MODULE 9: NDFs FOR REPTILES

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1. What is in this module?

This module provides additional guidance to Parties on some of the key considerations when undertaking NDFs for reptiles. It is complimentary to **module 1** and **2.** Where possible, the preparation of NDFs should be relatively simple, not onerous. In cases where the proposed volume of trade in a species and its vulnerability are both low, a simplified NDF can be undertaken. As such, the module has included guidance about the kinds and quality of data that would be typically required for an NDF. Regardless of whether the NDF will be simplified or comprehensive, the aim of this module is to provide guidance on undertaking reptile NDFs, understand what information/ data is required, why it is required, and the basic steps for getting the information.

2. Guiding principles: Life history traits, range and distribution, trade volume

CITES considers the extant Reptilia to include the crocodilians, turtles, tuatara, and squamates (snakes and lizards). As of July 2023, there are 12,000+ species of reptiles (The Reptile Database), about 10% of which are listed in the CITES Appendices. More than 10% of the 12000+ described reptile species have been recently recorded in the international wildlife trade, even though not all of these traded species are listed under CITES. Whether an NDF is needed and the approach to be taken will vary depending on the source of specific specimens in trade (see **Table 2B** in **module 2**). This chapter aims to provide general guidance on the source and type of data required, and parameters, specifically relevant for reptiles NDFs.

An NDF should consider aspects of a species' biology at the appropriate scales. Short-term population studies carried out at one or several sites can provide useful insights, however, extrapolation from one or few study sites to broad geographic areas or across a species' entire range may reduce the accuracy of the population estimate. Population sizes of reptiles are prone to fluctuate over time in response to local conditions like availability of food and drought. Conditions also vary inconsistently across a species' range; some populations may be thriving at the same time others are declining. Therefore, in almost all cases of trade in reptiles, it is necessary to be able to formulate NDFs on the best available data, expert opinion, reasoned rationale, and understanding of how wildlife populations respond to harvest and management. The degree of detail needed for an NDF should be proportionate to the harvest volume and vulnerability of the species concerned and be adapted to take into account changes in degree of exploitation, population status, habitat availability, domestic use, and conservation threats.

2.1. Life History Traits and Populations of Reptiles

Although recovery from harvesting is influenced by more than just a species' life history (e.g., density-dependence), in general a species that takes a long time to reach maturity, breeds infrequently, and produces only a small number of offspring, will take a long time to recover. Conversely, a species that grows and matures rapidly and has many offspring every year is likely to recover more quickly. Further, the mode of reproduction such as being oviparous versus (ovo)viviparous, or the ability to reproduce via parthenogenesis may affect a species' reproductive potential. In viviparous species, one vulnerable live stage is missing (risk of eggs may not hatch due to unfavourable conditions or losses due to egg predation). For example, *Shinisaurus crocodilurus* is an ovoviviparous species that matures within 3-4 years in the wild, giving birth to up to 14 offspring (mean 7) per year. Its life history could therefore be estimated as "medium" along the life history gradients in **module 1 Figure 1B**. Tegu lizards in the genus *Salvator* were one of the most exploited reptile species in the world by numbers during the 1980s. How could their populations endure harvest of millions of these large lizards every year? Understanding how their life history is relatively fast helps to explain how. These species mature within three years, most females breed annually laying clutches of 20 eggs on average, and have a relatively long life span of at least 10 years.

2.1.1. Geographic and Exploitation Gradients

Species are not distributed evenly across continents, regions, and countries and their populations may be scattered among suitable habitat patches. At the extremes, some species may be ecological generalists that occur almost everywhere, and others may be micro-endemics that can only be found in very specific patches of habitat. Similarly, patterns of exploitation of species for trade and hunting pressures are not even throughout a country. Thus, knowledge of where species occur in concert with some idea of where hunting occurs is important information for determining if a trade is likely to be detrimental.

The spectrum over which species in trade occur across broad landscapes can be broken down into geographic gradients. Geographic range refers to the overall area where a species may occur. Is this range small and fragmented or is it large? Populations and suitable habitat are not distributed evenly, and habitat quality varies across a species' range (i.e., spatial variation in population density and habitat heterogeneity). Therefore, it is important to have some idea in which part of their range the species actually occurs.

The combination of knowledge about the range and distribution for species is important for evaluating how harvest and trade may affect a species in a country. The term geographic distribution here refers to the pattern of occurrence of populations across a species' entire range. Knowledge of geographic distribution relies on accumulation of locations and known areas where the species is found. This information accumulates as surveys are conducted, local knowledge is transferred, and other studies document the presence of the species. The geographic distribution within the species' range in a country can be estimated for many reptile species based on available information and availability of habitat, while recognizing that working out fine-scale distributions of species is often a work-in-progress for most species of reptiles.

The IUCN Red List assessments use standard methodology based on species' presence at the scale of 4 km^2 to obtain metrics of geographic distribution referred to as Area of Occupancy (AOO). If AOO has been reported for a species in the IUCN Red List or elsewhere it is useful to include it in an NDF. However, NDFs are not required to employ the AOO methodology.

Across many species, the geographic distributions fall along a gradient spanning from species with populations across their entire geographic range to those that may occur only in scattered patches of habitat, though these patches may together cover a large range. In some cases, the distribution and range within a country can be almost identical, but in others it is not. For example, the Boa Constrictor (*Boa constrictor*) has a large distribution in South and Central America, but almost an equally large area of occupancy as a result of its ability to thrive in human modified-environments. Conversely, the Emerald Tree Boa (*Corallus caninus*) has a large distribution within South America, but a smaller area of occupancy owing to its reliance on rainforest habitat and an inability to thrive in human-modified environments. Likewise, the crocodile lizard (*Shinisaurus crocodilurus*) is distributed from southern China to northern Viet Nam. However, the species is associated to specific densely vegetated forest streams with backwater pools. Therefore, its geographic distribution is much smaller than its entire range (**Box B**). In practice, an NDF would consider the geographic distribution at a national level for the country of export only (and use standard metrics of AOO if available).

2.1.2. Considerations of Life Stage on Effects of Harvest

Among the reptiles, removal of different stages (eggs, juveniles, sub-adults, and adults) can result in very different impacts on populations. In very general terms, for long-lived species (often large-bodied) the effect of harvest of eggs and hatchlings is less detrimental than that of adults. Adults reproduce many times during their long lives, so removing adults has a disproportionate impact on population size over time. Because species with these traits typically have high natural hatchling mortality, a certain harvest of eggs and hatchlings may be indistinguishable from natural mortality of this life stage. Turtles and tortoises provide a clear example of why consideration of life stage is important, as their life history for many species is characterized by delayed times to maturity, small brood sizes, high hatchling mortality, and unpredictable reproductive success (**1**). There are exceptions to these broad generalizations, such as when entire cohorts of eggs and hatchlings are targeted over long time periods, as occurred in the past with sea turtles. However, it was the combined effect of unsustainable removal of adults and eggs that led to the decline of sea turtles. In contrast, protection of adults allows harvests of eggs to be managed sustainably. For example, a shipment of hundreds of hatchling pond turtles may have little impact on the turtle species' population at the national or regional level, but a harvest of hundreds of adults of the same species may cause a long-lasting decline in the same population. In one study of Common Snapping Turtles, it was shown that it would take 30 years for a population to recover from removal of half the reproducing females, without immigration (**2**). We also know that local populations of crocodilians can be overexploited by taking too many adults, and that these populations recover much faster when adults move in from outlying areas. Consideration of life stage is also more important when populations are isolated from each other, especially when the species' dispersal is limited or dependent on a particular life stage. Depending on the species, it may be hatchlings that disperse to sustain regional populations, or it could be the movements of sub-adults. For these reasons, an NDF should specify what life stage is being used and how it is predicted to impact the population. For species that have not been studied, a good starting point is to consider similar related species as surrogates. Life spans, modes of dispersal, and which life stages have highest rates of mortality are roughly similar across the major groups of reptiles.

2.1.3. Assessing Impacts of Trade Volume and Harvest Level on Reptile Populations

Non-detriment findings need to address the volume of trade in the species and provide an assessment of the potential effect of the volume of trade on the species' population in the exporting country and exploited population. A species' trade can be categorised as low, medium or high, based on the proposed number or volume of the specimens in trade (e.g., 0-500, 500-5,000, 5000+). Dozens or a few hundred specimens in a shipment and few shipments per year may be considered a low trade volume for many species, whereas a number in the tens or hundreds of thousands of specimens may be considered to be large. The problem is that the trade volume by itself does not account for the level of harvest in relation to the population size. Then, ecological studies of population size are notoriously difficult to carry out for reptiles, and doing so usually requires years of study at only one location.

Faced with this conundrum, how can resource managers and CITES Authorities include defensible assessments of trade volume in NDFs? Fortunately, for most reptile species coarse and very precautionary estimates of population density of the species based on all available data (both quantitative and qualitative) can be used to put the volume of trade into perspective of the species population. Once the geographic distribution and habitat use is described, a precautionary population density can be extrapolated across the distribution to provide a country-wide population size estimate as a starting point. Over time, both the AOO and average population density values can be updated and incorporated via adaptive management protocols.

The overall level of harvest (for international and domestic use) should be considered in relation to the precautionary population size, also taking into account the species' life history. Using the example in **Box A**, *Simalia amethistina* (scrub python) has an estimated geographic distribution amounting to 176,750 km^2. Suppose the population density is five individuals per km^2, which would be a surprisingly low population density, an annual harvest rate of 5% in this scenario would amount to a precautionary population size estimate of 883,750 with an annual off-take of 44,187 individuals per year. The life history of this species falls toward the fast end of the slow-fast continuum, and hunting takes place in a very small proportion of the distribution area. The ecological role of the species as predator and prey would probably not be compromised, as long as the species is able to disperse throughout its range. The best available data show it occurs throughout the island of New Guinea, in diverse habitats, both natural and degraded, and has an annual harvest of only 400 individuals from less than 5% of the species' AOO. The species has clearly not been extirpated from the areas in which it is harvested, has life-history traits that allow it to recover from harvesting, and a total wild population that is likely to comprise millions of individuals. There is no reasonable probability that such a scenario would be detrimental, thus a simplified NDF assessment would likely suffice. This case is also illustrative of the need for adaptability in the NDF because CITES may recognize taxonomic changes in *Simalia* over time, as well as anecdotal information on population declines in specific areas.

Box A. Example of geographic distribution

Here we will examine the area of occupancy for *Simalia amethistina* in Indonesia, a species of python inhabiting the island of New Guinea. Small numbers are harvested from Indonesian New Guinea each year to supply the pet trade.

- *Simalia amethistina* is found in Indonesia, which has a land area of 1,904,569 km^2 (Fig. 9A)
- However, *S. amethistina* is known to occur only in the Indonesian provinces of Papua and West Papua. The area of these provinces is 416,129 km^2
- Furthermore, *S. amethistina* only occur in rainforest habitats, which do not occur in some parts of the highlands, or in some parts of southern Papua.
- Based on this information, an estimate for the distribution area of *S. amethistina* in Indonesia **176,750 km^2** – i.e., the extent of lowland tropical rainforest in Papua and West Papua (Fig. 9B).

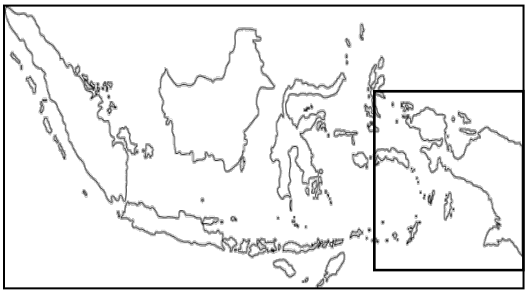

Figure 9A: The area of Indonesia

Figure 9B: *Simalia amethisina* occurs in the lowland rainforest areas of Papua and West Papua (red), but not in woodlands or the highlands (grey).

Box B: Example geographic distribution

Here we will examine the area of occupancy for *Shinisaurus crocodilurus* in Viet Nam, a semi-aquatic lizard species inhabiting rocky streams in evergreen forests of China and Viet Nam. Collection for international trade contributed to the species' decline in both countries.

- *Shinisaurus crocodilurus* is recorded from fragmented sites in northern Viet Nam and southern China. According to the latest IUCN Red List assessment, the species' range, or **global extent of occurrence (EOO)** (China and Viet Nam together) is estimated at **1,500 km²**.
- In Viet Nam, *S. crocodilurus* is known from the provinces of Bac Giang and Quang Ninh. The area of these provinces covers 10,028 km^2 in total (Fig. 9C), while the species only occurs at few sites.
- Estimated suitable habitats of the species in Viet Nam are small and fragmented (Fig. 9D).
- Within suitable habitats, *S. crocodilurus* occurs along vegetated and remote rocky streams only (Fig. 9E). During extensive annual field research between 2013 and 2016, the species has been recorded along a total of **nine streams** in Viet Nam, while its presence in some of these streams could not be re-confirmed during more recent surveys.
- Based on this information, the geographic distribution for *S. crocodilurus* in Viet Nam is estimated to be **smaller than the threshold of 2,500 km² and therefore categorized as "small"**.

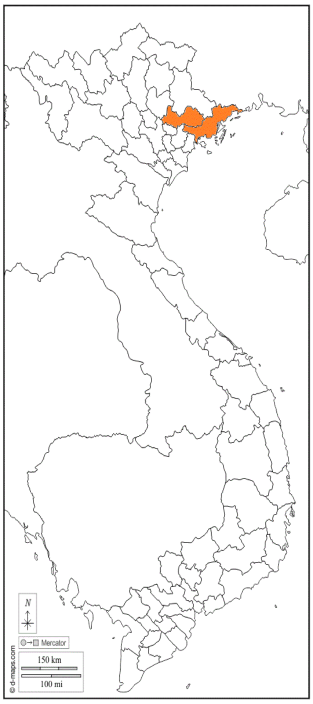

Figure 9C: Area of Viet Nam. *S. crocodilurus* occurs in Bac Giang and Quang Ninh (orange)

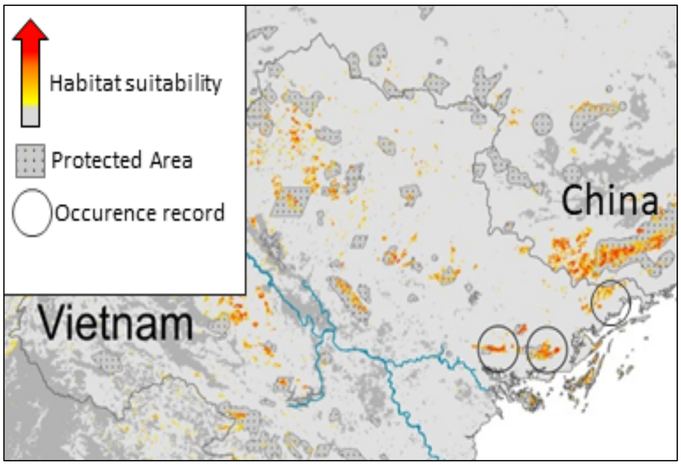

Figure 9D: Occurrence records of *S. crocodilurus* (circles) and estimated suitable habitats in Viet Nam (red).

Figure 9E:. Microhabitat of *S. crocodilurus* in Viet Nam.

3. Guidance on completing Simplified NDF Assessments for reptiles

Table 9A provides reference values for the five criteria in the Simplified Assessment Template. The reference values may not be equally applicable for all taxonomic groups and may require refinement after thorough testing by CITES Parties. Although these figures are specific, even coarse data on life history, area of distribution, and harvest pressures can be used to create a robust basis for determining the likelihood a reptile species has attributes that ensure harvest can be sustainable. Reptiles, like all species, possess suites of life history traits that are directly linked to population growth and persistence. Life history traits, taken together, influence the ability of a population to recover from decline, and endure harvesting. We can estimate species' time to maturity, brood size, and frequency of reproduction with published data, local knowledge (see **module 3**), samples from harvested specimens, and comparison with closely related species without expensive and time-consuming field-based studies carried out by ecologists. Furthermore, we can take into account the area of distribution of a species as well as the area over which most harvesting occurs. Qualitative and quantitative data can be used to create defensible scenarios of harvest level in relation to trade volume. The harvest level and geographic distribution will generally be assessed at a national level. However, if an NDF is to be done on a local scale, then the harvest level and geographic distribution will need to be scored at the local level.

Table 9A. Simplified NDF Assessment template table, which has been modified to include reference values relevant for reptiles for each criterion.

	Number of points			**Score**
Criteria	**1**	**2**	**3**	
Annual Harvest level	Low (<500)	Medium (500 - 5,000)	High (>5,000)	
Area of distribution	Large (>20,000km^2)	Medium (2,500 – 20,000km^2)	Small (<2,500km^2)	
Life-history	Fast	Medium	Slow	
Conservation or threat status	**If the status of the species is** threatened or Unknown give a **max score of 1 point.**			
Illegal trade	If levels of illegal trade are inferred by reference to seizure data, they should be included under "Annual harvest level". If illegal trade is known to be occurring, but *levels* are unknown give a **max score of 1 point.**			
Final Score and Justification	(If score lower than five (5) = **trade is non-detrimental** (record the score and justification in the worksheet provided). If the Simplified NDF score is equal to or greater than five (5) then a **Comprehensive Assessment should be undertaken**.			

4. When more comprehensive NDF assessments for reptiles are needed

4.1. Data and evidence requirements

The framework using life history, geographic, and exploitation gradients provides a strong foundation for any NDF for reptiles (see **Figure 1B** in **module 1**). Application of these foundations within the Simplified Assessment can indicate when a more Comprehensive NDF Assessment is needed. When completing the Simplified Assessment, it is useful to categorize the quality and quantity of information that is likely to be helpful in a more Comprehensive NDF. Information on population size and structure, harvest level in relation to population size, more precise geographic distribution, and data on harvest levels, harvest locations, number of areas harvested, frequency of harvests, life stage targeted for havest, and measures of hunter effort may be relevant. Evidence of the results of ongoing conservation and management efforts may be necessary to include. It is easy to visualize that a rigorous monitoring and management program would be aimed at providing these kinds of data. **Table 9B** indicates some of these types of data needed for complex NDFs.

A vast scientific literature can be consulted to evaluate the effects of harvest on animal populations, ranging from highly mathematical to practical examples. A relevant publication is:

Getz and Haight 1989. Population Harvesting: Demographic Models of Fish, Forest, and Animal Resources. Princeton University Press (Monographs in Population Biology 27.).

Table 9B. Common types of data useful for Comprehensive NDF Assessments for reptiles, with keywords for common approaches used to obtain the information. These data are not required for NDFs to be approved, nor is this an exhaustive list. The amount of data in each category ultimately required for a comprehensive NDF will vary depending on many factors including the species concerned, the perception of high versus low trade levels, external assessments of conservation status and threats, and the feasibility of obtaining precise data. For example, population size may be desired, but ultimately impossible to estimate with meaningful accuracy.

Data	Purpose	Common Approaches to Gather Information
Ecology/ Life history traits	Useful to assess a species ability to respond to harvest; can include: age at maturity, brood size, (ovo)viviparous or oviparous, life span, frequency of reproduction, parthenogenesis, sperm storage; degree of specialization, dispersal ability, seasonality, cryptic lifestyle, spatial distribution	Field research, obtaining specimens from harvest monitoring, literature searches, museum specimens, captive breeding
International trade	Trade trends can help inform assessments of impact of levels of annual harvest and if trade has been sustainable or associated with population declines	Analysis of available data from UNEP-WCMC, customs reports, local knowledge, traders, industry reports, any other source
Geographic distribution	Useful to understand how widespread species is, if populations are persisting, knowledge of differences among populations	Field-based surveys, Rapid Ecological Assessments, museums and databases, local knowledge, extent of contiguous occupied habitat
Habitat area and characteristics of habitat	Useful to understand how widespread species is, if populations are persisting, if habitat is being lost or gained and if populations are connected	Measures of habitat area (GoogleEarth, collaborate with NGOs, universities, other), create a species distribution model or habitat suitability model
Population abundance, density and size	Useful to gauge impact of harvest and change in abundance over time	Harvest monitoring, field-based surveys, ecological studies, (see **Table 9C**)
Population structure	Assess change in populations over time, assess effects of harvest of life stages, use structure to estimate population parameters	Harvest monitoring, field-based surveys, ecological studies, (see **Table 9C**)
Distribution of commercial hunting	Where harvest occurs within the species' range is critical to understand impact of harvest regardless of total harvest size	Hunter reports, interviews, harvest monitoring
Annual harvest for trade	Establish trend in harvest over time	Data archiving, Verification through inspections and harvest monitoring, including possible illegal trade
Harvest effort	Gives indication of potential impacts of harvest on population	Catch-per-unit-effort, Hunter reports, interviews, harvest monitoring

Data	Purpose	Common Approaches to Gather Information
Conservation status assessments	NDFs may take this into account and factor into effect of commercial harvest	IUCN Red List status, National Red List status
Threats	NDFs may take this into account and factor into effect of commercial harvest	Measures of habitat loss, persecution, illegal trade, other.
Measures to address threats	NDFs may take this into account and factor into effect of commercial harvest	Restoration activities, management practices, habitat protection
Domestic use and trade	NDF must take forms and purposes of domestic use into account and factor this into overall effect of commercial harvest	National resource management agencies, local market surveys, collaborate with NGOs, local ecological knowledge

4.2. Population Size, Structure, and Abundance

Resource managers, CITES Authorities, and conservation scientists are ultimately concerned whether populations are persisting across the geographic distribution, and if they are growing, declining, or stable. This is why NDFs require defensible assessments of the status of populations. Considering the difficulties in measuring the population size, structure, and recovery potential of many reptile species, what approach should be taken when making an NDF that is required to contain a high level of substantiated information? The published volume McDiarmid, et al. 2012, *Measuring and Monitoring Biological Diversity: Standard Methods for Reptiles* (**3**) is a good starting point for designing studies to measure and monitor reptile populations.

4.2.1. Population Size and Growth

If we could reliably estimate population size (the number of individuals alive in a defined population; N) and structure every year for every population in every ecological setting, biologists could construct life tables and apply simple models of the effect of harvest on every population's size and growth. The truth is, accurate and precise measures of population size and growth are probably the most desired, most difficult to obtain, most unreliable, and least utilized data in management of many commercially traded reptile species. Even at a single study site, measuring a population's size is a never-ending task; once it's measured it has already changed and must be measured again at great cost. Extrapolating those population numbers to other sites only creates the illusion of knowing the regional population size because of natural local population fluctuations, source-sink phenomena, and the correlations between population dynamics and habitat quality. Yet, wildlife and fisheries management are ongoing without these measures, with well-known cases of successful sustainable use management programs, some demonstrating remarkable population recovery and some ongoing for decades, (e.g., American alligator, ungulates, waterfowl). At the same time, the fundamental interaction between harvestand population-level processes is undeniable—populations subject to harvest are affected at some level. Monitoring programs are designed to provide data needed to assess trends in population abundance and structure over time, and managers use these inputs to develop strategies that ultimately affect population size and structure.

4.2.2. Population Abundance

Many resource managers and authorities are probably interested in scientifically defensible assessments of population abundance, or how common the reptile is within its habitat. Abundance is a much looser term than population size. Assessments of population abundance may not be based on the intensive sampling needed to obtain population birth and death rates and actual measures of population density. In **Box A** and **Box B** above and in many of the reptile case studies in **module 14**, the true population size would be almost impossible to estimate, but it is clear that even very conservative measures of abundance are sufficient to evaluate if the harvest level may be non-detrimental or unsustainable. Abundance can be assessed through a number of field-based methods that are best suited to the taxon being studied (**Table 9C**). Using comparable methods, measures of abundance can be used as an indicator of whether the population is growing or declining or stable. Naturally, implementation of any of these methods is time-consuming and can be expensive. These methods are used in ongoing management and monitoring programs, which feed data into creation of NDFs.

4.2.3. Population Structure

Population structure refers to the sex ratio and distribution of age or size classes in a population. Knowledge of population structure is very important for assessing impact of harvest on a population and many methods have been developed to use information on population structure to evaluate population trends and sustainability. For reptiles, it is usually best to consider the size distribution or distribution of life-stages rather than age because it is very challenging to know the ages of sub-adult and adult reptiles. This is especially true in crocodylians, turtles, and large-bodied lizards and snakes. Moreover, sexual maturity and fecundity are more associated with size than with age in reptiles. Incidentally, because populations of reptiles are structured by size, this helps explain why consideration of the life-stage that is harvested is important. Population structure can be obtained through ecological studies and through harvest monitoring. However, most field methods do not sample all life stages with equal probability, so analyses need to be carried out to account for bias. Harvest monitoring can also be biased against inclusion of some life stages, and also require careful analyses to determine the underlying population structure. Through harvest monitoring, the life stages most targeted will be identified and analytical methods can be used to infer the underlying population structure.

Table 9C. Common field-based approaches to measure population abundance and population structure of reptiles. Also refer to (3).

Order	Family	Habitat	Abundance estimate method	Examples of technique in application
Squamates	Snakes	Forest	• Transect surveys • Pitfall trapping • Hand-capture	Natusch and Natusch (2011) (4)
		Desert	• Pitfall trapping • Hand-capture	Fitzgerald et al. 2012 (5), McDiarmid et al. 2012 (3)
		Aquatic	• Draining of waterbodies to reveal snakes • Fyke nets submerged within lagoons • Hand-capture	Kusrini et al. (2022) (6), Houston & Shine (1994) (7)
	Varanids	Forest	• Active capture of lizards using baited snares	Khadiejah et al., (2019) (8)
		Desert	• Pitfall traps, active capture in snares	Fitzgerald et al. 2012 (5), McDiarmid et al. 2012 (3)
		Semi-aquatic	• Nets set over water courses, baited snares	Khadiejah et al., (2019) (8)
	Agamidae	Semi-aquatic	• Hand-capture, mark-recapture (colour)	Nguyen et al. (2018) (9), Gewiss et al. (2020) (10)
	Chamaeleonidae	Terrestrial / arboreal	• Nocturnal surveys, mark recapture	Andriantsimanarilafy (2022) (11)
	Scincidae	Terrestrial	• Pitfall trapping, lasso	Fitzgerald et al. 2012 (5), McDiarmid et al. 2012 (3)
	Gekkonidae	Terrestrial / arboreal	• Visual surveys, trapping, lasso	Fitzgerald et al. 2012 (5), McDiarmid et al. 2012 (3)
		Forest caves/ karst associated	• Hand capture, mark-recapture (colour)	Ngo et al. (2016) (12), Ngo et al. (2019) (13)
	Iguanidae	Terrestrial	• Visual surveys, trapping, lasso	Fitzgerald et al. 2012 (5), McDiarmid et al. 2012 (3)
	Shinisauridae	Semi-aquatic	• Hand-capture, mark-recapture (transponder)	Van-Schingen et al. (2014) (14); van Schingen et al. (2016) (15)
			• eDNA monitoring (shows presence only)	Reinhardt et al. (2018) (16)

Order	**Family**	**Habitat**	**Abundance estimate method**	**Examples of technique in application**
Crocodylia	Crocodiles	Forest and swamp dwelling	• Distance transects coupled with spotlight or nest surveys in terrestrial or inundated habitats • Nocturnal spotlight surveys in navigable, forested waterbodies • Burrow surveys and occupancy • Traditional ecological knowledge surveys • Lasso and hand-capture	Subalusky et al. 2009a (17), Subalusky et al. 2009b (18)
		Navigable waterbody dwelling (i.e., lakes, rivers, some marshes)	• Nocturnal spotlight (e.g., eyeshine) surveys • Aerial surveys of basking individuals and/or nests • Nest surveys • Traditional ecological knowledge surveys	Subalusky et al. 2009a (17), Subalusky et al. 2009b (18)
Testudines	Fresh water turtles	Marsh, Ponds, Rivers	• Hoopnets (baited), Fyke nets, Basking traps	IUCN TFTSG (19)
	Tortoises	Desert	• Hand capture, burrow surveys	IUCN TFTSG (19)

5. Module 9 references

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