Thoughts on Color Space and Tonal Compression

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In the March round for the Group I commented on an image of a Snowy Egret made by Bruce Finocchio. In part my comments touched on a mild case of clipping I saw in the red channel of the image which showed when I was looking a little more closely at the feather detail on the Snowy's side. I had been drawn to that because my experience with the warm, angular lighting evident in the image was that it can create issues if the contrast in the image is good, as it was in this case.

Bruce responded that he had checked the histograms and found that none of his values exceeded 247 in any channel and so he questioned why I felt there was clipping. After a few exchanges, we found that he had been looking at his working file (PSD) while I was looking at the JPEG posted for the round. The fact that the values effectively changed between the two files without any intervening image adjustments warranted some additional investigation.

I'll digress for a bit and cover an aspect of digital files that many folks often do not to understand or appreciate because of the tendency to focus on 255,255, 255 as the point of "clipping". You do not need to hit 255 to clip detail in any channel. In fact, you start to lose detail in any pixel value when that value (at a channel specific level) gets to 250. I don't know how many folks I work with have that same misunderstanding. It is also why I set my white value for a curve to 247 (the default value for the white eye dropper) and my black value to 10. I won't get into the black value for this discussion.

Our first consideration was that Bruce was working in the ProPhoto color space, as many of us do, and so had to convert the image to the sRGB color space as part of the saving process. He was using Relative Colormetric as the rendering intent where I tend to use Perceptual. Simply put, the Relative Colormetric conversion shifts all of the values that cannot be represented in the target space to the nearest value that can be shown in that space. Stated another way, the outliers are pushed into the boundary of the new space but any tones that are already within that space are left alone. Perceptual conversion shifts (compresses) all values proportionally until the outliers are all within the target color space. That means even values that are within the space to star with can be shifted during conversion. A Perceptual conversion will maintain tonal relationships but may introduce slight color shifting where a Relative Colormetric conversion will have minimal color shifting but may create banding or odd tonal areas as multiple outlier colors are shifted to the same or similar colors during the conversion process.

After a little more research, it turns out that there was no effective difference in the resulting values for Bruce's image or several other test images based on using Relative Colormetric or Perceptual as the rendering intent for converting to another, smaller color space. What we did find was that the very process of compressing the tonal range of an image from a large color space, such as ProPhoto, to a smaller space does impact the actual tonal value of a pixel with a disproportionate impact on the Red channel. This finding has to be qualified by stating we only examined highlight details since that was the source of the clipping question.

To try to put this into some context I am including a table showing the impact on one of the test images I worked on.

Relative Colormetric

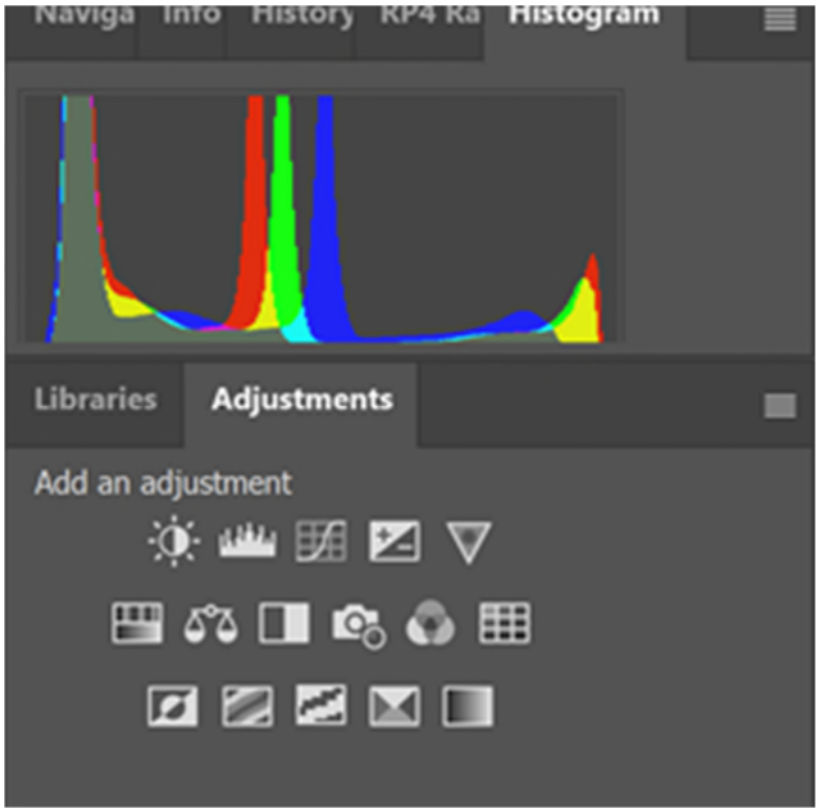
	ProPhoto	AdobRGB	sRGB
Red	246	248	250
Green	242	244	244
Blue	242	244	245

Perceptual

	ProPhoto	AdobRGB	sRGB
Red	246	248	250
Green	242	244	244
Blue	242	244	245

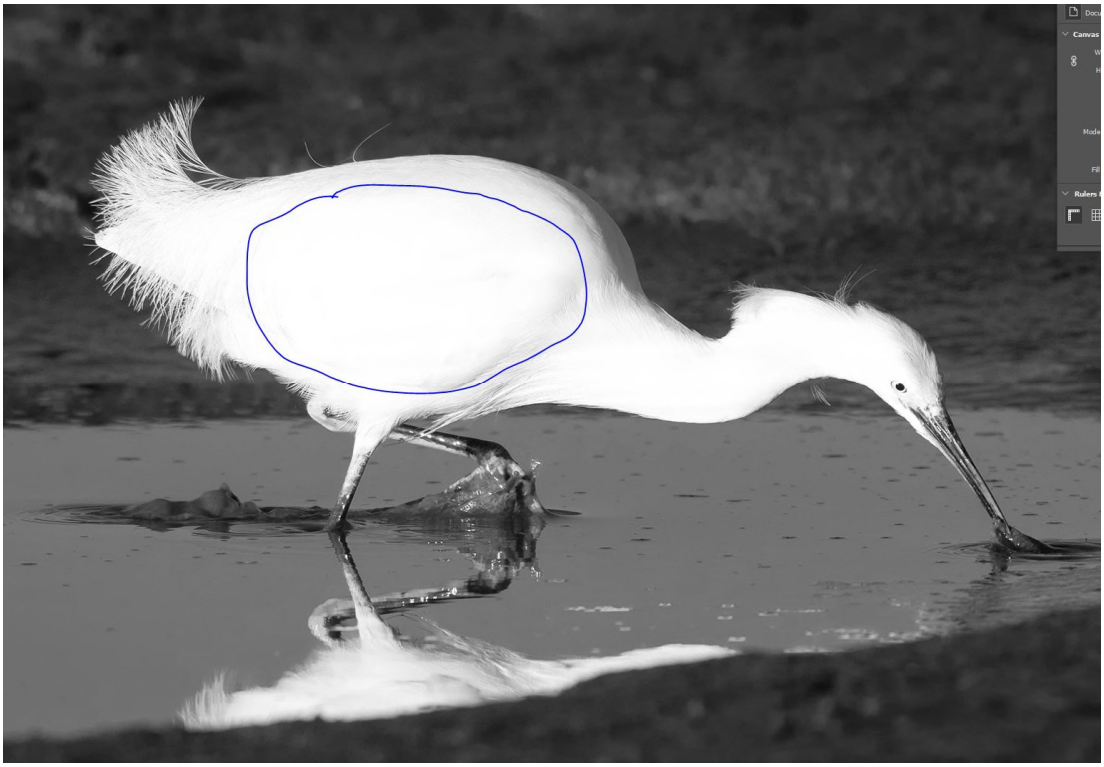
Note that even shifting to AdobeRGB resulted in some tonal compression, but it can become significant when converting from ProPhoto to sRGB. My highlight for this particular image was very safe at 246 in the Red channel, but was pushed to the loss threshold value of 250 when shifting to sRGB.

To give you some sense of the impact on Bruce's Snowy, this is the color histogram from his working file.

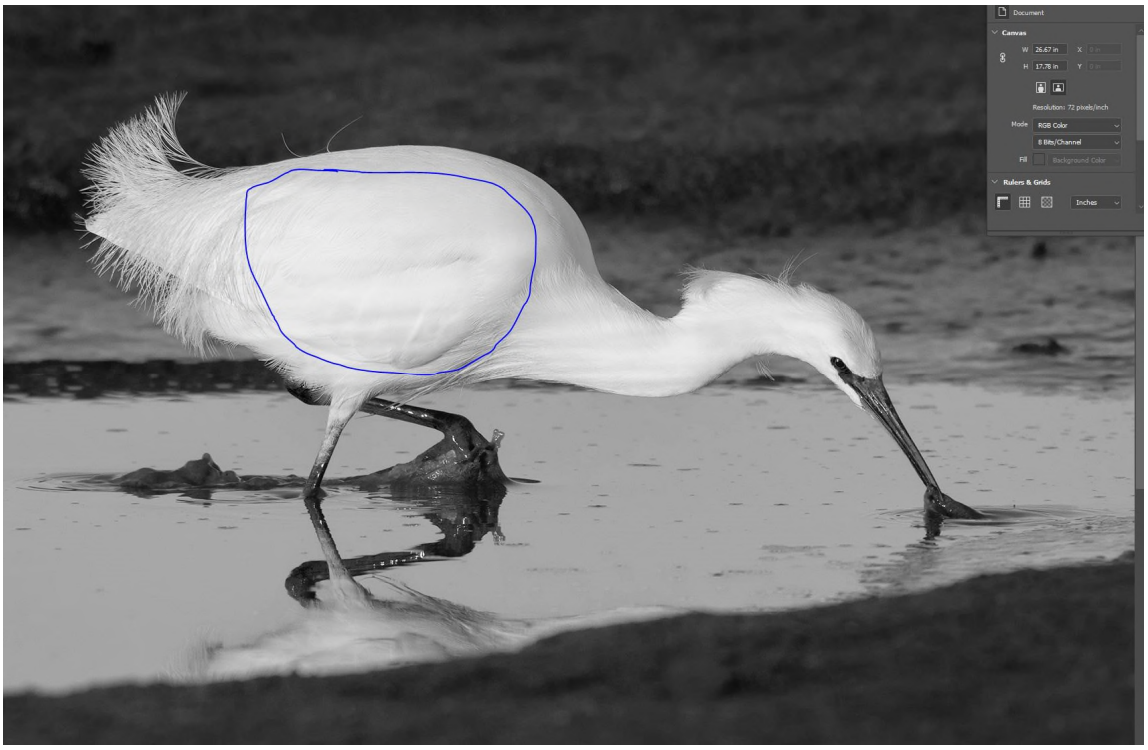


Note that it does not show any of the colors reaching even close to the 255 edge. Bruce's independent checking showed that, in the areas I was commenting on, his maximum values were running around 247, which should be entirely safe.

Here is a screen shot of the actual Red channel from the JPEG posted for the round.



For comparison here is a screen shot of the Blue channel. The difference is significant.



While this is likely an exercise in the fine underpinnings of working in a digital editor and conversion between color spaces, it is still something to keep in mind if your image has significant key highlight areas. The new caution is that after converting down form a larger color space, recheck the key areas using the INFO panel or examining the channels to verify there have not been any material adverse side effects from the conversion process.