British and Irish Association of Zoos and Aquaria

Reptile and Amphibian Working Group
UV-TOOL

Welcome to our UV Tool Project. This is an introduction to the UV-Tool and a guide to its use. (Most of the material in this document also appears in Tabs within the Tool.)

The UV-Tool is a working document created by the **RAWG UV-Tool Focus Group**, the current members of which are Frances Baines, Joe Chattell, James Dale, Dan Garrick, Iri Gill, Matt Goetz, Tim Skelton and Matt Swatman.

The UV-Tool is a simple Excel file with multiple tabs, containing an editable and expanding database of reptiles and amphibians, with estimates of their microhabitat requirements and basking behaviour.
The concept is to build up this database to provide a simple way of estimating the likely UV requirement of any species of reptile or amphibian, based on its microhabitat and basking behaviour, and then

- to provide a step-by-step guide to choosing a suitable UVB lamp
- to link to online lamp test reports to enable comparison of lamps regarding UV output and spectrum.

A Species Database Tab is the core of the Tool. We ask all contributing zoos to list their species along with biome, basking behaviour, photoperiod, suggested temperature gradients (day and night, summer and winter) and microhabitat, including specialist requirements added as "comments"; and references where possible. A Biome Listing Tab re-sorts the data so that animals occupying similar microhabitats can be assessed.

We welcome input from all zoos, herpetologists and private keepers with specialist knowledge.
Zoo contributors to date: Birmingham Wildlife Conservation Park; Blue Planet Aquarium; Bristol; Chester; Cotswold Wildlife Park; DWCT Jersey; Hadlow College; Living Rainforest; Marwell Wildlife; Newquay; Sparsholt College; Wildlife and Wetlands Trust; ZSL London Zoo
Guest contributors to date: Andy Beveridge; Chris Davis; Gary Ferguson; Greg Fyfe; Christopher Michaels; Roman Muryn; Jim Pether; Terry Thatcher.
Contact fbaines@uvguide.co.uk to submit a new entry or with your comments and suggestions.

The UV-Tool Concept

The basic premise

- Wild reptiles and amphibians evolved to make best use of their environment.
- UV is a free and plentiful resource.
- Animals self regulate their exposure to heat, light and UV.
- Optimal UV levels are likely to be the "natural" ones the reptile experiences when environmental conditions are favourable in its microhabitat. (It is vital to understand that microhabitat is not the same as "climate") Each species will have an optimal photo-microhabitat.

Therefore: "natural" heat, light and UV = optimal heat, light and UV
To create a suitable photo-microhabitat in captivity:
1. Measure the heat, light and UV in the animal's precise location in the wild; if no data available yet, use knowledge of the photo-microhabitat of the species and its natural behaviour in the wild to estimate the likely gradient.
2. Provide similar heat, light and UV GRADIENT in captivity.
3. Trust the animal to self regulate its day-to-day exposure.

With regard to vitamin D3, it seems likely that the reptile's body (e.g. skin thickness and pigmentation) and the reptile's behaviour (which determines its level of exposure to sunlight) have evolved together to optimise the level of vitamin D3 it synthesises. Some reptiles even specifically self-regulate their UVB exposure, which they increase if their vitamin D levels become sub-optimal.

The Tool has the following aims:
1. To enable the reptile or amphibian keeper to estimate the likely photo-microhabitat of any animal, and in particular, the UVB gradient, based upon knowledge of its thermoregulatory behaviour (e.g., diurnal rhythm, basking behaviour) and its typical microhabitat in the wild.
2. To provide a simple method of estimating the UVB available to that animal from specific types of UVB lighting, in the terrarium or other indoor enclosure.

Limitations:
• So little scientific evidence is available, at present, for the UV and visible light requirements of individual species that practically all recommendations in this Tool are just **estimates**, which may need considerable revision in future. Providing artificial UVB lighting for many species is still experimental. It is vital that Tool users observe their animals, respond to any problems immediately, and report their results.
• This Tool cannot provide an "instant formula" for lighting enclosures, lamp-to-animal distances, etc. The aim of the keeper should be to use UV and visible light creatively, to provide naturalistic gradients suitable for the animals in question, from species-appropriate maximum levels to full shade.
• **The Tool is not a husbandry guide.** It includes only extremely basic information on the likely photoperiod, thermal requirements, and natural microhabitat of each species, simply to assist the keeper in choosing appropriate lamp combinations for lighting and heating the enclosure.
It is vital that other sources are used to fill in the details regarding precise requirements and seasonal adjustments.
• Humidity requirements are not considered at all, as these are outside the scope of the Tool.
• The Tool does not provide any information on non-light-emitting heat sources such as ceramic bulbs or heat mats. **Most enclosures will require a COMBINATION of UVB lamps and non-UVB lamps to provide a balanced light spectrum, sufficient light intensity, and a thermal gradient.**
• At present, the Tool does not contain information on non-UVB lamps (such as ordinary incandescent lamps or infrared lamps used as "basking lights") but eventually, the scope of the Tool may be extended to cover the provision of visible light and infrared.
• The Tool links to lamp test results from UVGuideUK. These are measurements from single lamps or very small numbers of lamps. The sample lamps are, to the best of our knowledge, representative of typical products. However, individual lamps -even from the same batch - will vary in their UVB output, depending upon their original specifications and upon their age, the quality of the electrical supply, external temperature and other factors. Because there will inevitably be differences between individual lamps, the data for the lamps tested in these reports should not be relied upon as an accurate guide to the exact output of all lamps of this type.

How to use the Tool

This is a five-step process, which involves working through the Tabs in the Tool.

1. Locate your species in the Database.

1a. Is your species in our main species list? If so, find it in the **"Species List – Alphabetical"** tab and check out our microhabitat recommendations for this species, which includes a 'Ferguson Zone' based upon its basking behaviour.

1b. If your species is *not* in our list, identify a species in the same biome with similar microhabitat and basking behaviour, in the "**Species in Biomes**" tab and use this as a rough guide;

…and please consider submitting a new entry for your species!

2. Note the Ferguson Zone allocated to your species.

All species have been placed into one of four Zones (or in some cases, between two of the four Zones) according to their basking behaviour.

3. Determine the UV Index gradient you require.

The "**Ferguson Zones Information**" tab in the Tool explains the Zone concept, and gives suggested UV ranges for reptiles in each of the four Zones.

Artificial UV lighting may be provided in two ways. Low-level 'background' UV can be provided, designed to supply the equivalent of natural UV levels in light shade over a large proportion of the animal's enclosure – this we call the "**Shade Method**". This is very appropriate for shade-dwelling, crepuscular and nocturnal species.

Alternatively, higher levels just within the basking zone may be used, mimicking the effect of a beam of sunlight; this we call the "**Sunbeam Method**". This is, of course, designed for sun-basking species.

Outside the basking zone, the UV gradient will fall to low levels towards the cool, shaded end of the vivarium, as it does outdoors between sunlit and shaded areas.

The UV ranges are given as UV Index figures. The "**UV Index Information**" tab explains our use of the UV Index as a guide to suitable UV exposure levels for reptiles in captivity.

(*More details explaining the UV Index and Ferguson Zones are also provided, later in this booklet.*)

4. Choose a suitable lamp.

The final tab, "**Lamp Index**", provides a summary of lamps for which test results are available via internet links, provided in the tab. There is also a simple, colour-coded table indicating which lamps in the list are suitable (depending upon distance) for animals in each Ferguson Zone, for either Shade or Sunbeam methods. Select a suitable lamp and distance, looking for the UV Index you require at animal level.

5. Combine with other heat and light sources, to create the microhabitat.

Choosing the UV lamp, of course, is not the end of the story, because UV light is only one feature to be considered in the creation of a microhabitat. The UV lamp must be used in combination with suitable basking lamps or other sources of visible light and warmth, with suitable heat and light gradients, to ensure that the animal has an adequate basking zone and areas into which it can retreat from the heat, light and UV. There are few, if any, situations in which just one lamp can provide all that is necessary for a healthy environment.

The UV-Tool provides some pointers in regard to heat, light and suitable surroundings for different species, but much more detailed husbandry guidelines must be consulted, to provide necessary details.

The UV Index

The Solarmeter 6.5 Meter, used for all UV-Tool recordings, gives a reading of the UV Index; this is a unitless measure of the solar UV (ultraviolet) intensity at the Earth's surface relevant to the effect on human skin. It was designed to be used in estimating the risk for erythema (sunburn) that an unprotected fair-skinned human would have if exposed to sunlight of varying intensity.

Shorter wavelengths of UV have a stronger effect upon living cells than longer wavelengths. An action spectrum - the erythema action spectrum - exists to quantify this effect on human skin. Weighting the total solar UV irradiance with the erythema action spectrum indicates the UV exposure required to induce erythema of human skin. The UV Index itself is an irradiance scale calculated by multiplying the erythemally-effective irradiance in watts per m^2 by 40.

Sceptics will immediately point out that reptile and amphibian skin is totally different to human skin, and using the UV Index scale in herpetological studies is therefore absurd. It is therefore important to refute this by noting that:

(1) the UV Index is being used here only as a useful measure of the intensity of certain wavelengths of UV light known to have biological importance to reptiles and amphibians - *no-one is talking about sunburn or erythema!*

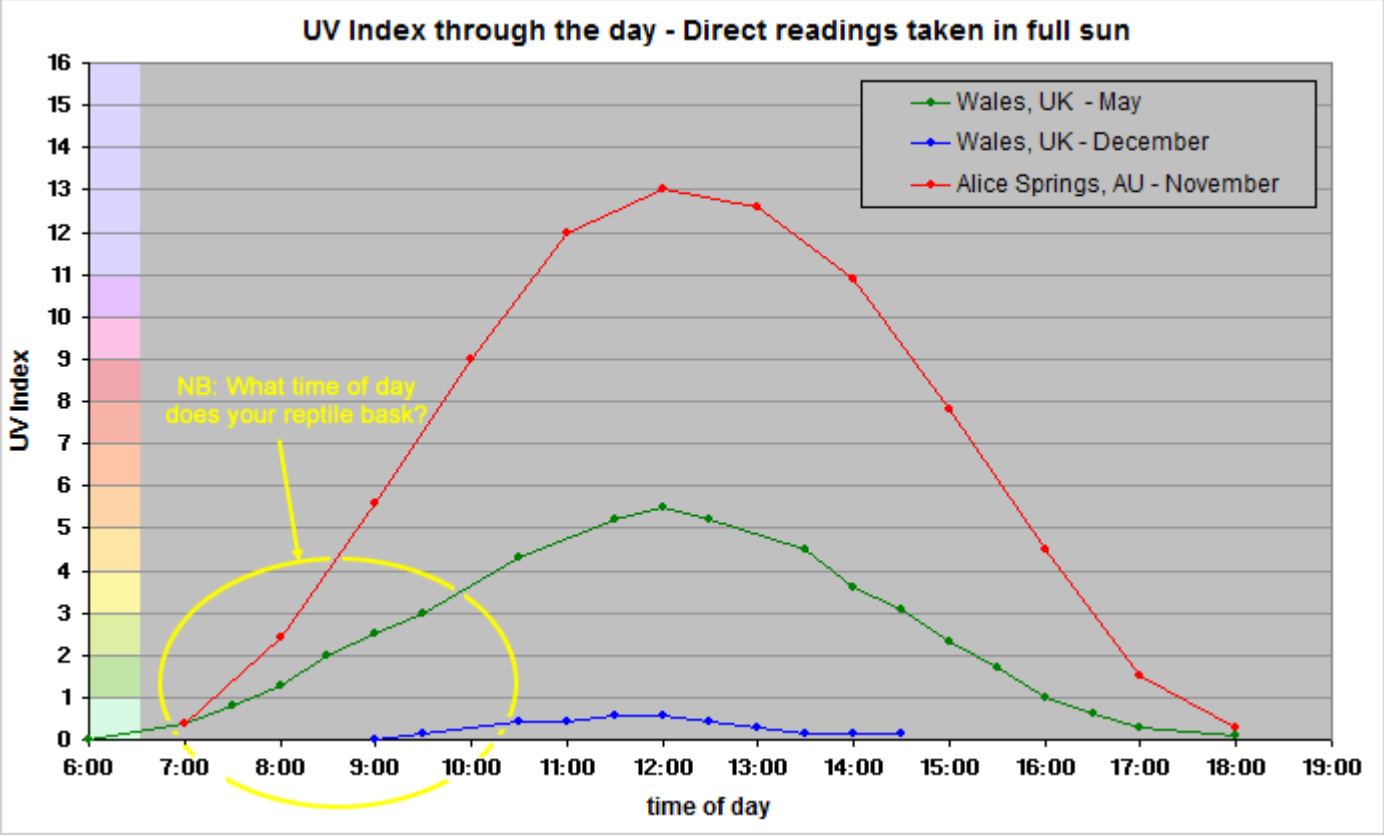
(2) the sensitivity response of the Solarmeter 6.5 UV Index meter, as published by the manufacturer, actually follows the action spectrum for vitamin D3 synthesis - which is very relevant to reptiles and amphibians - more closely than it follows the erythema action spectrum. Indeed, the spectral overlap in the range 290 - 400nm is 96%. This makes the Solarmeter 6.5 a very good tool indeed for estimating suitable UV levels in the microhabitat and in captivity.

The UV Index and Sunlight

The earth's atmosphere preferentially absorbs and scatters shorter wavelengths of UV (and visible) light. When the sun is low in the sky, the light passes through a thicker layer of atmosphere, and so less of the UV reaches the ground. The UV Index can therefore be expected to be within certain ranges in full sunlight and in shade, at different times of day at different latitudes. (See the colour code chart, right. The colour code for the UV Index is internationally recognised.)
On clear days, the most important factor is the solar altitude, i.e., the height of the sun in the sky.
The chart below shows how solar altitude affects the UVI on clear days. In summer in Alice Springs (November) the sun is almost overhead at midday and extreme UVI is possible. In summer in the UK, it only ever reaches about 60° altitude and UVI rarely exceeds 7.0; in midwinter in the UK, the maximum is only around 15° and UVI of 1.0 is rarely possible.

NB: Reptiles basking in full sun only in the morning will not be exposing themselves to the high levels seen at mid-day. Knowledge of basking behaviour is vital in establishing suitable maximum UVI levels in the vivarium, since the UVI gradient from lamps remains constant through the entire photoperiod.

UV Index colour code		
	Typically occurs in:	W.H.O category
11+	Full tropical midday sun	Extreme
10	Full tropical late morning sun; full summer mid-day sun in subtropical areas	Very High
9		
8		
7	Full tropical mid-morning sun or under light cloud at mid-day	High
6		
5	Full tropical early morning sun; light shade or overcast weather at mid-day	Moderate
4		
3		
2	Very early morning sun; shade at mid-day	Low
1		
0		



The use of the UV Index is very practical because:
• it is a familiar unit (from "sun-smart" campaigns, weather forecasting etc., easily understood, and especially useful to alert keepers to dangerously high UV levels.
• it gives an estimate of the vitamin D3-producing ability of sunlight AND lamps
• the Solarmeter 6.5 UV Index meter is relatively cheap, robust, portable, easy to use, reasonably accurate.

The UV Index can be used with UVB lamps, as well. Of course, the UV output from a lamp remains constant all day (after about 10 minutes of warming-up), but the intensity of the UV depends upon the distance from the lamp. It is possible to create a map of the gradient produced by any UVB lamp, using the UV Index meter. The resulting map, called an iso-irradiance chart, shows the shape of the beam and the UV Index at any position under the lamp (see later).

The Ferguson Zone concept

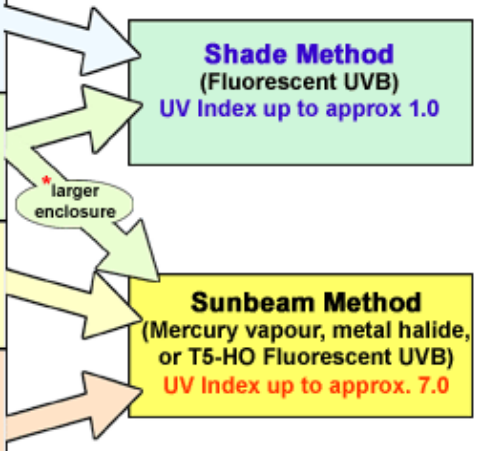
The key to choosing suitable UV lighting is the selection of an appropriate "photo-microhabitat". Suitable UV levels are estimated using a concept described by Dr. Gary Ferguson and his team from Texas Christian University (Ferguson et al, 2010). They recorded the daily UV exposure of 15 species of reptiles, in the field, as measured with the Solarmeter 6.5 UV Index meter (Solartech Inc. USA - www.solarmeter.com). They demonstrated that knowledge of the basking/ daylight exposure habits of any species enables a reasonable estimation of likely UV exposures to be made.
They divided species into 4 sun exposure groups or "zones", which we have designated the "Ferguson Zones". Ferguson Zone 1 species are crepuscular or shade dwellers. Zone 2 species are occasional baskers. Zone 3 species bask in partial sun or at restricted times of day; and Zone 4 species tolerate full sunlight and high UVB levels throughout the day.
Provisional allocation into one of the four Ferguson Zones is possible for any species with known basking behaviour, but this allocation must remain provisional until habitat recordings are made. Small numbers of UV recordings taken in the field alongside a few species are being compiled, but many more are needed.
The Ferguson Zone allocations in the UV-Tool are currently only estimates based on known basking behaviour.

The UV-Tool is designed for use with reptiles and amphibians, but the Zones represent the UV recorded in microhabitats across a wide range of climate types. Other animals and birds also inhabit these same microhabitats and share similar behaviour patterns relating to sun exposure; so in theory the UV-Tool is applicable to any taxa.

A suitable UV GRADIENT may then be provided in the captive animal's environment, enabling the animal to self-regulate its exposure. A GRADIENT is vital – there must be a full range of UV levels from zero (full shade) to the maximum suggested by the Zone assessment.
The chart below summarises the four Ferguson Zones (with the species featured in the original study, and examples of popular species considered typical of each Zone).

UV Index estimates based upon the Ferguson Zones (BIAZA UV-Tool 2012)

Zone	Characteristics	UVI Zone range (all-day average)	Max UVI recorded (one-off maximum)	Species in original study	Species typical of Zone commonly held in captivity
1	Crepuscular or shade dweller	0 - 0.7	0.6 - 1.4	*Cottonmouth water moccasin* *Texas rat snake* *Jamaican brown anole* *Broad-banded water snake*	*Leopard gecko* *Crested gecko* *Corn snake* *Burmese python*
2	Partial sun or occasional basker	0.7 - 1.0	*1.1 - 3.0	*Western ribbon snake* *Green anole* *Jamaican blue-pants anole* *Yellow-bellied water snake*	*Redfooted tortoise* *Monkey-tailed skink* *Chinese water dragon* *Panther chameleon*
3	Open or partial sun basker	1.0 - 2.6	2.9 - 7.4	*Desert side-blotched lizard* *Eastern fence lizard* *Cuban brown anole* *Texas spiny lizard*	*Bearded dragon* *Spur-thighed tortoise* *Red-eared slider* *Day gecko*
4	'Mid-day' open sun baskers	2.6 - 3.5	4.5 - 9.5	*Lesser Earless Lizard* *Sagebrush Lizard* *Northern Prairie Lizard*	*Uromastyx* *Chuckwalla* *Rhinoceros iguana* (NB: shade is vital even for these)
		UV-Tool 'Shade method'	UV-Tool 'Sunbeam method'		



*Zone 2 reptiles in a larger enclosure would probably utilise gentle "sunbeam" UVB up to approx. UVI 3.0

The "UVI Zone Range" column (blue figures)
All the UVI readings for the microhabitats at the time and place the reptiles were found were averaged. The average exposure of "crepuscular or shade dwelling" species fell in the range between UVI 0 – 0.7, the "partial sun or occasional baskers" were in a range from 0.7 – 1.0 and so on…
so this figure might be seen as a suitable "mid-background" level of UVB for the species in question.

The "Max UVI Recorded" column (red figures)
This refers to the highest UVI at which a reptile from each "zone" was found to be occupying in this study. Obviously this figure might reflect a "one-off" exposure – a single reptile found out in mid-day sun – but it gives a rough idea of the maximum levels this type of animal might encounter naturally. This might be a rough guide as to the upper acceptable limit for the UVB gradient to be provided in captivity.

Shade or Sunbeam Method?

The **"Shade Method"** uses the UVI Zone Range as a guideline to suitable "background" levels of UVB for the species in question. Low-level 'background' UV is provided at levels matching the Ferguson Zone Range, over a large proportion of the animal's enclosure.
For example, reptiles and amphibians in Ferguson Zone 1 would be offered a UVB level of between UVI 0.5 – 0.7 across much of their enclosure (with a gradient to zero into shade). Then, assuming they inhabit this area for most of their daily activity period, in theory they should receive a similar average exposure to that they would receive in the wild. Zone 2 reptiles and amphibians which do not bask would be offered a similar gradient, but with a slightly higher maximum - up to about UVI 1.0. However, Zone 2 animals which do bask, in enclosures large enough to accommodate basking lamps, could instead be offered UVB via the "Sunbeam Method" (see below).

The **"Sunbeam Method"** uses the "Max UVI Recorded" column, as a rough guide as to the upper acceptable limit for the UVB gradient to be provided in captivity. This maximum needs to be the highest level which a reptile can obtain at its closest approach to its UVB lamp. This higher level needs to be restricted to the basking zone ("like a sunbeam") with a gradient to zero into shade. The maximum also needs to be suitable for the species. For example, a maximum around UVI 3.0 - 4.0 might be suitable for a temperate zone 3 species that basks in woodland sunlight, but a subtropical Zone 3 species that basks in more exposed areas might be offered a maximum UVI around 6.0 - 7.0. Zone 2 species which bask (see above) might be offered a maximum UVI around 3.0

Exceptions
Albino and hypomelanistic morphs from any Zone are often more sensitive to UV and visible light, and are likely to need much reduced exposure levels.

SUMMARY The following figures are therefore based on Ferguson's study results:

Zone 1 = crepuscular or shade dweller, thermal conformer.
Suggested UVB: Shade Method: gradient UVI 0 – 0.7
Zone 2 = partial sun/ occasional basker, thermoregulator.
Suggested UVB: Shade Method: gradient UVI 0.7 – 1.0
or in a larger vivarium, Sunbeam Method: UVI range 1.1 – 3.0 in basking zone
Zone 3 = open or partial sun basker, thermoregulator.
Suggested UVB: Sunbeam Method: UVI range 2.9 – 7.4 in basking zone
Zone 4 = mid-day sun basker, thermoregulator.
Suggested UVB: Sunbeam Method: UVI range 4.5 – 8.0 in basking zone

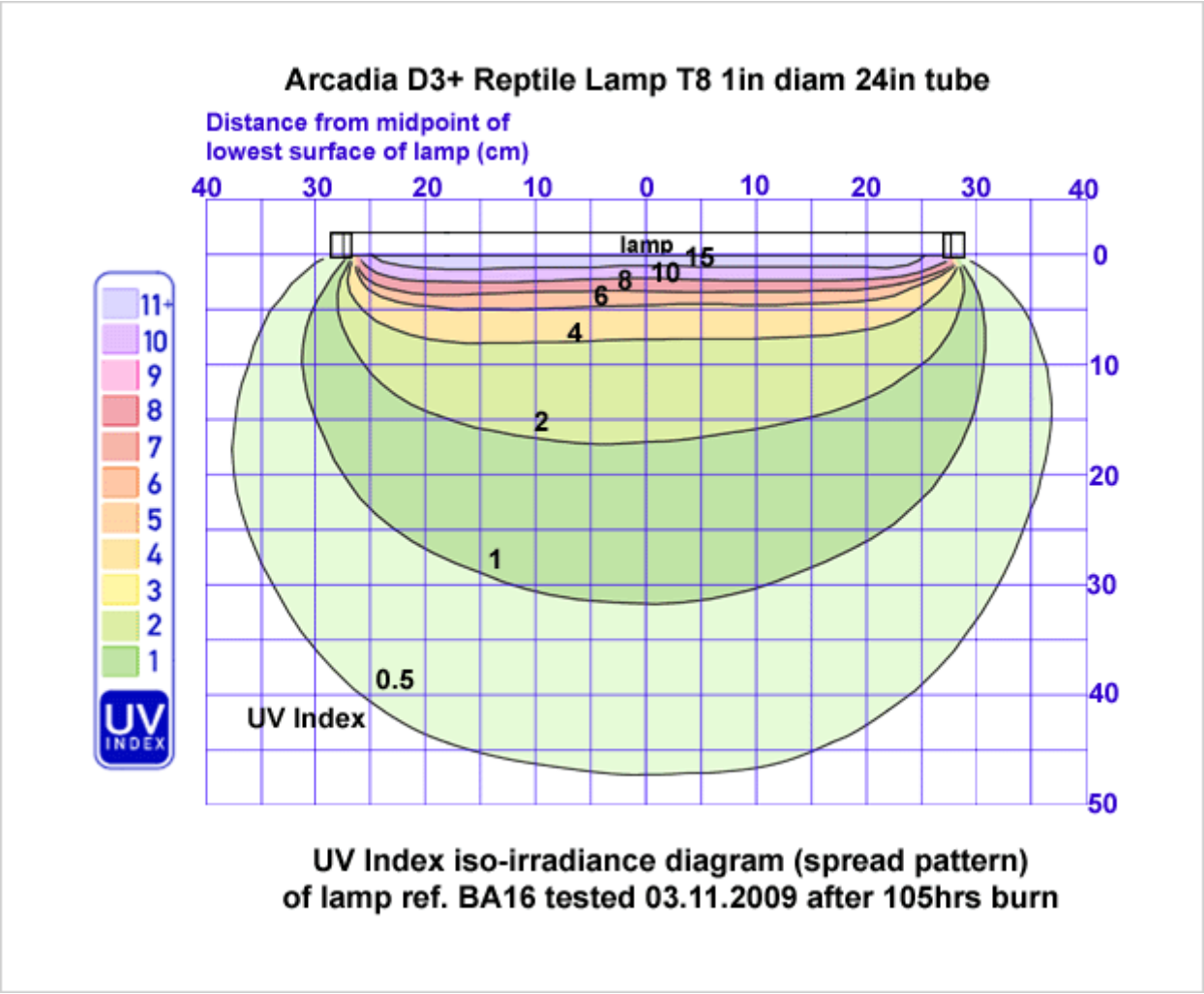
Choosing a Lamp

Shade Method.

Covering large areas with low-level "background" UVB resembling "outdoors in the shade".

a.) Select the appropriate Ferguson Zone and UVI range for your species.

b.) Next, use the iso-irradiance charts on the Lamp Test Result pages to select the appropriate lamp and the distance at which the desired levels are achieved.
UVI colour coding on these charts can be used to assess suitable distances. For example, Zone 1 and Zone 2 species should receive adequate UVB in the pale green region on the charts (UVI 0.5 -1).
Below is an example of a typical lamp for use with the Shade Method.



c.) Remember, whatever Ferguson Zone your animal is in, full shade must be available somewhere in the enclosure. In addition, albino and hypomelanistic morphs from any Zone are often more sensitive to UV and visible light, and are likely to need much reduced exposure levels.

d) Fluorescent UVB lamps rarely provide adequate full-spectrum “daytime” *visible* light (even for nocturnal species and shade-dwellers). They should normally be combined with other high-quality sources of visible light to create suitable photo gradients, even when thermal gradients, e.g. using heat lamps, are not required.

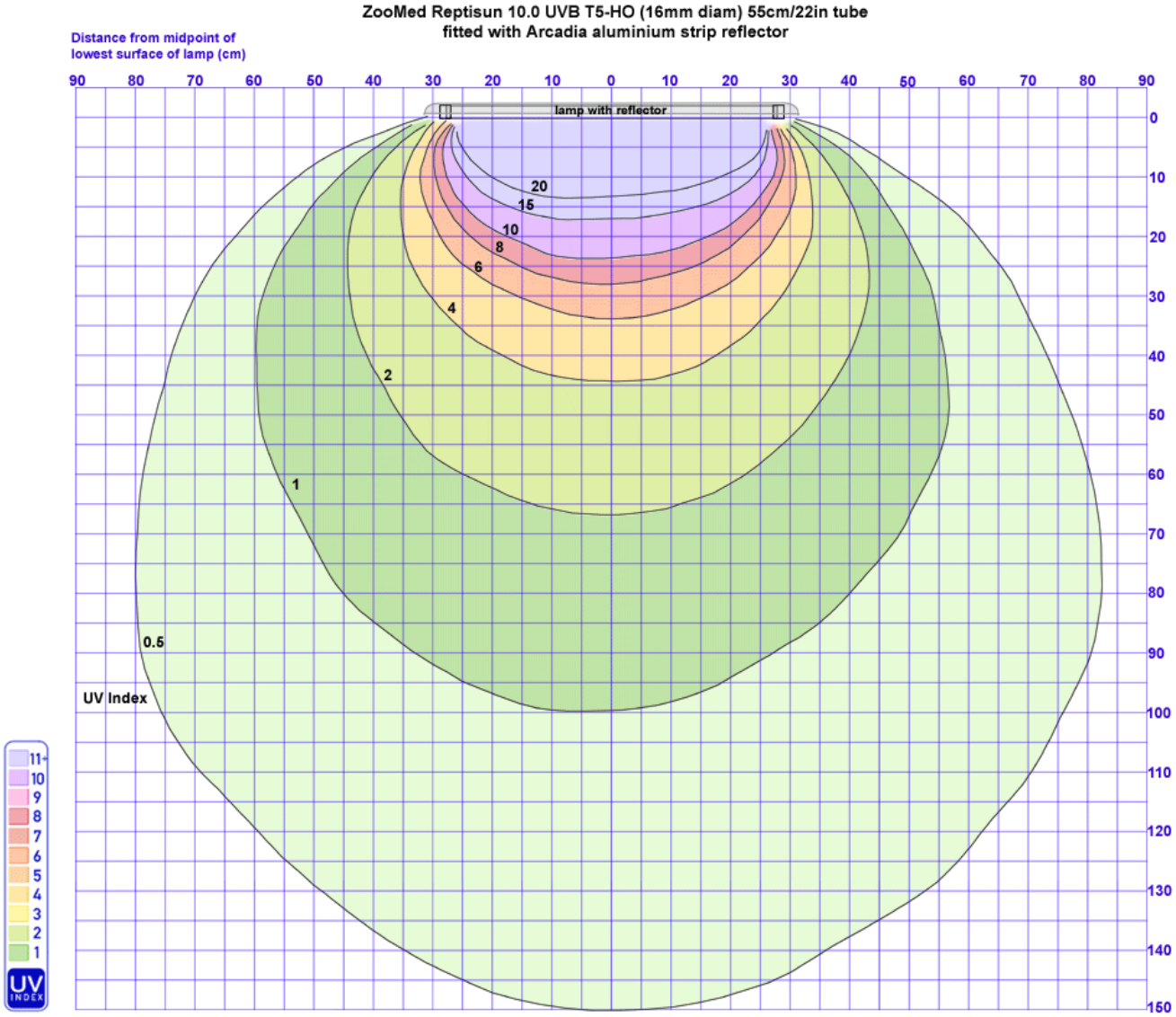
Sunbeam Method.
Producing a smaller area – in a basking zone – with high-level UVB resembling “a patch of direct sunlight”.

a.) Select the appropriate Ferguson Zone for your species.

b.) Consult the "Sunbeam Method" column to see the range of maximum UVI which were recorded at reptile level, for various species in each zone. Use your knowledge of the specific microhabitat and basking behaviour of *your* species, to decide, within this range, what is the most suitable **maximum** UVI to aim for in the centre of your basking zone at reptile level. For example, a maximum around UVI 3.0 – 4.0 might be suitable for a temperate zone 3 species that basks in woodland sunlight, but a subtropical Zone 3 species that basks in exposed areas might be offered a maximum UVI around 6.0 – 7.0. Zone 2 reptiles in a larger enclosure would probably utilise gentle "sunbeam" UVB up to approx. UVI 3.0.

c.) Although some Zone 4 reptiles have been observed basking above UVI 7.0, even these spend the majority of their basking time at far lower levels, in the early morning and late afternoon. We suggest that for safety, UVI 7.0 – 8.0 should be considered the maximum UVI at reptile level for zone 4 reptiles when the "sunbeam method" is employed, since the UV spectrum from artificial lighting is not the same as from natural sunlight.

d.) Finally, use the iso-irradiance charts on the UVB Lamp Index Test Result pages to select the appropriate lamp and the distance at which the desired levels are achieved. UVI colour coding on lamp charts can be used to assess suitable distances. For example, Zone 3 and Zone 4 species should receive adequate UVB in the yellow- green, yellow and orange regions on the charts (UVI 2.0 – 8.0). Below is an example of a typical lamp for use with the Sunbeam Method.



UV Index iso-irradiance diagram (spread pattern)
of lamp ref. BZ23 - with reflector fitted
tested 19.01.2013 after 110hrs burn

e.) Remember, whatever Ferguson Zone your animal is in, full shade must be available somewhere in the enclosure. Moreover, albino and hypomelanistic morphs from any Zone are often more sensitive to UV and visible light, and are likely to need much reduced exposure levels. It is possible that their UVB requirement is lower than their normal-coloured conspecifics for optimal vitamin D synthesis, however, since a reduction in melanin may allow greater cutaneous UVB penetration and hence increased vitamin D synthesis.

f.) The basking zone, and the corresponding UVI "sunbeam" zone, must be at least as large as the whole body of the reptile. Small spots of heat, light and UVB which only cover a small part of the reptile's body are hazardous and may cause burns.

g.) Fluorescent lamps and mercury vapour lamps have poor colour rendering and should always be used in combination with lamps providing full-spectrum visible light. Either incandescent lamps or metal halides can be used to improve the visible light as well as fine-tuning the thermal gradient in the basking zone.

Other useful tips

a.) Lamps should always be positioned above the animal, so its upper eyelids and eyebrow ridges shade the eyes from the direct light.

b.) All lamps present an electrical risk, many also present the risk of thermal burns and UV burns if the animal can approach too closely. All bulbs should be inaccessible to the animals – wire guards may be necessary. Use wide wire mesh, to allow as much light through as possible. Do not use ordinary glass or plastics as these may block ALL the UVB.

c.) If the manufacturer publishes a minimum safe distance, ensure that the animals cannot approach the lamp any closer than this.

d. Remember that UVB levels from a lamp decay with use, and individual lamps can vary in their rate of decay. Check all UVB levels regularly, at least monthly.

UVB Lamp Index

This is the final tab to be used in the lamp selection process. It contains a table, charting a range of lamps tested by UV Guide UK which appear to be of a good standard, most importantly having spectra with no un-naturally short-wavelength UVB or UVC.
The Ferguson Zones which can be covered using each lamp (depending upon distance) are indicated by colour coding, and either a tick or a comment (if, for example, the lamp could be used for a reptile in that Zone if it was fitted with a reflector, to boost the irradiance).
The operating ranges also respect safe minimum distances. For example, some metal halide lamps with a low UVB output might provide a high enough UVI for a Zone 3 species at distances under 25cm; but this would be unacceptably close owing to the high heat and visible light output at such close range; so that lamp would not be suggested for Zone 3 species.

Links are then provided to the test results for each lamp, which are hosted on UV Guide UK webspace. The links to the test results here require internet access.

Biomes

The tab “Biomes Map” gives a brief introduction to the World Wildlife Fund “Biome” concept, and provides a link to their website where the relevant Biome(s) for almost any species can be found if the location of its habitat is known.
However, for the purposes of this Tool, only a very crude Biome designation is needed: each species is to be allocated to one of just 14 “Major Biomes” (or more, if its range is extensive enough). This is because we are using the Biome designations primarily to facilitate database search, when a viewer has an unlisted species and is looking for a “similar” animal, as regards microhabitat and basking behaviour, on which to base his or her decisions regarding suitable lighting. The Major Biomes simply subdivide our Database into more manageable chunks.
We do appreciate that biomes are not microhabitats. Each biome is subdivided into many Terrestrial Ecoregions and each of these contains many microhabitats. The husbandry requirements of individual species must never be based upon simple Major Biome classifications.

Thank you for taking an interest in our Tool.
We sincerely hope that you find it useful…. and that you will consider contributing to it, either by sending your comments, or adding new species to the Database.

If you would like to add a new species, simply download a Species Submission Sheet from our website: www.uvguide.co.uk/BIAZA-RAWG-UV-Tool.htm

IF YOU WOULD LIKE NOTIFICATION OF UPDATES TO THE TOOL
please contact Frances Baines, Tool Co-Ordinator, at fbaines@uvguide.co.uk
and ask to be added to the mailing list.

REFERENCE:
Ferguson, GW; Brinker, AM; Gehrmann, WH; Bucklin, SE; Baines, FM and Mackin, SJ (2010) Voluntary Exposure of Some Western-Hemisphere Snake and Lizard Species to Ultraviolet-B (UVB) Radiation in the field: How Much UVB Should a Lizard or Snake Receive in Captivity? *Zoo Biology* 29 : 317–334

This edition of the Introduction to the BIAZA RAWG UV-Tool: May 2015