2006 to support the development and use of humane and effective companion animal population management worldwide[1]. Through our work to achieve this mission, we realised that effectiveness, or an answer to the question "are we making a difference?", was often a subjective assessment of how well an intervention had worked and was not commonly based on objective scientific measurement. However there were notable exceptions to this and some excellent innovations in monitoring (regular data collection to measure important indicators) and evaluation (thoughtful assessment of what the data shows regarding targeted impacts) occurring around the world that could form a foundation for guidance.

Previously published guidance on DPM had outlined the importance of monitoring and evaluation. Our own guidance on humane DPM (ICAM Coalition 2007) included a short chapter on 'implementation, monitoring and evaluation'. The OIE (World Organisation for Animal Health) included an article on monitoring and evaluation (article 7.7.7) in their global standards for Stray Dog Population Control (OIE 2014). The WHO (World Health Organisation) describes the importance of 'operational research for dog rabies control' in their most recent report from an expert consultation for rabies control (WHO 2013). However, although these publications provide compelling arguments for including monitoring and evaluation and important guiding principles for its implementation, they do not provide advice on practical application.

This guidance therefore aims to build on the previously established need for monitoring and evaluation. By providing detailed recommendations on valid, reliable, practical, and feasible way of assessing the impact of domestic dog population interventions; impact assessment is another term for the learning that can be achieved through monitoring and evaluation. We hope that this will support academics, practitioners and funders to track progress, learn and subsequently improve their DPM impact through the use of measurable indicators. The focus is on applying scientific solutions to real world problems and encouraging an increase in scientific research on DPM. Our scope is international, with a particular interest in simple, repeatable methods and meaningful indicators for communities searching for cost-effective impact assessment.

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[1] Current members include the International Fund for Animal Welfare (IFAW), World Animal Protection, Humane Society International (HSI), Royal Society for the Prevention of Cruelty to Animals (RSPCA) International, World Small Animal Veterinary Association (WSAVA) and Global Alliance for Rabies Control (GARC).

## PROCESS OF DEVELOPING THE GUIDANCE

The process of developing this guidance included an initial literature review, interviews with experts and practitioners in the field, testing of some of the novel methods of measurement and indicators, and extensive reviews and consultations with all the ICAM Coalition members and project collaborating partners.

## HOW TO USE THIS DOCUMENT

The following sections include an overview of the process of monitoring and evaluation, accompanied by explanation and introduction to the key terms used throughout the document. The main benefits of monitoring and evaluation to dog population management are also outlined here. They also present an important first step to monitoring and evaluation; identification of the impacts which we hope to see change. In other words "the difference we are trying to make through our intervention". Once the targeted impacts of the intervention have been identified, navigating through the rest of the document becomes simple and bespoke to your intervention. Not all interventions will be targeting the same impacts. Select those that are most relevant to your intervention and turn to the related section(s) of the guidance document. Select the indicators that are most suitable for you to evaluate the impact in your specific situation. We recommend that you choose more than one indicator to allow the change in the impact to be explored, and potentially validated, by more than one method; also known as 'triangulation'. Once selected, follow the guidance under each indicator to the method of measurement that is most practical and feasible for your particular dog population. In most cases, addition information on how to implement the method of measurement is given in a subsequent section. See figure 1 for a flow diagram that shows this process.

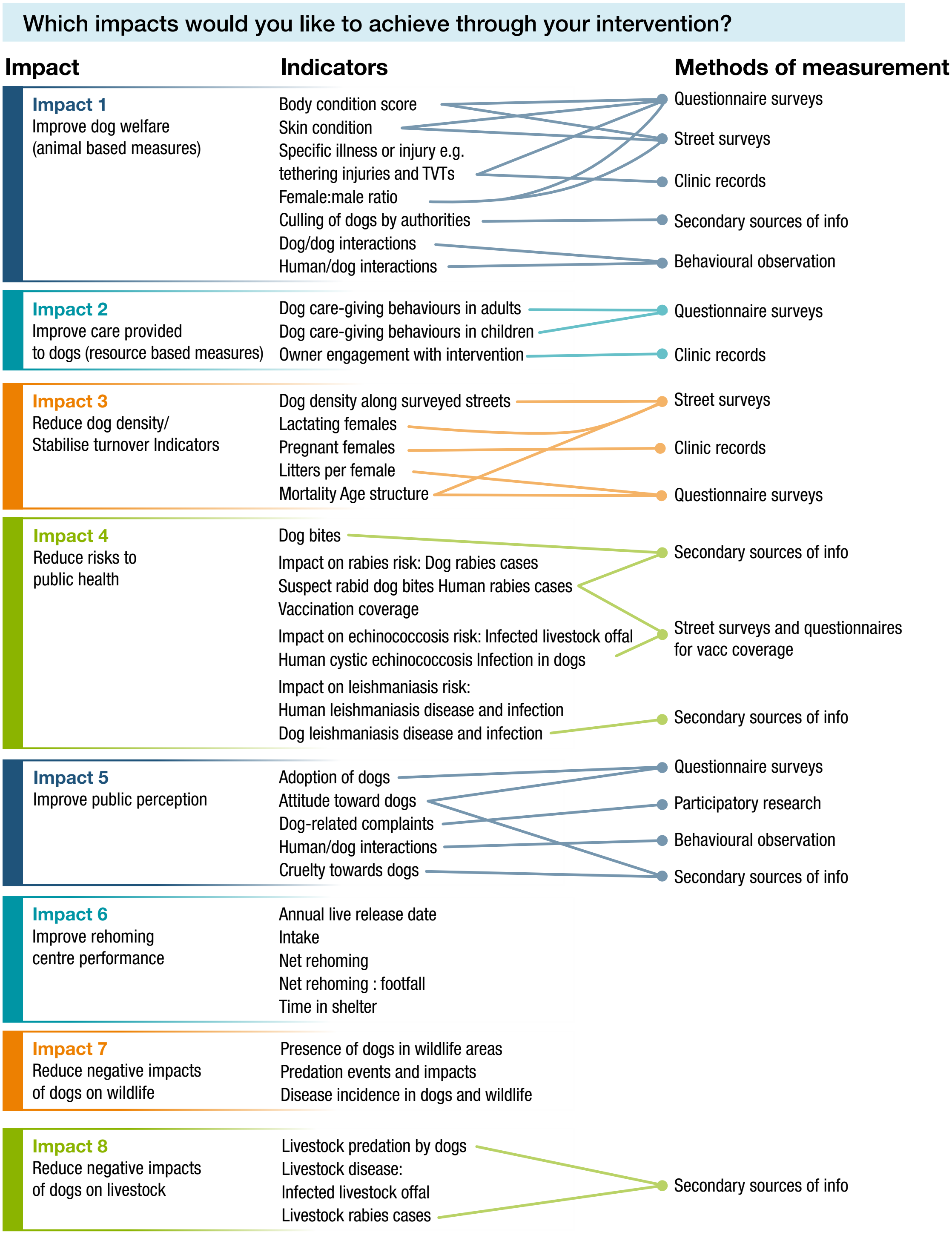



**Figure 1**

In the final two Sections 'Making your impact assessment robust' and 'Using your results', the guidance covers key ways of ensuring best possible data collection, the basics of analysis and interpretation, and how to use the results to improve your intervention or communicate your successes and reasons why your intervention needed to be altered. We strongly encourage communicating necessary changes to interventions as well as successes, learning what doesn't work and needs to be changed is as important as knowing what does work.

# WHAT IS MONITORING AND EVALUATION?

An **intervention** is a set of activities that aims to make a targeted change or **impact** to a set of people, animals or environment.

> Example: an **intervention** that catches, neuters and returns a number of stray dogs every month in an Asian city. The desired **impact** of this intervention is to reduce the density of dogs and to improve the welfare of the stray dogs.

**Monitoring** requires systematic and routine data collection. Monitoring an intervention includes measuring the progress of the intervention itself; the intervention **effort**. Monitoring also includes regular measurement of **indicators** that reflect changes in the targeted impacts, as well as relevant factors in the environment that may also influence the same impacts as the intervention. **Indicators** (also known as **metrics**) are measurable signs of impacts; they are the things we would see or hear if our desired impact was occurring. **Methods of measurement** describe how data relating to the indicators was collected.

> In our Asian city example, for the **impact** of reducing dog density a suitable **indicator** may be the number of dogs seen on a set of standard routes along public roads. The **method of measurement** for this indicator may be a street survey once every 6 months conducted following a consistent protocol (e.g. same routes, same time of day and same observation process) for observing dogs on public property. For the **impact** of improving dog welfare, we may select the **indicator** of proportion of the stray dog population that is emaciated. The **method of measurement** would again be the 6 monthly street survey including body condition scoring of all dogs observed. **Monitoring** would also include recording the number and location of all dogs neutered and returned; this represents the intervention **effort**.

**Evaluation** of an intervention uses data collected through monitoring, sometimes combined with other data sourced infrequently and specifically for the evaluation, to answer questions about "what difference did this intervention make?"; in particular in relation to the targeted impacts, although unexpected impacts are also important. Evaluation explores the difference made by the intervention and compares it to what would have happened without the intervention, also known as the counterfactual (Savedoff et al., 2006).

> In our dog population management example, an **evaluation** may look at the data relating to dog density in the city where the intervention took place and compare it to a limited number of routes used in another city where no intervention was used, over the same time frame. In this case, the question is "has dog density decreased over time in the city where the intervention took place?" and "how does this compare to the change in density in a city where no intervention was used?"

Evaluation may also ask whether the intervention could have been more efficient and cost effective overall, by comparing the cost of the intervention against any savings created through the impacts.

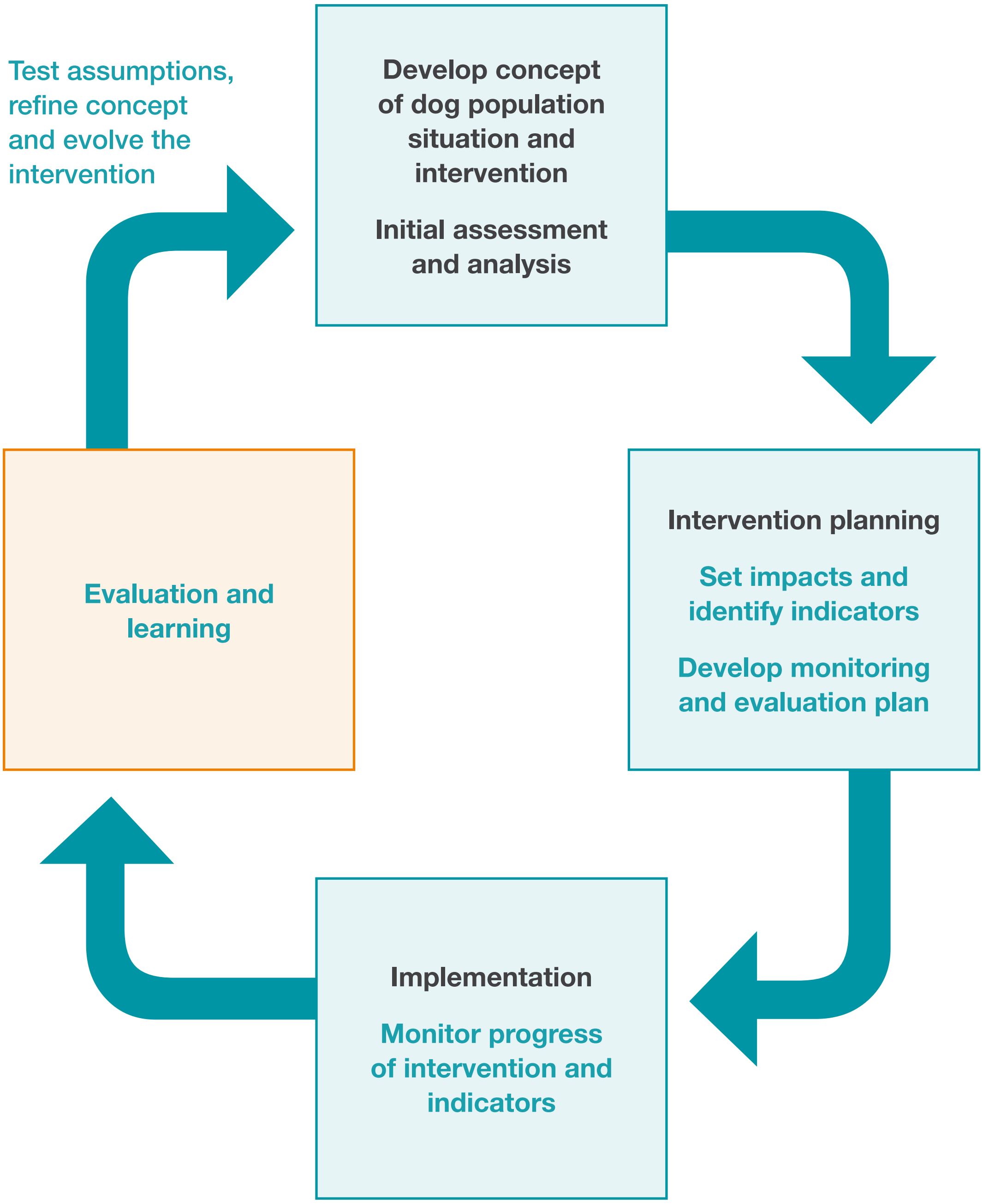
In summary:

| Definition | DPM example 1 | DPM example 2 |
|---|---|---|
| An Intervention is a combined set of activities with specific changes or impacts in mind | Catch, neuter and release of roaming dogs in an Asian city | Annual rabies vaccination of dogs in a semi-rural region of sub-Saharan Africa |
| Impacts are the changes we hope to contribute towards through our interventions | • Reduce dog density<br>• Improve the welfare of roaming dogs | Reduce rabies in dogs and therefore in people |
| Indicators are measurable signs of impacts (also known as metrics); they are the things we would see or hear if our desired impact was occurring | • Number of dogs seen on a set of routes along public roads<br>• The percentage of roaming dogs with emaciated body condition<br>• People saying "puppies dying on the streets is a rare sight these days" | Number of reported dog rabies cases, dog bites and human rabies deaths. People saying "I have not heard of a rabies case in my village for many years, it used to happen almost every year" |
| Methods of measurement are the techniques we use to measure our indicators | Observation of the number and body condition score of all roaming dogs observed during a six monthly 'street' survey | Quarterly meetings with Municipal Veterinary Department and General Hospital to access data on dog rabies cases, dog bites and human rabies deaths |
| Effort is the immediate result of your activities | The number of dogs caught, neutered and released | The number of dogs vaccinated, subsequent vaccination coverage (% of population vaccinated) |
| Input is the time and resources put into implementing the intervention | Financial costs per dog plus capital costs of intervention infrastructure | Financial costs per dog plus capital costs of intervention infrastructure |

Before an intervention is launched it is necessary to measure the baseline of indicators selected to reflect the impacts; although note that some methods of measurement are part of the intervention itself (e.g. the collection of data relating to dogs that pass through the intervention clinic, see Section Clinic records) and so the baseline would be measured through the first phase of the intervention. By establishing a baseline for each indicator, the change in the indicators after the intervention was launched can be measured. Establishing a baseline may also allow you to state a target within a specific time span and define clear goals from the outset. For example, a potential target could be to reduce the percentage of dogs with emaciated body condition from 20% to below 10% within 3 years of the intervention starting.

## WHY INVEST IN MONITORING AND EVALUATION?

Monitoring and evaluation has many purposes: to inform donors of the impacts created through their funding; to inform the public of any impacts on them and/or their dogs as beneficiaries of the intervention; to provide evidence for lobbying to sustain or replicate an intervention; and to compare intervention and their relative impacts. But the most important purpose is for improvement of the current intervention and subsequent interventions via learning what is, and is not, successful and the dissemination of these findings to a wider audience. The potential for learning and subsequent improvement can be visualised in an **intervention or 'project' cycle** (blue text and boxes indicate monitoring and evaluation activities):



The importance of monitoring and evaluation to learning cannot be overstated. Many interventions begin with a very basic understanding of the system they are hoping to impact upon, relying on assumptions about the root causes of problems experienced by dogs, and the communities amongst which they live. By using monitoring and evaluation, these interventions can test their assumptions about how their activities affect dogs and people using objective data. This will provide them with evidence of what is working and what needs to be changed. It is therefore essential that intervention staff and donors remain flexible and open minded to the evidence produced through monitoring and evaluation, ready to implement changes when needed.

Evaluating the impact of interventions and therefore ensuring our policies and intervention designs are based on the best available evidence is a concern for all organisations looking to make the world a better place. The human development movement has been striving for improvement in evaluating impact for decades. In the Centre for Global Development 2006 report ‘When will we ever learn? Improving lives through impact evaluation’ (Savedoff et al., 2006), Bill Gates is quoted as saying “Success depends on knowing what works” (*pp* iv). It is heartening to see that we are not alone in the struggle to evaluate impact and therefore develop evidence-based understanding about what works and what doesn’t. However, human development-related impact evaluations are numerous, and systematic reviews involving many tens of evaluations can be conducted to rigorously assess the impact of a policy or intervention across a number of different contexts. Furthermore, the human development field is supported by a shared understanding of what indicators are important; for example, there are 60 official indicators for the 10 Millennium Development Goals. However, systematic reviews of a wide body of impact assessments and internationally agreed and standardised indicators, are only an aspiration for the dog population management field at present. By developing a set of recommended and suggested indicators, and ways of measuring these for dog population management, we hope to provide a framework and inspiration for future evaluations that will further our understanding.

## IDENTIFYING DOG POPULATION IMPACTS

Monitoring and evaluation requires an understanding of what impacts the intervention is striving to achieve. If you don’t know where you are going, how will you know when you get there?

In the project cycle described previously, the cycle begins with an intervention concept; the desire to intervene to reduce a threat (such as zoonotic disease) or improve the situation for a group of beneficiaries (such as the welfare of roaming dogs). This desire is turned into an intervention plan with clear impacts and associated indicators, as well as budgeted and timed activities suitable for the dog population dynamics and dog ownership pattern of the location. A critical stage of intervention concept and planning is initial assessment and analysis. This process explores and understands the root causes of the visible problems in the specific location, including the sources of dogs causing or experiencing these problems, in order to inform bespoke intervention planning. This stage is described in detail in the ICAM Coalition Guidance on Humane Dog Population Management (available at www.icam-coalition.org). This includes in-depth consultation with all relevant stakeholders to establish an agreed, comprehensive understanding of the local dog population and a realistic set of impacts for the intervention. Ensuring these impacts are realistic requires a further stage of establishing the logical steps describing how the intervention will achieve the desired impacts with your specific dog population and community in mind. This is also termed a 'theory of change' and is sometimes expressed as a 'logical framework' or 'logic model'[2]. This stage will help test whether your intervention is truly suited to achieving the desired impacts and will explicitly state the intervening objectives that should also be monitored to establish attribution and whether the intervention is going to plan.

The intervention itself may include a range of activities, selected to suit the problems and root causes of the location. The ICAM Coalition Guidance on Humane Dog Population Management describes several of these potential activities; education, legislation, registration and identification, sterilisation and contraception, holding facilities and rehoming centres, euthanasia, vaccination and parasite control and controlling access to resources. In this current guidance we have identified indicators suitable for reflecting change in eight of the most common impacts resulting from interventions that include one or more of these activities. Most interventions will have a subset of these impacts in mind as opposed to all eight; these impacts may be worded slightly differently but we hope similar enough that they can be matched against one of the impacts described here. Selection of indicators will depend both on what indicators appear most relevant for your local dog population and your intervention theory of change, and also on what methods of measurement you can practically perform with the resources available.

We appreciate that this section has described an ideal situation where clear root causes to problems have been established, building a strong foundation for planning an intervention with identifiable impacts and indicators. In many situations, interventions work with a range of assumptions about the impacts they will be able to influence. For example: interventions that include sterilisation of dogs may hope that this reduction in reproduction will improve dog welfare, thoughtfully designed monitoring and evaluation will provide the evidence required to test such assumptions; questions about the source of unowned dogs (is this population self-sustaining or maintained by recruitment from owned dog populations?) can also be explored by monitoring and evaluating how interventions impact on the density and stability of these different populations. Further, some interventions will experience unintended consequences and monitoring and evaluation will need to be conducted with receptiveness to such unplanned effects. In short, although a clear plan for the intervention and how to assess its impacts is ideal, in reality, monitoring and evaluation requires flexibility and an open mind to what we can learn.

[2] Potential sources for further guidance on developing theories of change and/or logical frameworks include the definition, tools and resources available at www.theoryofchange.org, the Open Standards self-paced online tutorials from the Conservation Measures Partnership available at http://cmp-openstandards.org/ and 'Sharpening the development process' book by INTRAC available from http://www.intrac.org/resources.php?action=resource&id=345

# Recommended and Suggested Indicators by Impact

Photo: © World Animal Protection

# Recommended and Suggested Indicators by Impact



This section presents indicators for reflecting change in 8 common impacts targeted by dog population management interventions, for each impact more than one indicator is presented;

1. Improve dog welfare (animal based indicators)
2. Improve care provided to dogs (resource based indicators)
3. Reduce dog density/stabilise turnover
4. Reduce risks to public health
5. Improve public perception
6. Improve rehoming centre performance
7. Reduce negative impact of dogs on wildlife
8. Reduce negative impact of dogs on livestock

Some indicators are relatively well tested and we *recommend* these to measure changes in the stated impact. Others are relatively novel to DPM and appear valuable for measuring change in the stated impact but are not yet well tested; these are *suggested* indicators. We would value any feedback you have on the use of these suggested indicators, with the aim of promoting these to *recommended* if they prove valid (able to truly measure change in the impact they were supposed to be reflecting), reliable (repeated measures would produce the same result) and feasible (this indicator can be measured with methods that are possible to perform in most locations).

Following each recommended or suggested indicator is a description of the methods of measurement that can be used to collect data on these indicators. Refer to the Methods of measurement section for further guidance on how to conduct these methods.

The indicators and methods of measurement included in this guidance document have been selected because they can be meaningful reflections of change in important impacts and are affordable options that can be implemented by most DPM interventions. However we suggest that further support from scientific stakeholders, such as universities, would be beneficial; including for planning data collection, analysis of data, objective interpretation of results and subsequent publication in peer-reviewed journals (preferably open access) to support credibility and dissemination of findings to other DPM interventions.

Note that the indicators included here are those relating to impact (e.g. improvements in dog welfare or reduction in public health risks) and not effort (e.g. the number of dogs vaccinated, sterilised or otherwise intervened). See section ‘What is Monitoring and Evaluation?’ for further explanation of these terms.

# Impact 1: Improve Dog Welfare (Animal Based Indicators)



Dog welfare can be defined as how well a dog is coping with its environment (adapted from Broom, 1991). Failure to cope will result in the dog suffering, but a dog that copes well with the challenges presented by the environment can have acceptable or even good welfare. Dog population management interventions may aim to improve dog welfare either by adapting the environment to make it easier for dogs to cope, for example how people treat or care for dogs, and/or by the intervention improving the coping mechanisms of the dogs themselves, for example vaccination helps dogs to mount an immune response to fight the challenge of specific diseases. Furthermore, a dog's welfare includes not only its physical health but also its emotional well-being (adapted from Dawkins (2006)). Hence assessing dog welfare is best achieved by selecting indicators that reflect both physical health and how the dog feels, as expressed through its behaviour.

This impact of improving dog welfare focuses on 'animal based' indicators, these require measuring the welfare status of the dogs themselves. This is closely related to Impact 2 – 'Improve care provided to dogs', which focuses on 'resource based' indicators, focused on what is provided to dogs to influence their welfare. These impacts are clearly closely linked and we suggest that measuring both is ideal.

## Physical Health Indicators

### Recommended indicator - Body condition score

Body condition can be scored through observation alone without the need for physical examination of the dog and hence is relatively safe and quick to conduct. The scores are awarded on the basis of body fat coverage and not on coat health or injuries. Body condition can range from emaciated to obese (1 – 5); hence it reflects the quality and quantity of food resources and is affected by concurrent underlying conditions such as disease and parasite load. Several studies have shown an increase in body condition score following interventions that included surgical neutering and/or basic veterinary health care (e.g. Sankey et al., 2012; Steinberger, 2012; Totton et al., 2011; Yoak et al., 2014).

There are several scoring systems available. We recommend a 5-point scoring system (1 = Emaciated; 2 = Thin; 3 = Ideal; 4 = Overweight; 5 = Obese, see Annex A) as this is quick to learn and establish good inter-observer reliability (see Section 'Increasing and testing observer reliability'). When using body condition score for monitoring, use only the scores for adults and exclude both puppies and lactating females. Body condition score systems for puppies are different to those of adults, although systems do exist and could be used in addition, as puppies are difficult to observe when surveying and tend to occur in clusters, they provide less reliable data than adults. Females, even if they start in good body condition, may lose condition when lactating. This can be quickly regained when puppies are weaned, so their condition is not a reliable reflection of general population health.

The recommended indicator is the **percentage of adults (excluding lactating females) with a body condition score of 1 (emaciated).** If a very low proportion of the population is already at body condition score 1 it will be difficult to show significant change over time because the level is already very low, hence the indicator can instead be **the percentage**

**of the population at body condition scores 1 and 2 (emaciated and thin).** Note that although only dogs with poor body condition are used as the indicator, all dogs should be scored for body condition, as scoring is more likely to be subconsciously skewed when only focusing on a proportion of the population.

This indicator can be measured through street surveys. With this method of measurement the indicator will reflect the welfare of the roaming dog population. Alternatively body condition score data can be collected from dogs as they pass through an intervention (see section on 'Clinic' records). With this method of measurement the indicator will reflect the welfare of the population accessed by the intervention; this will be owned dogs if the intervention encourages owners to bring their animals to the clinic, representing a select subset of dogs which may have a different body condition to the general dog population.



## Recommended indicator – Skin condition score

Dogs can suffer from skin conditions with a range of causes, including fungal pathogens, parasites and allergies. In the context of using skin condition as an indicator of dog welfare at the population level, a diagnosis of the cause of the skin condition is not required; a skin condition indicates poor welfare both due to the discomfort of the skin condition itself and also potentially reflecting an underlying health problem. Importantly, a visible skin condition, without diagnosis of cause, can be scored through observation alone without the need for physical examination. A visible skin condition includes any sign of hair loss or scaly, inflamed or sore skin but does not include dirty fur, elbow keratosis (thickened skin at the elbows), skin tumours or hernias.

The simplest scoring system is presence or absence of a visible skin condition. This has been used successfully in evaluation of dog population management interventions in several locations (e.g. Garde et al. (2012) in Chile; Sankey et al. (2012) in Sri Lanka; and Totton et al. (2011) in India). **The indicator is the percentage of adults with a visible skin condition. It should be noted that prevalence of skin conditions** may change in across seasons (e.g. fungal infections and allergic responses may have seasonal fluctuations); hence comparisons should be made with data collected at the same time of year.

It is possible to develop an indicator for skin condition that includes some measure of severity. For example no skin condition, mild skin condition affecting <20% of the body and severe skin condition affecting >20% of the body; which is potentially beneficial if a more significant negative welfare impact is assumed for a severe skin condition as compared to a mild condition. However, this requires more training effort with observers to ensure they can reliably score a mild versus a severe case. In addition, a reduction in severe cases will probably occur in parallel to a reduction in all visible skin conditions and hence including this measure of severity may not improve the sensitivity of the indicator to change but it will be more

difficult to establish inter-observer reliability. With this in mind, we recommend using simply presence/absence of a skin condition.

As with body condition score, this indicator of visible skin conditions can be measured both through street surveys, which will reflect the welfare of the roaming dog population or from dogs as they pass through an intervention ('clinic' records), which will reflect the welfare of the population accessed by the intervention.



## Suggested indicator – specific disease and injury, e.g. tethering related injuries and canine transmissible venereal tumours (TVTs)

Dog populations are generally susceptible to the same disease and injury risks, however there may be particular diseases or injuries that are especially prevalent, or even relatively unique, to some locations and these may be targeted by the intervention for reduction. For example, in some locations, tethering dogs is common practice and is associated with particular injuries such as wounds around the neck. In other locations canine transmissible venereal tumours (TVTs) are relatively common. These two examples are described here in more detail, but the principles can be applied to any specific diseases or injuries that the intervention is targeting and therefore would like to monitor.

Tethered dogs that have experienced injuries may be brought to intervention clinics for treatment and hence clinic records may be a suitable method of measuring a change in the prevalence of these injuries (see Section 'Clinic' records for more details). However, dogs brought to the clinic by their owners could represent a particular biased sample, further these biases could change over time. A potentially more unbiased measure of the prevalence of these injuries could be collected during a questionnaire survey. When conducting a questionnaire survey at the household, the owner could be asked to show the interviewer their dogs at which time they could be assessed (either using a clinical exam or just visibly; the method used would need to be kept consistent) for injuries. Each dog could also be photographed to help with later more detailed analysis, although this must be done with the owner's consent. This could provide data on the indicator of **percentage of dogs with tethering related injuries.** This indicator could be further developed with categories of injury type or levels of severity.

Canine transmissible venereal tumours (TVTs) are transmitted between dogs during copulation (mating), licking, biting and sniffing tumour affected areas. The tumour cells are themselves the infectious agents. Although copulation is not the only route of transmission, it is a common route as the tumours are often sited on and within the genitalia. Interventions that include sterilisation of dogs may therefore affect the prevalence of these tumours in the population, not only in the sterilised dog population but also unsterilised dogs that may have a lower risk of contracting TVTs if fewer dogs are engaging in reproductive activity. Interventions may also include treatment or euthanasia of infected dogs and these may also reduce prevalence in the wider population over time as the reservoir of infected dogs decreases. Moreover, reduction in roaming dogs and increases in confinement (without concurrent increases in sterilisation or treatment) also seemed to be linked to reductions in TVT prevalence in the UK, presumably due to reductions in transmission risk as the number of dogs engaging in reproductive behaviour is reduced. TVTs can present a welfare problem, in particular in the case of secondary bacterial infections, myiasis (maggot infestation) or when the tumour becomes large enough to cause an obstruction or impede movement. Despite this theoretical link between TVTs and welfare, the prevalence of TVTs as an indicator of dog population welfare has not been widely reported, hence it is presented here as a *suggested* indicator.

Although TVTs can grow to a size that makes them easily visible, the majority will only be apparent on clinical exam or even during surgical sterilisation. Hence street surveys are not advised as a method of measurement, as the prevalence will be very low. Instead, the presence/absence of TVTs should be recorded as the dogs pass through an intervention that allows for clinical examination or surgical sterilisation (see section 'Clinic' records). The indicator is therefore **the percentage of dogs with a TVT.** This should be reported separately for dogs that were assessed during clinical exam and found to have a TVT and were not subsequently sterilised (e.g. in the case of euthanasia), to those that were observed to have a TVT during surgical sterilisation (which will include those dogs that were identified has having a TVT and subsequently sterilised); the prevalence may be different between these two populations as surgical sterilisation and clinical examination may have a different chance of exposing the presence of a TVT.

## Suggested indicator – Female : male ratios

A change in the ratio of female : male dogs from male skewed to equal ratios over time may function as an animal based indicator for dog welfare; the process behind this is assumed to be a change in how people are treating dogs of different genders. Dogs produce, on average, equal ratios at birth, however we often observe a skew towards more males than females in owned and roaming dog populations, especially in communities where sterilisation or other forms of reproduction control are not widely accessible. This is presumably because females present more of a management concern to owners; unwanted litters and regular oestrus leading to males fighting to gain access to the female are reasons that male dogs may be preferred. In these communities, owners may be preferentially caring for males, adopting/buying male dogs or purposefully killing female puppies leading to a sex skew towards males. Interventions that provide improved access to spaying females may reduce this bias against females and hence a more equal ratio of females:males will become apparent over time. The sex ratio is measured using either/both street surveys of roaming dogs or questionnaire surveys of owners; both these methods are covered in the Sections 'Street surveys' and 'Questionnaires'.

## Suggested indicator – Culling of dogs by authorities

This indicator is regarding the culling of roaming dogs *in situ,* i.e. culling in the streets, with no holding period opportunity for reuniting or rehoming the dog (note that systems including a holding period for reuniting/rehoming before euthanasia of dogs that cannot be rehomed is included in the section on rehoming/adoption centre performance). This assumes that the method used is inhumane and hence carries a welfare cost to the dogs. Some interventions are developed as an alternative to widespread culling and hence **a reduction or cessation of culling roaming dogs** will be seen as important indicators of an improvement in dog welfare. Note that culling of dogs may have been halted to allow the intervention to commence and so more suitable indicators may include **halting any resumption of culling in the intervention area and geographical expansion of replacing culling with the alternative intervention.** Accessing data on culling by authorities will probably require close collaboration with the relevant authority as this data may not be immediately publicly accessible. Use of secondary sources of information is covered in the Section 'Secondary sources of information'.

# Emotional well-being indicators

## Suggested indicator – Dog-dog interactions

The social behaviour of animals can be an indicator of their welfare; it can both reflect their underlying emotional state, for example fear underlying aggression or relaxation allowing expression of play behaviour, and can in itself lead to a welfare problem, for example in the case of injuries caused by fighting. Social behaviour has been used for the assessment of welfare in many other species (for example, social behaviour forms part of the Welfare Quality protocols for pigs, cows and poultry welfare assessment, www.welfarequality.net) and dogs in a shelter or laboratory setting. It is assumed that healthy, stable social groups will show more affiliative and less agonistic interactions. However it has not been used previously for assessing the welfare of roaming dogs and so it is presented here as a suggested indicator.

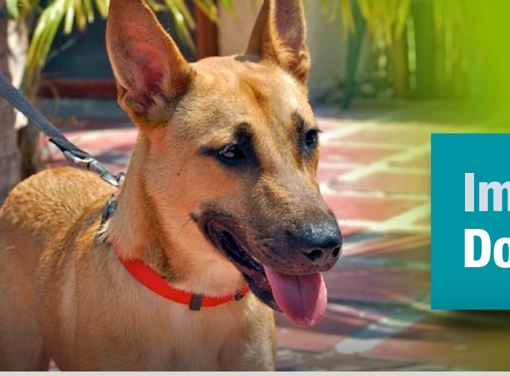
Observation of roaming dogs can be performed using a standard protocol and all social interactions between dogs scored according to their 'outcome': amicable, neutral, mating or aggressive. The behaviour of the dogs at the outset of the interaction may imply a different intent however it is the final outcome of the interaction that is recorded. **The indicators are therefore the percentage of amicable interactions and the percentage of aggressive interactions out of the total of all dog-dog interactions recorded.** Only dogs over four months of age should be scored for social behaviour. The social interactions between puppies, and the behaviour between puppies and adults, are potentially different from those between adults; arguably, interactions involving puppies follow a more hardwired pattern of behaviour that is less affected by concurrent stress than behaviour between adult animals and so may be a less sensitive indicator of the underlying welfare state of the population.

The social behaviour indicators are measured through direct behaviour observation of roaming dogs at a sample of sites selected for their high frequency of interactions between dogs. Section 'Behavioural observation method' details this method in full. It should be noted that this method of observing interactions will be biased towards noisy or more obvious social behaviours and observers are likely to miss more subtle social signals. However, so long as the method of observation remains the same over time this effect will be consistent and hence the indicators will still reflect changes in social behaviour, albeit the more noisy or obvious ones.

## Suggested Indicator – Human-Dog Interactions

The way that people behave towards animals can impact significantly on their welfare (Hemsworth, 2003). People may intend to simply increase the distance between themselves and dogs, for example by shouting or throwing stones, but repeated use of this behaviour can result in dogs becoming fearful of people. As roaming dogs are almost continuously in the presence of people, this high level of fear may result in prolonged stress which in turn will impact negatively on their welfare. Alternatively, repeated acts of kindness between people and dogs, including feeding and petting, may reduce fear, alleviate stress and improve welfare. There has been significant research into measuring the behaviour of stockpersons around farm animals (Hemsworth, 2003) but very little into the behaviour of people towards roaming dogs, hence this indicator is presented here as a *suggested* indicator.

Recording all behaviours of people towards dogs in a busy scene of both roaming dogs and people would be difficult to perform without using videos and later transcription of behaviours during reduced speed playback. Hence for efficiency, we suggest using the method of measurement described in section 'Behavioural observation method' which requires only recording those extremes of human behaviour, both positive (such as feeding a dog) and negative (such as hitting a dog). This allows for real-time recording of behaviour which is more efficient (no need for later transcribing), less obtrusive and so less likely to attract attention or alter peoples' behaviour towards dogs whilst you are observing. The indicators are therefore the percentage of positive human behaviours and **the percentage of negative human behaviours out of total of all 'extremes' of human-dog interactions.**



# Impact 2: Improve Care Provided To Dogs (Resource Based Indicators)



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The care provided to dogs can subsequently affect dog welfare and public health, but improving the way people care for their dogs can be a desired impact in its own right. Establishing indicators for the care of dogs requires a concept of what care is desired. The International Fund for Animal Welfare (IFAW) have developed the term 'adequate guardianship', defined as 'the resources, environmental conditions and social interactions necessary to meet an individual animal's physiological and psychological needs necessary to maintain an acceptable level of health and well-being'. This encompasses provision of the following:

**Resources:**

- Food
- Water
- Basic preventative and curative veterinary care

**Environmental conditions:**

- Safe, appropriate shelter
- Avoidance of injury and cruelty
- Opportunity for exercise

**Social Interactions:**

- Companionship of people and other dogs as suited to the individual dog

Importantly, adequate guardianship also requires a guardian to ensure these conditions persist; hence this impact of improving care provided to dogs is focused on the behaviour of people towards their dogs (note their caring behaviour should be reflected in the condition of their dog; this is included under the impact of improving dog welfare). This guardian needs to at least provide the basics of suitable food/water, shelter, basic veterinary care, prevent intentional cruelty and behave in a way consistent with community health and safety.

The precise behaviours required will depend on the location and what a dog needs to remain in a good state of welfare, taking into account local environmental conditions and diseases. For example in northern Canada, dogs may require shelter from the cold and unfrozen water to be provided daily by guardians, whilst in sub-Saharan Africa access to shelter from the sun, water and regular deworming for *Echinococcus granulosus* might be the priority guardianship behaviours. In particular, ensuring the consistent provision of basic veterinary care may be difficult in those countries where veterinary care is difficult to access, and so the definition of 'basic' will necessarily need to change dependent on location and local disease risks. Note that confinement on private property and under guardian control when on public property (leash or otherwise) is not stated in the aforementioned requirements for adequate guardianship. Roaming on public property may not necessarily lead to welfare problems, may allow the dog to meet some of its welfare needs (e.g. accessing companionship and exercise) and may also be acceptable in some cultures. In other cultures this may not be acceptable and may even be legislated against, in which case confinement will be part of adequate guardianship in that country. There may also be specific human behaviours that an intervention aims to reduce, such as permanent confinement of dogs on tethers or killing female puppies as a form of population management, which could be replaced by alternative management strategies made accessible by the intervention.

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As the breadth of potential indicators is wide, and dependent on the characteristics of the location, only a selection of indicators are mentioned here and innovation to develop the most meaningful indicators for the location is particularly encouraged.

This impact of improving care provided to dogs focuses on 'resource based' indicators; what is provided to dogs to influence their welfare. The assumption is that improved care will lead to improvements in dog welfare. However we suggest it is ideal to also measure changes in the 'animal based' indicators covered by Impact 1 – 'Improve dog welfare'.

## Suggested indicator – Dog care-giving behaviours in adults

Measuring changes in guardianship behaviours will require asking people about their behaviours. This is commonly done by using a questionnaire; see Section 'Questionnaire surveys'. Indicators relating to dog care that can be measured by data collected through a questionnaire include: percentage of dogs that are sterilised; percentage of dogs that were vaccinated in the last 12 months; **percentage of dogs that were dewormed or treated for ectoparasites in a time period suitable for the local conditions; percentage of dogs fed at least once daily; percentage of dogs given water daily;** and **percentage of dogs with permeant access to shelter.**

Note that conducting a questionnaire face-to-face at the household also provides an opportunity to observe and record the condition of any dogs owned by the household. This can provide an additional source of data on dog welfare and also allows for confirmation of care-provision behaviours reported by the respondent (e.g. 'my dog has access to shade' can be checked through observation of the dog). The sample questionnaire includes space to record body condition score and skin condition of any of the household's dogs observable by the interviewer.

A novel indicator was used to reflect a change in investment in dog care on a Lakota reservation in the US. The intervention managers observed an increase in the sales of commercial dog food, despite a decrease in the dog population size across the same period of time (Steinberger, 2012). Measuring changes in **commercial dog food sales** requires contacting dog food sales points and may only be suitable where communities are reliant on a few known sales outlets and where this is relevant to your intervention.

## Suggested indicator – Dog care-giving behaviours in children

Where an intervention includes school programmes to improve children's dog care behaviours, a questionnaire can be used to assess changes in knowledge and attitudes towards dogs; importantly this assumes that a change in knowledge and attitude will lead to behaviour change. This questionnaire can be delivered to a class of children before, immediately after and several months later (ideally also just 2 weeks later) to assess whether knowledge is increased and also retained through the programme. Not all classes need to be monitored intensively in this way; a sample of 2 or more classes per age group or across schools can provide an indication of how successful the education programme is at changing knowledge and attitudes of children towards dogs. Note that in some countries conducting questionnaires of children in schools will be regulated and appropriate approvals will need to be sought.

The questionnaire will need to be designed to suit the aims of the education programme. If expanding knowledge of good dog care is the aim, the children could be presented with multiple-choice questions about relevant care behaviours, hence the indicator is the **% of correct answers to dog care questions.** If a change in attitudes is also the aim, a set of attitude questions can also be asked and the indicator is a change in the **average attitude score.** A review of relevant literature, and a list of validated attitude scales for children, can be found in the report 'Promoting a 'duty of care' towards animals among children and young people' (Muldoon et al., 2009). One example of a validated attitude scale for 4-year old children, relating specifically to dogs, is a 9-item list developed by Lakestani et al. (2011) which can be found in Annex E .

The children are asked to answer the questionnaire individually without talking to one another. The questionnaire should be kept very short, taking no more than 5 minutes to complete. It's important that the children are reassured that this is not a test that matters to them individually and they need not worry about the results.

Such an approach will test changes in knowledge and attitudes following an education programme but does not measure actual behaviour towards dogs. Testing children's behaviour with real dogs would be difficult to achieve whilst ensuring health and safety of both children and dogs, but puppets or vignettes (short stories that set-up a scenario) can be used to ask children how they would respond in certain situations. For example, a story that builds up the scenario of walking home from school and finding a dog on the path that you do not recognise: What would you do? Or for dog-care, you wake up in the morning, get dressed, go downstairs and there is your dog: What does he need this morning? The indicator would be the **% of correct behavioural responses described for a set of dog-related situations.** For young children, this would need to be run with just small groups of children or individuals and the scenarios verbally acted out, however older children could read the vignettes and write their responses and so could be done with entire classes in a test set-up.

## Suggested indicator – Owner engagement with intervention

For interventions that include veterinary clinics or delivery of basic health care through field stations, an indicator of improved care may be reflected by an increase in owner engagement with the intervention. Indicators that could measure this increase in owner engagement include an **increase in the number or proportion of dogs brought to a clinic/field station by their owner/carer** (proportion calculated by comparing the number of dogs brought by an owner or carer compared to the number of dogs caught and brought in by intervention staff, where this approach is used in the intervention). Where relevant, **the amount donated or paid by owners for the intervention services** may be measured over time to reflect changes in financial investment by owners. These indicators are all measured through clinic records, covered in the methods of measurement section.

In some locations, the use of local veterinary services could also be used to reflect changes in dog care, with **the number of dog appointments per unit time at local veterinary surgeries** as the indicator. A change in such an indicator may result from interventions that encourage veterinary care through campaigning and education programmes, although an increase in the use of local veterinary services may also occur when the intervention itself is offering access to sterilisation/vet care. An increase in both intervention services and the use of local veterinary services was found in several counties in the US after an intervention and was hypothesised to be due to social positive reinforcement and widespread marketing/publicity (Frank and Carlisle-Frank, 2007).

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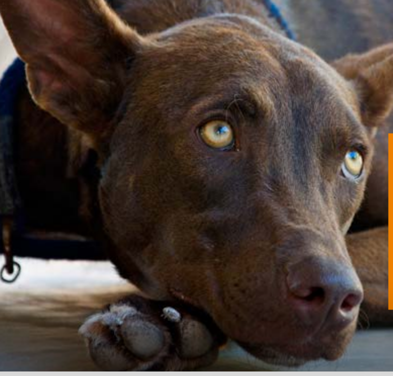

# Impact 3: Reduce Dog Population Density /Stabilise Population Turnover



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Reducing dog population size or density is commonly stated as a desired impact of DPM. This is targeted towards roaming or 'stray' dogs, as opposed to wanting to reduce the overall dog population. Stabilising the population, also termed reducing population turnover, may also be desired (reducing births and deaths, with each dog living longer on average). Reduced turnover could confer welfare benefits (e.g. fewer puppies being born and dying) and it may also be useful for disease control; if vaccinated dogs live longer, and fewer (naturally susceptible) puppies are born, the proportion of the population that is immune to the disease (termed *herd immunity*) will remain higher for longer, providing a better barrier to disease transmission.

## Recommended indicator – Dog density along streets

The indicator of the **number of roaming dogs per km (or mile) of street surveyed** is an indicator of dog density and is preferable to an estimate of total roaming dog population size (also known as abundance) or density estimates based on area. Firstly, it may be an ideal reflection of the public perception of the roaming dog 'problem'; although the average citizen has no concept of the total number of dogs roaming in their town, they have a very real experience of the number of dogs encountered on the way to work or on their children's journey to school. Further, urban areas often both expand and become more dense (losing open spaces to more streets and associated housing) leading to changes in the total dog population that was beyond the influence of any DPM intervention and may be imperceptible to the average citizen. However the average number of roaming dogs along streets will correlate with the chance of an average citizen coming across a roaming dog as they travel along the streets and hence remains a valid indicator of the impact of the intervention. Comparisons can also be made of the average number of roaming dogs per km of street surveyed between locations and perhaps most importantly how this number is changing over time, allowing interventions in different locations to be compared in terms of how they impact on dog density. Finally, measuring the number of dogs per km of street surveyed can be done relatively easily compared to establishing an accurate estimate of total population size.


The Section 'Street surveys' describes a method of observing dogs along a set of standard routes. These surveys can measure the number of dogs seen and their visible welfare state using the indicators introduced elsewhere in these guidelines (i.e. body condition score and skin condition score). Street surveys are then repeated over time (recommended every 6 or 12 months), using exactly the same routes and the same counting protocols, to establish how this indicator of number of dogs is changing. It is important that data from the same time of year is compared, as roaming dog numbers and welfare can vary with season.

Keeping the time of day of observation consistent is also very important, as this indicator is actually the number of dogs per km of street surveyed at *a particular time of day,* and the number will change throughout the day as dogs respond to movements of people, traffic and change in environmental temperatures. The best time of day for street surveys is peak roaming time, usually at dawn when traffic is lightest.

In some cases, an estimate of total roaming dog population size will be needed, perhaps most commonly ahead of planning a new intervention. An estimate of population size is not required for monitoring and evaluation of intervention impact and so is not discussed in any detail here, but see Annex D for more information on conducting population size estimates.



# Reduction in dog population turnover

## Recommended indicator - Lactating females

An important component of dog population turnover is fecundity, i.e. the rate of reproduction. Puppies only have time-limited passive immunity from their mothers for a short period after birth, hence they are more susceptible to disease and its subsequent transmission, making them an important factor in disease control. This limited immunity also contributes to their high morbidity and mortality, so their welfare is also often compromised. However, reliably measuring the number of puppies in a roaming dog population can be challenging. Puppies are difficult to spot due to both their small size and also because they spend some of their time confined to a den; in addition when they are spotted they tend to occur in clusters with their litter mates. These factors combined means the observable percentage of puppies in a population vary considerably from survey to survey. In comparison, the **percentage of lactating females in the roaming dog population** is a more reliable statistic because lactating females are easier to spot and do not appear in clusters. Hence lactating females are an indicator of fecundity in the roaming dog population and a proxy for the number of puppies.

The percentage of lactating females can be measured as dogs come through an intervention clinic by using clinic records, although this may depend on the intervention; some veterinary surgeons may discourage owners and catching teams from bringing lactating females for sterilisation. However the percentage of lactating females in the roaming dog population can also be efficiently measured during the same street surveys used to measure the number of dogs per km of street surveyed and associated welfare indicators. More details are provided in the Section 'Street surveys' under methods of measurement.

The percentage of lactating females should be calculated as the percentage of *all* females that are visibly lactating as this represents the reproductive activity of the roaming dog population. As opposed to the percentage of only unsterilised females that are lactating, which is unlikely to change with the intervention unless there is a significant change in the resources available to the remaining unsterilised females. The percentage of lactating unsterilised females can be monitored in addition if breeding is suspected to be resource limited in the intervention location, although this would require sterilisation status to be clearly visible, e.g. where ear notches have been used by the intervention to mark sterilised dogs.

A female is defined as lactating if her mammary glands are visibly swollen. Teat size may not be a reliable sign of lactating as females that have had previous litters may show enlarged teats. Females in the very late stages of pregnancy may also show enlarged mammary glands just before giving birth; because this is also a sign of active breeding these females can be included in the category of lactation to simplify surveying.

## Suggested indicator – Pregnant females

The **percentage of pregnant females in the intervened population** may be used as a potential indicator of fecundity, an important component of population turnover. However, no examples of its use could be found and hence it is presented here as a *suggested* indicator. It is possible that as the health of the population improves so the proportion of unsterilised females that become pregnant and carry a litter to term will increase, similarly the age at which dogs become pregnant may also decrease as their health status improves. In populations of dogs that show strongly seasonal breeding (e.g. in northern India where dogs show a peak in whelping in November; Reece et al. 2008) an additional peak in seasonal breeding may become apparent as either dogs become recruited to the breeding population earlier than one year old or perhaps start to have second litters within one year.

Assessing pregnancy by sight alone may be unreliable; however pregnancy can be assessed at the time of clinical examination (depending on the stage of pregnancy) or during surgical sterilisation. Hence a review of clinic records will provide data for estimating the percentage of females pregnant per month and how this has changed over time. See Section "Clinic' records'.

## Suggested indicator – Litters per female

The **number of litters per female dog per year** is an indicator of fecundity that can be estimated for the owned dog population by using a questionnaire survey. Not all interventions will be aiming to affect fecundity of the owned dog population, as the puppies produced by owned dogs may well be wanted, however this could be a relevant indicator for locations where unwanted litters of owned dogs are a problem. As described for the indicator of pregnant females, litters per female may change with an improvement in the health status of females, with more litters carried to term and females having litters at a younger age.

Section 'Questionnaire surveys' describes this method of measurement in more detail, including a section on how to calculate this indicator from responses to the sample questionnaire in Annex E.

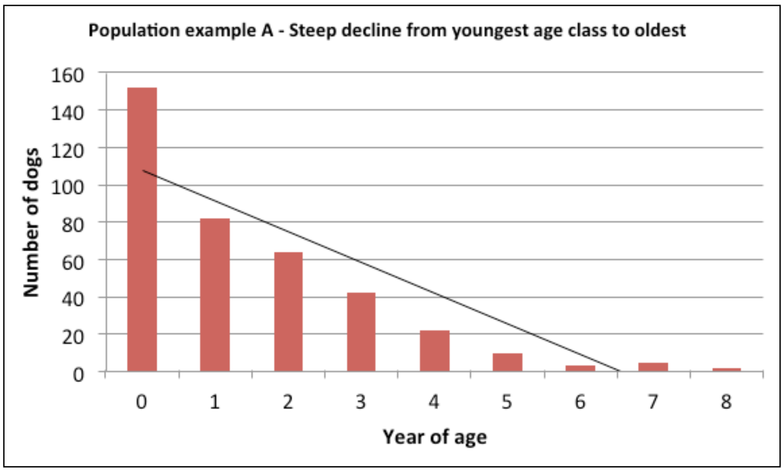
## Suggested indicator – Mortality and age structure

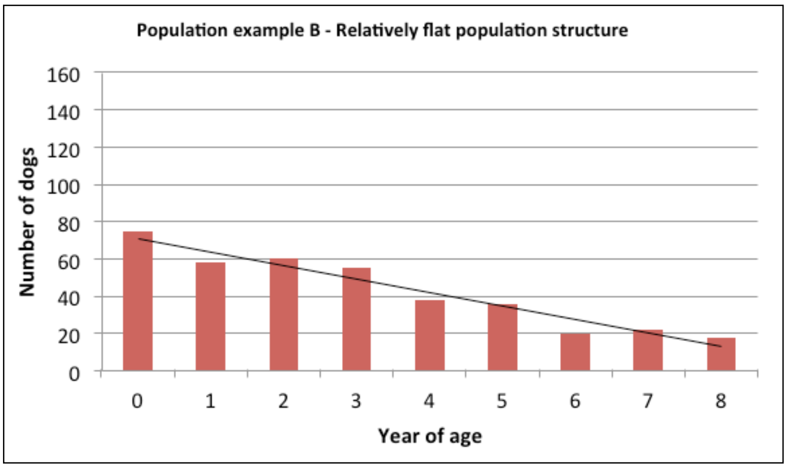
Population turnover also includes the component of mortality. For disease control, increased longevity of vaccinated dogs can help maintain herd immunity, whilst for animal welfare short lifespans are often accompanied by high mortality, morbidity and associated suffering. The indicator of mortality is usually expressed as the opposite statistic, **annual survival**. Examples of using changes in annual survival as an indicator of intervention impact could not be found hence it is described here as a *suggested* indicator only. Measuring mortality/survival is possible using different methods depending on the ownership status of the dogs.

When considering a population of owned dogs, owners can be asked via a questionnaire the ages of their dog (leading to an 'age structure' of the population), how many dogs have left their household in the previous 12 months and what was their fate (e.g. given away, died, disappeared, etc.). Questionnaires and the analysis required for calculating survival are included in Section 'Questionnaire surveys'.

If the target population is comprised mostly of unowned dogs, calculating mortality requires a longitudinal study and marking of dogs with individual marks such as tattoos or microchips, usually applied during a sterilisation intervention. A sample of dogs are re-caught, ideally again as part of the intervention, for example for booster vaccination or deworming, and their individual marks read. These marks are then used to look back into clinic records to the date when each dogs was sterilised. This provides a random sample of minimum times for which dogs survive in the population following the first intervention and marking event, and hence provides information on their survival rate. Using clinical records and re-catch data to calculate survival is described in the Section "Clinic' records'.

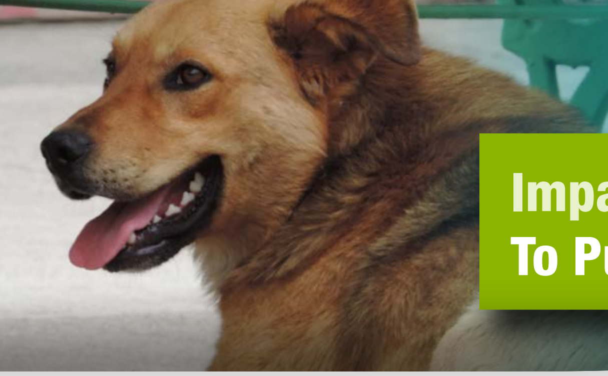
A potential alternative to measuring mortality is to measure **age structure of the population and specifically the proportion of the population that is comprised of older dogs** (these can be defined as 5 years old and above, but can be adjusted to local dog demography). When a dog population has high turnover it will be comprised of a large number of young dogs and relatively few older dogs, as turnover reduces the proportion of older dogs should increase. Data relating to age structure is commonly presented as a histogram of the number of dogs falling into age classes (this may also be called an *age pyramid* when data from males and females are presented back to back). These graphs can show sharp declines from the youngest age class down to the oldest class when turnover is high and a flatter shape with more equality between age classes as the population stabilises. For example, in the following graphs the same population size of dogs are shown with different age structures - example A shows a steep decline from the youngest age class down to the oldest with very few dogs, whilst example B shows a flatter shape with more equality between the age classes:



Kii (1982) suggests that the regression coefficient, a number which represents the slope of the regression line created by age pyramids can be used as an indicator of how a population is changing in age over time. (In humans in the developed world, the histogram can actually start to reverse with relatively large groups in the older classes and relatively few people in the young age classes; sometimes termed an inverted pyramid). With an owned dog population, the number of dogs falling into each age class can be found using a questionnaire, allowing the use of relatively small age classes with ranges of 1 year. Note that there is some evidence that reliability of age reporting reduces as dogs get older (Chris Baker, *pers comm.*) and so the oldest dogs may be best combined into one larger group of 5 year olds and older. However, where street surveys are used, the age classes could be as broad as puppies, adults and old adults, with old adults defined by several physical characteristics including grey muzzle, thickened skin, heavy eyebrows/sunken eyes, hairless patches and stiff gait. This would require discussion and agreement between the survey team as this category is particularly subjective. No examples using age structure, or more specifically the proportion of old dogs in the population, to assess the impact of an intervention could be found, hence this is described at this stage as a *suggested* indicator only.

Where questionnaires have led to detailed age structures with age classes of 1 year increments, the median age of the population can also be calculated. The **median age of dogs** can then be compared over time, or between treatment and control groups, and tested for significance using a Mann-Whitney Test, which looks both for differences in median and spread, essentially for whether one sample tends to have higher values than the other.



# Impact 4: Reduce Risks To Public Health





Public health risks associated with dogs can vary with location, both with regards to the pathogen involved and the severity or likelihood of risk. In this section, we highlight some indicators relating to the most common public health risks that could be targeted by dog population management , namely dog bites, rabies, echinococcosis and leishmaniasis.[3]

## Recommended and suggested indicators – Dog bites

Dog bites, whether associated with subsequent disease or not, can inflict serious injury and can cumulatively represent a high cost to human health services, hence they are commonly stated as a priority concern for citizens and governments alike. Incidence of dog bites can also be high compared to other public health risks associated with dogs. For example, in the US 4.5 million people are reported to be bitten each year equating to 1,500 bites per 100,000 people; with 1 in 5 of these requiring medical attention for the bite (Gilchrist et al., 2008).

To measure the impact of an intervention over time we *recommend* the indicator of **the change in frequency of bites per unit time (often per month or per year).** Reece et al. (2013) used the frequency of dog bites per year to assess the impact of an Animal Birth Control (ABC) intervention, which sterilised and vaccinated a high proportion of the roaming dog population in Jaipur, India. They found a significant decrease in dog bites during the intervention as compared to an increase in bites in the period before the intervention. Although human population was not used as a denominator for dog bites, there was a concurrent human population growth of nearly 5% per year in Jaipur, thereby strengthening this finding. Although dog bites may not be expected to increase at the same rate as the human population it can be assumed that they would at least change in the same direction. Reece et als (2013) findings that bites went in the opposite direction to the change in people was particularly strong evidence of the positive impact of the ABC intervention on dog bites in Jaipur.

Some studies have used the indicator of dog bite incidence to assess the impact of an intervention using human population size as the denominator. However, this requires accurate data relating to the human population size served by the hospital or health centre reporting the bites; this is not always straightforward especially when several years have elapsed since the last human census and is a potential weakness of incidence data. Hence using the **number of dog bites per 100,000 people per unit time (often per month or per year)** is only recommended when there is accurate data available about the human population served by the health service reporting the bites and when it is deemed necessary; for example when trying to compare bites between locations in order to assess impact, such as the comparison between control and treatment sites.

[3] For a fuller discussion of the public health risks relating to dog populations refer to Dogs Zoonoses and Public Health (2013) edited by CNL Macpherson, FX Meslin and AI Wandeler.

Some interventions aim to reduce the risk of a bite from individual dogs (as opposed to impacting on bites through reducing the number of dogs), for example, vaccinating dogs against rabies to reduce the chances a dog will become rabid and bite; sterilising female dogs to reduce maternal aggression (e.g. Reece et al., 2013); education programmes to promote safe interactions with dogs; and appropriate socialisation of young dogs. If a measure of dog density or population size is available for the same unit of time as the bite data over the intervention period this can be used as a denominator i.e. an indicator of the 'bite propensity' of dogs; for example bites per year/dogs per km of street surveyed for roaming dogs, where dog density has also been measured annually for the sub-population of dogs targeted by the intervention. This is a *suggested* indicator that has not been reported in the literature.

Indicators for dog bites depend on the use of secondary sources of data including data from both official government and private health providers and are described in more detail in the Section 'Secondary sources of information'. However, some specific considerations for dog bite data are expanded upon here. Sources of data on dog bites will differ with country, location and rabies status:

- The number of dog bites assessed as suspect rabid and treated with post exposure prophylaxis (PEP), see Section 'Recommended indicator – Suspect rabid dog bites' for more details.
- The number of dog bites treated by local medical centres or Emergency Rooms in hospitals that are not necessarily due to rabid animals; this will be the vast majority of dog bites.
- The number of dog bite injuries requiring surgical reconstruction in hospital. This may include some cases included in the data relating to bites treated with PEP.

Access to both government and private health provider data requires support and cooperation from the medical community. Ease of access may depend on whether dog bites are officially required to be reported, as is often the case when PEP is provided by government for free or subsidised cost, and whether these data are presented publicly. There will also be important considerations relating to the quality of data. For instance, it is important to be able to distinguish the following factors: (1), including whether it is clear that the dog was suspect rabid; (2), whether it was an owned or a roaming unknown dog, and (3) where the person was located when bitten; these qualifiers are relevant when analysing the data and in particular when assessing attribution of any impact to the intervention.

An alternative method of measuring dog bites is through questionnaires, asking people to report their personal or family experience with dog bites. Questionnaires are described in more detail in the Section 'Questionnaire surveys'. One specific consideration when collecting data on dog bites through questionnaires is to use short time spans, such as: 'Have you or anyone in your household been bitten by a dog in the past 12 months?' By using short time spans, as opposed to several years or 'in your life time', you decrease the time required in which a change in dog bites could be revealed. However, an alternative is to ask: "Have you been bitten by a dog in your lifetime? If yes, please state in what year this occurred". By asking in what year the bite occurred the frequency of bites per year across the years would become apparent and the pre-intervention period would provide a temporal control against which the frequency of bites per year in the intervention period could be compared. Asking people to remember the year in which they were bitten may appear to be a challenging task for accurate recall, but people tend to remember very vividly being bitten by a dog, especially if this was a suspect rabid dog. It would be important to clarify whether the person was living in the intervention area when the bite occurred, as they may have moved across their lifetime and hence be reporting bites from other locations. Note that an example of this approach could not be found in the literature and so this can only be *suggested* at this time.

A potential additional indicator for interventions that include bite prevention programmes for children would be a change in the **number of children bitten by dogs**. Both control and intervention classes could be asked to raise their hands if they have ever been bitten, the process could then be repeated every 6 months and the rate of increase in number of children bitten compared between control and intervention classes. Control classes could also receive a lesson on how to treat dog bites (i.e. washing with soap and water and going to the doctor) whilst intervention classes receive the full bite prevention programme. Should the indicators reveal that the programme is effective at reducing dog bites it would be necessary to follow-up all control classes with the full programme also. No published examples of this indicator could be found and so is included here as a *suggested* indicator.

These methods of measuring bites will differ in the resulting bite incidence or frequency. Hence it is essential to be consistent in the method used to collect dog bite data over time and to be mindful of potential changes in reporting such as bites becoming officially reportable or changes to health centre/hospital reporting systems and policies.



## Recommended indicators - Impact on rabies risk

Rabies is perhaps the most feared public health risk from dogs. It is an almost invariably fatal viral disease, with over 99% of all human cases transmitted via dogs (WHO, 2013). Some rabid dogs can show quite terrifying clinical signs and inflict serious injury. Hence in countries where canine rabies is present it is usual for DPM to include activities with the aim of reducing or even eliminating rabies risk from the intervention area. When assessing the impact of an intervention on rabies risk it is ideal to use a number of indicators in combination. These include dog rabies cases, suspect or confirmed rabid dog bites and human rabies cases. Each of these indicators are discussed in this Section with a final Section 'Vaccination coverage', which although not an indicator of impact is an important consideration for assessing attribution of a dog vaccination intervention.

### Recommended indicator – Dog rabies cases

The World Health Organisation (WHO) states that effective rabies surveillance should be based on laboratory confirmed cases (WHO, 2013), however laboratory facilities are by no means ubiquitous and efforts to conduct surveillance of rabies cases based on clinical diagnosis alone are also valuable. The effectiveness of clinical diagnosis is supported by the recognisable signs of rabies exhibited by most dogs (see Annex C) for a process of diagnosing rabies in dogs from clinical signs by Tepsumethanon et al. (2005)). In a study of rabies in the Serengeti, it was found that more than 74% of clinically diagnosed cases (recognised by villagers, livestock field officers, park veterinarians or research personnel) were later confirmed as positive by the gold standard fluorescent antibody laboratory test (Lembo et al., 2008); this 74% is the minimum percentage as some brain samples likely degraded before reliable laboratory testing was possible. In summary, it is ideal **to use the indicator of the number of laboratory-confirmed dog rabies cases per unit time (usually per month),** although **the number of clinically-diagnosed dog rabies cases per**

**unit time** is also a valid indicator of rabies risk and can be particularly useful for increasing case detection when laboratory infrastructure is weak.

If surveillance efforts or methods change part way through the period under assessment (e.g. introduction of laboratory confirmation) the differences this makes to the indicator of dog rabies cases needs to be reconciled. This may be achieved by including a period when both the old and new methods are used simultaneously to allow comparison of number of cases exposed by each method during the same time period.

Note that incidence of dog rabies cases (per unit of dog population size) is not often used, as the denominator of dog population size can be difficult to estimate accurately. However, where the dog population is known to have changed significantly, and the population size can be reliably estimated for the same time unit as used for the number of dog rabies cases, the incidence per unit of dog population size (such as 100,000) may be suitable. One alternative would be to use a measure of dog density as the denominator as opposed to dog population size, for example dogs per km of street surveyed. It may be preferable to use incidence where impact assessment involves comparisons between locations, such as treatment sites compared with controls. An example of this is given by Kitala et al. (2000) who reported incidence of dog rabies cases per 100,000 dogs for sites where active surveillance had been introduced (a method that utilised reports from key informants), compared to the incidence reported from surrounding areas where existing passive surveillance continued. As a result of introducing a more active method of surveillance, 72 times more rabies cases were reported.

Data on dog rabies cases is usually sourced from veterinary or public health authorities; a general discussion of secondary data sources can be found in the Section 'Secondary sources of information'. Indicators of dog rabies cases are particularly sensitive to surveillance effort, as evidence by the study previously described (Kitala et al., 2000). To reliably eliminate rabies from an area, Townsend et al. (2013) estimated that you need to detect at least 5% of dog rabies cases but ideally at least 10%; any less and you may mistakenly reduce control measures too early on the assumption that elimination has been reached when cases may be circulating undetected. Detecting at least 1 in 10 dog rabies cases may seem like a low number but this equates to a relatively efficient surveillance system. In an environment where most dogs roam, even significant surveillance efforts may not detect more than 10% of rabid dogs, because roaming rabid dogs may well die outside the home and be undetected by their owners.

When using any indicator of rabies, but in particular dog cases, intervention managers and impact assessors will need to be aware of the many stages involved between recognising a dog as potentially rabid through to a diagnosis being reported in official records. If any stage of this process changes in its effectiveness, the number of reported dog cases may change irrespective of a change in disease incidence and hence this must be considered when analysing the impact. Improvements to surveillance are likely to occur as a result of changes in methods and processes, such as (1) the introduction of field kits for testing (e.g. lateral flow kits; six currently available kits tested by the WHO Collaborating Centre for Rabies Surveillance & Research in Germany were found to have low sensitivity and not fit for purpose (Thomas Muller pers comm), however there is potential for improvement and reliable kits are likely to be available soon); (2) improved targeting to high-risk animals only (i.e. that are biting, behaving strangely, moribund or found dead) as opposed to random sampling of dogs; (3) greater communication and collaboration between human health and veterinary services; and (4) recruitment of field based key informants (e.g. as described by Kitala et al. (2000) in Kenya). Townsend et al. (2013) provide a fuller discussion of ways to improve effective surveillance when aiming for rabies elimination. To account for this highly influential confounding variable of surveillance effort and to maximise the chances of effective rabies control, it is ideal to establish a surveillance system that is as effective and consistent as possible at the outset of any intervention. Where this has not been possible, changes in surveillance effort during the period of data collection will need to be considered during analysis and interpretation.

## Recommended indicator – Suspect rabid dog bites

Indicators relating to dog bites are also discussed in the previous Section 'Recommended and suggested indicator – dog bites', however the key points most pertinent to the indicator of suspect rabid dog bites of people (not of other animals) are summarised here.

The indicator of **number of suspect rabid dog bites per unit time (usually per month or per year)** can be used directly or converted into an incidence per 100,000 people per unit time. Establishing incidence, however, requires an accurate estimate of human population within the catchment area of the hospital or health centre reporting the bites and this may prove challenging if the period since the last human census has been long and/or if the rate of human population growth is unknown. Hence using frequency of suspect rabid dog bites is recommended. Note incidence may be necessary when comparing locations, for example when comparing intervention (treatment) sites with non-intervention (control) sites (e.g. comparison of vaccination villages with control villages in Tanzania reported by Cleaveland et al. (2003)), or when sites have undergone a period of large and measurable human population growth, as may have occurred over a period of 10 years or more.

A general discussion of secondary sources for dog bite data can be found in the Section 'Secondary sources of information'. Specific considerations include being able to separate suspect rabid bites from non-suspect, as vaccination alone cannot be assumed to impact on non-rabid bites. When looking to separate suspect rabid and non-suspect rabid bites, it is important to consider the availability of post-exposure vaccines during the period, as during vaccine shortages some bites may have been incorrectly recorded as non-PEP due to lack of vaccine as opposed to the lack of suspect signs in the biting dog. This will be particularly relevant where the number of dog bites is not recorded but instead the number of PEP doses or courses delivered, i.e. where PEP use is a proxy for dog bites. This may be the case in most situations and is particularly susceptible to changes in PEP availability.

Where the number of bites from suspect rabid dogs is recorded, as opposed to only PEP delivery, the definition of a suspect case will need to be known in advance, and any changes to that definition recorded. Defining a case as suspect may include the following: (1) Was the bite provoked or unprovoked? (2) Is the dog known and is the vaccination history known? (3) Is the dog still alive, or has it died or disappeared? (4) Where there any particular behavioural signs shown by the dog (as listed in Tepsumethanon et al. (2005))? However, the circumstances of the bite may not be sufficiently clear to define a bite as non-suspect and hence PEP will be used as a precaution.

In addition, the location of the person when bitten (not just the location of the hospital or health centre where treated) will be needed so that suspect bites can be assigned to within or outside the intervention area. Access to dog bite data and ensuring adequate quality for reliable interpretation, will require support from the medical community. One novel approach used by Tenzin et al. (2012) in Bhutan was **the number of doses of human vaccine imported per year** as a proxy for the number of dog bites, which was not available, on the assumption that vaccine was not stockpiled. This indicator only works where all the sources of PEP are known and measured. In many countries multiple sources of PEP may exist and may be difficult to track.

## Recommended indicator – Human rabies cases

A reduction in human deaths from rabies is the most important indicator for measuring impact on human health. However, in countries where PEP provision is widespread and rabies prevention is well practiced by the public the number of deaths will be thankfully low and so the number of human deaths, although still important, will not be as sensitive for measuring change compared to dog rabies cases or suspect bites which will be more numerous. Hence the indicator of **the number of human rabies cases (equates to number of deaths, as rabies is almost invariably fatal) per unit time (usually per year)** will be most useful in those countries where PEP provision is not complete and human deaths unfortunately occur relatively frequently.

The number of human rabies cases is likely to be low even where PEP provision is not complete and hence is most meaningful over large geographical areas such as countries or regions as opposed to smaller geographical areas such as individual cities or districts. When human cases are very infrequent (<10) **the presence or absence of human rabies cases per time period** may be a more useful indicator.

Data on human cases can also be converted into an incidence per 100,000 people. Again this will rely on access to good human population estimates and may be most suitable when comparing locations (such as comparing different hospital catchment areas in Bhutan by Tenzin et al. (2011)) or when comparing across periods of time where significant changes in the human population are known. Where a single location is being evaluated and the time period is relatively short, the frequency of human rabies cases per unit time may be a sufficient indicator that is not subject to error in human population estimates (e.g. as used in Lima, Peru for the evaluation of a dog vaccination campaign where the number of human cases reduced to zero following the campaign; Chomel et al. (1988)).

The method of measurement for the indicator of human rabies cases uses secondary sources of data from health authorities, see Section 'Secondary sources of information'. As with dog rabies cases, the number of human cases will be affected by a number of factors other than disease incidence. For example, surveillance effort may change over time, and changes from clinical diagnosis to laboratory testing will impact on the number of cases reported. Rabies in people is also known to be severely underreported (e.g. 100 fold underreporting in Tanzania; Cleaveland et al. (2002)). This may be because people do not seek hospital treatment when dying of rabies, hence their death is not reflected in hospital records nor reported to central authorities. In addition, human rabies deaths may have been mistakenly attributed to a different cause (e.g. 11% of rabies cases were mistakenly diagnosed as cerebral malaria in Malawi; Mallewa et al. (2007)). Moreover, many of these reasons for underreporting can be affected by changes in surveillance effort, hence close collaboration with the health authorities will be necessary to monitor and incorporate any changes in surveillance into interpretation of indicator changes. In addition, improvements to surveillance systems and diagnostics would be best implemented at the outset of the intervention or in advance to establish a more accurate baseline.

Perhaps most importantly for DPM interventions is that the number of human cases will be significantly affected by provision of PEP; both related to its availability through the health system and also people's behaviour in searching out appropriate treatment. Any change in PEP provisioning may make the number of human cases unreliable as an indicator of the impact of a DPM intervention. Again this requires close collaboration with the health authorities to ensure changes in PEP provision can be considered.

We strongly recommend the use of combined sources such as dog rabies cases, dog bites and human cases to reveal changes in disease incidence.

## Recommended – Vaccination coverage

The indicator of **the percentage of the dog population vaccinated against rabies** is not an indicator of intervention impact (such as human or dog rabies cases) but instead an indicator of intervention effectiveness, resulting from a combination of intervention effort and response to the intervention from the authorities and public. However for assessing the impact of reducing rabies risk, vaccination coverage is essential for judging the attribution of the intervention to any changes. Rabies incidence can change over time in the absence of an intervention and a core indicator of intervention effectiveness such as vaccination coverage will allow for more thorough analysis, including testing for correlations between effectiveness and impact. This is the only indicator of intervention effectiveness discussed in detail in this guidance because measurement of this indicator requires some preparation.

The most appropriate method for assessing vaccination coverage will depend on whether dogs are usually confined or roam freely. If most of the dog population is roaming freely (either unowned dogs or owned roaming), resource-light street surveys can be used to assess the proportion of vaccinated (and marked) dogs. However if the majority of the dog population is confined it will be necessary to use house-to-house questionnaires. The vaccination campaign provides an opportunity to collect information on the proportion of confined versus roaming dogs; owners can be asked whether their dog is normally confined at the vaccination point (or doorstep if using a door-to-door vaccination approach), whilst dogs caught for vaccination are presumably at least sometimes roaming. Both street surveys and questionnaires are described in more detail in the Sections ‘Street surveys’ and ‘Questionnaires’, respectively.

Measuring vaccination coverage by either street surveys or questionnaires does require investment of resources. Where resources are limited and the methodology described in the ‘Methods of measurement’ section is not feasible, it is advisable to record only whether a vaccination campaign was conducted or not in *every* location within the intervention area, and then measure vaccination coverage in just a sample of locations. This is because leaving some villages or wards completely unvaccinated within the intervention zone can have a very serious impact on rabies control, as dogs in these remaining unvaccinated areas can act as reservoir for the virus and seed or prolong outbreaks (Townsend et al. 2013).

Seroprevalence/blood testing for rabies antibodies in dogs following a vaccination campaign is not considered suitable for monitoring vaccination coverage or levels of immunity. The circulating antibody response to rabies vaccination is relatively short and highly variable between individuals. Immunity to rabies involves mechanisms in addition to circulating antibodies and a titre below the perceived ‘protective’ level does not necessarily mean the dog is not immune. For these reasons, and perhaps also with the costs of antibody testing in mind, WHO advise “measurement of rabies-specific antibodies is not recommended for routine rabies surveillance” (WHO 2013; pp 93).

## Recommended indicators – Impact on echinococcosis risk

Human cystic echinococcosis is a disease caused by the tapeworm *Echinococcus granulosus* that leads to hydatid cysts developing in the liver and lungs. Whilst the disease can be treated, often necessitating surgery, it can also be fatal. There are an estimated 1.2 million human cases worldwide with 200,000 new cases diagnosed annually (WHO, 2010). Dogs are the primary final hosts in the cycle of *E. granulosus* and the sheep strain of *E. granulosus* accounts for the majority of human cystic echinococcosis cases (Eckert and Deplazes 2004). Sheep are the primary intermediate host of the sheep strain of *E. granulosus,* however other livestock species can function as intermediate hosts: specifically goats, pigs and macropods (cattle can also act as intermediate hosts but often do not produce fertile hydatid cysts and hence are less relevant to the *E. granulosus* life cycle). The route of infection for people is through contact with infected dog faeces through which they become accidental intermediate hosts and the life-cycle stops. Livestock are infected through ingesting eggs from pasture contaminated by infected dog faeces and dogs are infected through eating the cysts in the offal (usually liver and lungs) of infected livestock.

Control of echinococcosis is through regular deworming of dogs with praziquantal and preventing their access to infected offal through inspection and proper disposal of infected offal from slaughter houses and during home slaughter. This requires consistent education and cooperation of dog owners, livestock herders and slaughter staff.

*Echinococcus multilocularis* is another species of tapeworm that causes alveolar echinococcosis in humans, a rarer but much more serious condition. The life cycle of *E. multilocularis* is perpetuated by wildlife reservoirs (e.g. red fox, coyote, artic fox), hence dog interventions will not eliminate the worm but they will reduce human cases as the dog is a transmission vector of the worm to people. As control and surveillance of *E. multilocularis* is usually focused on wildlife, and not dogs, the rest of this section will focus on *E. granulosus*.

Surveillance for echinococcosis prevalence needs to be conducted over a prolonged period of time because the disease is asymptomatic in dogs and livestock and so clinical signs in live animals cannot be used as an indicator. It can also be asymptomatic for many years in people before clinical signs emerge. The prevalence of cysts in livestock at the time of slaughter is a very accessible measure of echinococcosis prevalence (see next section) but may take 5 years for changes in prevalence to become apparent and at least 10 years in people; as those animals and people with cysts today may have been exposed many years previously and so changes to current transmission risk will not be visible until several years later. As there are a limited number of significant hosts involved in the life cycle of the sheep strain of *E. granulosus,* and subsequent cystic echinococcosis in humans, just using the change in the prevalence of infected livestock will be sufficient as an indicator of echinococcosis control. However two further indicators are described here, human surgical cases and infection in dogs which would provide a fuller data set for impact assessment.

## Recommended indicator – Infected livestock offal

The key indicator for changes in echinococcosis will be **the number of livestock with liver or lungs infected with *E. granulosus* cysts at the time of slaughter per unit time (usually per month or year) and per age group of livestock,** this is presented as a percentage of livestock slaughtered in that same time period, i.e. as a prevalence. In most locations, sheep will be the most appropriate livestock species to monitor for sheep strain *E. granulosus* cysts, and in the rest of this section sheep are used as the example livestock species. However in some locations, where sheep are a minority, the prevalence in other livestock will be more relevant, such as goats or pigs or macropods.

The age of the sheep at slaughter is important as prevalence and infectiveness of cysts increases with age. The size of cysts also increase with the age of sheep, so although the prevalence of cysts in lambs may reflect the impact of the intervention over a prior short period (i.e. the life of the lamb) these cysts will be less than 3mm in size and are difficult to detect during visual inspection of the carcass (Lloyd et al. (1998) is an example of using sentinel lambs for surveillance but these required inspection by experienced parasitologists). Cysts in sheep at least 2 years of age will be easier to identify during inspection and hence the prevalence will be more reliable as the age of the sheep increases. Note this prevalence will represent disease control over the 2 previous years, hence the need to conduct impact assessment over several years as it will take a minimum of 2 years from launching a deworming intervention with dogs to see a reduction in cysts in these older sheep.

Accessing data relating to the indicator of prevalence of infected sheep will require collaboration with the veterinary services and use of secondary/official sources of data (discussed further in the Section 'Secondary sources of information'). Meat and offal inspection at the time of slaughter is common practice and legislated for in most countries, however recording of the type of infection is not always done (sometimes only a weight of infected offal is recorded) and hence working collaboratively with veterinary authorities and slaughterhouse inspectors may be needed to ensure that infection of liver and lungs with *E. granulosus* is recorded separately for each sheep along with its geographical origin (to establish whether the sheep came from the intervention area or outside) and age. In cases where *E. granulosus* control is relatively new, it may be necessary to provide training to slaughterhouse staff in identification of *E. granulosus* cysts using the services of a parasitologist. One challenge to this indicator will be where home slaughter is the predominant method of slaughter. In this case, a sample of sheep could be inspected during home slaughter, perhaps focusing on times of year or religious festivals where a high number of animals will be slaughtered, but this would clearly require significantly more resources than inspection at a slaughterhouse.

## Recommended indicator – Human cystic echinococcosis

Changes in the prevalence of cystic echinococcosis in people may be considered the most relevant indicator for those interested in public health. Cystic echinococcosis in people can be diagnosed using a range of techniques, including ultrasound and serology, however the most straightforward indicator for surveillance will be **the number of cases of surgical intervention for the treatment of human cystic echinococcosis per unit time and per age group.** This can be used as simply the frequency of cases or as prevalence per 100,000 people; as the time span for impact assessment will need to be long (at least 10 years). Prevalence may be most sensible to incorporate changes in human population size, and will be most relevant where comparisons between locations are made (e.g. comparing treatment and control areas). Age group is important because cases can be expected to disappear from younger people first, while older people may have picked up *E. granulosus* decades previously and not shown clinical signs until much older.

Data relating to the number of surgical cases will need to be accessed from health authorities; for example, Acosta-Jamett et al. (2010) accessed the number of surgical cases from 3 provinces in Chile from the Regional Health Service case reports. However, it is likely that underreporting does occur in many locations and hence it may be ideal to work collaboratively with hospital departments conducting liver surgery to access data on the number of surgical cases. One benefit of the fact that *E. granulosus* cysts can lie dormant for so long is that at the outset of an intervention the prevalence of disease in older people can provide a reflection of disease risk for the previous several years. The disease in younger people also often progresses much faster and so prevalence in children may be a more sensitive indicator for the impact of an intervention in the early years.

## Suggested indicator – Infection in dogs

The presence of an *E. granulosus* infection in dogs was historically identified by 'purging' (dosing) dogs with arecoline hydrobromide, resulting in diarrhoea and expulsion of the worm burden. This method is considered risky due to expulsion of live worms (with a potential to reinfect), and the deleterious and even fatal effects on dogs, particularly a risk for young and pregnant dogs. Currently, there are more effective and safe deworming treatments (e.g. praziquantal) that kill the infective worms before expulsion, and have little or no side effects to the dogs themselves.

Alternative methods of detecting *E. granulosus* infection include microscopic egg and proglottid detection in faecal samples, serum antibody testing, polymerase chain reaction (PCR) tests for parasite DNA in faecal samples and ELISA (enzyme-linked immunosorbent assay) tests for *E. granulosus* antigens in faecal samples. However, each of these tests face different challenges: microscopic egg detection does not allow for definitive diagnosis due to the similarity with other *Taenia* species eggs; diagnosis using proglottids requires these to be found in good condition in the faecal sample; serum antibody testing has low sensitivity and antibodies persist after infection has been cleared; and PCR tests have high cost and relatively low sensitivity. The relatively recent development of ELISA tests for the presence of *E. granulosus* antigens shows the most promise in terms of sensitivity and specificity, low cost and ease of handling samples (faecal samples can be collected from the ground, samples are best fresh but can be tested after up to 4 days on the ground). However this test currently requires production of antibodies from rabbits kept in animal facilities, hopefully this production will be moved to in vitro production in future.

Taking note of the challenges presented by tests for *E. granulosus* infection in dogs, we recommend instead focusing on the two indicators of *E. granulosus* cysts in livestock and echinococcus in humans for assessing intervention impact on this disease. Thankfully, the unique role of dogs in maintaining the sheep strain *E. granulosus* life cycle means that even without monitoring a change in infection rates in dogs, a reduction in infection of livestock and people following a dog intervention can be confidently attributed to that intervention.

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## Recommended indicators – Impact on leishmaniasis risk

Leishmaniasis is a disease of both dogs and humans caused by infection with protozoan parasites of the *Leishmania* genus. Transmission between people or/and between animals and people, is via the bite of an infected female Phlebotomine sandfly. There are two major categories of leishmaniasis in humans, the less severe cutaneous leishmaniasis (associated with skin lesions) with 1,000,000 new human cases per year and the potentially fatal visceral leishmaniasis (associated with anaemia, liver and spleen damage in people and kidney damage in dogs) with 300,000 new human cases and 20,000-40,000 deaths per year worldwide (Accessed at www.who.int/leishmaniasis/en/); although it should be noted that the majority of deaths are caused by *Leishmania donovani* for which the principle reservoir is humans and not dogs. Control measures include reducing bites from sandflies using bed nets and insect repellent for people, insecticide impregnated collars or 'pour-ons' for dogs, and killing sandflies through peridomestic spraying; or by reducing the infected dog reservoir through culling (the success of this last measure is particularly widely debated, e.g. Nunes et al. (2010)). There are also several vaccine candidates under evaluation and recently vaccines for dogs have become commercially available in Brazil and Europe.

Measuring the impact of interventions to control leishmaniasis would benefit from long-term monitoring as, in theory, interventions would build in their effectiveness over time as the prevalence of infected individuals and therefore transmission decreases. For example, if insecticide (deltamethrin) -impregnated dog collars are used in an intervention, initially some dogs will already be infected and although the collars will reduce transmission from these dogs they will remain infected. As the intervention continues, infected dogs will die due to the disease and other causes and be replaced with young dogs that, if protected from sandfly bites from near birth, would contribute to a continued reduction in the prevalence of infected dogs which could lead to decreasing transmission to people. However, examples of this long-term monitoring and increasing effectiveness are not currently available in the literature, and hence this hypothesis remains to be tested.

The extent of the intervention area and the size of the area used for monitoring the impact of the intervention will need to be carefully considered. Sandflies are mobile vectors and so the incidence of leishmaniasis on the borders of the intervention area may not be the best reflection of intervention impact. A buffer zone can be used to minimise this; sandflies have relatively limited average daily flight ranges (e.g. an average of <60m and maximum of 128m found by Casanova et al. (2005)) and so just a few 100m should be sufficient. However, they have been known to fly several 100m and hence even where buffer zones have been used, edge effects should be considered at analysis and interpretation, i.e. is there a difference in intervention impact at the edge of the impact area as compared to the centre?

## Recommended indicator – Human disease and infection

Arguably the most important public health indicator for the impact of a leishmaniasis intervention would be the **incidence or number of newly diagnosed human cases of leishmaniasis disease per unit time.** Because leishmaniasis is a difficult infection to clear, the incidence of new cases is used as opposed to the prevalence (prevalence is the proportion of people currently with the disease). A case of human leishmaniasis requires a range of tests for definitive diagnosis as the clinical symptoms are similar to other diseases, for example a clinical suspicion may be followed by testing for antibodies, searching for visible parasites in tissue smears and testing samples by polymerase chain reaction (PCR) to detect parasite DNA, and to establish the species of Leishmania parasite. Data for this indicator would clearly require accessing human health providers, potentially from specialist hospitals or units where leishmaniasis is being diagnosed and treated.

Because the conversion rate from Leishmania infection to clinical disease is relative low (often less than 1 in 20 infected people show clinical disease; Orin Courtney *pers comm*), the challenge in assessing the impact of a Leishmaniasis control intervention is that the intervention has to be very large to detect a significant clinical effect. Thus intervention studies to detect protection against the disease are relatively rare. The alternative indicator is **the incidence or number of new cases of people *infected* with Leishmaniasis per unit time.** This would include those people without clinical disease but with a parasite infection, i.e. they are asymptomatic. Dipstick tests for leishmaniasis serology are very easy to use in the field (e.g. the rK39 antigen-based immune-chromatographic test) however they are most suited to exposing disease and tend to be less sensitive to detecting asymptomatic infection where parasite loads are typically low. Note the WHO provide a comparison of 5 dipstick tests for serological samples in different regions to aid selection of the appropriate test dependent on location (the results can be found in WHO (2011) 'Diagnostic Evaluation Series No. 4 Visceral leishmaniasis rapid diagnostic test performance' at www.who.int/tdr/publications/documents/vl-rdt-evaluation.pdf). For testing for infection or past exposure, an ELISA or direct agglutination test (DAT) that also looks for the presence of antibodies in blood samples may be more sensitive. Another potential test is the leishmanin skin test which exposes the presence of a cellular immune response to *Leishmania* infection; a very small amount of antigen is injected intradermally into the skin on the forearm and the diameter of induration is measured 48-72 hours later. A positive response implies that the person has previously encountered leishmania (note that clinically sick or immune compromised people may not show a positive response even if infected). People who were previously negative for this test can be retested after a period of intervention to see if they are now positive and have therefore encountered the parasite since the first test or whether they have still avoided infection. However, it takes many months for the test to show as positive following a new infection, hence it is most suitable for interventions that are relatively long term, i.e. several years as opposed to several months.

As infection is usually not evenly distributed in a population, sampling all people in the intervention area is ideal. If the intervention area is too large those people living closest to recently diagnosed cases can be sampled, or those at greatest risk of new infection such as children. Sampling all children in the intervention area was the approach used in Iran by Mazloumi Gavgani et al. (2002) when assessing the impact of insecticide-impregnated dog collars in a matched-clustered randomised controlled trial. The results showed a reduced risk of leishmaniasis infection in children in the villages using insecticide collars as compared with control villages where no collars were used. The tests used to establish whether there had been new cases of infection in children were the DAT and the leishmanin skin test.

When testing people for *Leishmania* infection there must be a clear protocol agreed at the outset with the local health services for what to do in the case of a positive result. The standard treatments for leishmaniasis are complicated to administer, expensive and can have serious side effects, and since most infections do not lead to clinical disease, treatment is not applied to all infections but is instead based on the individual case.

## Recommended indicator – Dog disease and infection

The **number of dogs newly diagnosed with clinical leishmaniasis per unit time** can be used as an indicator of impact. As with human infection, curing an infection is difficult and hence it is the incidence of new cases that is used as opposed to the prevalence of all current cases. However, less than half of infected dogs show clinical signs of disease and asymptomatic dogs have been found to be a transmission risk. Hence **the number of dogs newly infected with *Leishmania* per unit time** will be a more sensitive indicator of intervention impact; measuring this incidence rate requires tracking individual dogs over time and identifying the number of dogs that previously tested negative that now test positive; this could be practically done with owned dogs, even if they are usually free roaming, but following the same unowned dogs over time may be challenging without the engagement of local people who feed/care for them. Testing for infection in a large population of dogs, as with people, can be done by testing for antibodies in blood samples (e.g. by using the rK39 antigen-based immune-chromatographic test described previously for people, although this is less sensitive in dogs, hence alternatively an ELISA or direct agglutination test (DAT)). However serology tests for antibodies are not as sensitive nor as specific as detecting parasite DNA in blood or tissue samples using polymerase chain reaction (PCR) and hence most current scientific studies use PCR when testing for infection. PCR will identify dogs that are asymptomatic; this is a test for the parasite itself as opposed to the dog's immune response to the parasite. Infected but asymptomatic dogs can be missed when testing for antibodies in blood samples, which are best suited for exposing the prevalence of disease. The choice of test, including potential combinations such as initial antibody screening followed by PCR in seronegative dogs, will depend on availability of resources (note PCR tests are more expensive than antibody tests) but the differing sensitivities must be taken into account when interpreting the data. PCR tests are required when evaluating the impact of leishmaniasis vaccine interventions; vaccines will also lead to antibody production and so separating vaccinated dogs from infected dogs using only tests for antibodies cannot be reliably achieved.

As with testing for leishmaniasis in people, there needs to be an agreed protocol in place for with the local veterinary services for responding to positive results in dogs.


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# Impact 5: Improve Public Perception



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Public perceptions of dogs will vary both between locations and between people living in the same location. There are a few indicators that will be widely applicable, however it is likely that perceptions will need to be explored in each location and key perceptions selected as locally relevant indicators.

## Recommended indicator – Adoption of dogs

The **proportion of dogs that are acquired through adoption as opposed to other sources** may be used as an indicator of increased empathy towards/positive perceptions of street and shelter dogs. This indicator will be affected by supply, so changes in availability of street or shelter dogs and ease of purchasing dogs will also need to be measured and considered during interpretation. As well as changes in attitudes towards shelters which could also have a significant impact on adoption rates. This indicator can be measured through a questionnaire (see Section 'Questionnaires') that includes a question about the source of owned dogs and/or by monitoring changes in shelter adoption rates over time. An increase in adoption was detected over 20 months by using a questionnaire on the island of Koh Tao, Thailand where an affordable veterinary clinic based intervention was run by a local NGO, a concurrent reduction in mortality was also observed leading to a general increase in the size of the owned dog population (Lee 2013, unpublished data).

## Recommended indicator – Attitudes towards dogs

Two methods of measuring attitudes are proposed in the 'Methods of measurement' section; (1) questionnaires asking respondents for their levels of agreement with a range of attitude statements and (2) participatory exercises where groups are asked to rank dog nuisances against other public nuisances.

Attitude statements in questionnaires can be used to develop three main classes of indicators: change in **level of agreement with key attitude statements,** selected because they are particularly relevant to the local situation and intervention to be evaluated such as "street dogs pose a danger to people"; change in **summative attitude scores** that combine levels of agreement with a range of attitude statements into a single score for 'acceptance' of dogs; and changes in **'factors' that underlie attitudes,** such as the factor 'dislike of stray dogs' comprised of 4 attitude statements (example from Miura et al. 2000), exposed through the statistical method of factor analysis. The processes leading to these different indicators are discussed in more detail in the Section 'Questionnaire surveys'. A summative score for acceptance of dogs was seen to change markedly over time following a comprehensive dog intervention (involving several activities, including sterilisation, vaccination, education of adults and in schools) in Colombo, Sri Lanka (Sankey et al., 2012), hence this is included as a *recommended* indicator.

Participatory exercises allow groups of local people to discuss, distil and express their opinions on certain subjects. These should provide a richer picture of local people's perceptions, and reasons for these perceptions, than those gathered using questionnaires. They can also be faster to implement, although they can suffer from lack of representation of the wider population, dependent on how well groups are selected and facilitated through the exercises. Three exercises are described in the Section 'Participatory research methods', with the final two exercises providing a **ranking of dog related nuisances against other neighbourhood nuisances** (which can be repeated over time to expose changes in how dog related nuisances compare to other problems) and *an assessment of whether dog problems and dog benefits have increased, decreased or stayed the same over time.* Participatory approaches are widely used in human development and could be very beneficial to implementing the intervention as well as for evaluation. For example, by improving an intervention manager's understanding of why people hold certain perceptions and what they would perceive as success and also by providing local people an opportunity to explore dog issues and expose potential solutions in which they could play a role. However, they are a relatively new concept to DPM and so the related indicators should be considered as *suggested* at this stage.

## Suggested indicator – Dog-related complaints

The **number of complaints relating to dogs reported to local government authorities** may also be an indicator of how public perception is changing over time. There may also be a change in the 'nature' of these complaints; some focusing on nuisances caused by dogs and others expressing concern over dog welfare, including reporting of cruelty towards dog (which may be reported to a different department to other complaints or to local NGOs). Hence ideally complaints are split into different categories allowing these changes to be explored more fully, although the total number of dog related complaints can be used if such categorisation is not possible. Although there are anecdotal reports of reductions in complaints following interventions, no systematic use of this indicator was found, hence it is presented as a *suggested* indicator. Measuring such an indicator requires collaboration with local authorities and is covered in the Section 'Secondary sources of information'.

## Suggested indicator – Human-dog interactions

Improvements in public perception may also be reflected in the way people interact with roaming dogs in public places. This indicator is also covered in the Section 'Suggested indicator – Human-dog interactions' under the impact of improving dog welfare, as the behaviour of people towards dogs can impact on the level of fear, prolonged stress and therefore welfare experienced by roaming dogs. However, this indicator could also reflect changes in the perception of people towards roaming dogs as it measures both their positive and negative behaviours towards dogs. The Section 'Behavioural observation method' describes a method for collecting data relating to 3 potential indicators: **percentage of positive human behaviours out of total of all 'extremes' of human-dog interactions; percentage of relaxed dog responses out of total of all 'extremes' of human-dog interactions; percentage of negative human behaviours out of total of all 'extremes' of human-dog interactions.** These indicators have not been reported previously in the literature and so are included here as *suggested* indicators.

## Suggested indicator – Cruelty towards dogs

The prevalence of cruelty towards dogs, whether in the form of neglect or deliberate abuse, can be a measure of public perception of dogs, including their sentience and value. The response to such cruelty, in the form of public outcry and prosecutions, reflects a further dimension of public tolerance towards such cruelty and also institutional/government perception of dogs and development of related legislation. This suggests two classes of indicators; the **prevalence of cruelty towards dogs** as measured through reporting of cruelty to governments and NGOs and also the number of successful **prosecutions against cruelty towards dogs** as measured through the justice system. How these indicators are expected to change in response to an intervention will depend on the country and the stage of the intervention; in some cases the intervention may be looking for increased reporting of cruelty cases as an indicator of increasing awareness and sensitivity of the public towards protecting dogs from harm, however at a later stage they may wish to see the prevalence fall as cruelty itself becomes less widespread. Similarly with prosecutions, an intervention may want to see an increase in enforcement of legislation against cruelty initially and then reduction in prosecutions over time as less cruelty is reported. An increase in the proportion of reported cruelty cases that are successfully prosecuted is likely to always be desired.

The use of these indicators to assess the impact of a DPM intervention was not found and so these are presented as *suggested* indicators at this time.

# Impact 6: Improve Rehoming/ Adoption Centre Performance



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Indicators related to rehoming/adoption centre performance could be argued to be a measure of centre effectiveness and therefore related to intervention effort and not impact. However, many parts of a DPM intervention have the potential to feed into whether a centre is successful or not, sometimes independently of the actions of the centre itself. For example sterilisation could reduce unwanted births which would reduce or alter the age structure of intake and an improvement in people's perceptions of dog could increase adoptions. Hence a discussion of indicators relating to this impact of centre performance is included.

## Recommended indicator – Annual live release rate

The Asilomar Accords (Anon, 2004) is a national initiative in the US to collate data on rehoming centre performance and hence provide an opportunity to monitor and evaluate changes over time, potentially across large geographical areas and across several rehoming centres. The key indicator used **is annual live release rate,** which is expressed as the percentage of total outcomes for shelter animals that are live outcomes (adoptions, outgoing transfers, and return to owner/guardian) over the year. The total outcomes include all live outcomes plus euthanasia not including owner/guardian requested euthanasia or died/lost in shelter/care. The Asilomer Accords guidance provides definitions of the data to be used in the calculations of these rates and also practical tools such as a data gathering form and simple equation for the calculation of the rate itself. Annual live release rates have been used to evaluate impact of interventions on both individual centres and whole communities comprised of several centres (e.g. Weiss et al. 2013) and hence is presented as a *recommended* indicator for situations where rehoming centres are unable to run policies of non-euthanasia of healthy animals.

## Recommended indicators – Intake, net rehoming, footfall and time in shelter

For centres that have a policy of not euthanasing healthy dogs, their annual live release rate will always be 100% and hence they require additional indicators. These will also be useful for centres without 100% live release rate to explore their performance in more detail. **Intake rates, split by age category** are an indicator of the size of the unwanted dog population and have been used in evaluation of intervention impact (e.g. Frank and Carlisle-Frank, 2007). Although it should be noted that if a rehoming centre is constantly running at full capacity, their intake rate may be more a reflection of how fast they rehome and therefore make space for new dogs than a reflection of the dog population externally. In some cases waiting list may also be kept and the length of these lists/average waiting time scrutinised along with intake rates. **Net rehoming rates** include the number of dogs rehomed and take account of any adopted dogs that are later returned, and so are a more accurate measure of rehoming success as opposed to gross number of rehomings. **Footfall** across a specified time period is the number of visitors (families and couples count as one) to the centre. Changes in **ratio of net rehoming: footfall** allows for evaluation of the success of rehoming dogs as it takes into account the number of opportunities dogs had to be adopted. **Average time spent in the shelter** can be an indicator of how long it takes for a dog to be rehomed, the **proportion of dogs over a certain length of stay** (e.g. 3 or 6 months) may also be an important indicator of shelter performance as these long-term dogs will potentially be suffering some welfare compromise.

All these indicators require the rehoming centre to collect data on a daily basis and analyse this data regularly. Ideally all these indicators are collected and patterns across indicators analysed, as well as changes in individual indicators, to allow for accurate interpretation of underlying causes (e.g. has intake increased because of a change in the external population or as a result of increased net rehoming? Has average length of stay decreased because we are rehoming more successfully or have more dogs returned because we have relaxed adoption 'rules'?) Transparency of these indicators should be encouraged; however, rehoming centres may not feel comfortable about exposing some indicators, in particular when their annual live release rate is below 100%, so this data may need to be treated confidentially and protected in any public evaluation reports.

Photo: © World Animal Protection

# Impact 7: Reduce Negative Impact of Dogs on Wildlife



The impact of dogs on wildlife can occur in several ways (see Hughes & Macdonald 2013): (i) through predation of wildlife by dogs, as was most often reported, followed by (ii) disease transmission to wildlife, and to a lesser extent (iii) through competition with wild carnivores, (iv) hybridization and (v) predation of dogs by wild animals. The most common interactions, predation and disease transmission will be the focus of this section. Note that in all cases collaboration with wildlife stakeholders would be advised in order to collect data relating to wildlife populations.

## Recommended indicator – Presence of dogs in wildlife areas

The **presence of dogs in designated wildlife areas** can be measured through surveys specifically recording signs of dogs or as one of the species noted during ongoing population surveys of wildlife. For example, Butler et al. (2004) had wildlife rangers record sightings of dogs and dog prints along a transect within the border of a wildlife park, about six times per month, providing a long term relative index of dog abundance in the wildlife area. In Israel, Manor and Saltz (2004) recorded any dog sightings while surveying for mountain gazelle at water holes, they used the proportion of observations in which dogs were sighted as a 'dog-presence index', allowing them to track changes in dog presence over time with planned interventions. The increasing use of camera traps to record presence, abundance, and population changes in wildlife, has the potential to gather opportunistic data on the presence of dogs in designated wildlife reserves (e.g. Jenks et al., 2011). In addition, but a rather resource heavy approach, is to radio/GPS collar a small number of dogs. Using this method, the location and range of dogs can be quantified and mapped (e.g. Meek, 1999), so the extent to which dogs encroach into wildlife designated areas can be accurately determined (e.g. Butler et al., 2004).

## Recommended indicator – Predation events and predation impacts

As the presence of dogs in wildlife areas does not automatically indicate negative impacts, additional indicators of the impact on wildlife will be needed. The **number of observed wildlife kills by dogs** would appear to be an ideal direct indicator of negative impacts by dogs. However as these are relatively rare events, data on this indicator may be difficult to collect. Asking both community volunteers and wildlife rangers to report kills by dogs to a central point may help with data collection (e.g. as used in Zimbabwe by Butler et al. 2004).

A relatively resource-intense approach is to radio/GPS collar a sample of dogs and follow them as they enter the wildlife area to increase the chance of observing a predation event. Conversely, a sample of the wildlife species can also be fitted with GPS collars containing mortality sensors to allow for prompt necropsies and identification of the predator involved using scat, tracks and distance between puncture wounds, although differentiating between wild canids and domestic dogs is not possible with these signs alone (Young et al., 2011). If the predation event is not observed, mitochondrial DNA analysis can be conducted on the saliva left on the carcass in order to establish the species responsible (Williams and Johnston, 2004). This approach can even be used to identify the individual responsible if saliva samples can also be taken from 'suspects'. However this must be done within a short time period of the kill to avoid contamination of the predator's saliva with scavenger saliva. In some environments this may well be a matter of just a few hours, plus the tests themselves are expensive.

The indicator of the number of observed wildlife kills by dogs alone is also not really sufficient. As described by Hughes and Macdonald (2013); this is "unquantified in terms of population impacts. Reporting individual instances of predation gives no indication of the impact on local prey populations and, therefore, whether it is of conservation concern". Additional indicators are therefore needed to reflect how the wildlife population is responding to this predation, ideally by **monitoring population numbers, distribution and structure of wildlife prey** at the same time as monitoring presence of dogs within designated wildlife areas or number of observed wildlife kills by dogs to see if there is any correlation. For example, the dog-presence index used by Manor and Saltz (2004) was found to correlate with kid:female gazelle ratios; there were more kids per female (a favourable ratio in terms of the potential for gazelle populations to grow), as dog-presence index declined.

## Recommended indicator – disease incidence in dogs and wildlife

Dog populations can act as a reservoir for diseases that are also a risk for wildlife, in particular carnivores. Rabies and canine distemper virus (CDV) are the two mostly commonly cited examples, but parvovirus and *Ehrlichia canis* have also been implicated. For diseases with short infection cycles and high mortality (characteristics of both rabies and CDV), transmission cannot be maintained in small endangered wild populations; as the number of animals that succumb to infection increases, the number of new susceptible hosts diminishes, and the infection eventually fades out. New infections in wildlife populations are usually triggered by contact with more abundant reservoir hosts, most often domestic dogs (Cleaveland et al. 2007). Although for CDV in African wild dogs (*Lycaon pictus*) there is evidence to suggest this pathogen is maintained independently of domestic dogs, and hence management through dog vaccination against CDV may not be suitable in all situations (Woodroffe et al., 2012). Indeed, Woodroffe et al. (2012) advise careful cost-benefit analysis before deciding whether managing disease in domestic dogs will protect wildlife. Exposure to canine pathogens may actually provide some ongoing immunity and therefore protection against large outbreaks and mortality, as well maintaining selection pressure for disease resistance.

Where DPM interventions have identified that it is cost effective to minimise the risks to wildlife by reducing the incidence of infectious diseases and parasites in dogs, the key indicator to measure success will be the **disease incidence in both dogs and susceptible wildlife species within the same area.** Although a reduction in disease incidence in both dogs and wildlife may be sufficient to attribute success of a DPM intervention, and is likely the most affordable indicator to measure, additional evidence of the epidemiology of the disease and how it is transmitted between dogs and wildlife is ideal. This may be achieved by carefully mapping and monitoring location and movements of both dog and wildlife species (e.g. using radio/GPS collars) to assess contact rates. Furthermore, detailed serological studies of both dogs and wildlife to determine the **proportion of the dog/**

**wildlife population with antibodies to diseases** would be advantageous. Measuring such indicators will need to be conducted in the long-term and across a range of age groups, taking account that CDV antibodies can remain in circulation many years after exposure to CDV and that vaccination for CDV will also lead to a positive blood result. When used in the Serengeti this approach revealed that CDV appeared and then disappeared for many years in spotted hyenas (*Crocuta crocuta*) before reappearing in juveniles, suggesting that the virus was not persisting in this wildlife species and had been introduced by dogs acting as a reservoir host (Cleaveland et al., 2007). The resources needed for long-term measurement of antibody levels, and the relatively complex analysis required to explore this data, means this indicator is usually measured as part of a long-term research programme into wildlife and dog disease transmission, and may be beyond the scope of the monitoring and evaluation plans of many DPM interventions.

Note that due to the almost invariably fatal nature of symptomatic rabies, looking for antibodies to rabies in serological samples may result in very few positive samples in non-vaccinated populations, and so is not recommended for general monitoring.

All the indicators mentioned in relation to the impact of dogs on wildlife require collaboration between those organisations working with dogs and those working with wildlife. Disease surveillance and predation recording is likely most effective where it is run as a joint cross-disciplinary effort between dog and wildlife stakeholders.

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# Impact 8: Reduce Negative Impact Of Dogs On Livestock



Negative impacts of dogs on livestock can occur through predation, disease transmission or lost production due to stress resulting from close presence of dogs. DPM interventions may be looking to evaluate their impact on livestock if they are concurrently reducing roaming dog density and therefore the number of dogs potentially predating or harassing livestock, or by reducing disease transmission through deworming/vaccination of dogs as reservoir hosts for *Echinococcus granulosus* or rabies.

## Suggested indicator – Livestock predation by dogs

The **number of livestock predated upon by dogs per unit time** appears the most direct indicator for the negative impact of dogs on livestock, and will presumably be well correlated to production losses through stress following non-lethal interactions between livestock and dogs. Note that changes in livestock numbers would also need to be considered when using this indicator, there may be seasonal changes in livestock numbers and vulnerability to predation (e.g. susceptible young animals during breeding seasons), as well as potentially changes in numbers over longer time periods. Further, changes to livestock management practices should also be considered, such as increases or decreases in confinement of livestock that could change their susceptibility to predation.

Accessing the number of livestock predation events through secondary sources may be challenging, as governments do not always maintain records of such predation events nor do farmers always report them. Presumably if there is a government run compensation programme available for livestock losses to predation, there will be data recorded on the number of predation events reported and subsequently receiving compensation, although the level of detail included on the location of the predation event (important for determining whether this occurred within or outside the intervention area) and which predator is culpable (i.e. dogs or wildlife) may differ. In other countries, compensation for livestock predation is received from insurance policies and hence data on the number of predation events may be best accessed through insurance companies; this was the approach used by Adriani and Bonanni (2012) to assess the impact of stray dogs on livestock in Italy.

An alternative approach is to use questionnaires of farmers regarding livestock losses. For example, Wang and Macdonald (2006) asked farmers living around a wildlife park in Bhutan about livestock predation events, although in this case they didn't report losses to dogs, only wildlife predators. The United States Department of Agriculture (USDA) uses a national survey of a random sample of producers to develop a report on cattle loss every 5 years, including losses of cattle to predators split into species (in 2010, 11.3% of cattle predation loss was due to dogs; NASS 2011). This indicator is presented as *suggested* only because no examples of its use in evaluating dog population management interventions could be found.

## Suggested indicator – Livestock disease

Echinococcosis is arguably more important as a human health issue than as a livestock health issue as often infections can be asymptomatic during the life-span of the livestock intermediate host or at least be minimal enough to go undiagnosed in a herd environment. However there are losses associated with *E. granulosus* in livestock, including direct economic losses from condemnation of offal and indirect losses from reduced growth, milk production and fertility in infected animals. Hence DPM interventions that aim to reduce *E. granulosus* in dogs can measure their impact on livestock by monitoring changes in **the number of livestock with liver or lungs infected with *E. granulosus* cysts at the time of slaughter per unit time (usually per month or year) and per age group** (covered in more detail in the section on 'Impact on echinococcosis risk' under the impact of 'Reduce risks to public health') and potentially also including a subsequent stage of economic analysis. For example, the economic impact calculated by Benner et al. (2010) for echinococcosis in Spain and by Budke et al. (2006) for the worldwide impact included both direct and indirect costs related to livestock as well as humans. Note that for assessing the extent and costs of livestock disease all species that are susceptible to *E. granulosus* can be included, but when assessing the risks to human health the prevalence in sheep is most relevant as the vast majority of human cases are transmitted from the sheep-dog cycle (Eckert and Deplazes 2004).

Rabies virus can infect all mammals and in rabies endemic countries the loss of livestock to rabies is both an animal welfare and economic cost of the disease. Unvaccinated dogs are a primary reservoir host for rabies, thus reduction of rabies in the dog population through an intervention that includes vaccination may also lead to a reduction in rabies in livestock. Hence a potential indicator of success of such an intervention would be **the number of laboratory-confirmed livestock rabies cases per unit time (usually per month),** although **the number of clinically diagnosed livestock rabies cases per unit time** is also a valid indicator of rabies risk and can be particularly useful for increasing case detection when laboratory infrastructure is weak. Potentially this data could also be used to estimate the economic impact of rabies reduction following an intervention. The challenge is that rabies in livestock is rarely reported or recorded in secondary/official sources, because there is neither a cure for rabies nor compensation for livestock, so severe underreporting will reduce the reliability of this data. Setting-up key informants within the farming community or livestock health workers/veterinarians may be an ideal first step to increase surveillance of livestock cases ahead of an intervention. Note that in Latin America compensation systems do exist, however this is for rabies carried by vampire bats (which can impact large proportions of a herd at one time) and hence not relevant to this document.

# Methods of Measurement

This section provides detailed descriptions and protocols for methods of measuring the indicators listed in the previous section. The method used will significantly influence the data collected, for example a different population of dogs will be scored for body condition when measured through street surveys as opposed to through clinic records. Hence the methods and the detailed protocols used to implement them should ideally not be changed over the lifetime of an intervention and its assessment.If a method of measurement has to be changed, a significant period of overlap between the new and old method will expose how the data relating to the indicator is affected by the new method and correction factors can then be applied to permit comparison between data collected by different methods.

# Methods of Measurement: Questionnaire Surveys



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## Questionnaire surveys

Questionnaires comprise a set of standardised questions that can be in closed (questions with a limited set of answers to choose from, such as 'yes' or 'no') or open format (questions that allow the respondent to answer in their own words). This is a well-tested methodology for collecting data relating to a range of indicators. They are relatively time consuming to deliver and analyse and so tend to be used infrequently for DPM evaluation and more often appear as part of initial in-depth assessment of dog populations ahead of intervention planning. However, dependent on the sampling frame and method used to select respondents, they can provide reliable estimates relating to the wider population and so may be useful for evaluation where resources allow. Annex E provides a sample questionnaire that has been based on DPM questionnaires that have been field-tested in several countries. It has been designed to be as short as possible and yet still to collect data relating to indicators mentioned in this guidance document. However, adding extra questions relevant to your intervention location is welcomed. Note the questions in Annex E have been phrased to ask about the performance of actual behaviours, such as stating how often a dog is fed rather than a subjective assessment of whether the feeding is regular or not. Further, multiple choice answers have been included to help with data analysis with all likely responses listed, including a 'don't know' response to avoid forcing the respondent to guess.

Note that when using questionnaires you should ask respondents for their permission to use their data, you should also explain how their name (if asked) will be used. The questionnaire in Annex E starts with a statement to read to respondents and a place where their permission can be recorded.

## Relevant Impacts

Questionnaire surveys can be used to measure a wide range of indicators related to several impacts. These include several indicators of improving dog welfare such as body condition score, skin condition and female : male ratio (where the target dog population is visible in households as opposed to on the street); indicators for improving care provided to dogs, including specific dog care behaviours performed by dogs owners and knowledge and attitudes of children following education interventions; under the impact of improving public health the indicators of dog bites and also dog vaccination can be measured using questionnaire surveys; and finally, indicators of an improvement in public perception including attitudes towards dogs and the adoption of dogs can be measured through questionnaire surveys.

## Sampling

Questionnaires designed to measure changes in human behaviour over time ideally follow a consistent sample (a 'cohort') of households, hence are longitudinal as opposed to cross-sectional in design. This is because cross sectional questionnaires use a new sample of people at each point in time (a 'point sample' of people), it is difficult if not impossible to select equivalent samples, and the differences in people's background can influence reported behaviours and attitudes, hence you may not be measuring a change in attitudes over time but the difference in the attitudes between the two samples of people chosen. Many factors could influence peoples' attitudes towards dogs and the way their dogs are kept, including gender, religion, degree of education and previous experience of owning an animal as a child. As it is difficult to control for all these factors during analysis, or to ensure the sample contains exactly the same representations of these different types of people, the most robust approach is to ask the same households for their dog care behaviours in order to assess how these have changed over time. This will require the initial sample to be larger than required for final analysis, to allow for dropout but still retain a sufficient sample size; reasons for dropout include people moving away from the intervention area, people losing and not replacing dogs and fatigue with the study. The potential problem with a longitudinal approach is that a change in dog care behaviour may occur in sample households as a result of being observed through repeated questionnaires, rather than in response to the intervention.

Where a longitudinal approach is not possible, a cross sectional questionnaire survey is the alternative. A larger sample size may be needed for a cross sectional approach to increase the chance of a representative and equivalent sample being selected each time. A larger sample size is also needed detect significant change, as analysis will be on different people ('subjects') at different time periods ('between subject' design and analysis), rather than on the same subjects at different time periods ('within subject' design and analysis). The 'between subject' differences at different time points may mask effects due to the intervention; a larger sample size of subjects at each time point can help to expose those effects. The same sampling method and frame should be used to select households at each cross-sectional survey event. For example, every 3rd house along every street in the intervention area, or cluster sampling where all houses in a sample of areas drawn from a larger sample are approached. Examples include the WHO Expanded Programme on Immunization cluster-survey technique, used in dog-related questionnaires by Davlin and Vonville (2012) and Kongkaew et al. (2004). Attempts should also be made to ensure the socioeconomic background of each sample is the same; this can be achieved by 'stratifying' the sample for socioeconomic status in the same way at each survey event (in a 'stratified' sample, some dogs or people have a known greater chance of being selected than others, this is used when your target population clearly appears as sub-populations with important differing characteristics related to your impact, see Section 'Making your impact assessment robust' for more details). This can be achieved by drawing samples from geographical areas of known socioeconomic status (data on age, education and general socioeconomic status by area can be available from census data).

## Recruitment of respondents

Recruiting a sample of respondents can be done in a number of ways, and the best approach to use will depend on the location and objective of the questionnaire survey. If using a longitudinal questionnaire to assess changes in dog care behaviour in a consistent sample of households, a face-to-face interview at the doorstep may be the best approach to limit dropout. One potential limitation of the door-to-door approach of recruitment is that it may be biased towards those people that are at home most often, such as young families, the elderly and unemployed. Administering questionnaires in the evenings and weekends can help to avoid this bias.

Door-to-door recruitment is also suitable when using cross-sectional approaches but it can be quite time consuming, especially if looking to include a large number of dog owners in an area where dog ownership is relatively uncommon (for example, in urban areas where dog ownership may be <10% of households; e.g. 7% in costal urban communities of Tanzania (Darryn L Knobel et al., 2008)). One approach available when using cross-sectional designs is to use 'convenience sampling': accessing respondents where people are most numerous and accessible, such as at bus stops, on buses, in parks or outside places of worship. The limitation of this approach is that you may be accessing a biased sample of people; however this could be seen as a benefit if an objective is to assess changes in peoples' perception of roaming dogs, which may be best asked of people spending time in public spaces where roaming dogs occur. One benefit of this approach is that selecting a quota of respondents based on visible factors such as age and sex becomes possible, by approaching people within those categories until the desired balance has been reached (e.g. to match the demographics of the location and therefore increase the chances of this being a representative sample).

Another potentially easily-recruited and therefore convenient sample of respondents is children at school (although some countries do have regulations about conducting questionnaires of children and so appropriate approvals must be sought). Depending on the access to education in the locality, children attending a range of secondary schools could still represent a range of socioeconomic and religious groups, although this approach restricts the sample to households with secondary-school aged children. Children of secondary-school age may both be able to fully comprehend the questions in the questionnaire and may well be involved in their family's dog care, but these assumptions would need to be tested in each location.

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Accessing respondents through landline phones has been a viable method of recruitment in the past, however many countries are experiencing an increase in the proportion of households with mobile phones only, leaving this method open to increasing bias. Access through the internet is a very cost-effective method and also benefits from immediate data entry into a database if respondents are filling in questionnaires online. However, as with mobile phones, the use of the internet is increasing overtime and hence your sample may also change over time, which may confound the effects you are aiming to detect. Postal questionnaires can be used for both longitudinal and cross-sectional designs but this requires a fully literate population of people to avoid biases. A low return rate should be expected for postal surveys.

Any method of recruitment can suffer from bias resulting from only people interested in dog-related issues agreeing to respond. This can be particularly problematic when using methods that do not include face-to-face recruitment, as the rate of responses can be very low (although incentives can be used to increase response rates such as entry into prize draws). As these methods are being used to assess changes in dog care and perceptions over time such a bias may not be too much of a problem, so long as the demographic of people with an interest in dog-related issues does not change over time. Recording response rates to questionnaires can help monitor changes in people's interest.

## Interviewer bias

Interviewers can unintentionally affect responses, for example through 'social desirability' where the interviewee provides the responses they think the interviewer wants to hear or attempts to create a particular perception of themselves; this may be done consciously or unconsciously. Avoiding this completely can be difficult; basic differences between interviewers can be relevant, including gender and age, and even without an interviewer present, the respondent may make assumptions about the desired responses based on where the questionnaire has come from (e.g. the sender email address or website hosting the questionnaire). Interviewers and question phrasing need to appear as neutral as possible and all interviewers should use a set script to both introduce themselves and ask the questions to avoid differences resulting from their phrasing. Consider not having staff or anyone publicly identified with an intervention conducting the interviews to maintain objectivity. If this is not possible, be sure to train your interviewers how not to unintentionally affect the responses, they may need to wear neutral clothing (i.e. no logos) or consistently wear the same logo every time the questionnaire is conducted. Using a team of students as interviewers (with the same gender and age composition at each survey event) may be a good option, as they may appear to interviewees as less of an authority figure to appease with appropriate responses.

## Health and safety

The safety of interviewers is extremely important to consider especially when using face-to-face interviews. The potential risks involved should be reviewed for every location and mitigated as far as possible. Examples of mitigation include interviewers working in pairs, stopping before sunset, having access to a mobile phone, transport and a supervisor close by to assist when required and check everyone in and out of the survey event. Interviewers are themselves also responsible for behaving appropriately, for example by assessing each house before knocking (if concerned, they can miss out a household and record where, when and why this was done), being polite but not overly friendly with respondents, politely refusing invitations to enter households, dressing appropriately, carrying official ID and halting an interview early if they are concerned (recording where, when and why this was done). In some countries personal alarms may also be available for interviewers to carry with them.

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# Agreement with attitude statements

Monitoring changes in perceptions or attitudes towards dogs can be done through repeated surveys that ask people for their level of agreement with dog-related statements. People are presented with both positive and negative statements relating to dogs, such as "dogs add happiness to people's lives" and "street dogs pose a danger to people", and are asked to what extent they agree or disagree with the statements. Their level of agreement is indicated on a scale, called a 'Likert scale' (see Annex E for examples of Likert scales), and can later be translated into a score allowing for comparison over time.

## Sample attitude statements

Annex E includes four lists of attitude statements that have been used in different environments: one in Colombo, Sri Lanka where both owned and unowned dogs are found roaming (Sankey et al., 2012); one in Tanzania where the roaming dog population is comprised of majority owned dogs allowed to roam freely, these statements were designed specifically for dog owners (Knobel et al., 2008); one to compare attitudes between UK and Japanese students (Miura et al., 2000); and one that was used to compare the attitudes of 4 year old children towards dogs in three European countries (Lakestani et al., 2011). Any of these attitude statement lists can be selected and used as presented or can be adapted to a new location – note the attitude statements for children are for use in a classroom situation as opposed to during a household questionnaire.

The process of adaptation for the adult attitude statements could include using two or more focus groups comprised of local people (both dog and non-dog owners) to discuss the statements and their suitability to the location. Irrelevant statements are then removed and ambiguous ones made clearer using locally relevant terms/phrasing. The groups can also be asked whether there are other important dog-related issues not covered and new statements covering these aspects devised. This new list should then be piloted on 20+ people of varying backgrounds and opinions. Following the pilot test results, the list can be updated further and retested, or accepted in its current form. Note that conducting this process of adaptation may require accurate translation into the local language. This can be done translating the English statements into the local language, and then back-translating into English to check for retention of meaning. This procedure is repeated by revising the statement in the local language until the back-translation matches the original English version.

For interventions that have the resources and access to relevant expertise, a novel set of attitude statements can be developed (e.g. as described in Knobel et al. (2008)). In brief, one potential process is to start with qualitative/open discussions about dogs within focus groups from which a long list of attitude statements can be developed. These are then trialled on a pilot group of 20+ people, either individually or in groups, to remove or amend statements to improve understanding of their meaning. The improved list is then piloted on a larger group (involving twice as many people as you have attitude statements), followed by factor analysis of the results. Factor analysis will expose any statements that appear redundant which can then be removed to make the final list shorter. Additional stages of testing reliability can also be run, including testing statements with the same people but over time.

## Analysis of changes in attitudes over time

Attitude statements are commonly presented in lists of over 10 items, to allow for measurement of a range of attitudes and several statements deliberately testing the same issue. This can create problems at the analysis stage: if every statement is individually analysed for change over time there is a chance of finding a falsely significant result (i.e. the score for a statement can differ from its previous score purely by chance. The likelihood of this happening for any one statement increases with the number of statements tested). Hence analysis of these statements can involve making a prior selection of key statements or combining statements to reduce the number of statistical tests conducted. Three different approaches to analysis are described here. The most suitable will depend on resources available for analysis and the level of interest in specific attitudes.

One approach to analysis is to focus on individual key statements within a list of attitude statements. Selection of statements as key to the intervention can be done in two ways. Firstly, the results from pilot testing can indicate statements that are particularly good for capturing variability in perceptions, i.e. not everybody gave the same responses. These statements may be particularly good at exposing changes in attitudes over time as there is 'space' for the data to show statistically significant change. Secondly, statements for which there is a logical explanation for how your intervention will lead to a change in this attitude plus a change in this attitude would be considered important to various intervention stakeholders, i.e. it is a relevant attitude to your work. An example might be an intervention that aimed to reduce dog bites and improve perceptions of dogs through a combination of rabies vaccination, reproduction control and education in safer interactions with dogs; this intervention might in particular want to look for changes in people's agreement with the statement "stray dogs pose a danger to people".

The attitude statements can also be combined into a summative score for acceptance of dogs. For example, from the attitude statements developed in Colombo, Sri Lanka, 10 statements are clearly either positive or negative with regards to acceptance of dogs (statements 2, 4, 5, 7, 11, 12, 13, 14, 16, and 18). Scores of 1 to 5 can attributed for how each interviewee responded to each statement; with a score of 1 for the response 'strongly disagree' with the statement and a score of 5 when the response was 'strongly agree' with the statement. The scores of negative statements are reversed (i.e. statements 4, 7, 13 and 16) so that all of the individual item scores have the same direction, which allows an overall score to be calculated indicating acceptance of dogs. Within this scoring system, a minimum score of 10 would mean total non-acceptance and a maximum score of 50, total acceptance of dogs. Note that this summative score does assume equal weighting to all attitude statements, which may not be accurate, with some attitudes more important than others. Consider using expert opinion to weight the statements as more or less important and use these weighting to adjust the scores; for example using the 'Delphi technique' to systematically achieve a degree of consensus of opinion between experts (e.g. as used by Whay et al. (2003) to find consensus between experts on the best measures for the welfare of dairy cattle, pigs and laying hens). Summing the scores may also mask changes in specific attitude statements, hence this method is ideally used in addition to considering changes in key indicator statements.

Factor analysis is a statistical method used when faced with a large number of observed variables (in this case, responses to a large number of attitude statements); it explores the correlation between these many variables to find a lower number of unobserved composite variables called factors. For example, this was used to analyse the responses to 47 attitude statements about dogs along 7-point Likert scales presented to UK and Japanese students

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(Miura et al., 2000). Changes in responses to all 47 statements should not be analysed over time, as this would lead to some significant results just by chance (even with a significance level of 5%, this equates to one significant result out of 20 tests appearing just by chance). So the 47 responses were analysed for how they correlated with each other using factor analysis; this exposed clusters of responses that correlated. Each cluster is called a factor and is given a suitable name depending on what responses it contains. For example responses to the 4 attitude statements "I think that stray dogs are a problem in this country", "I think that stray dogs tend to bite", "I think that stray dogs create a nuisance" and "I think that there are too many dogs in this country" were found to correlate and were given the factor name 'dislike of stray dogs'. Five factors were found to underlie the UK responses and 7 in Japan, including factors described as 'unconcern/concern for hygiene', 'dislike of stray dogs', 'acceptance of dogs as equals', and 'acceptance/unacceptance of euthanasia'. Each statement can be given a score depending on the average position of the responses along the 5 or 7-point Likert scale. Scores for all statements falling within each factor can then be combined to give a score for each factor. These factor scores can then be analysed for changes over time by combining statements in the same way at each survey.



## Using questionnaires to estimate fecundity

Questionnaire surveys can be used to estimate the number of litters per female per year, a measure of fecundity. In the sample questionnaire in Annex E, owners are asked of all their female dogs 'how many litters has she had in her lifetime?'; hence every female dog will have a breeding history, although for many this will be 0 litters so far in their lifetime. For every female dog, her average litters per year since she reached the age of 1 year (assumed to be the age of sexual maturity) can then be calculated (i.e. total number of litters for that female / number of years since reaching age 1). The average fecundity for the female population is then calculated as the average litters per year for all females of 2 years and above; only those females of 2 years and above are included to ensure they have experienced a full year of potential breeding after reaching the age of 1 year. The assumption of 1 years old as the age of sexual maturity can be tested by calculating the average age at first litter; the question 'How old was she when she had her first litter?' is also included in the sample questionnaire.

The average number of litters per female can also be further extended to the average number of puppies per female per year, an alternative indicator of fecundity. The average litter size can be calculated from responses regarding fate of puppies born in litters produced in the previous 12 months (the sample questionnaire in Annex E includes the following question to capture this data: 'if she has had a litter in the previous 12 months, please tell us about the fate of all puppies from this litter', followed by nine outcomes). The number of litters per female per year is then multiplied by the average litter size to calculate the average number of puppies per female per year.

## Using questionnaires to estimate survival



Questionnaire surveys can be used to estimate survival of owned dogs as part of either a longitudinal or cross-sectional study. A simple estimate of current adult survival is available by comparison of the total number of adult dogs owned a year ago with the number owned currently that are at least 12+*m* months old, where *m* is the minimum age in months at which a dog is considered as adult (e.g. 5 months). The respondents are asked “over the past 12 months, did any of the household’s adult dogs die or leave the household?” From the responses, the proportion that have died or disappeared can be estimated, leaving out those dogs that have been sold or donated to other people and which may still be alive. There may be cases where the fate of dogs that have left the household is unknown, however this is likely to be a relatively small number and the proportion estimated from the dogs with known fate can be applied to the total number of dogs that left the household, allowing the total number of dogs that have died or disappeared in the last 12 months to be estimated. The number of adult dogs that have died or disappeared in the previous 12 months is then subtracted from the number owned a year ago and the remainder (representing the number of dogs that have survived the previous 12 months) divided by the number owned a year ago to estimate adult survival.

An alternative approach is to estimate the age structure of the current owned population (split into equal age groups of one year) by asking the respondents the current age of their dog, or when and at what age each dog was obtained. In a population that is either constant or that has been growing at a constant rate for some years (perhaps in line with the growth of the human population) the age structure will have stabilised to the point where the number of dogs $a$ years old divided by the number $a - 1$ years old equals $S_a/\lambda$, where $S_a$ is adult annual survival at age $a$ and $\lambda$ is annual population growth rate of dogs. Although annual survival will be reduced in very old dogs survival of owned dogs that are allowed to roam is probably low enough for the number of dogs that reach that advanced age to be negligible. In that case an estimate of an age-independent adult survival probability $S$ is available as the average ratio of the size of successive adult age groups multiplied by $\lambda$.

Survival of pups is certainly not independent of age. Whereas respondents may not be able to provide reliable data on the age at which adult dogs died, those owning dogs that have recently had a litter of pups may be able to remember the age in weeks or months at which any pups died. Age-specific survival can then be estimated using the Kaplan-Meier method (Kaplan and Meier, 1958), which does not assume a stable age structure (important as any seasonality in breeding would destabilise pup age structure) and allows individuals whose survival is unknown (because they were sold or given away) to be accounted for in the analysis. The ages at which pups were known to die are listed sequentially. Just before each of those ages there is a number of pups known to have reached that age (pups sold or given away before that age are excluded from that number). The number of pups that died at that age is then subtracted and the remainder (representing the pups surviving beyond that age) are then divided by the total number of pups known to have reached that age. That provides an estimate of survival over the interval since the previous age at which one or more pups died. Multiplying those estimates up to a specific age provides an estimate of pup survival to that age.



## Tools available to implement and analyse questionnaires

Conducting questionnaires can be relatively time consuming and so tools to reduce the different processes involved are potentially very useful. Questionnaires can be designed on survey sites such as Survey Monkey (www.surveymonkey.com) and then, if internet access is sufficiently reliable, the responses can be filled in on a mobile phone or tablet during face-to-face interviews (note, any drop in internet access would mean halting the interview until connection is re-established). This avoids the need for printing forms and transcribing data from forms to computer later, and it also offers some basic analysis features. If internet access is not reliable, there are applications for phones and tablets that allow for data entry even when offline, for example Device Magic (www.devicemagic.com), SurveyToGo (www.dooblo.net) or Open Data Kit (www.opendatakit.org).

# Methods of Measurement: Participatory Research



The human development field has been the key innovator in devising ways of engaging beneficiaries in the process of development, not just as passive receivers of aid but as decision makers themselves who drive the development agenda in their own communities. One of the earliest examples is rapid rural appraisal (RRA) which emerged in the 1970s; this involved communities living in poverty in rural areas being supported to come together in groups to elucidate their problems using exercises that did not require literacy. Further, they prioritised those problems and explored their causes, leading to targeted development support that was driven by the desires of the beneficiaries themselves as opposed to external experts. Central to this participation approach is the concept of 'collective action'; that by bringing people together through participatory exercises they can build a collective group with the ability to work together to improve their situation, far more effectively than they could as individuals. Jumping forward many decades and we see these approaches used in many fields, including animal health, conservation and most recently in animal welfare, perhaps best reflected through the work of the Brooke and their book 'Sharing the load' (Van Dijk et al., 2011).

The role of participatory approaches in impact assessment has been present from the outset, where the beneficiaries that initially exposed the problems they wanted to have addressed, would also then monitor how these problems responded to the various interventions in which they engaged. This process can be termed participatory impact monitoring or action research, and is as much a method of intervention as it is a method of impact assessment. An animal welfare example can be drawn from 'Sharing the load' (Van Dijk et al., 2011), where a community of working animal owners come together to assess the welfare of their animals and the role of these animals in their own well-being, through a set of group building exercises under the guidance of a facilitator. The community may then use exercises where they review the needs of their animals from the animal's perspective (in 'Sharing the load' this exercise is called 'If I were a horse'), followed by a review of how well these needs are met (called 'Animal welfare practice gap analysis' in 'Sharing the load'); together, these exercises and others reveal the importance and suggest causes of animal welfare problems and hence potential solutions. The group members are encouraged to review the welfare state of their own animals and those belonging to their group (called an 'animal welfare transect walk' in 'Sharing the load'), and as they engage in solving these problems. The reviews are repeated so that changes can be tracked and hence interventions evaluated for their effectiveness. This participatory approach would be possible to replicate with dog owners, and as such, development and monitoring of indicators would be done by the dog owners themselves as part of the process.

Even where a participatory approach to the intervention has not been used, participatory tools can still be used to assess impact, where people within the intervention area are encouraged to reveal whether they have experienced changes or not. This approach is arguably extractive, with information being removed to inform evaluation of intervention effectiveness, rather than empowering local people to make decisions and take action and so may be a stretch of the term 'participatory'. Regardless of this criticism, this approach could provide insights to impact assessment that would not otherwise be found using the other methods of measurement described in the guidance. Hence, in the rest of this section we describe participatory tools for impact monitoring. Although we do not describe true participatory approaches to dog management interventions that have inherent participatory impact monitoring, we encourage innovation in this field and would value feedback from any interventions that take this next step.

Most commonly, participatory approaches to assessing impact will be used alongside other methods of measurement that produce quantitative data; a 'mixed methods' approach to impact assessment. However, it should also be noted that participatory approaches do not necessarily only result in qualitative data, participatory tools have been designed to convert qualitative results into quantitative data as well, allowing for comparison over time and between communities using numerical statistics. Although participatory tools previously described in the studies above are usually qualitative in nature, numbers can be drawn usually from the final stages of participatory exercises to aid impact assessment (Chambers, 2007).

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## Relevant impacts

The participatory tools described here would be most suited to measuring indicators relating to public perception of dogs.

## Participatory tools for impact assessment in DPM

The use of participatory tools in dog population management is still relatively rare with some notable exceptions (Morters et al., 2014; Sankey et al., 2012). Here we describe exercises that can be performed with groups of people from the intervention area in order to assess whether changes in perceptions of dogs have occurred over time.

### Creating groups

Participatory tools can be run with individuals, but they are most efficient and potentially most powerful when run with small groups of (5 - 15) people. These people need to be selected to represent the wider community and so should include both genders, a spread of ages and economic backgrounds. Groups should also include both dog owners and non-owners. Dependent on local culture and the level of tension over dog issues, these groups can mixed or kept separate. For example, dog owning groups and non-dog owning groups could be kept separate if there is likely to be tension between these groups resulting from recent problems with dogs (e.g. dog attacks). Another reason for keeping owners and non-dog owners separate is if you want to ask them different questions. Your intervention may

be focused on service delivery to dog owners and hence owner discussions will be focused on their opinions as direct beneficiaries. While this is not relevant to non-dog owners, you may want to ask them about indirect impacts on dog nuisance, welfare and density of dogs on the streets. The groups will also work best if they are drawn from the same community, rather than from across a wider geographical area, as they can more accurately confer on the state of dog issues within a shared locality. Recruiting groups is commonly done through local community leaders or through snowballing, where people are asked to bring along friends. It may also be relevant to set-up small groups that represent different stakeholders in the issue, for example veterinary community, medical community, local government or teachers. These groups may necessarily cover larger geographical areas but should be from within the intervention area.

One important consideration is why people would agree to participate in these groups? They may be interested enough in dogs to want to give up their time, but you may also need to provide incentives; this may be greater access to the intervention services (e.g. free parasite control for their dogs if they usually pay) or something independent of the intervention itself, such as a meal and drink every time they meet.

Including a wide variety of groups increases the representativeness of the results, but obviously does concurrently increase the time required. Finding the balance between numbers of groups and time may be helped by considering that these exercises will also increase people's appreciation and understanding of dog related issues. Hence there may be certain groups where increasing understanding of dog issues will also help with implementing the intervention, and these groups can be prioritised when time is limited.

The following exercises can be run with a new group of people at each evaluation event, however if possible, reconvening and following the same group of people over time would provide a more reliable measure of how people's perceptions have changed over time. A combination of both cross-sectional and longitudinal approaches may be best. If reconvening the same group, they should be asked to bring with them their original maps and scoring (which should have been kept by the group to increase ownership) or the facilitator can show photos of the maps and scores taken at the original meeting. This will remind the group of past assessments and help them make their new scores with recent changes in mind.

It should be noted that the composition of groups may change over time and this should be taken into account when interpreting results. Although attempts should be made to ensure group membership reflects the wider community it is not always possible to achieve this and so the ability of the groups to truly reflect the wider community should be critically assessed.

## Facilitation

Facilitating participatory exercises requires skill and experience to ensure the group exposes its true feelings and does not reflect the opinions of a few vociferous members. There is also a risk of social desirability if the facilitator is perceived to represent a particular perspective. Ideally the facilitator is not a representative of the intervention itself but an independent person seen as neutral – in many locations in the developing world there will be local experts in participatory approaches that are used to facilitate groups for other issues, such as poverty or health, whom may be ideal for this DPM application.

Although these participatory tools are designed to produce numerical outputs there will be a large amount of qualitative information produced during the exercise that can be extremely valuable for the intervention managers. Hence a representative of the intervention can be encouraged to take part as a (passive!) recorder to take notes on key perspectives expressed during the exercise; their affiliation to the intervention can even be left out of their personal introduction to the group to avoid any social desirability bias. Or the entire session can be videoed or audio recorded with permission of the participants, allowing intervention staff to listen to the responses after the event, these recordings may also help with later analysis.

## Participatory exercises

The following exercises are described relatively briefly. Support from local experts in participatory approaches is advised, along with 'how to' texts such as 'Methods for Community Participation' (Kumar, 2002) and 'Participatory Livestock Research: A Guide' (Conroy, 2004). Exercise 1 is advised for all groups – followed by either Exercise 2a or 2b – each exercise may take up to 2 hours to complete, so consider asking groups to stay for up to 4 hours (with breaks) or using 2 sessions. Please note this is by no means an exhaustive list of possible participatory tools, but rather just some initial ideas. We encourage innovation in this area and would value hearing feedback on these and other tools.

### Exercise 1 - Dog mapping

This exercise is based on resource mapping and is used as a way of introducing the group to each other and the concept of participation, as well as to start the group discussing dog-related issues:

- The group is asked to draw a map of their local area, including any prominent local features. They can use whatever materials they choose – encourage them to be as creative as possible.
    - Creating their own map starts the group off in a participatory manner. An alternative that may be suitable when using stakeholder groups such as medics, vets, local authorities who cover a very large geographical area, is to provide a printed map of the extent of the intervention area and ask the group to annotate prominent features relevant to the stakeholder group (e.g. the location of hospitals, vet surgeries or government service points).
- Once the basic map is created ask the group to indicate where dogs are seen in public places and estimate the number of roaming dogs at that location. Highlight locations where there are both positive dog benefits and problems. The facilitator notes down any mention of 'dog nuisances' and 'dog benefits' on cards for later.
- As the discussions come to a close, the facilitator shows the group the list of dog nuisances and dog benefits written on cards and ask if they want to change or add to what has been written as 'dog issues' in their location.
- **Output – an estimate of roaming dog population size for the local area plus a list of dog issues for the location, including both positive and negative issues with dogs.**

### Exercise 2a - Dog versus non-dog nuisance ranking

This exercise builds on the dog mapping exercise and is used to compare dog nuisances with other public nuisances that are not related to dogs:

- Once dog issues have been covered on the map, ask the group to highlight the location of any non-dog nuisances.
  - Non-dog nuisances are defined as attributable to the actions of neighbours (those outside the home) and something that would be considered by almost all people as at least an annoyance, while at the same time not being unquestionably a serious crime. For example, traffic jams or garbage/litter might be an annoyance but not a crime. Major offences, such as burglary, are omitted as these are more than a nuisance. Natural nuisances such as mosquitoes and flooding are also not included as these are not associated with the actions of neighbours. This definition is based on that provided by Fielding (2008).
  - The facilitator notes down any non-dog nuisances mentioned on cards.
- As the discussion come to a close, the facilitator shows the group the list of non-dog nuisances written on cards and ask if they want to change or add to what has been written for their location.
- Lay the dog and non-dog nuisances in a vertical line, with 5 columns to the right. Creating a matrix:
  - Column 1 is the severity of the nuisance. Ask the group to score the severity of each nuisance out of a total of 10 – with 10 being the most serious nuisance.
    - Note that if the group is not used to working with abstract numerical proportions, proportional piling can be used instead, where the group is given a large number of small items (e.g. 50 or 100 beans or stones) and asked to split the beans into piles, with the size of the pile representative of the severity of each nuisance.
  - Column 2 is frequency. Ask the group to score the frequency of each nuisance out of 10 – with 10 being several times a day and 1 being once in your life time.
    - It may be useful to give people an example of common activities that vary in frequency; e.g. 10 = how often I talk to the children in a day; 5 = how often I collect water in a week; 1 = how often I get married in a lifetime.
  - Column 3 is prevalence. Ask the group to score the experience of this nuisance for the group members out of 10 – with 10 being everybody in the group plus their neighbours have experienced this nuisance and 1 being no one in the group has experienced this nuisance but they have heard of it happening to others within their community.
  - Column 4 is total score for that nuisance. Total up all the scores from column 1 + 2 + 3.
  - Column 5 is rank. The nuisance with the highest score gets rank 1 and lowest score gets the lowest rank. Allow for tied ranks (nuisances with the same total score)

- Allow the group to review the total scores and ranks and make any amendments that they think are necessary.
- **Output – a comparison between the number and rank of dog nuisances compared to non-dog nuisances**.
- Repeat this exercise with different groups and over time to see if the number and rank changes over time. If perceptions of dogs are improving some dog nuisances will stop being mentioned at all and others will fall in rank against non-dog nuisances, assuming non-dog nuisances do not change significantly within the same time period.



### Exercise 2b – Dog issues trend analysis

This exercise builds on the dog mapping exercise but also asks people to consider whether both dog problems and benefits have changed over time:

- Lay the dog problems and dog benefits in a vertical line with 3 columns to the right, creating a matrix:
  - Column 1 is the importance of this benefit or severity of the problem. Ask the group to score the importance and severity of the issue out of a total of 10 – with 10 being the most important. Note this is all about how the group feels about this benefit or problem *today*, how this has changed over time is dealt with later. (Consider the option of proportional piling described for exercise 2a).
  - Column 2 is frequency. Ask the group to score the frequency of each issue out of 10 - with 10 being several times a day and 1 being once in your life time. (Consider the option of presenting common activities as described for exercise 2a)
  - Column 3 is prevalence. Ask the group to score their current experience of this issue for the group members out of 10 - with 10 being everybody in the group plus their neighbours are experiencing this issue and 1 being no one in the group is experiencing this issue but they have heard of it happening to others within their community.

(You may want to split the exercise at this point, with a break or coming back for a second session)

- Now ask the group to think about an important event that they all remember occurring 1 or 2 years previously. This can be a public event like a sporting event that happened in the country, a political event like an election or a natural event like a particularly violent storm or flood, anything that places the same point in time in everyone's memory. This becomes the title for column 4.
- Dependent on the timeframe required for impact assessment, a second event further back in time can be selected. This becomes the title for an optional column 5.
  - Preferably the launch date of the intervention or intervention related events are not used as time markers to avoid any biasing of responses in the next activity. But the events selected should be clearly within or before the intervention

timeframe, i.e. a time that represents a pre-intervention baseline or a time that could represent change following a known period of intervention.

- Now ask the group to state for each issue whether this issue as increased (☐), stayed the same (=) or decreased (☐) since the event(s). Indicating the direction of change with ☐, ☐ or = in column 4 and 5.

- **Output – comparison between dog problems and dog benefits and how they have changed over time.**
- This exercise can be conducted at several points in time after an intervention has commenced and with different groups to see if perceptions are changing differently.

# Methods of Measurement: Street Surveys



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Street surveys are an efficient method of collecting data relating to a range of indicators. Their efficiency makes them particularly suitable for monitoring and evaluation because they can be repeated several times over the course of an intervention. The data collected is only related to roaming dogs seen on public property (i.e. not those behind fences or within compounds) and the ownership status of these dogs may not be clear (although a good state of welfare and wearing collars are potential signs of ownership): these roaming dogs may be owned roaming, community owned dogs or entirely unowned dogs either born unowned or abandoned/lost by their former owners. This means that confined dogs will not be accessed through street surveys; this could be a disadvantage but as confined dogs are commonly not a priority target this may be a minor concern for some interventions.

## Relevant impacts

Street surveys are most commonly used to measure impacts related to roaming dog density, demography and welfare. Street surveys may also be useful for assessing the coverage of an intervention where the intervention has involved visible marking of dogs, for example collars or paint spray during vaccination campaigns or ear notches during sterilisation. These marks are noted and recorded for every dog observed to assess the proportion of the population that has been reached by the intervention. See the section 'Street surveys and questionnaires for measuring vaccination coverage' for the specific use of this method following vaccination.

## Method

The method described here involves counting dogs on a route that runs along streets. It is similar in principle to the 'strip transect' method of wildlife surveys, in that observers move relatively quickly along an extended line to avoid double counting and to collect information on how animal density varies across the area. The difference to strip transects is that there is no intention to extrapolate the counts to an estimate of abundance rather the concept is

to repeat these routes in a consistent manner and compare the counts over time (see Annex D on how estimates of abundance can be calculated if necessary). The method thus depends on protocol consistency; using one or more standard routes at a consistent time of day and year and following a standard counting protocol, for example using a consistent average speed and mode of transport which will affect the 'search effort', i.e. the chances you will see a roaming dog through your observational skills. Ideal modes of transport include motorbikes carrying a

2-person survey team, cars and bicycles; walking is generally too slow to allow surveying to be completed within a reasonable timeframe and risks double counting dogs as the survey team will be moving slower than some dogs roam.

## Protocol

- The survey team consists of 2-3 people (a driver, navigator and observer, with navigator and observer combined as one role when using a 2-person team, and no driver if using bicycles). However, all members of the survey team are responsible for spotting dogs.
- The team follows the predetermined route (see route selection section that follows) travelling at maximum 15km an hour, slowing or stopping to record every dog seen before moving on as quickly as possible; keeping up a pace is important to avoid double counting and cover the route efficiently.
- Every roaming dog seen on the route is counted. Dogs confined within properties, walking on lead or 'close to heel' are excluded from the survey. In some cases a dog will be inside a fenced area but the gate will be open and the survey team needs to agree a consistent rule about how these dogs will be treated.
- Every dog is allocated to one of 5 categories: male, female, lactating female, puppy (under 4 months), unknown adult. This is extended to up to 10 categories when the intervention includes visible marking, as each of the 5 categories can be marked or unmarked. This falls to only 8 categories when the marks are ear notches applied during sterilisation as lactating females and puppies will not have been through the intervention yet and so can only be unmarked.
- Every dog is also assessed for welfare status and potentially also whether they are wearing a collar (in some countries where tethering is common, dogs on tethers but not confined behind a fence can be included in the survey as these dog are accessible to roaming dogs and so are a relevant part of population in terms of breeding and disease transmission).
- In some cases additional attributes (sex, intervention marks and welfare status) will not be possible to judge accurately due to the dog moving out of sight or lying down. The observers must not guess these attributes but either categorise the dog as unknown or leave welfare status unrecorded (i.e. unobserved) for that dog. Data on these attributes will be obtained from the sample of dogs that can be reliably assessed.

## Route selection

Standard routes for the survey can be designed within existing administrative boundaries, such as wards or municipalities, or routes can be drawn randomly across the entire area:

**Routes within administrative boundaries** ('ward' is used here as a generic term for administrative boundary): One or more routes can be drawn in every ward, however if the area is too large to cover, a sample of wards can be chosen. Routes should be approximately 25 - 30km (15 - 18 miles) long to allow the survey to be completed within 2 hours. They should encompass different road types, excluding only those roads where dogs are very unlikely to be found and surveying would be difficult (e.g. motorways), and also including different environment types such as dense urban areas versus open rural settings falling within the ward. These road and environment types should be included in the route in approximately the same proportion as they appear in the ward. The drawing and saving of routes can be done online using Google 'My Maps'.

**Routes along random sample of streets across intervention area:** If using wards is not possible or not preferred, routes can instead be drawn along a random sample of streets across the entire area of interest. This sample of streets needs to be selected without bias to where dogs are located. One option for selecting the sample is to create a zig-zag track across the survey area. This can be done using Google 'My Maps'; a zig-zag line can be drawn across the whole area using the 'add line' function; then the 'add driving/cycling/walking route' function (dependent on the chosen mode of travel) can be used to create a route that fits as closely as possible to the original zig-zag line. This should create an unbiased route that covers both small and large roads.

## Available tools for street surveys

Mobile phone applications (apps) are particularly suitable for street surveys because they can easily be carried by the surveyors, can record Global Positioning System (GPS) information and can eliminate the need for later transcribing of data.

If the Google account used for designing the routes on the computer is synchronized with a smart phone, that phone's Google Maps application can be used to display the route on the phone's screen. The phone can be used first to navigate to the start of the route and then to follow it, by taking the turns required to keep the Maps cursor moving along the displayed route.

A second mobile phone application called 'OSMtracker' (free to download) can be used as an event recorder to record the type and welfare state of every dog seen – note this app can only be used on Android smart phones. OSMtracker also records the time and GPS coordinates of each event so that following download of the data from the phone to the PC the spatial distribution of the dog types can be displayed on a map.

# Methods of Measurement: Secondary Sources of Information



Questionnaire surveys
Participatory Research
Street Surveys
Secondary Sources
Clinic records
Behavioural Observation
Vaccination Coverage

Secondary sources of information include official or government-derived information. These measures often do not require additional effort on the part of the DPM intervention managers, other than the effort required to collate the data from the source. They also provide relatively independent data and means of validating the impacts of the intervention. Ideally access to these data is achieved through a working collaboration between the intervention managers and the government department responsible for collecting and reporting these data, which can be established at the planning and outset of the intervention. Using a freedom of information act to access data may be possible in some countries where such legislation exists; however, a working relationship is preferable to ensure long-term access as needed (e.g. segregated by species, geographical locations etc.).

## Relevant impacts

Impact indicators that can be measured by secondary sources of information include several public health indicators such as human cases of rabies, surgical interventions for cystic echinococcosis, dog bites and dog rabies cases, and public perception indicators relating to public complaints about dogs to local authorities.

## Surveillance effort

Secondary data is particularly sensitive to changes in surveillance effort and hence close communication with the government department will ensure any changes are known and incorporated into analyses. Changes in effort or effectiveness can occur at any stage of the surveillance process from recognition of disease in the field by a member of the public/dog owner, attendance by a veterinarian or medical practitioner in the case of a bite or suspected human disease, diagnosis using clinical or laboratory tests, reporting of cases within the health centre/practice, reporting to the local authorities, through to reporting to central authorities. Ideally intervention managers work with the relevant government departments to improve surveillance prior to starting an intervention; this may include setting up local key informants (people in a naturally good position to collect specific data, such as school teachers collecting data about dog bites experienced by children, veterinary field officers collecting data about animal rabies cases and pharmacists collecting data about dogs bites receiving PEP), improving diagnosis by veterinary and medical professionals and improving reporting through data management systems integrated with phone apps. Any resulting changes in surveillance must be accounted for if using historical data as a baseline.

Often making a disease reportable (professionals including laboratories must report positive test results to central authorities for tracking of disease trends) or notifiable (any person in possession of an animal suspected of having a notifiable diseases must report the case to relevant animal health authorities who will investigate the case) improves surveillance and control. In addition, introducing the capacity for laboratory testing of suspect cases is often promoted (e.g. by WHO) rather than reliance on diagnosis using only clinical signs. This represents the ideal situation but often not the reality in many countries where diseases such as rabies are endemic. Further, making a disease reportable and requiring laboratory confirmation does not necessarily lead to good surveillance, although it should encourage investment in systems that make reporting possible. So although the goals of making a disease reportable/notifiable and providing accessible laboratory testing are valid, these may not be sufficient for ensuring consistent and good surveillance.

## Frequency versus incidence

Data relating to indicators such as cases of human or dog disease can be presented as a frequency (i.e. number of cases per month or year) or as an incidence per 100,000 people or dogs that were at risk of the disease during that time. Using incidence accounts for changes in human or dog populations over time, but population estimates may be difficult to establish reliably in some locations and so using the frequency/number of cases without a denominator may be necessary. Situations when incidence is most suitable include comparisons between locations, such as treatment and control areas, or when assessing changes over a long period of time (> 10 years) when population changes are expected to be significant and population estimates are available for the entire period. Good practice when incidence appears suitable would be to present both the frequency and incidence for the indicator data and to be very clear what denominator was used and how this denominator of human or dog population size was estimated. It may be in the future that these population estimates are revised and hence the indicator data can be similarly revised if original denominators were clearly stated.

## Geographical resolution

Access to secondary sources of information can occur at several points along the surveillance process: direct from a health centre, hospital or veterinary station; from city, regional or state authorities; or from central authorities. The point at which data should be gathered will depend on the geographical extent of the intervention: if it is focused on one city, accessing data from a local hospital or veterinary station may be the most appropriate and avoids any errors relating to communicating data up through a chain of authorities. It also depends on the systems of reporting up from the healthcare provider to the authorities at the central level. Where these systems are working well and the central authorities are transparent this may be a very efficient way of accessing data from the intervention area and also other non-intervention areas for comparison. Ideally collect a sample of data from both the earliest stage in the surveillance process and central authorities to assess whether the data matches and how any differences might have occurred. This may also reveal a difference in the level of detail for each data point, for example the exact location of a case may be provided at the health centre/veterinary station level but reduced to only a geographical region once data reaches central authorities. This summarising of data as it moves up the chain may also indicate the best level at which to access data to inform impact assessment.

Dogs may be accessed by an intervention clinic one or more times. This may involve treatment for injuries, surgical neutering or may be as simple as a single vaccination, dipping or deworming at a field station. Whatever the nature of the intervention, this provides an ideal opportunity to collect relatively detailed information about individual dogs. Note that the suggested data to be collected later in this section may need to be amended dependent on what infections/diseases are most relevant locally and what the clinic can provide in terms of treatment.

In many locations, local vets will also be providing preventative and curative treatments. If these vets are incorporated into the intervention the basic clinic data from these vets would ideally also need to be collected as this can measure change in relevant indicators.

Note there are issues with dog owner/client confidentiality which may require this data to be anonymised and/or the clients to give their permission for the data to be used.

Photo: © World Animal Protection

# Methods of Measurement: Clinic Records



Questionnaire surveys
Participatory Research
Street Surveys
Secondary Sources
Clinic records
Behavioural Observation
Vaccination Coverage

## Relevant impacts

Data collected through clinic records can be used to measure indicators relating to dog welfare, dog population stability and care provided to dogs, specifically reflecting owner engagement with the intervention over time. The specific indicators include:

- Indicator of dog health/welfare
  - Reduction in the % of dog with BCS 1 (or BCS 1+2)
  - Reduction in the % of dogs with a visible skin condition (can also include changes in types of skin condition if diagnosis was possible)
  - Reduction in specific diseases targeted by the intervention
  - Reduction in % of dogs with a TVT seen either at clinic exam or during surgery
  - Female:male ratio gets closer to 1:1 – female dogs are no longer neglected/killed as their unwanted litters can now be prevented. Note that if the clinic catches or invites one sex over the other this will bias the sample and the female:male ratio will not be representative of the wider population
- Indicator of population stability
  - Adult annual survival
  - Increase in the proportion of old dogs in the population (old / puppy+juvenile+adult+old); this indicator is only possible to measure with clinic records where the treatment is regular (e.g. vaccination or deworming) and not a one-off, i.e. sterilisation. Where sterilisation is being used the population accessed by the clinic may start to skew towards the younger age groups as the majority of older dogs have already been sterilised
  - Decrease in the % of lactating females or pregnant females and changes in seasonal patterns of breeding.
  - Indicators of the quality and value of the service and also responsible dog ownership by owners
  - Increase in the proportion of dogs that are re-treatments
  - Increase in the number of dogs that are brought by owners or carers rather than caught by staff
  - Increase in the average donation/payment per dog or reduction in the size of the difference between intervention veterinary costs and donations/payments from owners (this takes into account changes in the costs of the intervention)
  - Reduction in the number of unwanted but otherwise healthy dogs euthanised

## Biased sample

It should be noted that the dogs coming through an intervention are very likely a biased sample, i.e. they are 'special' in some way. They have come to the intervention for a reason, either to do with their owner, carer or in the case of unowned dogs, dog catchers. This means these dogs may, or may not, be a good representation of all dogs in the wider area and so conclusions about general dog population welfare must be drawn with caution. If the percentage of dogs passing through the intervention is high (e.g. 70% of the dog population is brought/caught for rabies vaccination), this is a very large sample and changes in indicators measured from this population of dogs may be sufficient for monitoring intervention impact without any attempt to extrapolate to the wider dog population. However, any changes to protocol that could impact on which dogs are brought by owners/carers or caught by intervention staff must be noted down and made available during later analysis and interpretation of the data. For example, changes to the messaging about services provided by the intervention may target different type of dogs; for example advertising early age neutering may skew the dogs brought to the intervention towards younger dogs, or advertising free or low-cost parasite treatment may increase the proportion of dogs with skin condition brought to the intervention.

Note that for veterinary interventions much more information may be collected on individual dogs than will be necessary to ensure good quality of care. The following is limited to information that is suitable for monitoring and evaluating population level changes and hence is not an exhaustive list:

**Data to collect for each dog**

- If the dog is brought by an owner
  - Dog identification, at least name but microchip or tattoo if present and digital photograph if possible (note tattoo character length can be minimised by using an alphanumeric code)
  - Owner name and address, including postcode, borough or ward to allow for aggregation of data to geographical areas
  - Amount paid/donated by owner
- If dog is brought by a carer (they do not own the dog, but they have accepted responsibility for bringing them for veterinary care)
  - Exact address of where they collected the dog
  - Amount paid/donated by owner
- If dog is caught
  - Exact address of capture including GPS coordinates if available (e.g. by using a mobile smart phone)
- Age of dog. Record this as accurately as possible, but at least whether the dog falls into the 4 categories of;
  - under 4 months (puppy)
  - 4 months-11 months (juvenile)
  - 1-5years (adult)
  - over 5 years (old dog)
- Gender
- Reproductive status. Castrated/spayed, unsterilised, pregnant, lactating.
- Body Condition Score. 5-point score (see Annex A)
- Skin condition. Presence or absence of a visible skin condition. Diagnosis of cause if known.
- Any concurrent illness, infection or injury.
- Transmissible venereal tumour (TVT) at clinic exam. Presence or absence of a TVT
- TVT at spay/castrate. Presence or absence of a TVT (it's important to separate TVTs that were discovered during surgery from those that were visible at clinical exam, as the prevalence will differ)
- Treatment provided
  - Is this the first visit for the dog or repeat visit?
  - What treatment was given (e.g. sterilisation, vaccination, deworming, dipping, wound treatment, etc)?
  - If euthanasia, categorise by reason for euthanasia: physically unhealthy, behaviour problem (as perceived by owner to be unmanageable) or unwanted by owner for other reason (i.e. the dog is physically and behaviourally healthy)

## Tools available for data recording

Clinic records can quickly become very numerous and therefore difficult to handle, hence a data collection tool is particularly useful. Microsoft Access databases can be developed for specific clinics, including drop down lists to reduce entry error on common terms (e.g. municipalities in addresses, treatment type, gender, reproductive status). Ideally data is entered straight into the database at the clinic; this is supported by having the database hosted on a laptop or on an online system to allow access by several devices, including mobile phones.

There is an Access database available to download for free from www.conservationresearch.org.uk/Home/ICAMCoalition.html. This is designed for recording clinic information from interventions that access unowned dogs for sterilisation and vaccination and was developed to suit the Animal Birth Control (ABC) approach of DPM used in India and includes the data requirements outlined in 'The Standard Operating Procedures for implementation of the Animal Birth Control (ABC) Programme' published by the Animal Welfare Board of India (AWBI, 2009).

### Survival estimates of roaming dogs utilising clinic data

Interventions can provide an opportunity to apply a permanent individual mark to a dog, such as a microchip or tattoo; most commonly this will be whilst the dog is anesthetised for sterilisation. After these dogs have been returned to their owners (or the point of handling in the case of unowned dogs) there can be opportunities for a sample of these dogs to be accessed again and their individual marks read. Example opportunities include during booster rabies vaccination; re-catching for treatment or accidentally because a mark has been missed; or re-catching a sample of dogs just to read their individual marks. These dogs will provide a sample of the population that are known to have survived for a specific length of time, from the date the marked dog was released to the date of reading. This is only possible if accurate clinic records have been maintained.

A program can be downloaded and installed to estimate adult survival from a sample of re-accessed individually-marked dogs from www.conservationresearch.org.uk/Home/ICAMCoalition.html. This program also allows for the inclusion of dogs that passed through the intervention in a period of time before individual marking was introduced; these dogs would carry a mark (such as an ear-notch) to show they had been intervened but no individual mark (such as a tattoo). The proportion of these dogs as compared to individually-marked dogs can also be used in the estimate so long as the date of commencing individual marking is known. This was included because interventions commonly do not individually mark successfully from intervention outset. Adult survival is assumed to be independent of age but a stable age structure assumption is not required. Instead we need to know the date of every release of a marked dog since the start of the intervention and whether it was marked as a puppy. We also need to know the date on which individual marking commenced and the date of re-reading the individual mark. In addition to adult annual survival we then need two further parameters, the probability that a surviving released dog is included in the sample (the sampling effort) and a possibly reduced survival for those dogs neutered as puppies – in the computer program referred to previously, these have default start values and precise values are calculated by the program as described later. Those parameters then give the probability of survival and inclusion in the sample for each individually marked dog and also the expected number of dogs in the sample with an intervention mark (such as an ear notch) but without an individual mark. That number has a Poisson distribution about its expectation whereas the appearance or non-appearance of each individually marked dog in the sample become the outcomes of a sequence of Bernoulli trials and hence combine to form a likelihood that can be maximised with respect to the three parameters. The method has the potential to include covariates of the survival probability, certainly the sex of the released dog if both males and females are included in the intervention but perhaps also factors such as the type of intervention used, e.g. the method of neutering operation used.

# Methods of Measurement: Behavioural Observation Method



The behaviour of animals can be a very visible reflection of their underlying welfare state and can present welfare challenges in its own right, for example in the case of injuries from fighting. Similarly the behaviour of people towards dogs can have a very real impact on the dogs' welfare state, both positively and negatively. By repeatedly and unobtrusively observing dogs and people together in their 'natural' habitat, we can record the nature of their interactions and how this changes over time.

## Relevant impacts

Data collected through behavioural observations can be used to measure indicators relating to dog welfare, dog population stability and public perception/tolerance of dogs:

- Indicators of dog welfare
  - The percentage of amicable interaction out of the total of all dog-dog interactions
  - The percentage of aggressive interactions out of the total of all dog-dog interactions
- Indicators of dog population stability
  - The percentage of mating interactions out of the total of all dog-dog interactions
- Indicators of dog welfare and human tolerance
  - Percentage of positive human behaviours out of total of all recorded human-dog interactions.
  - Percentage of relaxed human-dog interactions out of total of all recorded human-dog interactions.
  - Percentage of negative human behaviours out of total of all recorded human-dog interactions.

## Assumptions

Time available for behavioural observation will be very limited. Ideally this will require less than 3 days for every monitoring event (with monitoring events happening once or twice per year). This means that video recording with later transcribing will not be possible, as this is labour and time intensive. All data will need to be recorded in real time. A phone or tablet event recording app would be very beneficial for this method.

## Sites

At least 12 sites from within the area serviced by the dog population management intervention are selected for their high densities of dogs and/or people, leading to a greater chance of observing interactions between dogs, and between dogs and people. Sites should be small enough that the entire area can be seen through a 180° scan without the observer needing to move, and they should also be observed at peak 'interaction time'; when interactions are likely to be most frequent. Examples include school gates at drop-off or picking-up time, bus stations at rush hour, squares/parks at lunchtime. As the same sites observed at the same time of day should be used over the monitoring period to reduce confounding variables, it would be wise to review a large number of sites and then select the best on the basis of several criteria.

**These criteria include:**

A. High frequency of interactions between dogs or between dogs and people. Some sites may provide both, but it is likely that most sites will be better either for dog-dog interactions or people-dog interactions. The sites should be selected to provide a balance of both.

B. Ease of observation. This will include accessibility of the site (do you need permissions to be there?), can you travel there easily and can you observe the site unobtrusively without disturbing either dogs or people?

C. In some cases there will be sites that are locations for a high frequency of complaints. Changes in dog-dog or dog-person behaviour at these sites may be politically important and so these sites will be worth including.

D. If the number of days available to complete the observation is short, sites can be selected with different peak interaction times to allow a number of sites to be visited in one day, shortening the total number of days needed to complete the observations.

E. Sites should be selected that are spaced far enough apart to limit the chances of observing the same dogs at different sites. One study in Chile found roaming male dogs had an average home range of 22.4 hectares (Garde et al., 2012); this would require sites to be spaced approximately 450-500 metres apart to limit the chance of observing the same dogs. One option would be to conduct a pilot behavioural observation study where all dogs are photographed to assess the overlap between sites. However, even with this level of planning these sites cannot be assumed to be completely independent.



# Protocol

## Pre-observation data collection

On arrival at the site the observer establishes the observation point (a safe position out of peoples' way but allowing maximum view of dogs and people; the same point should be used for every observation in future) and then records the GPS position of the observation point, characteristics of the site (e.g. it's a bus stop at rush hour), time, weather, number of dogs and number of people within view. If their arrival at the site proved interesting to either dogs or people, the observer may also need to wait quietly for a few minutes until their presence has become apparently irrelevant to both dogs and people.

## Observation

Behaviour sampling with continuous recording for 30 minutes of observation. If there are no dogs when the observer arrives or if dogs leave the site resulting in the total number of adult dogs falling below 2, the observation should pause and restart when at least 2 adult dogs appear back on site. The observation is considered complete once 30 minutes of observation have been recorded or if the observer has been present at the site for 1 hour, whichever occurs first. Only the behaviour of adult dogs should be considered, with a cut-off age of 4 months (i.e. under 4 months of age is considered a puppy and not included). The observer should aim to keep as much of the site in view as possible and if necessary keep their eyes moving around the site to maximise coverage.

**Record the outcome of every dog-dog interaction:**

- Every interaction that is observed within the 30 minutes of active observation is recorded.
- An interaction is defined as when the dogs are within 3 dog lengths of each other and are communicating with each other with body language and/or vocalisations. This need not include looking directly at each other as direct eye contact can be perceived as threatening, hence eyes may be averted during the interaction.
- Record the final outcome of each interaction as either aggressive, amiable, mating or neutral (see description of behaviours in each category that follows in table 1). Individual behaviours do not need to be recorded, just the final outcome of each interaction. Interactions may start with dogs appearing to behave in one way, but they can evolve through the course of the interaction, involving communication through body language or vocalisations, into a final outcome concluding with the dogs parting (more than 3 dog lengths apart and communication stops).
- If the dogs part and then rejoin for another interaction, that subsequent interaction can be scored again.

**Record the frequency of the following 'extremes' of human-dog interactions:**

- Positive human behaviours towards dog:
  - Person feeds a dog
  - Person pets a dog
  - Person calls a dog to come to them either using name or other friendly sounds (e.g. kissing noise, clicks, slapping thighs)
- Negative human behaviour towards dog:
  - Person hits or kicks a dog with any part of their body or an inanimate object like a stick
  - Person throws something at a dog to scare/hurt it (i.e. not throwing food to them), this includes 'sham' throws; person pretends they are throwing something at a dog to scare them
  - Person shouts or claps hands to scare a dog

Table 1 – Categorisation of dog behaviours during interactions between dogs, categorised into amicable, neutral, mating and aggressive (amended from ethogram used in Garde et al. (2012); an ethogram is catalogue or inventory of behaviours or actions exhibited by an animal and used in animal behaviour studies).

| Behaviour category | Descriptions of behaviours |
|---|---|
| Amicable interaction | Licks, paws, nudges with nose, or grooming between dog, often with tails wagging.<br><br>Play behavior including charges with bouncing gait, play faces (mouth relaxed, slightly open, teeth covered), wrestles and play chases. |
| Neutral interaction | Approach and retreat, often including sniffing, limited body language, non-demonstrative. Not aggressive but also not friendly. Includes non-reproduction related mounting, unless this is clearly part of play or ends in aggression. |
| Mating interaction | Copulation (not only mounting where one dog stands with forepaws on another), usually ending in a 'tie' |
| Aggressive interaction | Growling, teeth visible, barking, biting, fighting.<br><br>One dog flees with tail tucked to avoid other dog, cowers or rolls over. |

**See Annex B for example recording sheet**


# Methods of Measurement: Street surveys and Questionnaires for Measuring Vaccination Coverage



Vaccinating dogs is the most effective and humane approach to controlling rabies by eliminating disease from the dog reservoir. This section describes how vaccination coverage (the proportion or percentage of the dog population that has been vaccinated) can be measured following a vaccination campaign. As rabies vaccines that meet international standards are very effective, vaccination coverage immediately after a vaccination campaign has been completed can be equated to the level of herd immunity ('herd immunity' occurs when a sufficient proportion of the population has acquired immunity through vaccination, effectively creating a barrier to disease spread, such that the unvaccinated proportion of the population is also protected and the disease outbreak dies out rather than spreads).

## Relevant impacts

Vaccination coverage is not an indicator of impact but an indicator of effort (note that this may also be defined as intervention 'effectiveness' as it is a combination of the intervention effort and the community response to the intervention). However, when assessing the impact of an intervention on rabies impact indicators such as dog rabies cases, suspect bites and human rabies cases, a measure of vaccination coverage is necessary for attribution of the intervention.

## Marking

To measure the proportion of the dog population that is vaccinated in an intervention, it is necessary to mark every dog that is vaccinated, for example with a collar or non-toxic paint spray/stick (such as livestock paint/stock markers or vegetable-based dyes). Paint is preferable for young dogs to avoid them being harmed by collars as they grow and paint is much harder for people to remove than collars. Marking is most relevant for street surveys but also useful when using questionnaires to validate coverage (i.e. not only asking the owner if the dog is vaccinated but looking for the mark on the dog itself for confirmation), and when conducting campaigns to avoid vaccinating dogs twice or missing dogs. It is necessary to accurately record the number of dogs vaccinated and marked at each vaccination station/household location (some dogs will not be marked due to the owner's preference or dog behaviour, and the number of vaccinated but unmarked dogs should also be recorded).

Assessment of the proportion of dogs marked provides the data necessary for evaluating vaccination coverage, which will be the same as the proportion marked (unless a significant proportion of vaccinated dogs were not marked). Assessment should take place as soon as possible after the vaccination campaign to minimize mark loss, ideally no longer than 3 days. Marks can be lost very quickly, for example in Tanzania 13% of vaccinated dogs lost their collars within one day of vaccination and 6% lost their spray paint mark (Cleaveland, unpublished data). Owners should be encouraged to retain the mark on their dog for as long as possible. During some interventions unowned dogs will also be sterilized at the time of vaccination and these dogs can be ear-notched whilst anaesthetised, providing a permanent mark with no risk of loss.

## Sample size

It is not necessary to observe the mark status of every dog: a sample of the population can be observed to get an estimate of coverage of known reliability.

**The sample size required can be calculated using the following equation:**

$$n = \frac{N}{\left(\frac{e^2(N-1)}{1.96^2 p(1-p)} + 1\right)}$$

Where,
$N$ = the estimate of the total dog population in the area being surveyed

$e$ = the desired level of precision, selected to be 10% in the example below, expressed as a proportion when used in this equation, so 0.1

$p$ = the target vaccination coverage, usually set at 70%, expressed as a proportion when used in this equation, so 0.7

$n$ = the sample size required to be 95% confident that when 70% vaccination coverage is estimated the true coverage is within 10% of the target, i.e. 63%-77% (using e = 0.1 and p = 0.7)

Note that this does require the total dog population to be estimated, although 'guestimates' (i.e. estimates known to include some level of error) will be the reality in many cases.

## Street surveys

When using street surveys to assess vaccination coverage, the mark status of every dog seen should be recorded, whether roaming or confined. When the required sample size (*n*) is 30% or more of the total population (N), which is the case until N is approximately 190 dogs, it will be necessary to survey all streets to observe a sufficient sample size, based on the experience that on average between 30-50% of the total roaming dog population is seen on any one survey. Once *n* is below 30% of N the survey can be done along a sample of streets to save time. This sample of streets needs to be selected without bias to where vaccinated dogs are located (e.g. not only the streets surrounding the vaccination station location).

One option for selecting the sample is to create a zig-zag track across the survey area. This can be done in Google Maps using 'My Places' and 'Create with Classic Maps'. A zig-zag line can be drawn across the whole area using the 'Draw a line' function, then the 'Draw a line along roads' function can be used to create a track along the roads that fits as closely as possible to the original zig-zag line. This should create an unbiased track that covers both small and large roads.

If Google Maps is not available the same approach could be achieved using a compass; starting at one side of the survey area and heading on a set course (e.g. NE) until the opposite edge of the survey area is reached, taking whichever road seems to fit closest to the course, then returning across the survey area this time taking the course at 90° to the original setting (e.g. NW), repeating these transects until the survey area has been covered. If an insufficient sample size is achieved the same approach is repeated starting at a different point on the periphery of the survey area.

A similar approach has been trialled in semi-rural and rural areas of Tanzania (Hampson and Cleaveland, *pers comm*); instead of starting at the periphery of the survey area the observers are asked to start three transects at each of several common locations; a church, school (often at the periphery of the village) and vaccination station (often at the centre of the village). The direction of surveying is chosen by spinning a pen or bottle. This provides a consistent but unbiased (with regards to dog marking) selection of starting points common to many village locations and avoids the need for a compass or access to Google Maps.\

## Questionnaires

Where the majority of dogs are judged to be owned and confined a questionnaire will be more suitable for measuring vaccination coverage, either using a door-to-door approach, passer-by survey or using a telephone survey. Passer-by surveys are a form of 'convenience sampling' as they make use of convenient opportunities to access large numbers of people, hence they can shorten the time needed to access a minimum sample of dog owners to ask whether their dog has been vaccinated. It is important to try and limit any bias produced by the sampling; for example by choosing several convenient opportunities that will provide a sample of people from a mix of socioeconomic backgrounds. Potential opportunities to access samples include asking children at school if their dog has been vaccinated, people waiting at bus stops or shoppers at grocery shops/markets. Telephone surveys will only be suitable if landline penetration in the area is good; however with increasing exclusive use of mobile phones the ability of telephone surveys delivered through landlines to produce representative samples of respondents is reducing, and as the geographical location of the respondent is essential for this survey using mobile phones or internet to deliver the survey is not possible.

When surveying in a relatively small area (N, the estimated total dog population < 190 can be used as a potential cut off) it may again be most suitable to use a house-to-house approach along every street; the frequency of stopping at houses to deliver the questionnaire will depend on the size of *n* in proportion to *N*; e.g. where *n* is 50% of N stop at every other house to deliver the questionnaire, when *n* is 30% of *N* stop at every 3rd house. In larger areas where *n* is less than 30% of *N*, alternative sampling approaches can be used. One approach is the WHO Expanded Programme on Immunization cluster-survey technique[4]. This uses two stages of sampling: 1) selecting a sample of villages or wards and then 2) selecting a sample of households within those villages or wards. For example in Thungsong District, Thailand a sample of 384 households were selected from an initial random sample of 30 clusters (villages) and then a random sample of at least 13 households (until at least 7 dog-owning households had been found) were selected per village (Kongkaew et al., 2004).

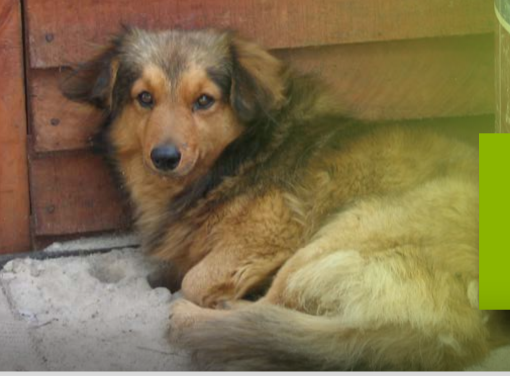
The questions included in the questionnaire can be very limited; simply asking if people have a dog and, if so, whether it was vaccinated in the recent campaign or within the last 12 months via some other route (e.g. private veterinarians or animal health workers). Additional

[4] See http://whqlibdoc.who.int/hq/2005/who_ivb_04.23.pdf for a WHO reference manual on this technique

questions can be asked, for example about whether the marks applied at the vaccination campaign are still present (this will be particularly useful if there is a concurrent street survey being used) and if a dog is found unvaccinated why they were not vaccinated through the campaign. The questionnaire can, of course, be expanded further to help measure indicators other than vaccination coverage (see Section 'Questionnaire surveys' for more details).

## Comparison between methods

When street surveys and questionnaires have been compared, the results were relatively similar if a sufficient sample size had been achieved in each method; for example Cleaveland et al. (2003) found 62.1% coverage estimated through street surveys and 67.8% estimated from questionnaires in Tanzania. Potential biases are that street surveys tend to miss puppies which are often poorly reached through vaccination campaigns and this leads to an overestimation of coverage. Street surveys also tend to miss confined dogs which are more likely to have been vaccinated leading to underestimation. One option where both confined and roaming vaccinated dogs exist is to run a combination of majority 'resource-light' street surveys and where this indicates the coverage may be marginally below or above target to then follow-up with 'resource-heavy' questionnaires to provide another measure of coverage.



# Making Your Impact Assessment Robust



Selecting the appropriate impacts, indicators and methods of measurement for your intervention is an important first step in conducting an impact assessment. This section further explores other factors to keep in mind as your plan and implement your impact assessment, highlighting ways of increasing the robustness of your evidence.

## Ethical review

In this guidance we have selected indicators and methods of measurement that minimise animal suffering. However, it is good practice to conduct an ethical review of the indicators and methods of measurement that you plan to use for impact assessment, in addition to an ethical review of intervention itself, in particular veterinary and animal care activities that can affect welfare. Such ethical reviews are also a requirement for publication in many peer-review journals and may also be part of legislation covering research involving animals. The overarching principle of ethical review is to ensure that the potential risks are balanced by the likely outcome of the research and hence it encourages investigators to minimise harm and increase potential benefit through selection of the least invasive methods possible and good experimental design. By using non-invasive techniques such as observation (e.g. street survey and behavioural observation) this minimises the risks to the animals and the balance is favourably tipped. For a more thorough discussion of ethical reviews, and guidance on how to conduct them, see RCVS and BVA (2013).

A key question of your ethical review is whether there is the potential to cause 'pain, suffering, distress or lasting harm' through any of your methods of measurement, the threshold of pain that is used is that of introducing a hypodermic needle through the skin. In the case of taking blood samples purely for reasons of surveillance, there is potential to cause harm and an ethical review should be conducted. In some countries, such a procedure would also fall under animal testing and procedures legislation and an additional licence may be needed. Where a blood test is taken in the course of veterinary treatment and a small amount (10% or less) is used for surveillance, this may fall outside of animal testing and procedures legislation as the primary purpose was to treat the animal and no additional harm was caused. Where data is being collected from owned animals (e.g. questionnaires or clinic records) the informed consent of the owner to use the data for impact assessment should be asked and clearly recorded. This data will need to be securely stored and not shared with agencies outside of those responsible for the impact assessment, especially when the owner's details need to be maintained to allow for longitudinal study, if follow-up is not required the data can be anonymised to maintain confidentiality.

Setting up your own ethical review board is possible but may be quite time consuming. An alternative is to access an ethical review board through local research institutes, who usually have a committee already formed. As this ethical review should be conducted before the data collection starts this may also be a good opportunity to create collaboration to access further support, such as data analysis and interpretation.

# Attribution and measuring your intervention effort

This guidance focuses on collecting indicator data relating to impact. However, evidence that impact has occurred needs to be presented alongside evidence of intervention effort and causality; for example, was it your intervention that caused the improvement in dog welfare or some other change in the environment? This is commonly termed **attribution**: can the change in the impact be attributed to your intervention or was this change caused by something else?

Establishing attribution can be supported from the outset by developing impacts that can realistically be achieved by your intervention, where a causal link can be logically argued between your effort and the impact (this was introduced as a 'theory of change' in the section on 'Identifying Dog Population Impacts'). For example, a reduction in nuisance complaints relating to dog reproductive behaviour can be logically linked to an intervention that sterilised a significant proportion of the roaming dog population, especially if a reduction in lactating females was observed over the same time period. However, the same intervention (assuming no vaccination was involved) could not claim to have reduced rabies prevalence and any observed reduction must have been due to some other change in the environment, such as a dip in the natural oscillations of the disease. Conversely, an intervention that focused on rabies vaccination of dogs, and not sterilisation, could not claim to reduce reproductive behaviour of dogs.

Attribution can also be supported by focusing monitoring and evaluation on the intervened population only and not spreading out beyond the immediate population where impacts may become too diluted to be visible. Further testing of attribution requires robust experimental design, as described further in the following section.

## Elements of robust experimental design

Although most DPM interventions are not initially envisaged as 'experiments', rather they are developed for social good, by utilising experimental theory they can be set-up to provide robust evidence of intervention effectiveness. This section highlights some of the key elements of experimental design that are applicable to DPM interventions. Although including all elements could be considered a 'gold standard' and may not be achievable for all, including any of these elements could improve the quality of any future impact assessments.

Perhaps the most fundamental element of experimental design is using a matched control. This is a population of dogs (and their associated people) where no intervention has taken place but the dogs experience a similar environment and ownership style. The dogs that have received the intervention are termed the treatment group. For example, in Jaipur the number of human rabies cases reported by the hospital from the intervened portion of the city was compared to those in the non-intervened outer ring of the city and found to be lower (Reece and Chawla, 2006); note that the intervention was spread to the entire city after a few years as the beneficial impact was so clear, hence this control no longer exists within Jaipur. An alternative is to have a control group where only a standard intervention is used and a treatment group where additional aspects are used; this is usually used where the standard treatment is expected to have a beneficial impact and withholding such a benefit from people or animals in the control group would be unethical. An example is mass vaccination for rabies control in one group of control villages and mass vaccination plus sterilisation in another group of treatment villages; then comparing indicators related to rabies control between these two groups to assess whether sterilisation contributed positively to rabies control. The approach of a standard intervention as a control and additional aspects as a treatment may be more realistic, as a complete absence of dog management is relatively rare, especially if the actions of individual owners to control their own dog's contribution to the population are defined as part of an intervention.

Note that ideally there would be several treatment groups and several control groups, termed replicates. This is because you would expect variation in all impacts over time and by having several groups of each type you will have a measure of this variation. You can then compare this to the difference between the control and treatment groups and ask the question, is this difference between the control and the treatment greater than the variation within the treatment groups? If yes, this intervention has been effective at creating the desired impacts.

Another form of control is a temporal control. This is the period before an intervention starts (sometimes called a baseline) and can be used for comparison with the period during or after the intervention. Ideally both temporal and location controls are used together, in other words the pre- and post- intervention periods are compared for both treatment and control groups as well as comparing the different responses of treatment and controls during the intervention. One example of replicated treatment and control groups combined with use of temporal controls is from Cleaveland et al. (2003); all villages (>40) in the Serengeti district were selected as treatment villages (dogs vaccinated against rabies) and 10 villages were selected randomly from the neighbouring district as control villages. The effect of vaccination in the treatment villages resulted in a reduction of dog rabies cases and suspect bites when compared with the control villages. This significant reduction in rabies cases in the treatment villages was also found when data was compared to the pre-intervention period. This finding strengthens the evidence that vaccinating dogs against rabies, lead to a reduction of dog rabies cases. The study also found that the number of dog rabies cases stayed the same in the control villages across both the pre-intervention and intervention period, and the suspect dog bites showed a slight but non-significant increase in the intervention period as compared with the pre-intervention period. The slight increase in suspect bites was due to the intervention providing an improved supply of human rabies vaccine to all villages during the intervention, hence people were more likely to seek bite treatment from their local health centre as vaccine was now available, where previously supply had been intermittent.

The most rigorous approach is the cluster randomised control trial, where the locations that will be treated/intervened and those that will act as controls are selected at random. This ensures any pre-existing differences between the locations do not bias whether they are selected for intervention. There is also replication of both controls and treatments; this is what leads to the term 'cluster'. One example of this approach is provided by Mazloumi Gavgani et al. (2002) who randomly selected a control and treatment village from 9 matched pairs of villages in the provinces of Kalaybar and Meshkin-Shahr in northwest Iran. These villages had been matched for leishmaniasis prevalence in children, so the design was a matched-cluster randomised control trial. They used deltamethrin- impregnated dog collars in the treatment villages and found a reduced incidence of leishmaniasis in dogs and children in the treatment villages compared to the control villages. By using a cluster randomised control trial the authors have removed several potential factors that could have produced this result other than the treatment itself; creating very robust evidence for the effectiveness of deltamethrin- impregnated dog collars on Leishmaniasis.

In reality, the use of a control group in dog population management is extremely rare, perhaps because the resources required to monitor and evaluate both treatment and control locations has been perceived as too large. However, we would strongly encourage this approach wherever possible as we can be more confident of attribution from the DPM intervention. Even if randomisation is not possible and only a subset of the indicators can be measured in the controls at baseline and beyond, the inclusion of a matched control can strengthen the evaluation results considerably.

As mentioned previously, the benefit of using a control group or groups is that they capture the natural variation in impacts that would have occurred over time regardless of your intervention. These variations can include confounding variables; those factors other than your intervention that influence your indicators. For example, an intervention that uses rabies vaccination of dogs to reduce human rabies cases may find that improvements in the availability of post-exposure prophylaxis (PEP) for people bitten by dogs will also reduce human rabies cases. These confounding variables should be identified when evaluating the impact of an intervention. At the planning stage, all likely confounding variables should be established so that these can be measured as well as the intervention effort. In some cases, these confounding variables can be controlled for or even avoided with good experimental design. For example, an intervention that includes providing low-cost surgical sterilisation in a deprived area may be hoping to see a reduction in the percentage of roaming lactating females. However, the percentage of lactating females may also affected by the time of year due to one or more peaks in breeding, hence time of year can be a confounding variable for some locations. Although the seasons cannot be controlled, their influence on indicators can be minimised by only comparing the percentage of lactating females recorded at the same time of year. There are many other examples of avoiding the effect of confounding variables on indicators. These include conducting street surveys at the same time of day, avoiding extremes of weather that will affect dog behaviour, introducing questionnaires in the same way and avoiding unusual days like holidays when different people will be at home.

To ensure monitoring and evaluation has the best chance of exposing a real change in an indicator, the method of measurement used needs to be reliable. The need to be reliable extends to the observers conducting the measurement as they are an important source of potential error and the Section 'Increasing and testing observer reliability' explains how this can be tested and minimised. Furthermore, a systematic bias could result from the desire of the observer measuring the indicators to see a change, as might be expected when that person is involved in running the intervention. They have a vested interest in wanting to see that the intervention has worked and so, even subconsciously, may record data more favourably over time. One way of avoiding this is to use independent evaluators that have no reason to want to see a change in a certain direction. Even more powerful would be to ensure the observers recording the measurements are unable to identify which is the intervention and which is a control areas – this is referred to as a blind experiment – this ensures an observer could not contribute bias to the results even if they wanted to. In reality, using blinded independent evaluators may not be possible for many interventions due to cost (although one cost effective option could be to swap staff between different interventions for monitoring and evaluation events) and also the ability to truly blind someone from an intervention when the dogs themselves may carry marks indicating they have been through the intervention. However, it is a gold standard to aim for whenever possible. Where not possible the people measuring the indicators have to be conscious of their inherent bias and fight against these, trying to remain objective throughout their monitoring and evaluation work.

## Measuring intervention effort

Measuring intervention effort is essential for attributing change in impact indicators to the intervention itself, and managers need to have documented what they have done to bring about change. This is focused on the immediate results of the intervention. However, inputs, the time and resources to implement the activities, should also be measured as these will be important for assessing the efficiency of the intervention. For example, an intervention that offers low-cost sterilisation needs to record the finances required to run their clinic (the inputs), the number of dogs that come through their clinic for sterilisation and treatment (the intervention effort, see Clinic records for more details), and also what proportion of the dog population this represents in their intervention area.

The intervention also needs to have described a logical chain of steps leading from the intervention effort through to the impact (this was introduced as a 'theory of change' in the section on 'Identifying Dog Population Impacts'). By providing evidence of intervention effort and change in impact indicators, alongside a logical explanation of how this intervention has influenced the impacts, managers have a foundation from which to attribute the change to their intervention. Accurate recording of inputs will also allow additional questions about cost effectiveness to be answered.

In addition, measuring some indicators of impact will require accurate records to have been made during intervention implementation, including *when* dogs were accessed by the intervention. For example, calculating survival of unowned dogs requires knowing when the dog was last handled by the intervention (requiring a combination of individual identification and records showing when that dog received its individual mark). Ideally all this data should be stored using a database that allows for later analysis rather than on spreadsheets (which are more difficult to manipulate) or on paper. There are many database systems available, for example 'Access' available from Microsoft Office, and also online databases that can allow access from a number of computers. Whichever software is chosen the database must be backed-up to avoiding losing data.

## Sampling

Sampling methods and sample size will be a consideration for all methods of measurement. This starts with identifying the target population: which dogs and/or people across what area does our intervention intend to impact upon? If this target group of dogs and associated people is small, the methods of measurement can be applied to the entire population; this would be termed a census. However, the target group is usually too large to affordably census on a regular basis and so just a sample of dogs and/or people are chosen to represent the wider group; results drawn from this sample are used to infer changes occurring in the wider group, with the acceptance that there will be a level of error in the inference as a result.

Sampling is broadly done in two ways, simple random or stratified random. In a simple random sample, every dog or person has an equal chance of being picked, for example stopping at every 10$^{th}$ house to ask a household questionnaire. In a stratified sample, some dogs or people have a known greater chance of being selected than others. A stratified random sample may be used when your target population clearly appears as sub-populations of different sizes with important differing characteristics related to your impact, and you don't want to run the risk of missing a sub-population when using a random selection. For example, consider a situation where dogs living in a large rural area have poorer welfare and greater disease risk than those living in a small urban area within your intervention zone. You may wish to select more dogs from the rural area for your sample and fewer from the urban area. Knowing the different chances of selection for these different sub-populations that make up your sample will be important at the analysis stage and also for repetition during future monitoring events.

Planning to apply the method of measurement to an appropriate sample size will also be important; too small and there is little chance of exposing a change in an impact indicator, too large and there will be wasted resources on unnecessary measurement. Establishing an appropriate sample size can be done statistically using power analysis, before you begin the bulk of your data collection; this essentially describes the 'power' your data will have to expose a change in the indicator, if a change has truly occurred. The power of your data will be increased by increasing the size of your sample, increasing the size of the change you want to expose (e.g. a reduction in the percentage of emaciated or thin dogs in the population by 20%, rather than 10%) and increasing how risky you are willing to be about the accuracy of results (e.g. will you accept being 80% confident that the results are accurate? In other words, is 20% an acceptable risk that your results are actually wrong?). Conducting power analyses is usually done mathematically and will require the support of a statistician who should also be able to advise you on what statistical tests will be most suitable and most powerful for your data. They will need to know the indicator you are interested in and how it will be measured. What is the size of the effect that you want to measure, so what is the baseline value of your indicator and what target do you have in mind as a definition of success, e.g. a 10% reduction from baseline of 50%? How much risk are you willing to accept regarding the accuracy of the results? They will also need some idea of variability or error in your measurement; for example, if you repeatedly measure the body condition score of the same group of dogs over a very short time frame, how much does the % of the population scored as thin or emaciated change? This last question can be answered by pilot testing your methods on dogs or people. Note that improving your measurement to reduce any errors will also help increase the power of your data to expose a change.

Preparing and conducting power analysis clearly requires time and the resources of a statistician, but is the ideal approach to ensure your monitoring has the best chance of resulting in accurate evaluation. Where this is not possible a general approach is to increase the sample size to the maximum you can afford whilst still being able to repeat your measurements over time, which is the core characteristic of evaluation.

## Consistency in method

Selecting an appropriate size and composition of sample will help to ensure the data resulting from your measurement is accurate and representative of your target group of dogs and/or people. However, perhaps even more important is maintaining a consistent and precise protocol for how the method of measurement will be conducted, as this will reduce error in your data resulting from variations in how the method was carried out. Even where a sample is accidentally biased towards a group of dogs or people, if the selection criteria and method are consistent, the data will accurately expose a change in this biased group, if such a change has truly occurred.

Inconsistency can come from many sources, including differences between observers (see later section on 'Increasing and testing observer reliability' for an example of this) and failure to develop and consistently apply a standard method, leading to changes in the sample selected or protocol used for measurement over time (e.g. the introduction used by an interviewer when conducting a questionnaire changes over time because it was not written down initially, a different introduction can influence the answers given by the interviewee).

Ensuring there are complete and accurate records of all methods used, and allowing time to familiarize and train people to the same standard, will help to reduce error in the data. Logistically this may be supported by assigning a lead person(s) to be responsible for monitoring and evaluation of the intervention with consistency as a key indicator of their performance.

## Increasing and testing observer reliability

The aim of monitoring and evaluation is to explore and expose changes in targeted impacts. In order to do this, methods need to measure changes in the indicators as precisely as possible. One of the challenges to this will be reliability in measurement (first introduced in the section 'Attribution and measuring your intervention effort'). A potential source of error that can be mitigated will be the effect of the person that conducts the method of measurement. As far as possible, the staff involved should be consistent and make every effort to score in the same way at each monitoring event. However, staff changes are inevitable and people can also unintentionally drift in their approach and assessments, especially as some changes will be slow and will require several years of monitoring to become apparent. In order to overcome this challenge, every monitoring event (even if staff are the same) should include a period of refresher training where the protocols are reviewed and discussed in detail. Ideally, a bank of photos is built up of dogs in varying body and skin condition that can be used for refresher training on scoring the body and skin condition of dogs.

Further, key indicators can be checked for inter-observer and intra-observer reliability. Inter-observer reliability is a measure of how much agreement, and disagreement, there is between the different people involved in conducting the method of measurement. Intra-observer reliability is a measure of how consistently the same person scores over time. The following is an example of testing inter-observer and then intra-observer reliability in scoring body condition. This should be carried out before any monitoring event and at regular intervals:

### Body condition score training and agreement test

The body condition score recommended in this guide is a 5-point scale (Annex A) requiring observation only with no need for physical examination. The indicator produced through body condition scoring is the percentage of the adult (non-lactating) population that is body condition score 1 (emaciated) or 1 and 2 (emaciated and thin). Methods of measuring body condition include street surveys and clinic records.

Before either method of measurement is conducted, all observers that will be scoring dogs should review the protocol and category descriptions in the body condition score tool (Annex A), and together discuss and score at least 20 dogs of varying condition to ensure they have the same understanding of the tool. This can either be done using photos of dogs or by directly observing dogs in the street, shelter or clinic environment. A powerpoint presentation to help with this training titled 'Dog body condition scoring using visual assessment' is available on the www.icam-coalition.org website. Ideally at least some direct observation of live dogs should be done in the environment matching the method of measurement they will be using; i.e. in the street if they are to score dogs during a street survey and in a clinic if they will be scoring as dogs pass through an intervention. This should be done both by new observers, and people who have conducted these methods before, in a group together.

Once they have taken part in the training and agreed through open discussion, the body condition scores for at least 20 dogs, observers can then take part in an inter-observer test. The following is a suggestion for how this test could be run, based on the process developed by AssureWel (www.assurewel.org):

### Inter-observer test

The observers are asked to score test sets of 10 photos of dogs. You can develop your own test sets or you can access test sets in the form of an online quiz at www.icam-coalition.org. This online quiz is comprised of dogs falling into different categories of body condition score. The photos are presented in a random order and the observers select the body condition score for each dog. The quiz gives you immediate feedback on whether your assessment was correct or incorrect.

If the observer scored less than 9/10 correct, they are advised to review the powerpoint presentation 'Dog body condition scoring using visual assessment'. You can also discuss the photos in this presentation to help identify anatomical features that may have been missed. They can then retake the quiz. If they scored 9/10 or 10/10 they also need to retake the quiz again as observers need to score 9/10 or 10/10 on two consecutive sets to pass the test and be considered proficient at visually assessing body condition score. If they score below the 9/10 threshold on a set they need to start again with at least a further 2 sets before 2 consecutive pass scores can be achieved. For an observer who scores 9/10, or more, on two consecutive sets you can be 85% certain that they can score dogs for body condition with at least 80% accuracy (binomial distribution, with $n$=10 and $p$=0.80).

As the aim of monitoring is to evaluate change over time, consistency in scoring over time (intra-observer reliability) is just as important as agreement between observers (int¬er-observer reliability). Hence observers should retake the quiz at the outset of the next monitoring event following a period of refresher training.

Test sets can also be built-up specific to a location. Ensure that photos are at high resolution and in sharp focus (this is especially relevant for scoring the presence of ribs) so that they can be shown on a large computer screen or projected. The full body of the dog should be visible, showing both one side and at least the lower part of the back, so that both hip bones and the vertebrate can be seen if prominent, plus the extent of the waist. Ensure that dogs from the full range of categories are present in the test set in approximately the proportion you would expect to see in the location.

Once in the field, reliability can be informally tested by observers working pairs and asking each other for confirmation of a score. Discrepancies can be talked through and where agreement can't be reached the observers can refer back to the original definitions of each score and even take a photo of the dog(s) for discussion with a wider team after observation is concluded.

## Using your results

This guidance aims to help intervention managers to decide *how* to measure their impact, by selecting the most meaningful indicators and suitable/affordable methods. However, perhaps the hardest job falls to the intervention managers to ensure monitoring is actually done; that time is made for analysis and interpretation; learning and improvement occurs, along with dissemination of results to others.

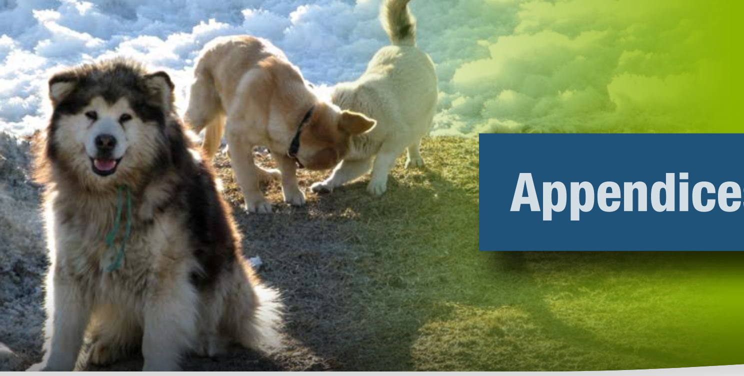
This process can be helped by developing a monitoring and evaluation plan. This can include: a detailed description of each indicator along with the impact it measures; a detailed protocol for the method of measurement and associated budget and timeline for when this should be conducted; name(s) of people that will be responsible for ensuring the method is conducted and data reported; and finally a plan for regular but infrequent evaluation 'events'. Evaluation events are workshops where relevant project staff and representatives from wider stakeholders, potentially including donors, come together to review indicator data and assess the extent, or barriers, to change over time; resulting in an impact assessment of the intervention and suggestions for improvements.

Commitment to monitoring and evaluation will also be greater if designed from the outset as an opportunity to learn as opposed to the need to prove impact to external audiences. This uses as a starting point the learning that intervention field workers themselves need in order to implement the intervention more effectively, rather than the results that managers need to demonstrate impact to senior or external people. The concept is that evidence of impact will be an emergent property of the learning, rather than the other way around and is termed 'learning-based monitoring and evaluation' rather than 'results-based monitoring and evaluation'.

Part of the monitoring and evaluation process includes a phase of analysis and interpretation, requiring the support of someone with an understanding of data analysis. We recommend, if such expertise does not exist within the intervention team, that external scientific expertise is sought, potentially from universities, research institutes or donors, before monitoring begins. Building such a relationship from the outset ensures that data is collected in a way that supports later analysis to answer questions about how indicators have changed. For example, using sufficient sample sizes and using protocols that minimise potential confounding variables or at least concurrently collecting data on these variables so that their effect can be tested.

Returning to the subject of evaluation events, these set a deadline for when all the relevant data should be available for interpretation and learning. This helps to ensure those people collecting indicator data can see that it is being valued. It also ensures that data is not simply collected for many years, but that it is analysed and actually used for learning on a regular basis. The evaluation event can also finish with a reporting phase, to all intervention staff, community and government representatives, and donors. Wider dissemination to other interventions via project evaluation reports, media releases, conference presentations and peer-reviewed publications would allow more widespread learning. The ICAM Coalition in particular would value receiving such project evaluation reports and any information on performance of indicators/methods of measurement mentioned in this guidance or innovated by the intervention team.

# Appendices





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Through your insights we hope to help others make the world a better place for dogs and the communities amongst which they live.

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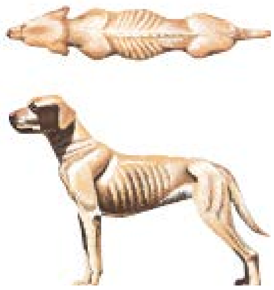
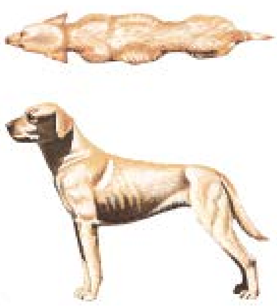
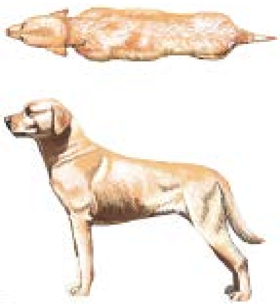
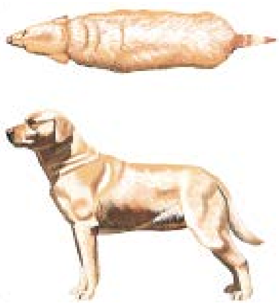
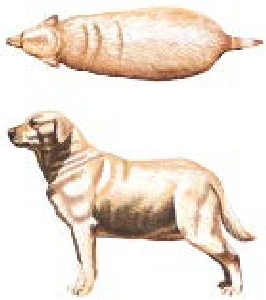
# Annex A: Body Condition Scoring

Body condition score is based on 4 main body areas; check each one in turn to assess score:

- **Backbone** – if clearly visible score 1, if not visible check ribs
- **Ribs** – if clearly visible score 2, if not visible check abdominal tuck

  *Note, do not include the final rib before the waist in your assessment, as this may be visible on some dogs even if they have good fat covering due to conformation*

- **Abdominal tuck** (area behind the rib cage where the abdomen is clearly smaller than the rib cage in score 3 and below) – if clearly visible score 3, if just visible score 4, if not at all visible score 5, then double check by viewing waist from above
- **Waist from above** – if clearly visible score 3, if just visible score 4, if no waist score 5

| | | |
|---|---|---|
| **BCS 1 EMACIATED**<br>Ribs, backbone, pelvic bones visible from a distance. Obvious waist and abdominal tuck. No body fat. |  |  |
| **BCS 2 THIN**<br>Ribs visible but no backbone visible. Some body fat present. Abdominal tuck evident. Waist visible from above. |  |  |
| **BCS 3 IDEAL**<br>Ribs not visible even on close inspection. Waist visible from above. Abdomen tucked up and in, lower line of tummy slopes upwards from end of ribs to back leg. |  |  |
| **BCS 4 OVERWEIGHT**<br>Waist barely visible from above. Abdomen slightly rounded, flanks concave. Lower line of tummy is horizontal from ribs to back leg. Moderate amount of fat – jiggle noted when walking. |  |  |
| **BCS 5 OBESE**<br>Waist absent. Abdomen rounded. Lower line of tummy bulges downwards. Sway from side to side when walking. |  |  |

## Acknowledgements:

- Descriptors for 5-point body condition score amended to be observation only without palpation from Food For Thought™ Technical Bulletin No. 77R; Innovative Research in Dog and Cat Nutrition™ (accessed from http://www.iams.com/pet-health/cat-article/how-to-visually-assess-cat-and-dog-body-condition#qa2 Jan 2014).
- Refinement of terms in descriptions and illustrations from Nestle Purina Body Condition System.
- Photos courtesy of Professor Darryn Knobel.

# Annex B: Example of Recording Sheet for Behavioural Observations



(Ideally this would be part of a phone app to reduce time needed for transcribing data)

| | |
|---|---|
| Observer: | Date and time: |
| Location/Site name: | GPS reading: |
| Comments (weather, events, did all dogs leave site and if so for how long did you have to delay observations?): | |
| Behavioural observation<br>Time start: ___________ Estimated number of dogs: ___________<br>Time stop: ___________ Estimated number of people: ___________ | |

| Dog-dog interactions | Tally (outcome of interactions only, not individual behaviours) |
|---|---|
| **Amicable:** Licks, paws, nudges with nose, or grooming between dog, often with tails wagging. Play behavior including charges with bouncing gait, play faces (mouth relaxed, slightly open, teeth covered), wrestles and play chases | |
| **Neutral:** Approach and retreat, often including sniffing, limited body language, non-demonstrative. Not aggressive but also not affiliative. | |
| **Mating:** Copulation (not only mounting where one dog stands with forepaws on another), usually ending in a 'tie' | |
| **Aggressive:** Growling, teeth visible, barking, biting, fighting. One dog flees with tail tucked to avoid other dog, cowers or rolls over | |
| **Total dog-dog interactions** | |

| Important human-dog interactions | Tally |
|---|---|
| **Positive human behaviours:** Person feeds a dog. Person pets a dog. Person calls a dog to come to them either using name or other affiliative sounds | |
| **Extreme relaxed behaviour from both human and dog:** Person walks within one dog length/directly over the top of a dog and the dog doesn't move its body to avoid them. Dog approaches person in friendly manner, person does not avoid this approach and allows dog to touch them or stand/sit/lie beside them | |
| **Negative human behaviours:** Person hits or kicks a dog with any part of their body or an inanimate object. Person throws something at a dog to scare/hurt it, includes 'sham' throws. Person shouts or claps hands to scare a dog | |
| **Total human-dog interactions** | |

# Annex C: Six Criteria for Rabies Diagnosis in Living Dogs





(Tepsumethanon et al. (2005))
The authors analysed clinical signs from 1,170 records of rabies suspected dogs that had bitten humans between 1988 and 1996. Laboratory confirmation was carried out on those dogs that died within 10 days of observation. This identified 6 criteria for rabies diagnosis using clinical signs with 90.2% sensitivity, 96.2% specificity and 94.6% accuracy; indicating approximately 10% false negatives and 4% false positives should be expected. The 6 criteria are as follows:

| **1. Age of the dog?** | |
|---|---|
| Less than 1 month: not rabies | One month or more or not known: go to 2. |
| **2. State of health of the dog?** | |
| Normal (not sick) or sick more than 10 days: not rabies | Sick less than 10 days or not known: go to 3. |
| **3. How did the illness evolve?** | |
| Acute onset from normal health: not rabies | Gradual onset or not known: go to 4. |
| **4. How was the condition during the clinical course in last 3-5 days?** | |
| Stable or improving (with no treatment): not rabies | Symptoms and signs progressing or not known: go to 5. |
| **5. Does the dog show the sign of "Circling"? (It stumbles or walks in a circle and hits its head against the wall as if blind)** | |
| Yes: not rabies | No or not known: go to 6. |

| **6. Does this dog show at least 2 of the 17 following signs or symptoms during the last week of life?** | | |
|---|---|---|
| Drooping jaw (Fig. 1) | Abnormal sound in barking | Dry drooping tongue |
| Licking its own urine | Stiffness upon running or walking | Regurgitation |
| Altered behaviour | Biting and eating abnormal objects | Aggression |
| Biting with no provocation | Running without apparent reason | Restlessness |
| Abnormal licking of water | Bites during quarantine (Fig. 2) | Appearing sleepy |
| Imbalance of gait | Frequent demonstration of the "Dog sitting" position (Fig. 3). | |

| Yes: rabies | No or showing only 1 sign: not rabies |
|---|---|

Figure 1 Drooping jaw

Figure 2 Bites during quarantine

Figure 3 Dog sitting position

All images copied from Tepsumethanon, V., Wilde, H. and Meslin, F.X., 2005. Six criteria for rabies diagnosis in living dogs. Journal of the Medical Association of Thailand = Chotmaihet thangphaet, 88(3), pp.419–22. Available at: http://www.jmatonline.com/index.php/jmat.

# Annex D: Calculating Dog Population Size



In the section on the impact of reducing dog density, the indicator of dogs per km (or mile) of street surveyed was introduced as an accessible measure of dog density that could be monitored over time. However, in some cases an estimate of total population size will be desired, for example when planning and intervention after which density alone will be sufficient for monitoring.

The simplest approach is to multiply the average number of dogs per km of street with the total street length for the area in question, this street length is usually accessible from local government records or from Geographical Information System (GIS) maps (exclude lengths of motorways and trunk roads when calculating total street length, as roaming dogs are very unlikely to be found on these road types). If the routes used for the street survey were within administrative areas for which there is data available on factors potentially related to roaming dog density (such as the number of detached houses or socioeconomic factors relating to housing provided by recent censuses), such factors can be tested for their relationship with the number of dogs seen on the routes. Route length is included as a covariate first and then factors tested for their additional predictive value using multiple regression. If significant covariates are found these can be used along with route length to refine the estimate for areas that were not surveyed but for which data on covariate factors exist. This method will provide the total number of dogs seen roaming at the particular time of day that was chosen for surveying and not the total roaming dog population; as some dogs will have been missed by the observers and others will roam at other times of the day.

To establish the total roaming dog population a *detectability estimate* will be needed - this is the chance that a dog that roams was seen and recorded by the observers conducting the street survey.  The detectability estimate can then be used to 'correct' the estimate calculated from dogs per km of street surveyed and total street length to a total estimate of population size.

Establishing detectability requires more intensive survey effort, using either questionnaires of owners to establish the number of owned dogs that are allowed to roam or mark-resight experiments (see explanation that follows).  Because these methodologies are more intensive, the rapid street survey method described for measuring the number of dogs per km of street surveyed can be used widely and then, in just a sample of areas, the more intensive method is used in addition to the rapid method to establish the total population of dogs in that area. The estimated population size in that area from the rapid survey can be compared to the estimate from the intensive survey, exposing the underestimate produced by the rapid survey:

$$\textit{detectability estimate} = \frac{\textit{rapid street survey estimate}}{\textit{intensive survey estimate}}$$

## Which intensive survey methods to use?

The most suitable method for intensive surveying depends on the proportion of the roaming population that are unconfined owned dogs rather than unowned dogs.

### Roaming owned dogs - questionnaires

If almost all roaming dogs are owned, the most efficient approach is to use a questionnaire which asks owners about the number and confinement of their dogs. This results in an estimate of the average number of dogs per dog owning household that are not always confined (i.e. are allowed to roam for at least part of the day/night), and the total number of dog-owning households in the area. One reason to avoid questionnaires and use the following method of mark-resight is where owners have reason to be dishonest about confinement, for example if there is a local ordinance requiring dogs to be confined.

### Unowned dogs – mark-resight

In some countries or regions, for example in India, it is evident that a significant proportion of the roaming population is unowned.  If tolerance of and resources for unowned dogs are sufficient to allow some of their pups to survive to sexual maturity the unowned population will exist at a density determined by the carrying capacity in that region.  Even in areas where resources are insufficient to allow any pups born on the street to survive to breed themselves there may be enough abandoned dogs and their surviving pups to form a significant proportion of the roaming population, perhaps only seasonally in tourist areas. If unowned dogs do form a significant proportion of the roaming population then the size of that proportion will be unknown, in which case some direct estimate of the size of the roaming population via intensive street surveying is required using mark-resight methods.

If the sample areas selected for the intensive surveying are small enough to deal with in their entirety there will be no need to define sub-sample regions. The approach is to conduct an initial survey in order to mark a known number $n_1$ of randomly selected dogs, either with an artificial mark such as a paint spray or collar or by photographing distinctive natural markings.  If the sample areas are contained by boundaries that are meaningful to dogs, such as the boundaries of a village, marking can be done throughout the village. If the boundaries have no meaning to dogs and they are likely to cross them, such as the boundaries of a municipality within a town, the streets used for marking should be far enough within the boundaries to avoid any of the dogs in the marked sample having moved out of the region by the time of the second survey.  During a second survey of all the streets (including those streets up to the border of the area if any were initially excluded for marking) one or more days later $n_2$ dogs are seen, of which $m$ were included in the $n_1$ sample.  The ratio $m/n_1$ is the fraction of marked dogs that were on the streets at the time of the second survey and is assumed to equal the fraction of all roaming dogs that were on the streets at that time.  Dividing the second survey street count $n_2$ by that fraction gives the Peterson estimate of the total number of dogs, which can also be calculated as follows:

$$\frac{n_1 n_2}{m}$$

If the sample areas selected for intensive surveying are too large to survey along all streets, a sub-sample of smaller regions may be used, preferably pre-existing regions such as wards or health post regions.  Ideally this sub-sample is selected randomly but avoiding any of the selected regions having common borders (WSPA (2007) provides a method for random selection of regions whilst avoiding common borders).  The survey method used within each sub-sample region is then as described above for the entire sample area. The abundance estimates for the sub-sample regions are then used to estimate abundance over the whole sample area, either by summing the estimated dog population for the regions and dividing by the fraction of pre-existing sub-sample regions surveyed (Horvitz and Thompson, 1952) or by using a regression estimator to exploit any covariates of the abundance estimates that may be available for each of the pre-existing regions (the common practice of extrapolating by area is an example where area is used as covariate but a poor one because region area and dog abundance are usually not strongly correlated).

Another opportunity to apply mark-resight to large sample areas is to use the standard routes established for the dog density street surveys. By marking (or photographing) dogs along at least a sample of the standard routes, the fraction of those seen on a second survey of the same route can be used as a detectability estimate. Just as in the Petersen method, the proportion marked is upwardly biased (leading to an underestimate of total dogs) as a result of heterogeneity but is now also subject to a bias in the opposite direction because in conducting the second survey only along the standard route we may have missed some of the marked dogs that were roaming at that time but were on other streets.

If the intervention itself involves marking dogs, for example with collars or paint to show a dog has been vaccinated or with an ear notch to show it has been sterilised, then these intervention marks can be used for mark-resight (for example, as used in Hiby et al. (2011) Animal Birth Control (ABC). This may be particularly relevant if the intervention coverage, i.e. the proportion marked, is also required to evaluate the effectiveness of the intervention (see the section on estimating rabies vaccination coverage). This will require consistent and accurate data collection on intervention effort; specifically the number of dogs marked, on what date and in which area they live. It may also require an estimate of mark loss, as collars may fall off or be removed and paint wears off over time. Survival of the dogs will also be relevant in the case of a permanent ear notch that has been applied some months or years previously. Accounting for mark loss and survival will provide an accurate estimate of the marked population that currently exists. One option is to reduce the time between applying the marks to resighting so that the mark loss and mortality can be assumed to be zero; i.e. limiting the days between vaccination and coverage estimation. For an intervention where survival is the relevant factor, resighting for ear notches will be best done in the first weeks and months of the intervention.

The Petersen method suffers from the need to assume that all dogs that roam are equally likely to be seen. That assumption is unlikely to hold because of behavioural differences between dogs affecting when and for how long they are visible on the streets. As a result the abundance estimates are likely to be biased downwards (underestimating the total population), particularly if surveys are conducted at the same time of day.

Extensions of the Peterson method that use multiple subsequent surveys to reduce the variance of the estimator include the Schnabel method (Schnabel, 1938) as used by Beck for roaming dog abundance in Baltimore, USA (Beck, 1973) and the Schmacher-Eschmeyer method as used by Totton in Jodhpur, India (Totton et al., 2010). As in the Peterson method, the dogs seen during each subsequent survey are classified into those that have, and have not, been previously marked (i.e. paint marked or photographed) but the size of the marked sample is increased by marking some or all of the unmarked dogs seen during each survey. If marking is by photography, only dogs that have distinctive natural markings are photographed in order to facilitate the classification process. However these extensions require the same assumption as the Peterson method (i.e. that all dogs that roam are equally likely to be seen) and suffer from a similar level of bias if this assumption fails, so it would seem more efficient to use the Peterson method in a larger sample of regions rather than expend the available effort on multiple subsequent surveys.

If the risk of bias is not acceptable, an alternative is to conduct a sequence of surveys and establish the 'encounter history' of each dog seen (for example 0 1 0 1 1 representing a dog first seen on the second of five surveys and then seen again on surveys four and five). Encounter history can be analysed using models of type $M_h$ or $M_{th}$ (Otis et al., 1978) to incorporate variation between dogs in the probability of being seen (referred to as 'heterogeneity' in the mark recapture literature) or variation in that probability both between dogs and from survey to survey. For example Belsare and Gompper (2013) used program CAPTURE to run the jackknife estimator model of type $M_h$ on encounter history data from six villages in Maharashtra, India to estimate the number of roaming dogs in each village.

Such models are likely to reduce bias as compared to the Peterson method, depending on the source of variation in the probability of being seen. Intuitively, information on that variation is available from the numbers of dogs seen very frequently and the number seen only once in comparison to the numbers expected if all dogs were equally likely to be seen. As expected, Belsare and Gompper (2013) report higher estimates using the jackknife estimator than those obtained using Beck's method, which gave point estimates below the minimum population size (as determined by independent surveys) in each village.

However it is time consuming and complicated to establish the encounter histories. The dogs have to be identified as individuals so marking via a paint spray cannot be used. Some dogs do not have distinctive natural markings that allow them to be identified from photographs and descriptions, for example 23% of dogs collected for spaying in Jaipur are uniformly black or tan coloured (Reece, *pers. comm.*). The photographs only establish encounter histories for the distinctively marked dogs so that the resulting abundance estimate has to be corrected by dividing by the proportion of dogs that are distinctively marked. During the surveys, each dog seen has to be recorded as distinctively marked or not and be photographed only if it is distinctively marked. The criteria used to decide if a dog is sufficiently distinctive must remain consistent between surveys. If an observer's ability to distinguish dogs increases over time, there is a risk that a dog will be defined as identifiable and photographed in later surveys and recorded as not having been seen before, whereas in fact it was seen but was considered insufficiently well marked in those early surveys when the observer was less confident. Although encounter histories are likely to reduce bias they do require significant time and effort, limiting the area that can be covered by this approach and brining in other potential biases linked to small sample sizes. This suggests simple Peterson estimates using artificial marks or photographs is the method of choice in most cases.

# Annex E – Sample Questionnaire





Date: ____________ Interviewer: __________________________ Interview no: ___________

District: __________ Ward: ___________ Street: ____________ House no/name: _______

Household GPS reading Latitude: __________ Longitude: ____________

Type of structure: ☐ Single/detached house ☐ Attached house ☐ Flat
☐ Row house ☐ Hut/Shanty ☐ Compound

## 'Starter question' (defines time commitment): Does your household own a dog?

*'Own' is defined as a dog living in the house or yard most of the time and being fed by the household on a regular basis.*

☐ NO ☐ YES

*Ask the respondent if you can ask further questions. State:*

> *"Your answers to these questions, and those of other people we ask, will be used to help us understand the dog population better. There are no right or wrong answers to these questions, so please answer as accurately as you can and you can skip any question that you do not wish to answer. Your name and address will remain confidential and will only be used to identify where in ___ you live and to find your house again if we need to ask follow up questions in future"*

*If he/she owns a dog tell him/her that the interview will take up to 20 minutes.*

*If he/she does not own a dog tell him/her that the interview will take up to 10 minutes.*

Permission received? ☐ Yes ☐ No
☐ YES, but please come back later
What day/time? ______________________

*If YES, go to Question 1.1*

## SECTION 1 – HOUSEHOLD INFORMATION

1.1. First, some questions about you;

Name: ____________________________________ Gender: ______ Age: _________
*(age can be recorded as 'adult' or 'child' if they don't want to give their exact age)*

What religion are you?: ☐ None ☐ Muslim ☐ Christian
☐ Hindu ☐ Buddhist ☐ Other _______

1.2. How many people live in the household? _________

1.3. Does the household feed any dogs that are not your own on a regular basis *(regular basis defined as at least once per week)*?

☐ NO ☐ YES ☐ Don't know

## SECTION 2 – DOG BITES

2.1. Was anyone in the household bitten by a dog within the last 12 months whilst physically in ______*? *(*Refer to intervention area)*

☐ NO ☐ YES ☐ Don't know

If **yes**, provide details of the dog bite below:

| What is the sex of person bitten? | What age were they when bitten? | Bitten by which dog? | Do you know the age and sex of biting dog? | | Do you know why the dog bit? | How did you treat the site of the bite, if at all? (include all relevant responses) |
|---|---|---|---|---|---|---|
| | | | Sex | Age | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | 1. Own dog<br>2. Owned dog from the community<br>3. Unowned dog from the community<br>4. Unknown strange dog<br>5. Don't know | | | 1. Yes, answer suggests provocation<br>2. No, answer suggests bite was unprovoked<br>3. Don't know | 1. Wash the wound with water only<br>2. Wash the wound with soap and water<br>3. Go to the bite centre/ hospital<br>4. Nothing<br>5. Other? (please describe)<br>6. Don't know |

*If asking for agreement with attitude statements include them here for non-dog owners and at the end for dog owners.*

*If the household does not own a dog, please thank the respondent for their time and ask if they have any questions before leaving.*

*If the household owns a dog go to Question 3.1.*

## SECTION 3 – HOUSEHOLD DOGS

3.1.

| | | Adults > 3 months | | | Puppies < 3 months | | |
|---|---|---|---|---|---|---|---|
| | Total | M | F | Unk | M | F | Unk |
| How many dogs are there living in this household? | | | | | | | |
| How many dogs were in this household 12 months ago? | | | | | | | |

Over the past 12 months, did any of the household's <u>adult</u> dogs die or leave the household?
*(only for adult dogs, puppies of under 4 months are included in female breeding history table only)*

☐ NO ☐ YES ☐ Don't know

If yes, please record the details of all adult dogs that have left the household in the last 12 months in the table below:

| | What sex was the dog? | What happened to him/her? | How old was he/she when this happened? |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| | 1. Male<br>2. Female<br>3. Don't know | 1. Sold<br>2. Given away<br>3. Killed by owner<br>4. Killed by authorities<br>5. Killed by someone else<br>6. Died in accident<br>7. Died of disease/ parasites<br>8. Died through starvation<br>9. Died other<br>10. Disappeared<br>11. Abandoned/ Disowned<br>12. Stolen<br>13. Unknown | |

Ideally, how many dogs would you like in your household? _________

3.2. Household adult dogs information *(only for adult dogs currently owned by household, puppies of under 4 months are included in female breeding history table only)*

| Dog no. | Name? | Sex? | Age? (be as precise as possible) | Sterilised? | Breed? | Where did you get this dog from? | Age when acquired? | What is the main role or function of this dog? | Who looks after the dog? |
|---|---|---|---|---|---|---|---|---|---|
| 1. | | | | | | | | | |
| 2. | | | | | | | | | |
| 3. | | | | | | | | | |
| 4. | | | | | | | | | |
| 5. | | | | | | | | | |
| 6. | | | | | | | | | |
| 7. | | | | | | | | | |
| 8. | | | | | | | | | |
| 9. | | | | | | | | | |
| 10. | | | | | | | | | |
| | | 1. Male<br>2. Female<br>3. Pregnant fem<br>4. Lactating fem<br>5. Don't know | | 1. Yes<br>2. No<br>3. Don't know | 1. Pure bred<br>2. Pure-bred cross<br>3. Mongrel<br>4. Don't know | 1. Pup of own dog<br>2. Bought inside ____*<br>3. Bought outside ____<br>4. Gift from inside ____<br>5. Gift from outside ____<br>6. Adopted off the street<br>7. Adopted from shelter<br>8. Other (specify)<br>9. Don't know | | 1. Guard household<br>2. Protect livestock<br>3. Protect crops<br>4. Pet/companion<br>5. Hunting<br>6. Breeding<br>7. Other (specify)<br>8. Don't know | 1. Respondent<br>2. If not respondent, age & sex of household member<br>3. Don't know |

* ____ Refer to intervention area

3.3 Household <u>adult</u> dog care *(includes welfare scores if dog can be seen)*

| Dog no. (as in table 3.2) | Is the dog confined? | How is the dog confined? | Access to shelter when confined? | Has dog been vaccinated? If yes, how long ago? | Has dog been dewormed? If yes, how long ago? | Has dog been treated for fleas/ticks? If yes, how long ago? | How often is dog fed by your household? | What kind of food? | Was this dog given fresh water yesterday? | Body condition score? | Skin problem? |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | | | | | | | | | | | |
| 2. | | | | | | | | | | | |
| 3. | | | | | | | | | | | |
| 4. | | | | | | | | | | | |
| 5. | | | | | | | | | | | |
| 6. | | | | | | | | | | | |
| 7. | | | | | | | | | | | |
| 8. | | | | | | | | | | | |
| 9. | | | | | | | | | | | |
| 10. | | | | | | | | | | | |
| | 1. All day only<br>2. All night only<br>3. All day & night<br>4. Sometimes<br>5. Never<br>6. Don't know | 1. Compound/ yard/garden<br>2. House<br>3. Kennel<br>4. Static chain<br>5. Running chain<br>6. Other (specify) | 1. Yes, all the time<br>2. Yes, but not all the time<br>3. No<br>4. Don't know | 1. Yes, and number of months/ years<br>2. Never<br>3. Don't know | 1. Yes, and number of months/ years<br>2. Never<br>3. Don't know | 1. Yes, and number of months/ years<br>2. Never<br>3. Don't know | 1. Twice a day or more<br>2. Once per day<br>3. Once every 2 days<br>4. Less frequently than once every 2 days<br>5. Don't know | 1. Commercial<br>2. Home-made<br>3. Leftover human food<br>4. None<br>5. Don't know | 1. Yes<br>2. No<br>3. Don't know | 1<br>2<br>3<br>4<br>5<br>6. Dog not visible | 1. No<br>2. Yes<br>3. Dog not visible |

3.4. Female breeding history (please include all female dogs, if a female has never had a litter the answer to the second question will be 0 and the rest of the table can be ignored as the follow-up questions are for breeding females only)

| | | | | |
|---|---|---|---|---|
| Female dog no. from previous table | | | | |
| Is she confined when in oestrus/heat? | | | | |
| How many litters has she had in her lifetime? (if she was owned by someone else previously, please include litters born with this previous owner) | | | | |
| Tick if know about full breeding history (no unknown breeding during previous ownership) | | | | |
| How old was she when she had her first litter? | | | | |
| Has she had any litters in the previous 12 months? | | | | |
| If she had a litter in the previous 12 months, in which month was the most recent litter born? | | | | |

If any females have had a litter in the previous 12 months, please tell us about the fate of all puppies from the most recent litter for each female:

Female number from previous table_____

| Pup no. | Sex | Fate | Age at event |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |

| | | |
|---|---|---|
| 1. Male | 1. Still in household | 8. Died of disease/parasites |
| 2. Female | 2. Sold | 9. Died through starvation |
| 3. Unknown | 3. Given away | 10. Died other |
| | 4. Killed by owner | 11. Disappeared |
| | 5. Killed by authorities | 12. Abandoned |
| | 6. Killed by someone else | 13. Stolen |
| | 7. Died in accident | 14. Unknown |

(Spare page for recording additional litters)

Female number from previous table_____

| Pup no. | Sex | Fate | | Age at event |
|---|---|---|---|---|
| 1. | | | | |
| 2. | | | | |
| 3. | | | | |
| 4. | | | | |
| 5. | | | | |
| 6. | | | | |
| 7. | | | | |
| 8. | | | | |
| 9. | | | | |
| 10. | | | | |
| | 1. Male | 1. Still in household | 8. Died of disease/parasites | |
| | 2. Female | 2. Sold | 9. Died through starvation | |
| | 3. Unknown | 3. Given away | 10. Died other | |
| | | 4. Killed by owner | 11. Disappeared | |
| | | 5. Killed by authorities | 12. Abandoned | |
| | | 6. Killed by someone else | 13. Stolen | |
| | | 7. Died in accident | 14. Unknown | |

Female number from previous table_____

| Pup no. | Sex | Fate | | Age at event |
|---|---|---|---|---|
| 1. | | | | |
| 2. | | | | |
| 3. | | | | |
| 4. | | | | |
| 5. | | | | |
| 6. | | | | |
| 7. | | | | |
| 8. | | | | |
| 9. | | | | |
| 10. | | | | |
| | 1. Male | 1. Still in household | 8. Died of disease/parasites | |
| | 2. Female | 2. Sold | 9. Died through starvation | |
| | 3. Unknown | 3. Given away | 10. Died other | |
| | | 4. Killed by owner | 11. Disappeared | |
| | | 5. Killed by authorities | 12. Abandoned | |
| | | 6. Killed by someone else | 13. Stolen | |
| | | 7. Died in accident | 14. Unknown | |

## SECTION 4 – VACCINATION HISTORY

*(only included if using questionnaire to estimate vaccination coverage; question about roaming can be changed to a specific time window when street survey occurs)*

4.1 Vaccination coverage estimation

| Dog no. | Was this dog vaccinated in the recent campaign? | Was it marked? | Is this mark still present? | Is your dog in the house/yard now? |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |
| 7 | | | | |
| 8 | | | | |
| 9 | | | | |
| 10 | | | | |
| | 1. Yes<br>2. No, already vaccinated<br>3. No, didn't know about the campaign<br>4. No, couldn't get there<br>5. No, don't want my dog vaccinated<br>6. No, other (specify)<br>7. Don't know | 1. Yes, collar<br>2. Yes, paint<br>3. No<br>4. Don't know | 1. Yes<br>2. No, fell or wore off<br>3. Don't know | 1. Yes<br>2. No, roaming<br>3. No, on walk with owner<br>4. Don't know |

*If asking dog owners for agreement with attitude statements include them here.*

*Please thank the respondent for their time and ask if they have any questions*

## Attitude statements used in Colombo, Sri Lanka

Based on questionnaire used to assess the dog population in Colombo, Sri Lanka by Blue Paw Trust and WSPA (WSPA, 2007b).

1. Having a dog is a waste of money:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Unsure | Agree | Strongly agree |

2. I like dogs:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Unsure | Agree | Strongly agree |

3. Dogs should always be kept outside the house:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Unsure | Agree | Strongly agree |

4. I don't like being close to dogs:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Unsure | Agree | Strongly agree |

5. Dogs add happiness to people's lives:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Unsure | Agree | Strongly agree |

6. People who own dogs should spend time every day playing with them:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Unsure | Agree | Strongly agree |

7. If a dog of mine got a skin disease, I would not want it around the house:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Unsure | Agree | Strongly agree |

8. If a female dog of mine had a litter of puppies, I would not want to keep any of them:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Unsure | Agree | Strongly agree |

9. A person should treat their dog with as much respect as they would a human member of the family:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Unsure | Agree | Strongly agree |

10. A dog is a valuable possession:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Unsure | Agree | Strongly agree |

11. Street dogs should be looked after by the community:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Unsure | Agree | Strongly agree |

12. The welfare of street dogs is important to me:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Unsure | Agree | Strongly agree |

13. People should not feed street dogs:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Unsure | Agree | Strongly agree |

14. I like having dogs around on my street:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Unsure | Agree | Strongly agree |

15. Dogs should have the same rights and privileges as humans:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Unsure | Agree | Strongly agree |

16. Street dogs pose a danger to people:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Unsure | Agree | Strongly agree |

17. Street dogs should not be allowed to breed:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Unsure | Agree | Strongly agree |

18. It is not acceptable to kill dogs:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Unsure | Agree | Strongly agree |

# Attitude statements used in Tanzania

Attitude statements developed and used as part of a questionnaire survey to assess the attitude of dog owners towards their dogs in 12 sites across Tanzania (Knobel et al., 2008).

1. Our dog/s is/are a valuable possession:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Unsure | Agree | Strongly agree |

2. Our dog/s is/are an important part of the household:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Unsure | Agree | Strongly agree |

3. We like owning a dog:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Unsure | Agree | Strongly agree |

4. Our dog is a member of the family:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Unsure | Agree | Strongly agree |

5. You should treat your dog with as much respect as you would a human member of your family:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Unsure | Agree | Strongly agree |

6. Our dog/s is/are accustomed to being touched:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Unsure | Agree | Strongly agree |

7. Our dog/s enjoy being petted:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Unsure | Agree | Strongly agree |

8. We often play with our dogs:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Unsure | Agree | Strongly agree |

9. We enjoy our dogs' companionship:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Unsure | Agree | Strongly agree |

10. It is unhealthy to touch dogs:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Unsure | Agree | Strongly agree |

11. We never touch our dogs:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Unsure | Agree | Strongly agree |

12. Our dog will bite us if we touch it:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly disagree | Disagree | Unsure | Agree | Strongly agree |

# Dog attitude Questions, used in Japan and UK

Based on the dog attitude statements (named the "DAQ") developed for a study of university students in Japan and UK (Miura et al., 2000)

Please indicate how strongly you agree or disagree with the following statements, by drawing a circle around the appropriate number on the agreement-disagreement scale. For example, if you think you disagree with the statement strongly, you might circle the 2 on the left side of the scale. Note the circle can be drawn by interviewee or interviewer can read out statements and ask for level of agreement and circle the correct number on behalf of the interviewee.

| Disagree strongly | Disagree | Neutral | Agree | Agree strongly |
|---|---|---|---|---|
| 2 | 1 | 0 | 1 | 2 |

| | Disagree | | | | Agree |
|---|---|---|---|---|---|
| 1. I think that there are too many dogs in this country. | 2 | 1 | 0 | 1 | 2 |
| 2. I think that the most important role of dogs is guarding. | 2 | 1 | 0 | 1 | 2 |
| 3. I think that a dog is 'Man's best friend'. | 2 | 1 | 0 | 1 | 2 |
| 4. I wish more hotels would allow dogs to stay with their owners. | 2 | 1 | 0 | 1 | 2 |
| 5. I think that dogs cannot live without human help because they were domesticated by humans. | 2 | 1 | 0 | 1 | 2 |
| 6. I think that keeping a dog is a waste of time and money. | 2 | 1 | 0 | 1 | 2 |
| 7. I think that dogs should be allowed indoors. | 2 | 1 | 0 | 1 | 2 |
| 8. I feel sorry for a dog when I see the dog obey every command, because the dog seems to be controlled by the owner. | 2 | 1 | 0 | 1 | 2 |
| 9. I think that having a dog increases security. | 2 | 1 | 0 | 1 | 2 |
| 10. I think that keeping a dog is annoying to its owner's neighbours. | 2 | 1 | 0 | 1 | 2 |
| 11. I think that dogs have personalities like humans. | 2 | 1 | 0 | 1 | 2 |
| 12. I think that an owner should look after his/her dog until it dies naturally, if the dog has an incurable illness. | 2 | 1 | 0 | 1 | 2 |
| 13. I think that dogs are smelly. | 2 | 1 | 0 | 1 | 2 |
| 14. I think that training dogs is a reflection of human arrogance. | 2 | 1 | 0 | 1 | 2 |
| 15. I think that owners should keep their dogs (rather than get rid of them) even if the dog has attacked people. | 2 | 1 | 0 | 1 | 2 |

| | Disagree | | | | Agree |
|---|---|---|---|---|---|
| 16. I think that dogs should be allowed to roam unless they cause problems in human society. | 2 | 1 | 0 | 1 | 2 |
| 17. I think that having a dog provides opportunities for meeting new people. | 2 | 1 | 0 | 1 | 2 |
| 18. I wouldn't want to keep a dog indoors, because they shed their hair. | 2 | 1 | 0 | 1 | 2 |
| 19. I think that only working dogs such as sheep dogs, guide dogs and police dogs need training. | 2 | 1 | 0 | 1 | 2 |
| 20. I think that stray dogs should be euthanized. | 2 | 1 | 0 | 1 | 2 |
| 21. I think that dogs are happier when kept outdoors rather than indoors. | 2 | 1 | 0 | 1 | 2 |
| 22. I wish restaurants would allow dogs to enter with their owners. | 2 | 1 | 0 | 1 | 2 |
| 23. I think that euthanizing a dog is cruel. | 2 | 1 | 0 | 1 | 2 |
| 24. I think that stray dogs tend to bite. | 2 | 1 | 0 | 1 | 2 |
| 25. I wish shops would allow dogs to enter with their owners. | 2 | 1 | 0 | 1 | 2 |
| 26. I think that dogs should be chained outdoors. | 2 | 1 | 0 | 1 | 2 |
| 27. I think that an owner should let his/her dog run free in public places like parks. | 2 | 1 | 0 | 1 | 2 |
| 28. I think that stray dogs create a nuisance. | 2 | 1 | 0 | 1 | 2 |
| 29. I think that euthanasia is justifiable if a dog is suffering. | 2 | 1 | 0 | 1 | 2 |
| 30. I wouldn't want to keep a dog indoors, because they are unhygienic. | 2 | 1 | 0 | 1 | 2 |
| 31. I think that when people get a new dog, they should take the dog to a training class. | 2 | 1 | 0 | 1 | 2 |
| 32. I think that stray dogs are a problem in this country. | 2 | 1 | 0 | 1 | 2 |
| 33. I think that dogs should have access to all rooms in the house. | 2 | 1 | 0 | 1 | 2 |
| 34. I think that having a dog makes it difficult for its owner to travel. | 2 | 1 | 0 | 1 | 2 |
| 35. I think that dogs are more loyal than people. | 2 | 1 | 0 | 1 | 2 |
| 36. I get upset when I see dogs chained outdoors. | 2 | 1 | 0 | 1 | 2 |
| 37. I think that training dogs is cruel. | 2 | 1 | 0 | 1 | 2 |
| 38. I think that dogs are unhygienic. | 2 | 1 | 0 | 1 | 2 |

| | Disagree | | | | Agree |
|---|---|---|---|---|---|
| 39. I think that the most important role of dogs is giving people companionship. | 2 | 1 | 0 | 1 | 2 |
| 40. I wouldn't want to keep a dog indoors, because they are smelly. | 2 | 1 | 0 | 1 | 2 |
| 41. I think that owners should keep their dogs (rather than get rid of them) even if the dog is aggressive to strangers. | 2 | 1 | 0 | 1 | 2 |
| 42. I think that having a dog is fun. | 2 | 1 | 0 | 1 | 2 |
| 43. I think that dogs should be spayed or neutered to prevent unwanted puppies being born. | 2 | 1 | 0 | 1 | 2 |
| 44. I think that dogs should obey their owner's commands all the time. | 2 | 1 | 0 | 1 | 2 |
| 45. I think that it is justifiable to euthanize aggressive dogs. | 2 | 1 | 0 | 1 | 2 |
| 46. I am interested in TV programs and articles on dogs. | 2 | 1 | 0 | 1 | 2 |

## Attitude statements used with 4 year old children in UK, Italy and Spain

Attitude statements taken from Lakestani et al. 2011; original list was 12 statements long but 3 statements relating to dog emotions (e.g. Dogs can be scared of people) were found to reduce reliability of the test and so were removed from further analysis, only the 9 statements that resulted in reasonable reliability are included here. 4 year old children were asked to rate each of the following item as “never”, “sometimes” and “mostly”:

1. Dogs are dirty
2. Dogs can be friends with people
3. Dogs are smelly
4. I love my dog/I would like to have a dog
5. Dogs bite
6. Dogs are scary
7. I like hugging my dog / I would like to hug a dog
8. Dogs are fun
9. I like walking my dog and playing with him/ I’d like to walk a dog and play with it

For positive items, responses were coded as follows: never = 1, sometimes = 2, mostly = 3. This was reversed for negative items. Attitude scores were calculated by taking the mean of these response codes for each child. Attitude scores ranged from 1 to 3, with a high score corresponding to a positive attitude to dogs.