

Understanding bit depth

To understand what the bit depth numbers mean, it is best to begin with a grayscale image where there is just luminosity. A 1-bit or bitmapped image contains only black or white pixels. A 2-bit image contains four levels (2^2), 3-bit eight levels (2^3), and so on, up to 8-bit (2^8) with 256 levels of gray.



Bit depth

The bit depth refers to the maximum number of levels per channel that can be contained in a photograph. For example, a 24-bit RGB color image is made up of three 8-bit image channels, where each 8-bit channel can contain up to 256 levels of tone, while a 16-bit per channel image can contain up to 32,768 data points per color channel, because in truth, Photoshop’s 16-bit depth is actually 15-bit + 1 (see sidebar on page 307).

JPEG images are always limited to 8-bits, but TIFF and PSD files can be in 8-bits or 16-bits per channel. Note though that Photoshop only offers 8-bits or 16-bits per channel modes for standard integer channel images, while 32-bit support in Photoshop uses floating point math to calculate the levels values. Therefore, any source image with more than 8-bits per channel has to be processed as a 16-bits per channel mode image. Since most scanners are capable of capturing at least 12-bits per channel data,



Figure 5.11 The bit depth of an image is a mathematical description of the maximum levels of tone that are possible, expressed as a power of 2. A bitmap image contains 2 to the power of 1 (two levels of tone), in other words, black or white tones only. A normal Photoshop 8-bit grayscale image or an individual color channel in a composite color image contains 2 to the power of 8 (2^8) and up to 256 levels of tonal information. When three RGB 8-bit color channels are combined together to form a composite color image, the result is a 24-bit color image that can contain up to 16.7 million shades of color ($2^8 \times 3$).

this means that scanned images should ideally be saved as 16-bits per channel images in order to preserve all of the 12-bits per channel data.

In the case of raw files, a raw image contains all the original levels capture image data, which will usually have been captured at a bit depth of 12-bits, or even 14-bits per channel. Camera Raw image adjustments are mostly calculated using 16-bits per channel, so once again, all the levels information that is in the original can only be preserved when you save a Camera Raw processed raw image using 16-bits per channel mode.

8-bit versus 16-bit image editing

A higher bit depth doesn't add more pixels to an image. Instead, it offers a greater level of precision to the way tone information is recorded by the camera or scanner sensor. One way to think about bit depth is to consider the difference between having the ability to make measurements with a ruler that is accurate to the nearest millimeter, compared with one that can only measure to the nearest centimeter.

There are those who have argued that 16-bit editing is a futile exercise because no one can tell the difference between an image that has been edited in 16-bit and one that has been edited in 8-bit. Personally I believe this to be a foolish argument. If a scanner or camera is capable of capturing more than 8-bits per channel, then why not make full use of the extra tonal information? In the case of film scans, you might as well save the freshly scanned images using the 16-bits per channel mode and apply the initial Photoshop edits using Levels or Curves in 16-bits mode. If you preserve all the levels in the original through these early stages of the edit process, you'll have more headroom to work with and avoid dropping useful image data. It may only take a second or two longer to edit an image in 16-bits per channel compared with when it is in 8-bit, but even if you only carry out the initial edits in 16-bit *and then* convert to 8-bit, you'll retain significantly more image detail.

My second point is that you never know what the future holds in store for us. On pages 338–341 we shall be looking at Shadows/Highlights adjustments. This feature can be used to emphasize image detail that might otherwise have remained hidden in the shadows or highlight areas. This feature exploits the fact that

Bit depth status

You can check the bit depth of an image quite easily by looking at the document window title bar, where it will indicate the bit depth as being 8-, 16- or 32-bit.

Why is 16-bits really 15-bits?

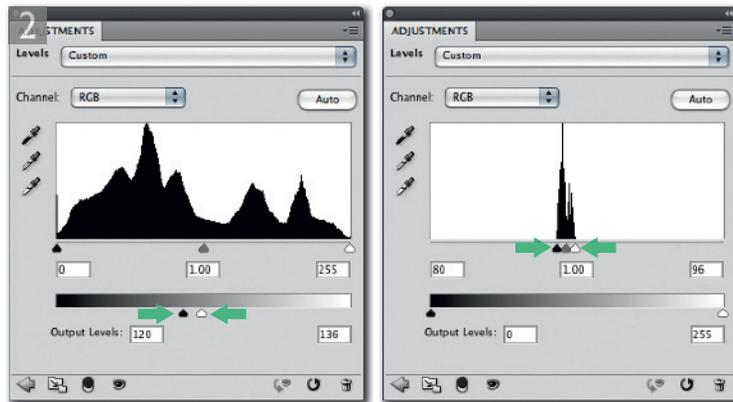
If you have a keen knowledge of math, you will notice that Photoshop's 16-bits per channel mode is actually 15-bit as it uses only 32,768 levels out of a possible 65,536 levels when describing a 16-bit mode image. This is because having a tonal range that goes from 0 to 32,767 is more than adequate to describe the data coming off any digital device. Also, because from an engineering point of view, 15-bit math calculations give you an exact midpoint value, which can be important for precise layer blending operations.

Comparing 8-bit with 16-bit editing

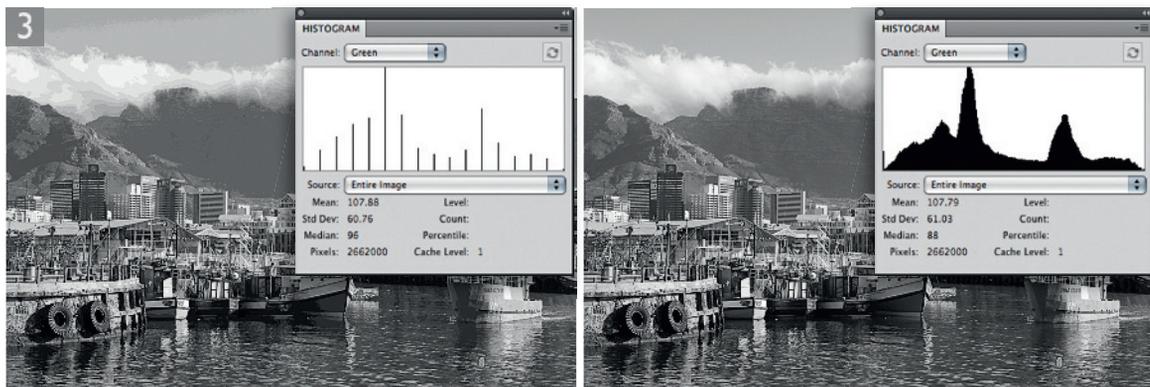
1 Here, I started out with a full color image that was in 16-bits per channel mode and created a duplicate that was converted to 8-bits per channel mode.



2 With each version I applied two sequential Levels adjustments. The first (shown here on the left) compressed the output levels to an output range of 120–136. I then applied a second Levels adjustment in which I expanded these levels to 0–255 again.



3 The outcome of these two sequential Levels adjustments can clearly be seen when examining the individual color channels. On the left you can see the image histogram for the 8-bit file Green channel and on the right you can see the histogram of the original 16-bit file Green channel. As you can see the 16-bit version retained a nice, smooth histogram.



a deep-bit image can contain lots of hidden levels data that can be further manipulated to reveal more detail in the shadows or highlights. A Shadows/Highlights adjustment can still work just fine with 8-bit images, but you'll get better results if you open your raw processed images as 16-bit photos or scan in 16-bit per channel mode first.

Photoshop also offers extensive support for 16-bit editing. When a 16-bit grayscale, RGB, CMYK or Lab color mode image is opened in Photoshop you can crop, rotate, apply all the usual image adjustments, use any of the Photoshop tools and work with layered files. The main restriction is that there are only a few filters that can work in 16-bits per channel mode, such as the Lens Correction and Liquify filter. You may not feel the need to use 16-bits per channel all the time, but I would say for critical jobs where you don't want to lose an ounce of detail, it is essential to make at least all your preliminary edits in 16-bits per channel mode.

In the tutorial shown opposite, I started with an image that was in 16-bits mode and created a duplicate version that was converted to 8-bits. I then proceeded to compress the levels and expand them again in order to demonstrate how keeping an image in 16-bits per channel mode provides a more robust image mode for making major tone and color edits. Admittedly, this is an extreme example, but preserving an image in 16-bits offers a significant extra margin of safety when making everyday image adjustments.

16-bit and color space selection

For a long time now Photoshop experts such as myself have advocated editing in RGB using a conservative gamut color space such as Adobe RGB (if you want to find out more about RGB color spaces then you will need to read Chapter 12 on color management). Although 16-bit editing is not new to Photoshop, it is only since the advent of Photoshop CS that it has been possible to edit more extensively in 16-bit. One of the advantages this brings is that we are no longer limited to editing in a relatively small gamut RGB workspace. It is perfectly safe to use a large gamut space such as ProPhoto RGB when you are editing in 16-bits per channel mode because you'll have that many more data points in each color channel to work with (see the following section on RGB edit spaces).

Camera Raw and bit depth output

If you use Camera Raw to process a raw camera file or a 16-bit TIFF, the Camera Raw edits will all be carried out in 16-bits. If you are satisfied with the results obtained in Camera Raw and you have managed to produce a perfectly optimized image, it can be argued there is less harm in converting such a file to an 8-bits per channel mode image in Photoshop. However, as I mentioned in the main text, you never know when you might be required to adjust an image further. Keeping a photo in 16-bits gives you the peace of mind, knowing that you've preserved as many levels as possible that were in the original capture or scan.