

Understanding Histograms

Possibly the most useful tool available in digital photography is the histogram. It could also well be the least understood. What does a camera histogram tell the photographer and how best to utilise that information?

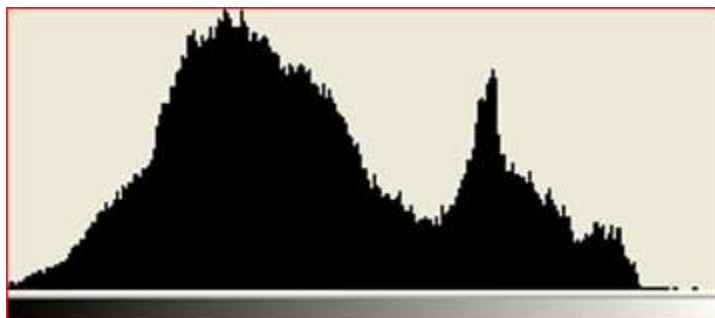
Virtually every digital camera has the ability to display a histogram directly, or more usually superimposed upon the image just taken. On most cameras the histogram display takes place on the rear LCD screen, and most cameras can be programmed to do this both on the image that is displayed immediately after a shot is taken, during 'Live View' if available or later when frames are being reviewed.

The 21st Century Light Meter



In Bloom. Costa Rica – February, 2003

Canon EOS 1Ds with 16-35mm f/2.8L lens @ 24mm. ISO 200



This histogram shows an almost perfect distribution of tones – from deep shadows on the left to just short of bright highlights on the right. This fits comfortably within the approximately 5 stop dynamic range capability of most digital imaging chips.

A light meter reading tells you what exposure will render a standard 18% grey reference card as a mid tone. This reading may have been made because the camera read a variety of areas of the scene and averaged them out, or because you read the highlights, the shadows and some other areas and decided that a particular setting would yield the best compromise exposure for that scene.

This setting, like every other that you or your automated camera makes, is a compromise. In most real world situations there is no such thing as an ideal or “perfect” exposure. There is simply one that places the tonal values found in the scene most appropriately within the capability range of the camera’s imaging chip. And “most appropriately” means that the mid-tones found in the image fall roughly half way between the darkest and the brightest values. Hold that thought while we look at the concept of dynamic range.

Dynamic Range

The digital imaging chip in your camera is very similar to colour transparency film when it comes to its sensitivity to light.

Like slide film, if a part of the image receives too much light it becomes burned out, and if too little light it is rendered as black. A recognizable image is only recorded if the light hitting the chip falls within a range of about 5 F stops. (*Remember – each F stop is a doubling or halving of the amount of light hitting the film*). With digital, things are much the same and even the dynamic range is about the same as for slide film; about 5 stops. Also keep in mind that the total range of brightness values encountered in the real world is only about 10 stops – from the dimmest light that you can read in to the brightest beach or snow scene in which you might find yourself).



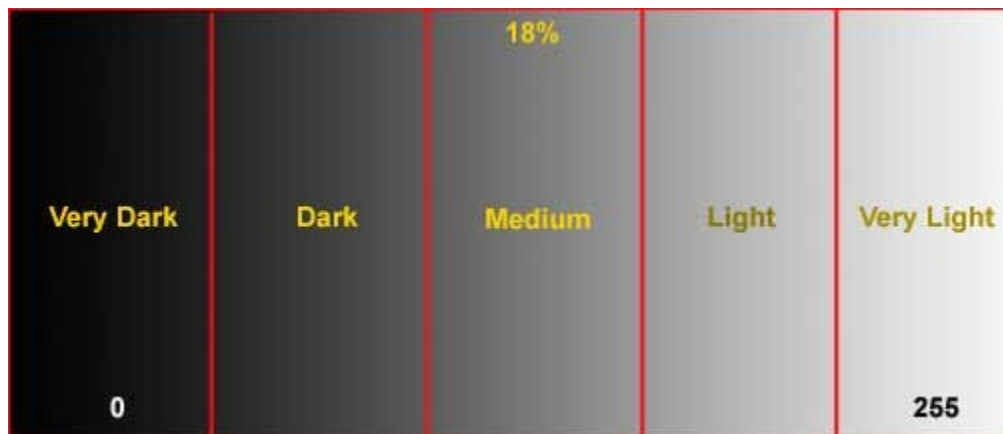
Canon EOS 1Ds with 135mm f/2.0L lens @ ISO 100

In an image recorded in 8 bit mode (*we'll ignore 12 , 14 and 16 bit modes for now*) there are 256 discrete brightness levels between absolute black (0) and absolute white (255). 18% grey (*the point that all exposure metering measures*) has a numeric value of about 128, half way between black and white. If you think about it this is fairly logical. This means that if you are exposing for an average subject, say something like a scene with people, trees, grass etc, these subjects will be exposed at about the mid point of the camera's dynamic range. Why is this important?

This is because if a subject is exposed too close to either extreme you will run into the limitations of the chip's ability to record the image. Too close to 0 (absolute black) and there won't be an image at all, or it will be very dark and noisy, and too close to 255 (absolute white) and there will be nothing there except over-saturated pixels with no image information. **The Histogram is the best tool to help you ensure that your image has not over-reached the limitations of the sensor.**

The Histogram

It is a simple graph that displays where all of the brightness levels contained in the scene are found, from the darkest to the brightest. These values are arrayed across the bottom of the graph from left (darkest) to right (brightest). The vertical axis (the height of points on the graph) shows how much of the image is found at any particular brightness level.



Note that the five zones (or F stops) containing the dynamic range recordable by the cameras has, just for simplicity been labelled as... **Very Dark / Dark / Medium / Light / Very Light**. But each of these 1 stop ranges contains within it just over 50 discrete brightness levels. It's a good idea to consider about 4- 5 points at the very bottom (black) and another 4-5 points at the very top of the scale (white) to be so close to the extremes as to not really be part of the image-forming segment of the graph. (*This is an oversimplified explanation. For how the data is really distributed please read the 'Expose to the Right' PDF in the same place you found this.*)



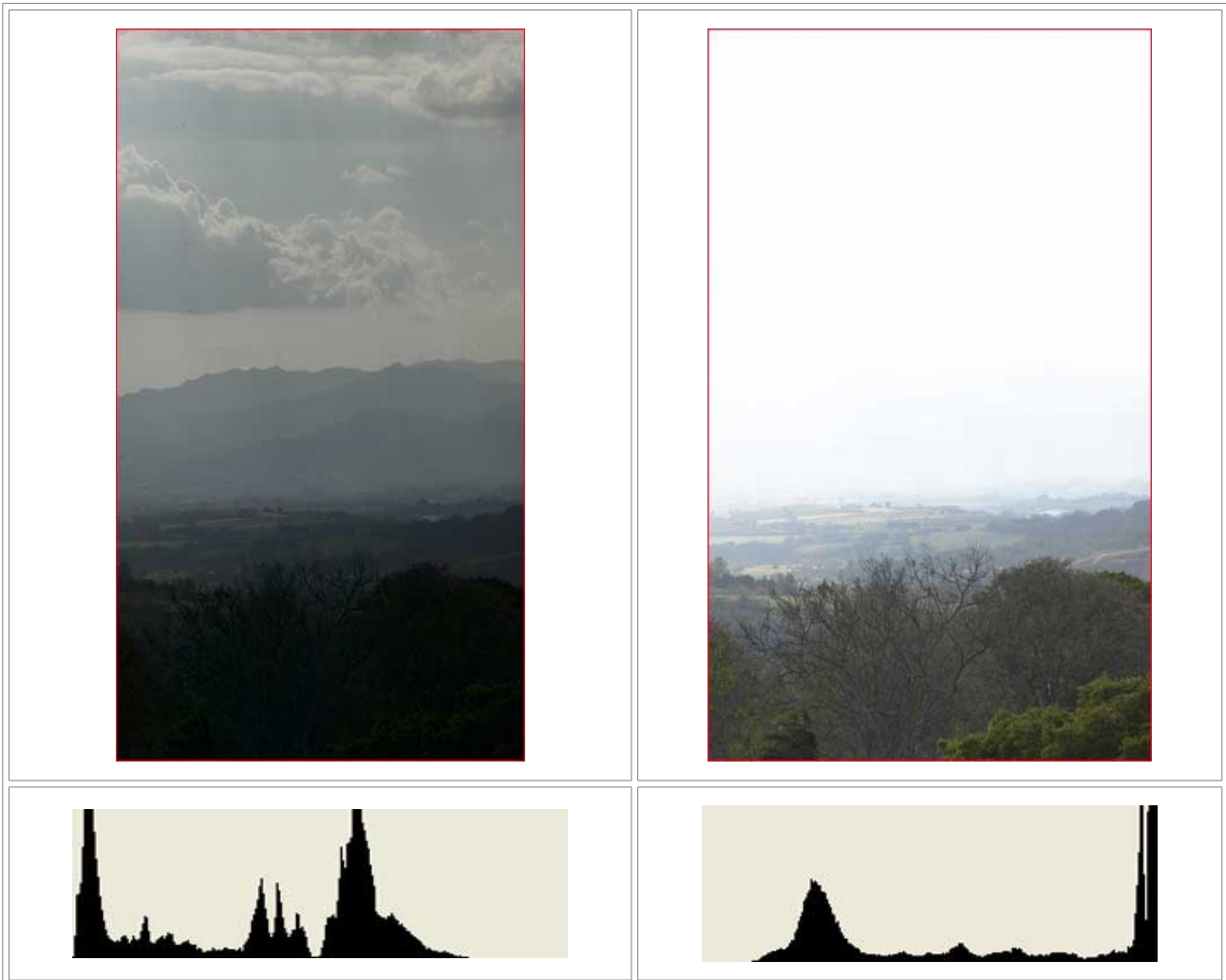
This view of the rear LCD on a Canon 1Ds shows a histogram for a particular shot and also the dotted vertical lines that Canon has engraved on the display separating the 5 stops of dynamic range that are available. As you can see this image has most of its content either in the shadows, or the highlights, with little in the mid-range.



So now things start to become clearer. The histogram shows us quite a bit, and just as a glance at the hands of an analogue watch instantly tell you the time without your even being conscious of the exact numeric values, similarly once you become proficient at “reading” a histogram you’ll be able to almost instantly evaluate the quality of the exposure that the camera is making. This is especially true when the histogram is superimposed on or just next to the image itself, making the graph that much more meaningful. Lets look at some examples.

Examples

As mentioned earlier, with the exception of a histogram that is very heavily bunched up to the right (overexposed) there really isn't such a thing as a "bad" histogram, or for that matter a "good" one. The histogram simply shows you the way things are, and it's then up to you to decide if what it is telling you needs to be acted upon. Here are some examples.

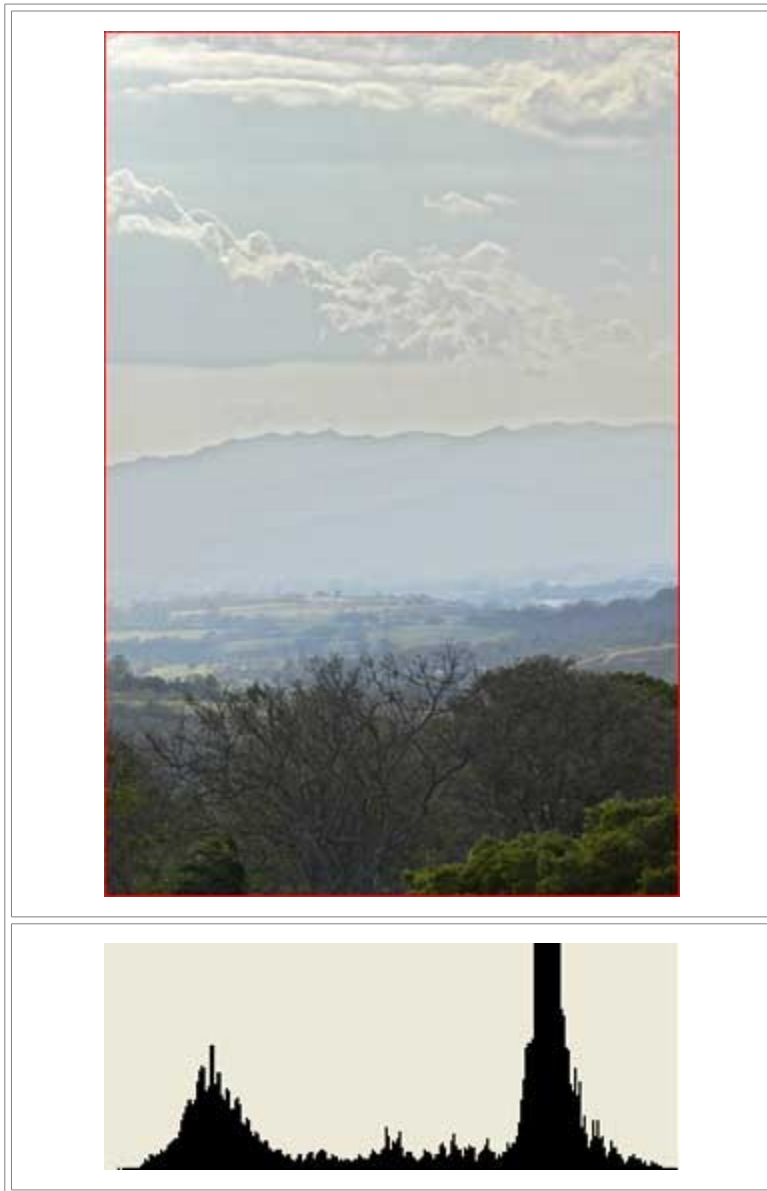


Here we see the same photograph taken with exposures about three and a half stops apart. Both were at an aperture of $f/9$. The one on the left was shot at $1/2000$ sec and the one on the right at $1/200$ sec. The histogram of the one at the left is bunched up at the dark end (underexposed) and the one on the right is bunched up at the light end (overexposed).

There wasn't an exposure with today's digital (or transparency film) cameras that could encompass the full dynamic range of this photograph – which is about 8 stops. (Although some newer cameras claim a wider dynamic range). You therefore have to make some decisions on how to handle such a scene. To stuff 8 stops worth of dynamic range into a recorded image that can only handle 5 stops your choices are....

- *use balanced fill flash on the foreground*
- *use a graduated neutral density filter*
- *take multiple exposures and merge them digitally*
- *go home*

Fill flash wouldn't work in this case because the foreground subject was too large and too distant. Going home wasn't what I had in mind, so I would have used graduated neutral density filters, or shot the two frames seen above at about 3 1/2 stops apart and merged them digitally in my photo editor. The image below is the result. Not great art, but it illustrates the point.

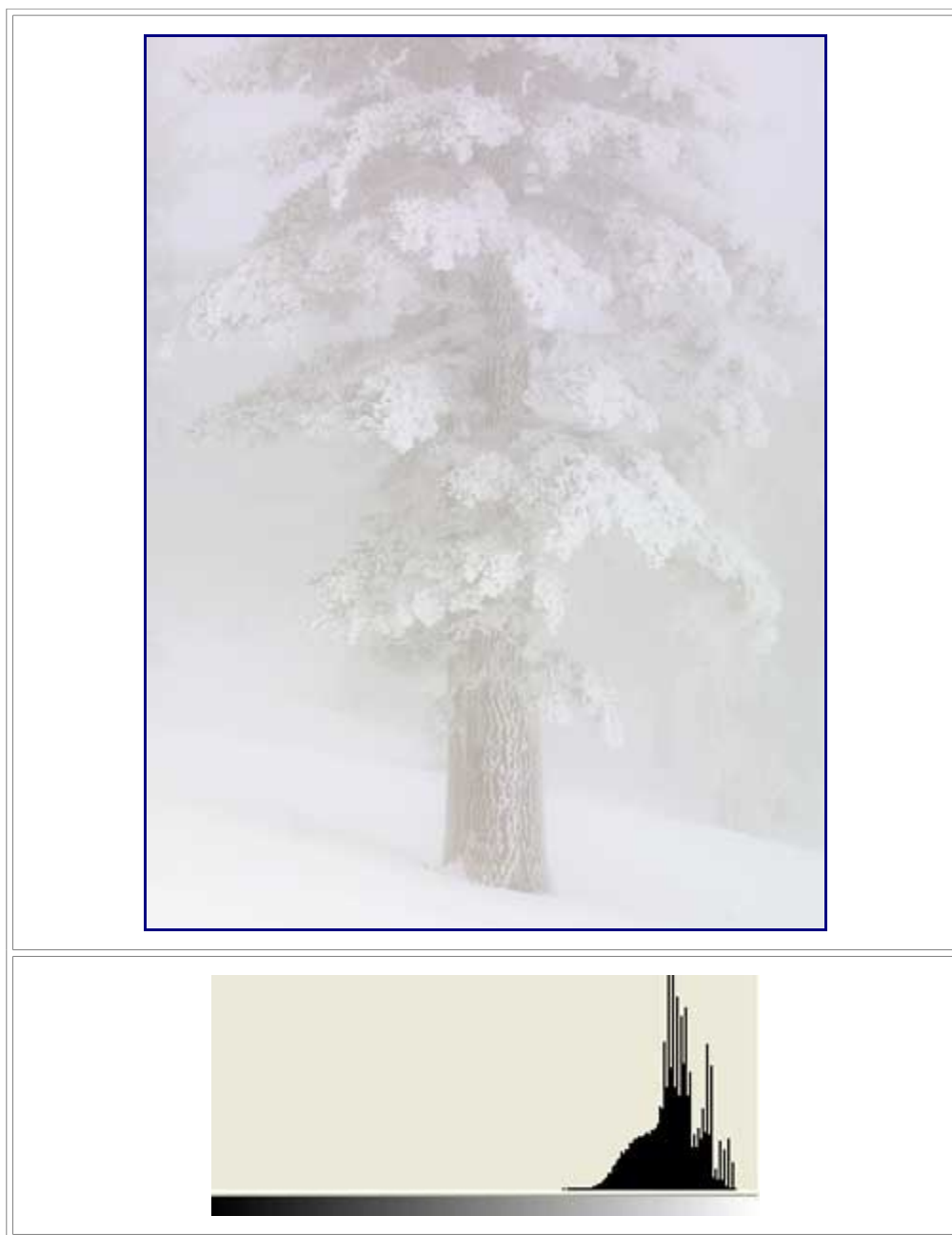


Histograms Just "Are"

As mentioned earlier, with the possible exception of showing badly blown out highlights there really is no such thing as a *bad* histogram. They just *are*.



This low key shot's histogram shows that almost all of the data in the image is down in the lowest areas (darkest) with just a small amount of data showing the bright moon. But since the dark areas aren't right up against the left hand side and the light areas aren't up against the right hand side of the histogram, the subject falls within the dynamic range that can be captured. The detail in the moon is what "makes" this shot.



In this "high key" image we see just the opposite. Almost every value seen is toward the right side of the histogram, in the highlight area. That's where it needed to be to properly reproduce the brightness found in this snow scene. Yet, since it doesn't bump up against the right hand side of the histogram I know that none of the highlights are blown out.

Not too long ago a histogram was something mysterious. Today it has become a valuable tool for the photographer who wants to gain mastery of their digital camera's image quality. I hope that this tutorial has helped remove some of the mystery for you.

Start using the histogram review feature of your digital camera. Set your camera to display a combined thumbnail and histogram for 5-10 seconds after every frame. Get in the habit of glancing at it. It's the greatest invention since the built-in light meter.