

Criteria for the Selection and Use of Light Sources and Binoculars for Visual Encounter Surveys of Adult and Sub-Adult California Red-legged Frogs (*Rana draytonii*)

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Visual Encounter Surveys (VES) are used to conduct surveys of adult and sub-adult frogs by detecting eye shine reflecting back to the observer. The use of the proper lights and binoculars increases detection rate, increases the detection distance from the observer to the frog, reduces the need to enter water bodies and associated vegetation, thereby reducing risk of trampling adults, larvae, or egg masses, and with experience, in many instances can provide the observer enough detail to determine species.

Recent technological advances in portable light technology have provided herpetologists and other biologists that study nocturnal taxa with an ever-increasing selection of this critical tool. Coupled with a good set of binoculars, and with the proper training and practice, these two tools are invaluable when conducting Visual Encounter Surveys.

Visual Encounter Surveys are a key component of the current U.S. Fish and Wildlife Service (USFWS) protocol for conducting surveys of adult California red-legged frogs (*Rana draytonii*), as identified in the *Revised Guidance on Site Assessment and Field Surveys for the California Red-legged Frog* (USFWS 2005). This method is used to determine presence or absence of individuals, and must be conducted using a light source and binoculars (USFWS 2005). No capture, handling or contact of frogs, tadpoles, or larvae is permitted to occur without the appropriate permits; however, no permit is required to conduct USFWS protocol-level Visual Encounter Surveys for *R. draytonii*.

One significant advantage of properly-conducted VES, as stated earlier, is reducing or eliminating the risk of direct injury or mortality to various life stages of *R. draytonii* (or other vegetation and amphibian species present in the pond). It is not always possible to avoid entering water bodies to conduct surveys, whether because vegetation obscures or blocks the observer's view of the survey area, or because the size of the water body demands it, however, the proper selection and use of lights and binoculars permits the biologist to work at greater distances from the pond's interior or edge. This minimizes the potential for disturbance, harm, or mortality to frogs, tadpoles, larvae, and habitat that could occur when entering the pond or bank vegetation, and is precisely why it was written into the USFWS protocol for this listed species.

Because visual encounter surveys occur at a distance from the frogs, the selection of the correct light source and appropriate binoculars becomes one of the most important aspects of successfully accomplishing an accurate and complete survey. Adequate illumination of the animal is a must, in order to properly view the morphological characteristics of the amphibians for which you are conducting surveys.

The following excerpt from the *Revised Guidance* (USFWS 2005) provides recommendations and sets limitations for lights:

“Nighttime surveys shall be conducted with a Service-approved light such as a Wheat Lamp, Nite Light (sic) or sealed beam light that produces less than 100,000 candle watt. Lights that the Service does not accept for surveys are lights that are either too dim or too bright. For example, Mag-Light-type lights and other types of flashlights that rely on 2 or 4 AA/AAA’s, 2 C’s or 2D batteries. Lights with 100,000 candle watt or greater are too bright and also would not meet the Services requirements.”

The intention of these upper and lower limits of illumination is obvious; insufficient light will likely result in false negative survey results, while there is concern that excessively bright lights could harm the eyes of *R. draytonii* and other amphibians, although research on that effect is lacking.

Interpreting Brightness Ratings:

At the time the USFWS protocol was written in 2005, light manufacturers typically used candlepower as a brightness rating. However, it is widely understood today that candlepower ratings varies widely among manufacturers, and that a more uniform measure of the amount of light emitted by a source is represented as “Lumens”.

Although there is no absolute correlation between candlepower and Lumens, the USFWS limitation of 100,000 “candle watt” (sic – should have been “candlepower”) roughly translates to 393 Lumens, based on equivalence of light output measurements provided by Streamlight, the manufacturer of one of the lights used in the formulation of the 2005 USFWS protocol. Lights should be selected which are below the approximate 393-Lumen upper limitation in the protocol.

Selecting Lights for Visual Encounter Surveys:

Two types of lights are recommended for conducting Visual Encounter Surveys for *R. draytonii* or other amphibian species; a flashlight for long and medium-range work in combination with binoculars, and a headlight for moving through the survey area and for close work.

Light and battery technology has advanced rapidly in the years since the 2005 protocol was written, and now extremely bright, white LED lamps with highly efficient reflectors or fresnels are commonly available. Incandescent lights are still available and are useful; however, the newest LED lights produce light in wavelengths that are more visible to the human eye, making it unnecessary to use lights near the 100,000 candlepower limitation set by the 2005 protocol. The new LED lights also consume less energy, so batteries last much longer during use, which is a significant advantage over incandescent bulb lights.

When the first version of this document was written in 2013, Cree model S4 LED lights were about the brightest on the market, and are still used in many flashlights and light conversion units. One year later, there are much brighter individual bulbs, and lights with multiple bulbs which provide enormous amounts of illumination, but many of these are well above what is required for our purposes.

To adequately detect eye shine in *R. draytonii* when using binoculars, we recommend LED flashlights rated between 160-250 Lumens. This is roughly equivalent to between about 40,700 to 63,615 candlepower. Flashlights with these ratings are readily available from various manufacturers, many with two or more output settings for reduced light and increased battery life. If brighter flashlights are desired, only those with several output settings should be selected, to conform to the USFWS Protocol, and avoid harm to amphibians' eyes.

Visual Encounter Surveys may last 4-6 hours each night in some instances. At a minimum, the battery in your light should last for 2-3 hours between recharging, which is significantly longer than the 40 minutes typical for high-capacity, high-intensity incandescent lights with equivalent light intensity ratings. Even with this longer life, it may be necessary to carry either multiple lights or extra, recharged batteries, when conducting longer surveys.

Headlamps commonly used for camping, hiking or other uses (i.e., Apex, Petzl, Black Diamond, Princeton Tec, etc.), at 45-130 Lumens, do not provide enough light intensity or focus to adequately detect amphibian eye shine at any practical distance, and would be less effective than the Mag-Light types or others described in the 2005 protocol as unacceptable. Instead, headlamps are optimal for walking around the survey area, approaching the pond and/or amphibians, manipulating survey equipment, or other close-distance tasks. Incandescent headlamps have been largely replaced with bright LED versions, and there are new models and features flooding the market every day. Headlamps that feature brightness level controls are very useful, as are those with the ability to change the beam from wide-angle to spot.

Prior to the 2005 protocol, headband, hat or helmet-mounted Wheat lamps and Nite Lites - high-capacity, lower-wattage incandescent light systems commonly used for hunting, trapping and caving, were often used for wildlife and amphibian surveys, and these lights can now be obtained in brightness ratings from about 80,000 to 150,000 candlepower. Some of the newer Nite Lites are available in high intensity LED, which can make them useful for general herpetological surveys, bullfrog management, etc. when it is necessary to have both hands free. However, these lights are generally optimized for helmets or hats, so some reconfiguring or adaptation is generally needed to use them in the most efficient way. They are not optimal for conducting Visual Encounter Surveys because they are difficult to place in line with the viewing axis of your binoculars, due to their configuration.

So, what should you choose? We recommend selecting the best quality, high-output LED flashlights you can afford, because they are generally well constructed, have well-designed reflectors and/or fresnels, and are rechargeable (some with Ni-MH or even Lithium-ion batteries). They are also compact, lightweight, sometimes waterproof or water-resistant, and can be slipped into a flashlight ring or holder when both hands are needed (e.g. walking through vegetation, deep water, handling nets or gigs, etc.). Currently, we are using Streamlight UltraStingers, which come equipped with xenon incandescent bulbs, which we replace with 230- Lumen LED conversion units by TerraLUX. We also use Streamlight Strion HP LED flashlights; these are very light and feature three brightness levels and rechargeable batteries with long life. However, there are many manufacturers and models available, with more coming onto the market every few months. We recommend you make your decision based on the recommended Lumens, flashlight format, and rechargeable features of the light that best suit your needs.

Selection and Use of Binoculars During Visual Encounter Surveys:

Lights are used to reflect amphibian eye shine that is viewed through binoculars. Binoculars are required under the 2005 survey protocol to adequately detect amphibian eye shine. *Surveys conducted without the use of binoculars will call into question the validity of the survey* (USFWS 2005).

The selection of binoculars should be made with the same consideration for quality and effectiveness as your lights. We recommend using roof-prism binoculars only, as opposed to porro-prism models. Roof-prism binoculars gather and transmit more light than porro-prism designs, and are more compact, making them easier to use while holding your flashlight against them. Use the highest-quality waterproof binoculars you can afford – you *will* notice the difference, compared to lower-quality units. For those times when you must force your way through vegetation, deep water, or will be leaning toward the water, the use of binocular harnesses can be helpful. We typically tuck our binoculars into our waders to keep them under control and out of the water.

The most effective angle of the light is in the same approximate plane as your binoculars, so that the greatest amount of light reflected off the amphibian's retina is visible through the binoculars. Depending on the size and format of your lights, you might hold your light immediately above, below, or adjacent to the binoculars. For an earlier discussion on this technique, see:

Corben, C. and G.M. Fellers. 2001. A technique for detecting eye shine of amphibians and reptiles. Herpetological Review 32(2): 89-91.

The proper selection and use of lights and binoculars is critical to conducting effective, accurate amphibian surveys, because they permit visual observation of identifying characteristics at a safe distance. Following the guidance in this document will aid in the selection of the best equipment for conducting amphibian visual encounter surveys.