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A Technique for Detecting Eyeshine of Amphibians and Reptiles

CHRIS CORBEN
333 Enterprise Dr., #6, Rhonert Park, CA 94928, USA
email: corben@delphi.com

and

GARY M. FELLERS
USGS, Western Ecological Research Center
Point Reyes National Seashore, Point Reyes, CA 94956, USA
email: gary_fellers@usgs.gov

Spotlighting has been a standard technique for locating amphibians and reptiles at night. The basic technique is to shine a flashlight at an animal so that the light reflects off of the animal's retina, creating a noticeable eyeshine. The method works well for species with larger eyes such as alligators and ranid frogs, but is fairly ineffective for detecting most medium- and small-sized animals because their eyeshine doesn't stand out sufficiently from the background. A brighter light is of little benefit, because it does not enhance the contrast of a weak eyeshine against the background, and the light is much more likely to cause animals to flee, turn away, or simply close their eyes.

We have used a modification of the basic eyeshine technique so that it allows us to detect animals at a much greater distance and to detect much smaller species. We use binoculars in combination with a moderately bright light. We rest the binoculars on the top of a light, line up the field of view with the light beam, and then move the two in unison while scanning for eyeshine. It generally takes a few hours of practice to effectively coordinate the light and the binoculars, but once mastered, the technique becomes easy to use and greatly enhances an observer's ability to locate animals. We have not quantified the effectiveness of using binoculars while spotlighting, but we estimate that it increases the number of individuals located by two to five fold, with the greatest increase being the more cryptic and smaller species.

Almost any set of binoculars can be used, but some are more versatile. Binoculars that can focus to within < 2.5 m are particularly useful since this allows one to locate nearby animals. The 7 x 26 Baush & Lomb Custom binoculars and the waterproof Baush and Lomb Elite 10 x 42 work well.

The choice of light is important for getting the best results. If the light isn't sufficiently bright, it can be difficult to distinguish vertebrate eyeshine from other reflections, especially water droplets. Ambient light has a profound effect. On a dark night, even a low powered flashlight can be used to good effect, whereas bright moonlight will limit the range of even a fairly intense light. If the target animals are only visible over a short range, as when searching in fairly dense vegetation, a light of lower intensity is often advantageous, because it doesn't dazzle your eyes and will be less likely to disturb the subject. If the target animals are likely to be seen at substantial distances, then a brighter light works best. Atmospheric conditions, such as dust in the air or rain, will often limit the effective range. For most purposes, a light of intermediate intensity is a good choice, and a 30 Watt spotlight is a good compromise. Table 1 provides a comparison of light output from various lights and Table 2 provides reference data for environmental light conditions that *Rana aurora* might be exposed to when sitting a pond during the day.

A light should ideally have a beam angle a little greater than the field of view of the binoculars being used. A light that produces even illumination is best.

Just as important are factors that effect comfort. If the light is too heavy, it can quickly become tedious trying to hold it with the binoculars perched on top, and maneuverability will be compromised. Most importantly, it should be easy to hold the binoculars in place on top of the light because the binoculars need to be as close as possible to the beam of light.

One commercially available light that works well is the Nite Sport II (Nite Light, Little Rock, Arkansas, USA, $70). This light has a rechargeable 6 volt gel cell battery (that can attach to one's belt) and a headlamp unit. The 1.3 m cord connecting the battery to the headlamp is particularly sturdy, so it is not the weak point as it is in many headlamp systems. The light runs about 5 hours on a charge. The optional Halogen bulb (HMP03) increases the light output from 67 to 79 lux (measured at 5 m). A particularly nice feature of the Night Sport II is the built-in rheostat. This allows one to use the full power of the light to locate animals, but then reduce the brightness for the final approach.

We have modified our lights by bolting a Mag-Lite Bite-a-Lite (Mag Instrument, Ontario, California, USA, www.maglite.com) to the clip on the back of the headlamp. Bite-a-Lite is a small plastic part that fits over the end of a AA Mag-Lite so you can hold it in your teeth. By drilling a 3 mm hole through the Bite-a-Lite, a 3.5 cm long bolt and washer can be used to attach the Bite-a-Lite to the Nite Sport. This modification makes the light easy to hold and frees one's hands.

Alternatively, you can assemble a 30 Watt light from readily available parts. Night Lite sells a spotlight (W1585) that can be modified by upgrading their 6 Volt bulb with a 12 Volt H4405 sealed beam lamp (Bulbman, 1-800-648-1163, www.bulbman.com) that produces 1468 lux (at 5 m). You will then need a 12 Volt gel cell, charger, and a connector for the light and battery. These parts are available at many electronic stores.

Table 1. Light output measured in lux (=lumens/m^2) at a standardized distance of 5.0 m using a digital light meter (Model 407026, Extech Instruments, Waltham, Massachusetts, USA, www.extech.com).

Light Source	Lux
Q Beam - 200,000 cp	786
100 Watt - sealed beam	653
Q Beam - 100,000 cp	558
30 Watt - sealed beam	358
35 Watt - garden flood	70
Mag-Lite - 3 D-size cells	39
Nite Sport II - Halogen bulb	18
Nite Sport II - Regular bulb	16
Mag-Lite - 2 AA-size cells	1

Table 2. Mid-day ambient light levels measured at a *Rana aurora* breeding pond at Point Reyes National Seashore, California. Measurements were taken at eight places where frogs had been observed sitting during the day on previous occasions. The light meter sensor was oriented at three different angles and the range of values is reported for the eight sites.

Light Source	Lux
Full sun	100,000
Full moon	2
Partially shaded pond edge	
Facing toward sun	40,000 - 80,000
Facing north	7,000 - 10,500
Facing south	12,500 - 25,000

In many situations, vegetation blocks the eyeshine of a particular animal from all but a few viewpoints. This makes it difficult to point out an animal to anyone else or, sometimes, even to keep track of where an animal is as you approach it. We have found that it is often helpful to work in pairs with one person spotting animals and the other doing most of the capturing. In this situation, a laser pointer can be a useful accessory. When an animal is located, a laser pointer can be used to direct a second person's attention to the animal. It is generally not a good idea to place the laser spot right on the animal since the bright light can elicit an escape response. The pointer can be used instead to "draw" a small circle around the animal. A second method is to illuminate a spot about 1 m away from the animal and then move the beam towards it, turning the pointer off just as the spot reaches the animal. Note that lasers come with a range of ratings for light output. The more powerful ones (which claim to reach > 200 m) are generally the most useful. Shorter wavelengths provide better visibility, so a 635 nm laser appears nearly seven times brighter than a 670 nm unit with the same output.

There are a few precautions to keep in mind when spotlighting. When working with a partner to catch more wary species, it is important to make sure that the person approaching an animal is not illuminated from behind since this creates a strong silhouette that immediately alerts the animal to the approaching biologist. Similar precautions are necessary when working under a full moon.

Vertebrates are not the only animals with eyeshine. Spiders have surprisingly bright eyeshine and tend to be very abundant, but their eyes look more point-like than those of vertebrates. Moth eyes and small droplets of pine sap can look extremely similar to vertebrates' eyes. Water droplets become abundant when the temperature drops to the dewpoint, and while water droplets generally are not too difficult to distinguish from vertebrates' eyes, their sheer abundance can be very distracting.

Spotlighting has been used primarily for anuran surveys, but the technique is far more broadly applicable. For example, it is particularly effective for terrestrial salamanders, even in areas with moderately sense understory. We regularly spotlight even the more diminutive species such as *Batrachoseps attenuatus*, *Plethodon elongatus*, and *Rhyacotriton variegatus*. In less than one hour (on a rainless night), we were able to spotlight five adult *Dicamptodon tenebrosus* away from water; this is especially notable since this species is generally difficult to find during the day without moving significant amounts of cover. Spotlighting is useful for reptiles as well. One of the authors (CC) originally used the technique in Australia for locating nocturnal geckos, snakes, frogs and small mammals.

We have found that many species of salamanders in the western U.S. can be found during remarkably dry weather. In such conditions, most animals are found sitting near the entrance to a small burrow or within a crevice, but there are typically a few individuals that are out well away from cover. Spotlighting with binoculars should be considered when looking for amphibians and reptiles in habitats that are easily impacted by more traditional collecting techniques (e.g. moss covered talus slopes), where it is difficult to turn cover (e.g. searching for geckos on lava flows or on the trunks of trees), or where repeated surveys are necessary and other techniques (e.g. time constrained surveys) would result in unacceptable levels of habitat disturbance.

With an increasing interest in survey techniques, especially for declining amphibians, biologists should include spotlighting with binoculars as one of their tools. It is an efficient technique that is easy to learn and that uses equipment most biologists already possess.