HDR for Nature Photographers

We stand on the threshold of a new era in digital imaging, when image files will encode the color gamut and dynamic range of the original scene, rather than the limited subspace that can be conveniently displayed with 20 year-old monitor technology. Greg Ward

High Dynamic Range (HDR) photography is in the news and in many advertisements. Some people love it, and some people hate it. So what is the true story? First we need a few facts. There are no HDR prints, and no HDR monitors are currently available to photographers. We are stuck with Low Dynamic Range (LDR). However, nature is HDR; and, if we want high fidelity photographic recording in high contrast situations, we must arrange for HDR image capture.

Two questions immediately arise:

1) How can we capture a High Dynamic Range Image (HDRI)?
2) If we can't make HDR prints or use digital displays, what can we do with the HDRI?

Capturing an HDRI: First consider the complete range from the darkest to the brightest parts of a scene and how many STOPS this range represents. Recall each STOP means a factor of two change in luminosity. Professionals in this field prefer to use Exposure Values (EVs) rather than STOPS since the latter term brings to mind a physical aperture, and we are really concerned with everything that determines the exposure, *e.g.* aperture, shutter speed, and ISO speed. Therefore, 1 EV means a change in contrast ratio (CR) of $2^1 = 2$, 2 EV a change of $2^2 = 4$, 3 EV a change of $2^3 = 8$, and so on. In general (EV Range) = 2^{EV}. The relationship between CRs and EVs is illustrated in Fig. 1.

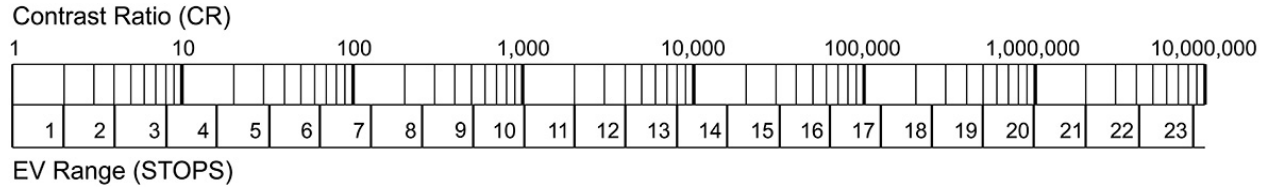

Figure 1: Contrast Ratios (CR) and Exposure Values (EV).

So what about the scenes we encounter in the real world? A bright day with everything from dark caves to bright fringes of clouds may present contrast ratios of 1,000,000 or perhaps 20 EV. On the other hand a foggy day with low visibility may only provide contrast ratios of 100 or about 7 EV. The same 7 EV would be sufficient for an indoor scene where only reflected light is recorded.

Our eyes handle all these situations through nonlinear response and adaptation, but photographic film and sensors are not so good. Here are some estimates of maximum EV spans: Color slides: 6 – 8 EV, Black and white film: up to 12 EV, Small digital cameras: 6 – 8 EV, Digital SLR: up to 11 EV. Digital sensors will improve, but at present this is all we have; and the only way to make a high dynamic range image is to combine a number of images taken with different exposures – a technique that has been used since the early days of photography.

The prescription for making a HDR image is to quickly obtain a series of exposures with a stationary camera. The aperture and color balance are fixed and the shutter speed is varied to acquire images differing by 2 EV for RAW capture or 1 EV for JPG, *e.g.* exposure bracketing

-2, 0, +2 or -1, 0, +1 centered on the estimated best exposure. Three exposures are usually made, but a wider range may be required.

The next step is to use standard image processing software to merge the images into a single HDRI file. This can be done with Photoshop CS4, Photomatix Pro, HDR PhotoStudio, and a variety of other programs. The full luminosity range of the resulting HDRI cannot be displayed simultaneously on a monitor, and furthermore 32 bits are required to store each of the color channels (R, G, and B) for each pixel. This means 96 bits per pixel, but fortunately formats have been developed that can store the full range of luminosities quite efficiently. OpenEXR and Radiance are popular HDR formats.

Processing the HDRI for display: The HDRI can be processed by means of tone mapping (contrast mapping) to obtain an LDR image suitable for display on an LCD screen or for printing. The simplest procedure would be to reduce the contrast until the appropriate range of EVs is obtained, but this procedure usually produces flat and unappealing images. Proper tone mapping reduces the dynamic range while preserving the appearance of the original scene. This requires control of local contrast and colors. Programs such as Photomatix Pro offer automatic tone mapping while permitting the user to vary local (micro) contrast, saturation, smoothing, and so on. It is the photographer's choice whether to aim for enhanced realism or to pursue garish, grungy, effects. Grungy is what some photographers think of as the HDR look, but similar effects can be obtained from single images through the use of Photoshop plugins such as Topaz Adjust.

Examples: Landscapes provide opportunities for HDR processing, but any scene containing sunlight and shadows can benefit from HDR capture and tone mapping. Sun illuminated egrets in trees and alligators with water and dark shadows are obvious examples. Figure 2 shows samples from three almost simultaneous exposures of an alligator in bright sunlight. The images

Figure 2: Bracketed exposures of an alligator: 1/1000 s, 1/250 s, and 1/60 s at f/6.7.

were merged into an HDRI in Photomatix Pro, and the HDRI was then tone mapped to give the LDR image shown in Fig. 3. Wide panoramas usually require HDR capture. Figure 4 shows a

Figure 3: Tone mapped (LDR) alligator image.

panorama of sunset over Silver Lake on Ocracoke Island that was obtained from a panoramic HDRI. The amount of saturation and local detail to include are, of course, up to the photographer. It is easy to make an image as bland as one obtained with film.

Figure 4: Tone mapped panorama of sunset on Ocracoke, NC.

In closing I note that some tone mapping is involved in the conversion of a RAW image to TIFF or JPG, the printing of a color negative, and especially in an artist's representation of a scene from nature on canvas with paint. As stated in the opening quotation, HDRIs take digital photography to a new level. Now images can be referenced to scenes rather than to dated output technology. For up-to-date information about tools and techniques for HDR imaging, I recommend www.hdrlabs.com.

Additional reading:

C. Bloch, *The HDRI Handbook*, (Rocky Nook Inc., Santa Barbara, 2007)
J. Gulbins and R. Gulbins, *Photographic Multishot Techniques, ibid*.
G. Ward, High Dynamic Range Image Encoding,
www.anyhere.com/gward/hdrenc/Encodings.pdf
FAQ - HDR images for Photography: http://www.hdrsoft.com/resources/dri.html#dr