SARG Guide

Surrey Amphibian and Reptile Group

Determining Probable Absence for Reptile Species

Steve Langham

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Contents

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1. Introduction

1.1. Historically, the determination of species presence has always been easy. Just one confirmed sighting establishes presence. This may not mean that a viable population is present, but it does confirm that they are there. However; if a species is not observed, what can be deduced? Is the species absent? Or was it just not observed on the survey visit? How many surveys must be conducted, and in which meteorological conditions without observation before a species can be presumed absent?

1.2. This guide aims to outline the SARG approach to determining probable absence. The ability to calculate probable absence to a high degree of confidence has become increasingly important. It is now Natural England policy that no species re-introductions for a site can be sanctioned until that species has been shown to be absent, with a confidence of at least 95%.

1.3. In order to calculate probable absence, we need to know something about the species' detection probability and the survey methods employed. Hence; we need to discuss survey methods and the calculation of detection probabilities before we can describe the probable absence calculation approach.

2. Reptile Survey Methodology

2.1. Over several years, SARG has developed a survey methodology which is a compromise across many factors. The key driving factors are:

- Generating actionable intelligence for land managers.
- Transects that facilitate volunteer survey effort.
- Generating low-bias statistical data for conservation purposes.
- Minimising the risk to wild animals and livestock.
- An emphasis on long-term surveillance.

2.2. SARG uses a transect survey system using corrugated iron refugia. Refugia are placed across the survey area at a density of approximately one tin per hectare of suitable habitat. Not every hectare may be tinned, as we constrict each site to a maximum of 30 tins to ensure that volunteer effort is not too demanding. Large sites may be divided into sub-sites. Surveyor effort (time on and off site) is recorded, as are all sightings and negative results for surveyed tins. Meteorological meta-data is appended to the survey record by the recording system.

2.3. Surveys are undertaken by a pool of surveyors to mitigate the bias of individual surveyor skill level.

2.4. Emphasis (through training) is placed on the detection of reptile species using visual skills between refugia in addition to animals seen under refugia. In essence, refugia are used as waypoints along a transect. The ratio of detections in the open to detections under refugia has proven to be an effective metric of surveyor skill. Visual skills are particularly important for the detection of legged lizard species, which do not habitually use refugia in the same manner as legless reptile species.

3. Detectability

3.1. Analysis of the SARG data set has shown that detectability is broadly independent of refugia density. However; there is a strong correlation between the number of observations and the time spent conducting a survey. Hence; the approach we have taken for determining detectability involves the normalisation of survey duration into a detection probability per hour of survey (in suitable conditions).

3.2. There is an additional strong bias depending upon the skill of the surveyor. SARG attempts to mitigate this bias by employing a pool of surveyors with varying degrees of skill. Hence, surveyor skill level is averaged out across the survey programme.

3.3. Individual survey data is processed to generate mean sightings per hour. These numbers are further processed to generate detection probabilities per species, by hours of survey. These detection probabilities are averaged across all surveys for a site to generate mean detection probabilities by site for each species over the last five years. The five year moving window ensures that overly historic data is not included in current calculations, yet ensures that sufficient data is collected to generate robust statistical and trend information. Typically, this window reflects the last 35 surveys.

3.4. Each survey site has its own mean detection probabilities for each of the species it supports.

4. Example – Calculating Detection Probability

An example of the processing stages is shown below: (this example uses only the last 5 surveys. For real calculation, tens of surveys are used).

Stage 1 – Raw collected data for a single site (re-visualised)
Number of sightings per survey by species

Survey	Date	Effort (hrs)	Ca	Vb	Nn	Af	La	Zv
#1	14 /10/15	2.67	0	1	0	4	0	4
#2	22/04/15	2.50	0	0	1	1	0	4
#3	25/03/15	5.00	0	1	4	7	0	0
#4	23/12/14	5.00	0	0	0	0	0	0
#5	20/10/14	5.00	0	1	5	16	0	3
#6	18/10/14	5.00	0	1	4	8	0	0

Stage 2 – Processed data
Normalisation by effort.
Rejection of unsuitable conditions (e.g. #4 – December survey is not suitable conditions).
Number of sightings, per hour by species.
Formula: Number of sightings/duration (hrs)

Survey	Ca	Vb	Nn	Af	La	Zv
#1	0.00	0.37	0.00	1.50	0.00	1.50
#2	0.00	0.00	0.40	0.40	0.00	1.60
#3	0.00	0.20	0.80	1.40	0.00	0.00
#5	0.00	0.20	1.00	3.20	0.00	0.60
#6	0.00	0.20	0.80	1.60	0.00	0.00

Stage 3 – Processed data
Detection probability, per hour of survey effort by species.
Formula: Reduce any mean sightings per hour over 1.00 to 1.00

Survey	Ca	Vb	Nn	Af	La	Zv
#1	0.00	0.37	0.00	1.00	0.00	1.00
#2	0.00	0.00	0.40	0.40	0.00	1.00
#3	0.00	0.20	0.80	1.00	0.00	0.00
#5	0.00	0.20	1.00	1.00	0.00	0.60
#6	0.00	0.20	0.80	1.00	0.00	0.00

Stage 4 – Aggregated processed data
Mean detection probability per hour of survey effort by species at the target site
Formula: Mean of species detection probabilities per hour across all surveys for the site.

Ca	Vb	Nn	Af	La	Zv
0.00	0.19	0.60	0.88	0.00	0.52

Note: It is important to average detection probabilities across surveys, rather than to derive detection probabilities by dividing the total number of animals by the total hours of survey. The two approaches give very different results!

5. Calculating Probable Absence

5.1. Calculating probable absence requires a detection probability for the species. By factoring how many hours of survey effort is conducted, the formula can compare the expected results (as if the target species were present) with the actual results.

5.2. To determine the confidence for probability of absence, the following formula should be used:

$$C = 1-(1-Pdet)^n$$

Where **C** is the confidence.
Pdet is the detection probability for the target species.
n = the number of hours survey in suitable conditions.

5.3. In order to determine the number of survey hours required to achieve a confidence to a specified level. The following re-arrangement of the formula should be used:

$$n = \ln(1-C)/\ln(1-Pdet)$$

Where ln is the natural logarithm.

Worked Example: How many hours of survey (in suitable conditions) is required to determine the probable absence for adder (*Vipera berus*) using the detection probability of 0.19 (from the previous example) to a confidence of 95% (the NE threshold for re-introductions)?

Confidence = C = 0.95
Probability of detection (for adder), per hour = Pdet = 0.19 (example)

$$n = \ln(1-0.95)/\ln(1-0.19)$$
$$n = \ln(0.05)/\ln(0.81)$$
$$n = 14.2 \text{ (round this up to 15 hours)}$$

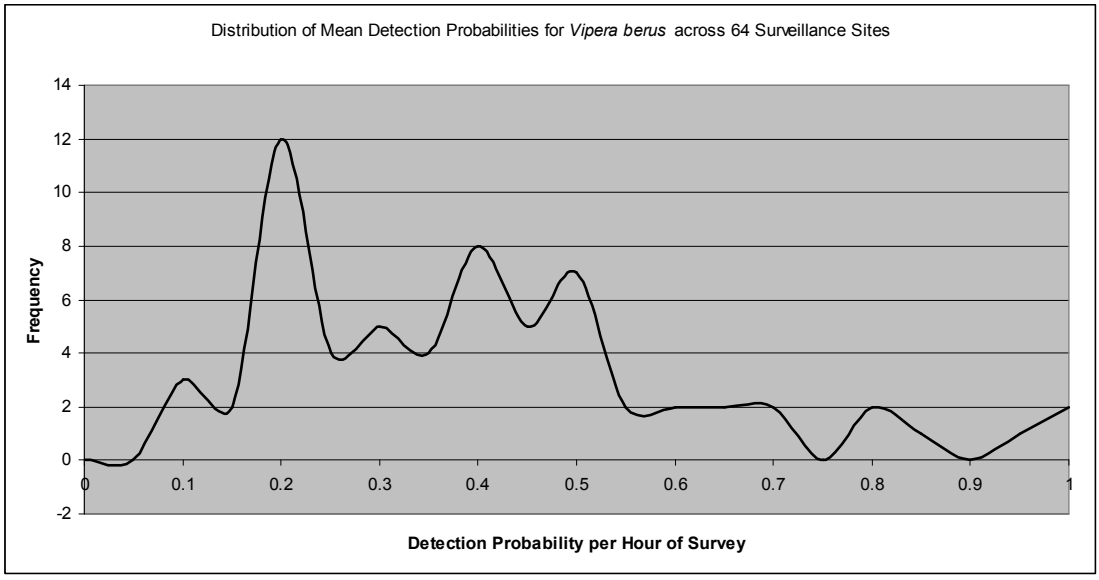
So, 15 hours of survey (in suitable conditions) without a sighting would generate a probable absence for adder to a confidence of 95% (using the example figures).

5.4. However; the formula relies on the selection of an appropriate detection probability. This Pdet should not be taken from a single site. In practice, this formula would be applied to a site where the target species has not been observed. In such a case; from where do you derive the detection probability?

6. Choosing an Appropriate Detection Probability

6.1. Probability of detection per hour of survey effort for any species varies enormously across sites. This may be because of differences in the number of animals present, the habitat type may affect detection or pubic pressure may have influenced the animals' behaviour. Whatever the cause, there is significant variation in detection probabilities.

6.2. The following chart shows the distribution of detection probabilities per hour across 64 long term SARG survey sites supporting the adder (other species' distributions can be found at Annex D).



6.3. With such a wide selection of detection probabilities to choose from, which is the most appropriate?

6.4. It is current SARG practice to select the lowest detection probability for the species across all sites where the species has been observed, as this represents the safest case.

6.5. The target site may have a *more difficult to detect* population than the lowest Pdet site, but how would we know this? Additionally, we do not know whether this lowest case figure represents a viable population.

6.6. It seems that the choice of a detection probability figure is a matter of policy. SARG policy is to select the lowest available figure as this provides the most cautious case that will generate objective results.

6.7. Annex A shows the current SARG minimum detection probabilities for all native reptile species. These figures change slightly from year to year as the data driving the statistics are live and subject to minor fluctuations. All sites covered by SARG are in the counties of Surrey, Hampshire, West Sussex and Berkshire, so the given detection probabilities are only safely used in these areas. Other regions may generate entirely different probabilities for detection.

7. Improvements

7.1. Potential improvements to this approach for determining the confidence of probable absence are listed below:

7.1.1. **Differentiation by habitat type:** Perhaps the categorisation of sites by predominant habitat type may improve accuracy. Aggregating results across habitat types may be generalising the detection probabilities unnecessarily.

7.1.2. **Determination of suitable survey conditions:** Currently, the only specification for suitable conditions is by month of year, the time of the survey and the absence of precipitation. Additional analysis of the SARG data set could provide further guidance for the most appropriate meteorological conditions such as temperature range, wind strength variations, cloud cover, UV index or even humidity.

7.1.3. **Regional categorisation:** Currently, detection probabilities are drawn from across all SARG long-term monitoring sites. Accuracy may be improved by specifying regional zones sharing geological and climatological profiles.

7.1.4. **Survey Weighting:** Further research could provide correlation together with cause and effect for the variation in detections per survey at a given site. This could include meteorological factors or even the date (as we know that detection probabilities vary by month). It may be possible to weight a survey based on survey characteristics to generate a more accurate confidence for probable absence. E.g. a survey conducted in April may carry more weight than a survey conducted in July (depending on species).

8. ANNEX A – SARG Minimum Detection Probabilities

8.1. These figures are only suitable for the Western Weald and have been generated in September 2016.

8.2. All probabilities of detection are normalised to hours of survey effort in suitable conditions.

Species	Minimum Detection Probability per Hour	Hours of Survey Effort to achieve 95% confidence of absence
Smooth snake	0.023	129
Adder	0.091	32
Grass snake	0.028	106
Slow worm	0.009	332
Sand lizard	0.042	70
Common lizard	0.051	58

9. ANNEX B – Suitable Conditions

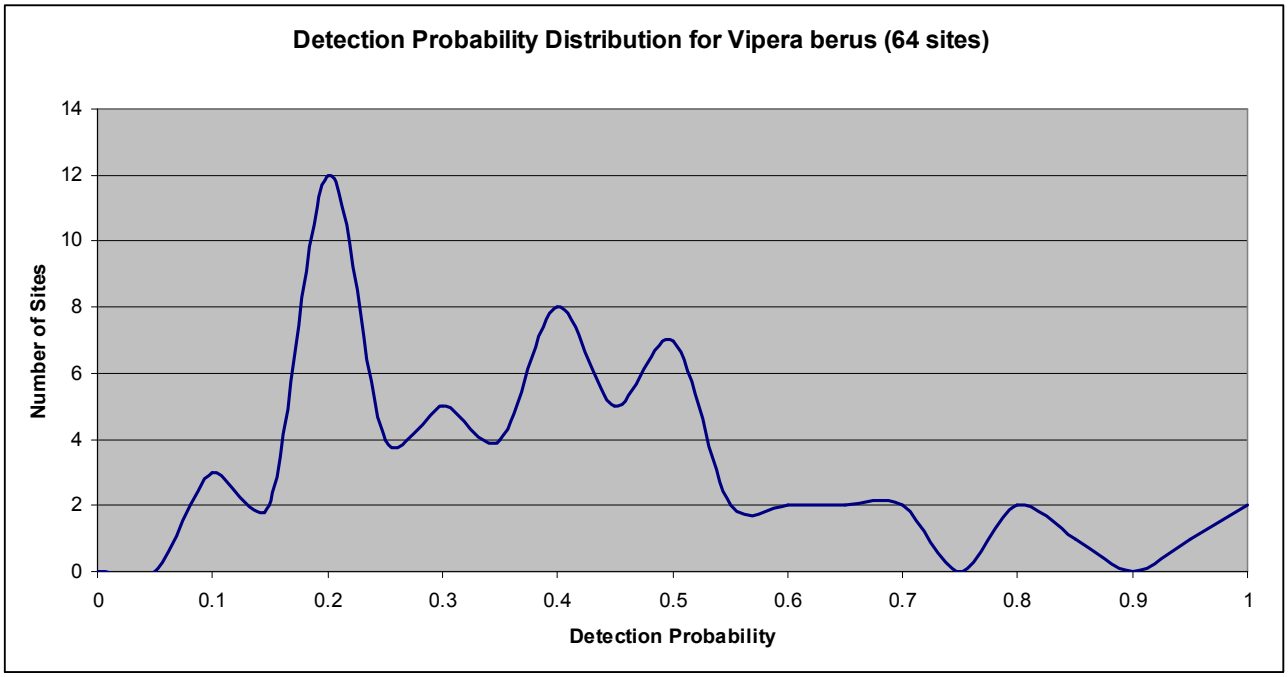
9.1. The subject of 'Suitable Conditions' is still under research using SARG statistics. The current working assumption is that for a survey to be compliant with probable absence calculations, it should be undertaken between the first of April and the end of September in meteorological conditions without precipitation. The survey should be conducted in core daylight hours, taken as between two hours after sunrise until two hours before sunset. (e.g. for Surrey in September from about 08:00 to 17:30)

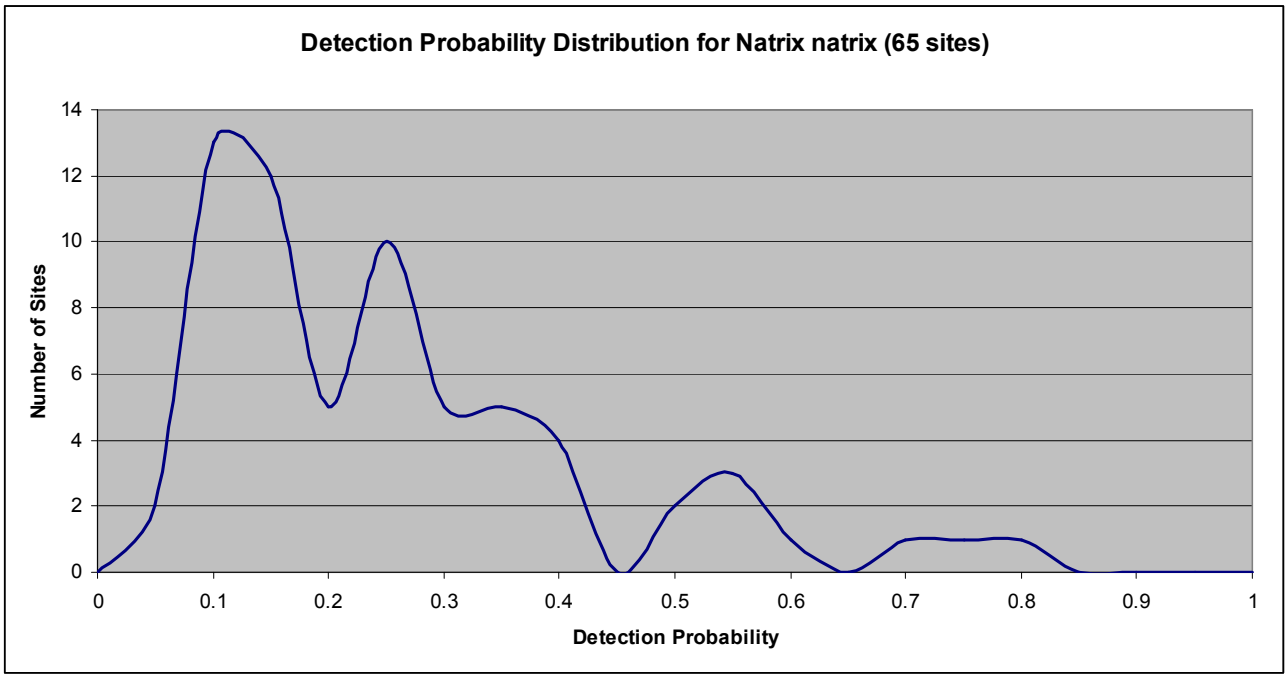
10. ANNEX C – SARG Data Set Summary (2011 to 2016)

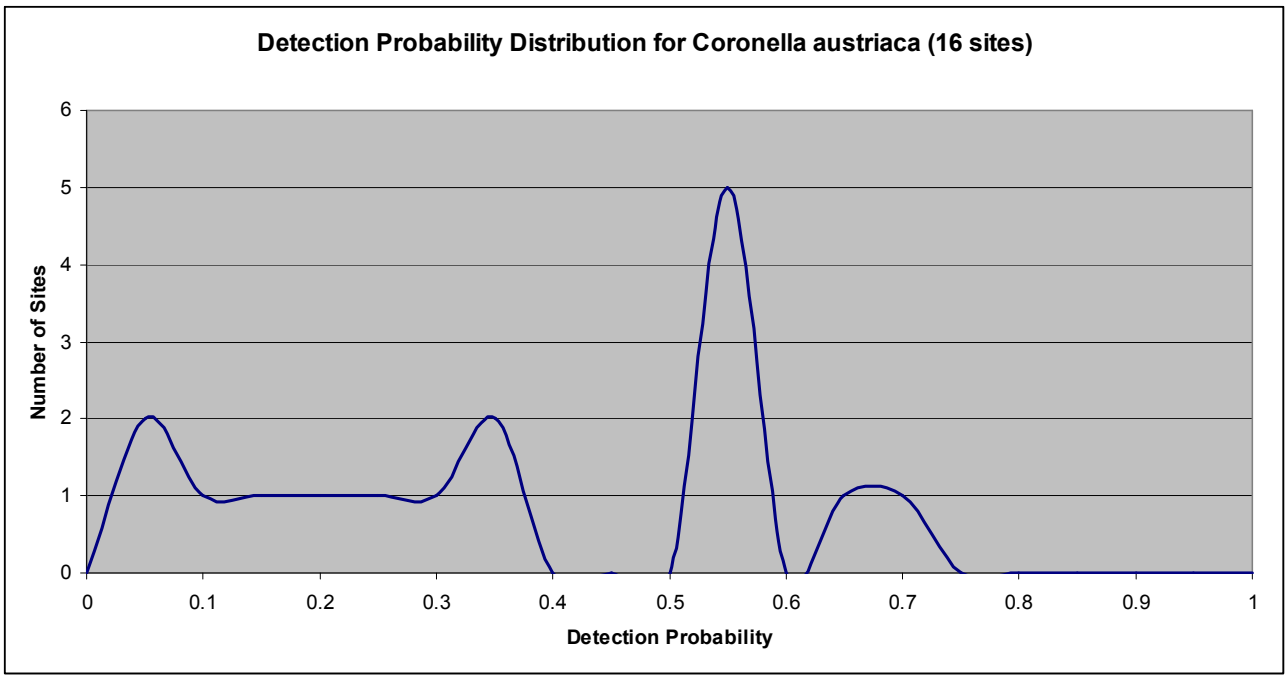
10.1. The following table demonstrates the size of the data set which has driven the detection probability statistics.

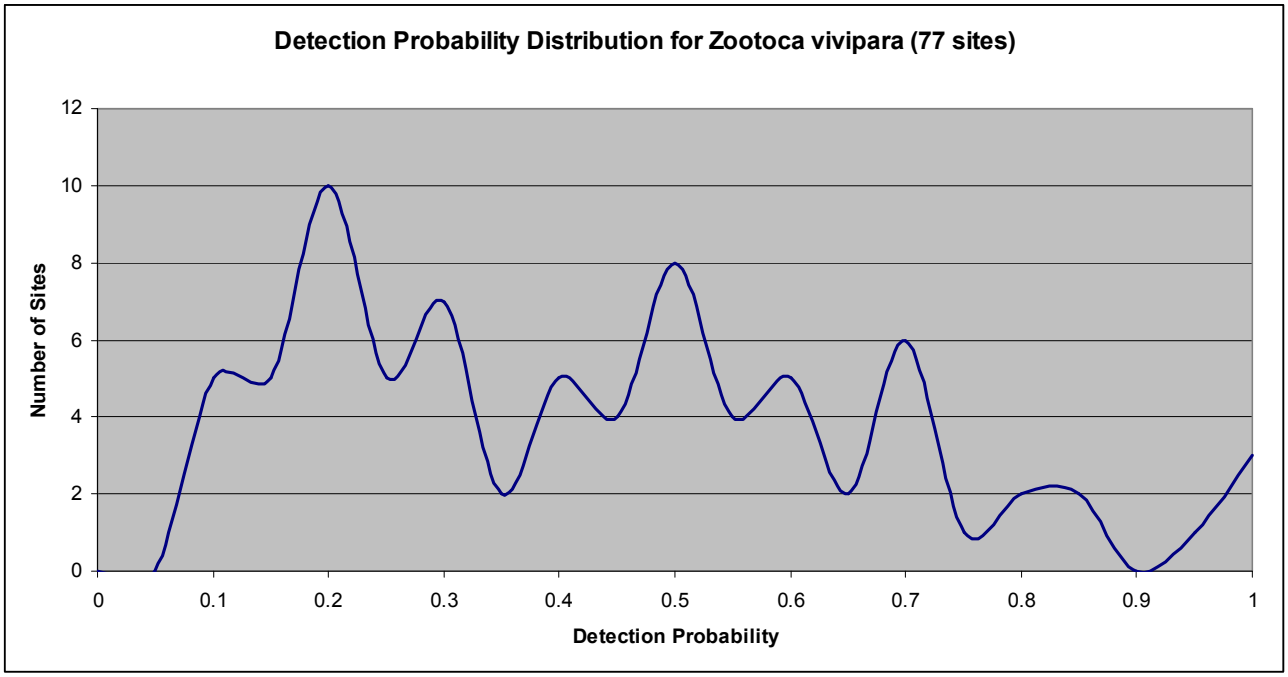
Species	Number of Survey Sites	Hours of Total Survey Effort	Total Number of Animals Observed
Smooth snake	16	1,867	998
Adder	64	3,787	1,871
Grass snake	65	3,724	1,205
Slow worm	70	3,875	6,192
Sand lizard	22	2,174	708
Common lizard	77	3,968	3,682

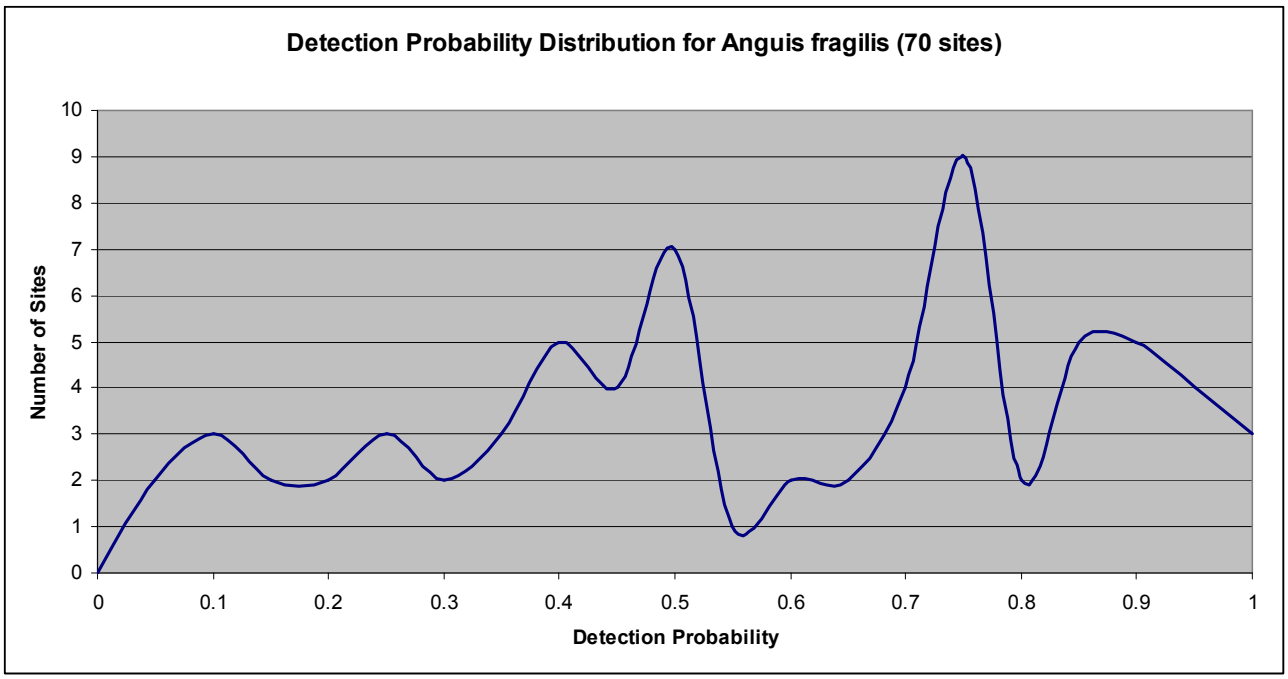
11. ANNEX D – Hourly Detection Probability Distributions

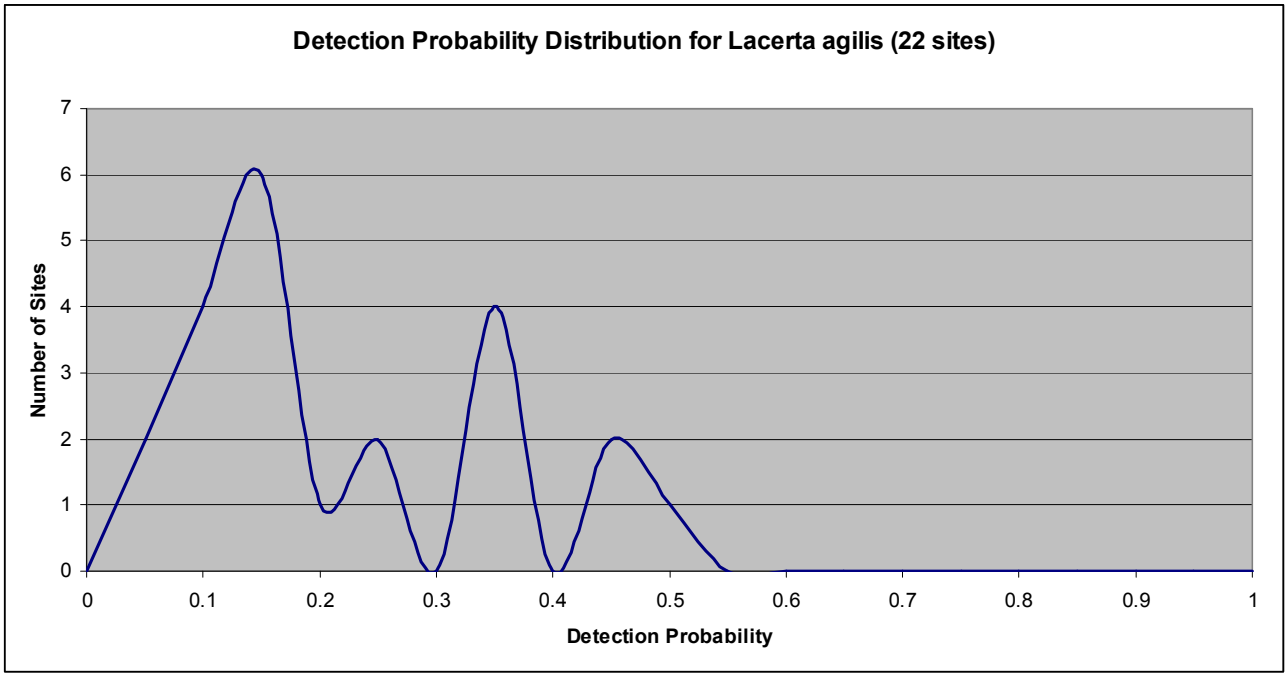





Detection Probability Distribution for Coronella austriaca (16 sites)
Number of Sites
0
1
2
3
4
5
6
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Detection Probability


Detection Probability Distribution for Zootoca vivipara (77 sites)
Number of Sites
0
2
4
6
8
10
12
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Detection Probability


Detection Probability Distribution for Anguis fragilis (70 sites)
Number of Sites
0
1
2
3
4
5
6
7
8
9
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Detection Probability


Detection Probability Distribution for Lacerta agilis (22 sites)
Number of Sites
0
1
2
3
4
5
6
7
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Detection Probability