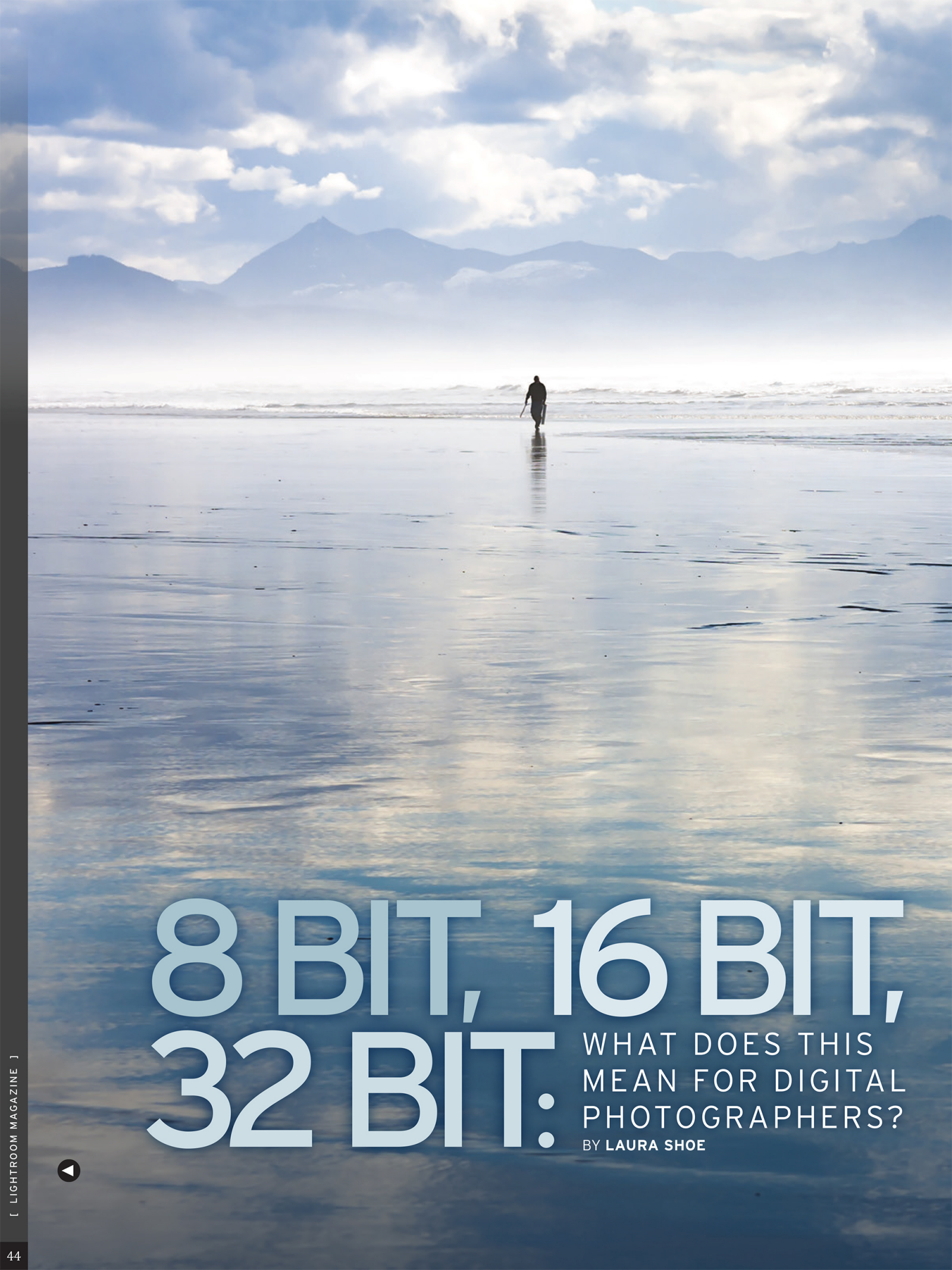


# 8 BIT, 16 BIT, 32 BIT: WHAT DOES THIS MEAN FOR DIGITAL PHOTOGRAPHERS?

BY **LAURA SHOE**

YOU MAY BE PHOTOGRAPHING IN RAW RATHER THAN JPEG BECAUSE YOU KNOW THAT RAW FILES ARE UNPROCESSED, GIVING YOU MORE FLEXIBILITY, AND THAT THEY CONTAIN MORE INFORMATION. BUT HOW DO THEY CONTAIN MORE INFORMATION? AMONG OTHER THINGS, DIGITAL PHOTOGRAPHY RAW FILES ARE CAPTURED AT A HIGHER BIT DEPTH—DEPENDING ON THE CAMERA, 12, 14, OR 16 BIT, COMPARED TO 8 BIT FOR JPEGS. WHETHER 12, 14, OR 16, THESE HIGHER BIT-DEPTH FILES POTENTIALLY CONTAIN MUCH MORE INFORMATION THAN 8-BIT FILES.

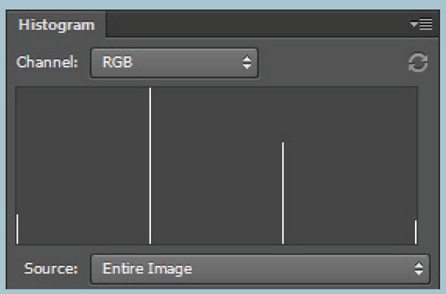
*Laura Shoe is an Adobe Community Professional and Adobe Certified Expert in Photoshop Lightroom, and writes a popular Lightroom blog at www.laurashoe.com. She is also the author of the widely acclaimed Lightroom Workshops on Video,* The Fundamentals & Beyond *and* Producing Great Output. *She has taught Lightroom and Photoshop for Rocky Mountain School of Photography, creativeLIVE, Photographic Center Northwest, and others, and lectures regularly. She particularly enjoys helping photographers to understand and get comfortable with technical topics so that they can truly enjoy digital postprocessing. Laura worked for almost 20 years in the corporate world before pursuing her passion of photography.*

# WHAT IS BIT DEPTH?

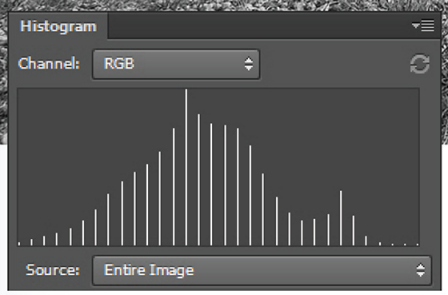
BIT DEPTH REFERS TO HOW MANY DIGITS ARE USED TO STORE THE TONAL INFORMATION.

For each pixel in your image, the tonal value (or brightness) of the scene you're photographing is stored in the image file on your memory card, along with the color. Computer files store information in sequences of zeros and ones (binary). Bit depth refers to how many digits are used to store the tonal information. Imagine if your camera used a bit depth of 1. You'd have one digit to store how dark each piece of the scene was, the only possible values would be 0 and 1, and the only two tones that could be represented are black and white. This image has very little detail since it contains no shades of gray.

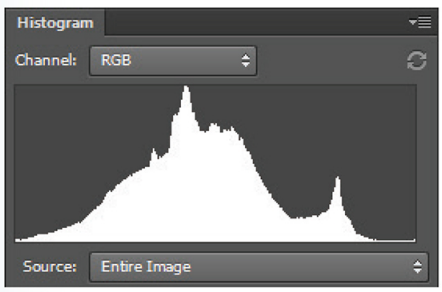
If the file had a bit depth of 2, there would be two digits to store each tone, and the four values of 00, 01, 10, and 11 would be possible, so the image could have black, dark gray, light gray, and white.



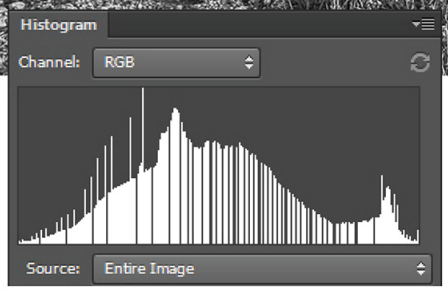

Notice that we have gained some detail, but that the image is still very choppy. In the histogram for this image, we see huge gaps between the tones, confirming this choppiness, or posterization. (The histogram is a graph of the tones in an image, going from pure black on the left edge to pure white on the right edge.)




Let's jump to a file with a bit depth of 5, which allows $2^5$, or 32 possible values from 00000 to 11111. We gain a lot of detail, but there's still obvious posterization, or banding, in the sky. The histogram supports this.




Now let's look at an 8-bit image, which allows $2^8$, or 256 values, and is what a JPEG supports. Eight bits shows the full detail of the scene with no visible posterization, even when viewed at full size, and the histogram looks much better.



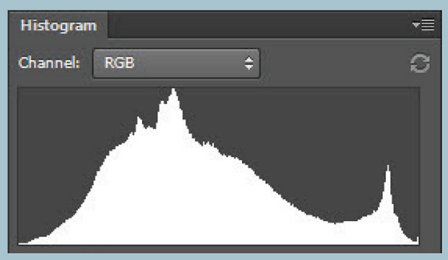

So why not stop here with 8 bits and 256 tones? The problem is that as soon as you start enhancing your image, you start compressing and expanding the tonal range. This creates choppiness in the histogram and potentially, visible posterization in your image. To show this, I made two adjustments to the photo: I brightened it and added contrast. Notice how this introduced gaps in the histogram.

## VISIBLE ISSUES IN YOUR PHOTO ARE WHAT MATTERS.

I've included these histogram screenshots, captured from Photoshop, so that you can better understand bit depth and its implications, but in the end, gaps in the histogram are not what matters. In fact, the histogram in Lightroom, unlike Photoshop, won't show you these gaps because, for various reasons, it smooths out the data. Visible issues in your photo are what matters. With the relatively small adjustments to the photo above, there's no banding, even when I zoom to 1:1. In practice, you'll find that banding, as well as color shifts, are most likely to occur when you start with a photo that has a narrow tonal range and expand it greatly (i.e., with a very narrow histogram that you stretch out greatly with very heavy editing). You'll find that areas in your photo with smooth gradations in tones, such as skies and skin, are most vulnerable.

You're already doing one thing that can help you avoid these issues: editing your JPEGs in Lightroom, which does a better job of blending tones in these circumstances than Photoshop. The other thing you can do to get the highest possible quality is to capture your image in a higher bit-depth file so that you have more data to work with.

# WHAT'S THE DIFFERENCE WITH A HIGHER BIT-DEPTH FILE?

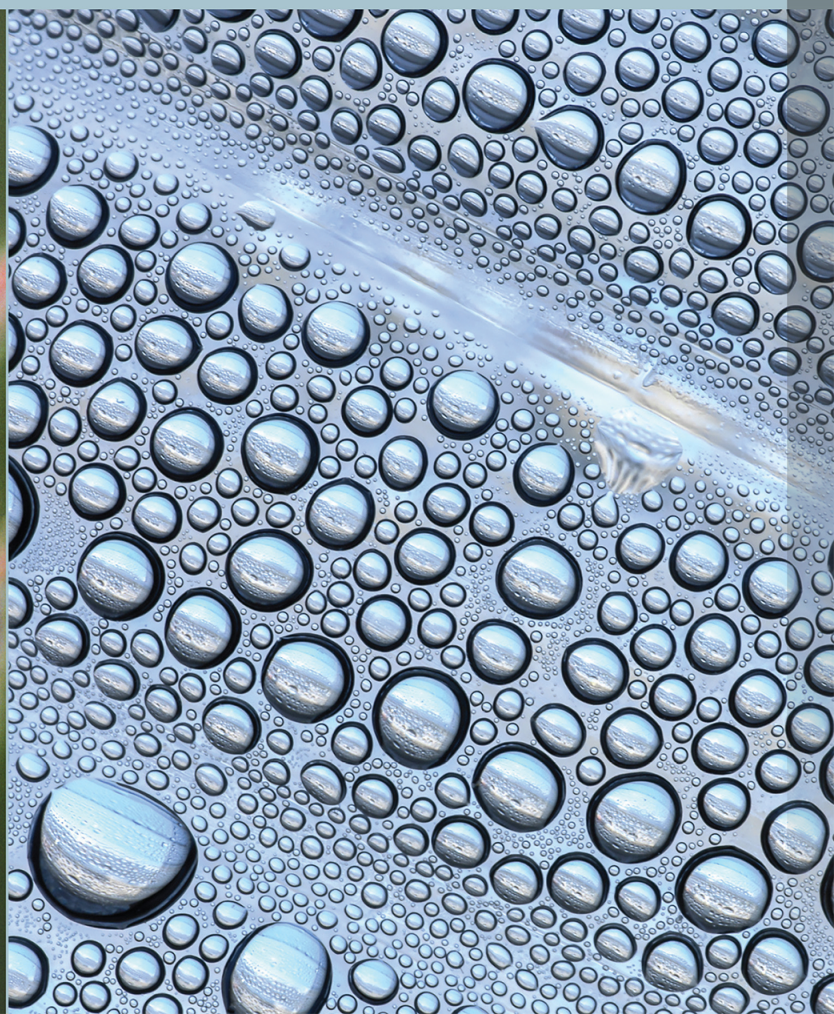



*Histogram from 12-bit version with lightening and contrast boost*

Twelve-bit files have more than 4,000 tones, and 14-bit files have more than 16,000, compared to only 256 for JPEGs. Higher bit-depth files also potentially have a much larger number of colors: an 8-bit JPEG can represent around 16 million colors, whereas a high bit-depth file can represent more than 68 billion. With vastly more tones and colors, your photos will hold together, even under the heaviest editing. Here's the Photoshop histogram from the 12-bit version of the car photo with the brightening and increased contrast

To have this additional editing headroom, you need to capture a high bit-depth image (i.e., a RAW file, not a JPEG), and you have to edit it as a high bit-depth file. While you're working in Lightroom, your work on the RAW file will automatically be in 16 bit (standardized to accommodate 12, 14, and 16 bits). When you move a file from Lightroom to Photoshop, you need to ensure that the Photoshop file stays in 16 bit instead of being compressed into an 8-bit file. To do this, in Lightroom, choose Lightroom (PC: Edit)>Preferences, click the External Editing tab, set File Format to PSD or TIFF, and set Bit Depth to 16 bits/component.

The downside to higher bit-depth files is larger file sizes. All else being equal, a 16-bit image file is twice as big as an 8-bit image file, but large memory cards and hard drives are so much cheaper these days than they used to be.



# WHY DO WE NEED 32-BIT FILES FOR HDR?

Sixteen bits offer more than enough values to represent all potential tones, from the deepest blacks to the brightest whites, that our cameras can capture in one image; that we need for editing headroom; and that our monitors and printers can reproduce. However, 32 bits are needed to represent the full range of tones that we can actually see, and that we can capture using multiple exposures. Merge to HDR Pro in Photoshop and other HDR programs can combine the full range of tones from these multiple exposures into a 32-bit result.

Since our monitors and printers can't reproduce this complete range, we then use *tone mapping* to decide how these tones are going to be condensed into the range that a lower bit-depth file can handle and that our monitors and printers can reproduce. You can do this tone mapping in your HDR program and then save your 16-bit file for further editing in Lightroom, but the tone mapping controls in these programs, including Photoshop, are complicated. Starting with Lightroom 4.1, there's a much easier way (as long as you're not after an over-the-top, faux-HDR look). Simply save your 32-bit file as a TIFF in your HDR program, and then do the tone mapping in Lightroom using the Basic panel in the Develop module.

When you first view your 32-bit file in Lightroom, most likely your highlights will still look blown out, and your shadow areas will still be too dark. This doesn't mean that the data isn't there from the multiple exposures; it just confirms what I just explained—that your monitor can't show you the full range of tones. Adjust the Exposure, Highlights, Shadows, Whites, and Blacks to darken the highlights, brighten the shadows, etc. *(Note:* When you're working with a 32-bit file, Lightroom increases the Exposure range from +/– 5 to +/– 10 to give you more editing flexibility.) You can also turn to additional tools, such as the Tone Curve and the Adjustment Brush. ■

ALL PHOTOS BY LAURA SHOE

*Multiple exposures captured to merge in Merge to HDR Pro in Photoshop*