Setting Exposure Revisited – Glenn Pure

In the February 2019 newsletter, I explained how to set exposure on your camera. This article was the second part to a more general article on basic camera settings. On request of the organisers, I also presented a paper on this at the BLP Fremantle conference in September 2019 in which I've evolved some of the thinking and corrected a couple of minor errors. This is a written version of the paper I presented at the conference.

My presentation started with a quote from Ansel Adams: "*The single most important component of a camera is the twelve inches behind it.*" I want to emphasise that you should be in control of the camera, not the other way around.

With the choice of many 'auto' options on modern cameras, it's tempting to question this. However, if you want to do something a little different, or you want to fix something that the camera got wrong – which it will do reasonably often when set to auto – you'll need to understand what to change and how to change it.

In the same vein, another quote from Ansel Adams: "*You don't take a photograph, you make it*." It's all about seeing a photo in a scene and having the ability to control the camera so it captures that in the way you've seen in your mind's eye.

In setting exposure, there are very few things that you need to worry about. The first thing that's important to understand is that a camera doesn't see a scene the way human vision does. It's not necessarily obvious what these differences are, but they are critical.

The most important aspect of that is how the camera records light and dark compared to our own vision. When we look around a scene, our eye is constantly adjusting to the brightness of what we are looking at. This is achieved through the iris opening up in darker situations or closing down in bright light. Camera lenses also have irises that control the light reaching the sensor, but each time a photo is taken the iris is set at one particular size. The camera records a scene in one instant. We scan a scene over seconds or minutes to build up a picture in our mind's eye.

A camera has to record it all in a split second and in a way that enables us to see detail in as much of the scene as possible. We don't want the bright bits to be washed out and lacking any detail. We also don't want the dark areas to be pure black with nothing to see there. We also want contrast and detail in them all.

In a perfect world, this wouldn't be a problem. Unfortunately the sensor in a camera is limited in the extremes of light and dark it can record. This is called the dynamic range. While modern cameras have great dynamic range, there are still limits that can cause problems. Getting a good photo involves using this limited dynamic range to record a real-life scene in the best way possible. It's all about getting the exposure right.

What does correct exposure actually mean? It's about having the camera set so it can record detail (tonal differences) in the bright and dark parts of an image, particularly the subject being photographed which in our case is typically a bird. Generally, it's more important to worry about getting the bright areas (highlights) right.

Figure 1a: This is what happens when the highlights are over-exposed.

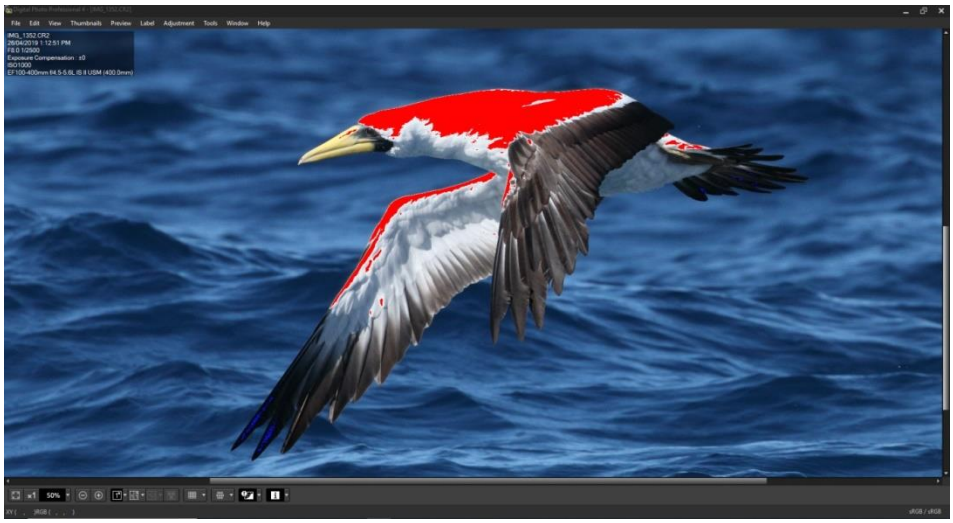

Figure 1b: A screenshot from my image processing software with the highlight (red) and shadow (blue) warnings turned on. Detail is lacking on the highlights on the bird's back in particular, shown by the large patch of red.

Figure 1c: A version that more closely aligns with the way our own vision would see this bird, showing good detail on the back. That's the goal to aim for.

There are only three settings involved in getting the exposure right: **aperture**, **shutter speed** and **ISO**. The three combine and interact to determine the final exposure. Changing one of these settings will require at least one of the others to change to maintain the same exposure.

All three are very simple in their effect on exposure but they all have secondary effects or influences and these are the things we have to take account of when setting them.

Shutter speed is probably the simplest to understand. A fast shutter speed means the shutter is open for only a very short time and the sensor in the camera records only the briefest moment. Fast shutter speeds are used to freeze motion, like birds in flight. But they will often be needed to stop blur for birds that are simply feeding, preening or otherwise engaged in normal non-flying activities. Some birds are unrelenting fidgets and will be in near constant motion. Thornbills come to mind and generally, the smaller the bird, the bigger the fidget it is. This makes them challenging to photograph in a way that freezes their motion especially as they often like the protection inside bushes and other shaded areas where light is weaker and a fast shutter speed is harder to achieve.

The sorts of shutter speeds needed are going to typically be at least 1/500 second to freeze lively birds and faster is better, especially if you want to freeze a particular behaviour like snatching an insect from the air or a frantic scratch. Even faster is needed for most flight photography. I'd usually aim for at least 1/2000 second, but it's sometimes possible to get away with less for larger, slower-moving birds or where it's possible to pan with the bird's motion effectively. On the other hand, trying to freeze a swallow mid-flight might need 1/3200 or 1/4000 second.

For perched birds that aren't moving around much or that do 'freeze' from time to time, aim for at least 1/160 sec. It's possible to go really slow if you are stuck in a poor light situation. The lowest I think I've done is 1/25 second but you'll need the bird to be still and to preferably brace the camera against a fixed object like a tree trunk or rock if possible. Take plenty of shots in those situations because more than a few will be blurred.

Figure 2. Example of a successful slow shutter speed shot, taken in poor light in forest on Lord Howe Island. I had braced the camera against a rock to help reduce blur from camera movement. In these cases, any movement from the subject will also cause blur.

While motion blur from slow shutter speed will usually detract, that's not always the case. Deliberate blur can be used for artistic or narrative effect. There is a fair degree of subjectivity involved here. One test is to ask yourself whether the photo would look better if it wasn't blurred?

Figure 3. A Striated Thornbill having a shake-down after visiting my backyard birdbath. The spray of droplets and motion blur of the bird's body conveys the story of the bird just having bathed. Having the head and perch sharp reinforces this. The shot would have had much less merit if it had all been blurred.

Deliberately choosing to freeze a moment or capture some blurred action is something unique to the way a camera records a scene compared to our own vision. Our vision won't detect the beautiful frozen splash pattern that results when a heron plunges its bill into the water. Nor will be see the smeary blur or dozens of wings as a flock of birds takes off. So a camera image enables you to create something new and unique. It's worth thinking about this every time you take a photo.

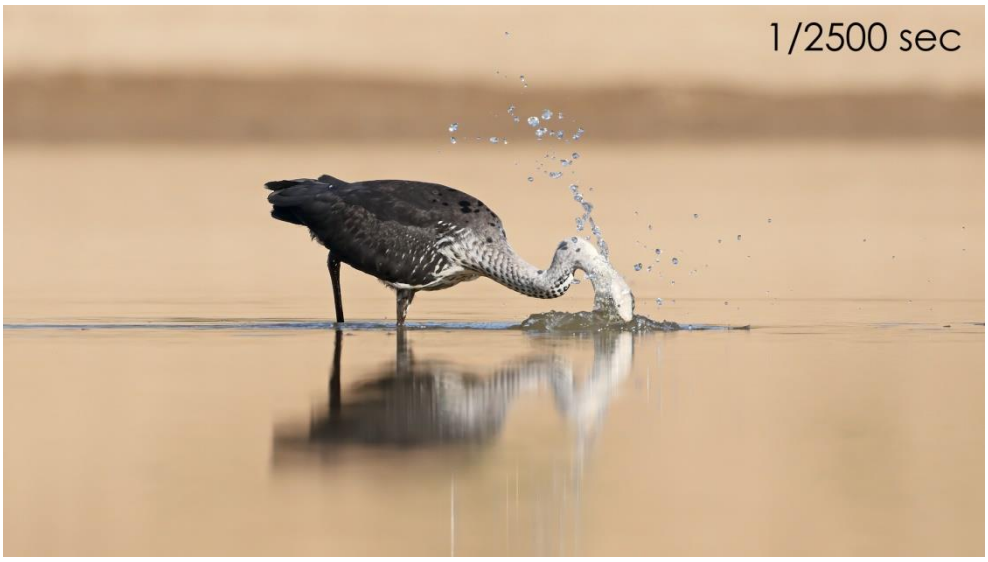

Figure 4. Shows the effect of deliberately freezing motion with a fast shutter speed.

The next exposure setting is **aperture**. This controls the size of the iris or diaphragm opening in the lens. The wider the opening, the more light gets to the sensor and vice versa. Aperture is represented by the *f* number. Confusingly a smaller f number like *f*2.8 means a bigger iris opening and more light reaching the camera sensor than say *f*11.

You might wonder why anyone would ever want to reduce the aperture and thereby reduce the amount of light reaching the camera sensor? Like shutter speed, changing the aperture also affects more than just exposure. In this case it will change the depth of field and is important for bird photographers.

Figures 5a and 5b. The effect of a smaller aperture on depth of field. Notice how the bird's feet aren't quite in focus at f5.6 versus f9. Also notice the effect on the background. The softer and simpler look of a very blurry background helps the bird stand out but it clearly involves a trade-off with getting the subject in focus.

Depth of field gets shallower as focal length gets bigger. This means that much less in front of and behind the focus point will be sharp when using a typical bird photography lens. For example, if I had a lens with a focal length of 40mm on my camera and set the aperture to *f*8, then set the focus on a subject 7 metres away, everything from infinity (the most distant object visible) to objects as close as about 3.5 metres from the camera will be in sharp focus. If, however, I tried the same settings on my 400mm focal length bird photography lens, also focussed on a subject 7 metres away, the only things in sharp focus will be those between 7.07 metres and 6.93 metres from the camera – a depth of field of just 14 centimetres. Depth of field also gets bigger the further away the subject is and shallower the closer it is.

There are tables online that will tell you what the depth of field will be for any particular combination of focal length, aperture and subject distance. Here's a couple of examples, and there are even phone apps available:
https://www.photopills.com/calculators/dof
https://dofsimulator.net/en/

What does this mean in terms of typical settings for bird photography? For my 400mm lens I often work at *f*6.3 or *f*7.1. Stopping down to *f*11 or *f*16 might be needed in extreme cases where you have a larger bird at closer range or a number of birds that ideally should be in sharp focus. However, the difference in depth of field for a subject at 7 metres with a 400mm lens is not great between *f*5.6 and *f*16. At *f*5.6 the DOF is 10cm and at *f*16 is it only 28cm – just under 3 times

bigger. However the difference in the amount of light reaching the sensor between *f*5.6 and *f*16 is a factor of 8 meaning a shutter speed 8 times lower would be needed, or an ISO 8 times higher.

That brings me to the final exposure setting of **ISO**. This is a measure of how sensitive your camera's sensor is to the light reaching it. At a high ISO setting, only a small amount of light is needed to generate a good signal from the camera sensor and create a well exposed photo. So why wouldn't you set your ISO to the maximum possible, especially when working in low light situations such as birds under bushes, in forest or early and late in the day? Most of you know the answer to this: digital noise goes up as ISO gets turned up. Dynamic range also falls off dramatically

Figure 6. An example of a high ISO shot with accompanying high noise levels.

So what ISO setting is best? The short answer is as low as possible to give you the aperture and shutter speed combo you want for your photo. Many of you might wonder how high you can turn the ISO up before results become unacceptable. This depends on a few things, particularly the size of the image sensor in your camera and the number of pixels it can record. Assuming you have a current generation camera with the latest or near latest sensor technology, my experience is that for a crop sensor (APS-C) like my Canon 80D with a pixel count of 24 megapixels, the upper limit is about 1,600 ISO. For a full frame camera the useable ISO will about 1.4 times that or about 2,300, because the sensor has twice the area of the APS-C sensor and noise decreases by the square root of area (the square root of 2 is about 1.4). For those using an Olympus OM-D M1 or similar, this has a sensor about half the area of my Canon's APS-C sensor so the maximum useable ISO will be about 1.4 times less than 1,600 or about 1,100 ISO, assuming all else is equal.

There are differences between camera manufacturers but they aren't huge. Nikon uses sensors made by Sony and it currently has a small but significant lead in high ISO performance so can produce acceptable results at slightly higher ISO. But this could easily change in the future.

There is a much more important factor though affecting maximum useable ISO. The upper limit can be raised substantially by using effective tools and methods to deal with noise in the image in

post-processing. The estimates I've just outlined apply when only basic efforts are made to reduce noise in the camera image. More effective methods include selectively applying stronger noise reduction in areas that lack detail (such as out of focus backgrounds) and using specialist noise software that preserves detail while reducing noise. Specialist software tools include Topaz Denoise and Neat Image. Both are good. I use the latter.

Figure 7. The same shot as Figure 6 but processed using Neat Image. To help get the best result, I also applied stronger noise reduction to the background and foreground after carefully selecting these areas. You may need to zoom in on this figure, and Figure 6, to see the difference in noise level.

By doing this I can increase the maximum useable ISO of my camera from 1,600 to perhaps 5,000 or even 6,400. For high ISO shots, the biggest problem areas are going to be the shadows and darker parts of the photo because these are most affected by noise and the reason why dynamic range falls at high ISO. The darker areas and shadows are where any detail is most likely to get lost in all the noise and be unrecoverable, even with sophisticated noise reduction tools. The take-home message here is to set exposure if at all possible so these parts of the photo aren't getting too dark.

That covers the three exposure variables. How do you go about setting them for any particular situation? Pretty well all cameras have a built in light meter and it's usually capable of taking readings at multiple points within the field of view. Most cameras will also have multiple modes for setting the exposure, from full auto to full manual. I wouldn't recommend using full auto – you will have little control. Other options are Aperture priority, where you set the aperture and the camera does the rest; and shutter priority where you set the shutter speed only. There is also manual exposure where you set both aperture and shutter speed. Many cameras have an 'Auto ISO function' so that even in manual mode, the camera will automatically determine the exposure by adjusting the ISO to get a correct exposure for the set shutter speed and aperture (or at least what the camera thinks is a correct exposure). When using Auto ISO, the camera will usually allow you to set an upper limit on the ISO so the camera won't select a value that will produce an unacceptably noisy photo.

What's the best option? I use full manual exposure where I set shutter speed, aperture and ISO myself. That gives me maximum control. For those who don't feel comfortable about that, the next best is probably Manual exposure with auto ISO, so you control shutter speed and aperture while the camera sets the ISO.

In poor light situations you'll probably have to make compromises on shutter speed and aperture over those you'd ideally use. The camera's light meter will tell you if you are correctly exposing so check your camera manual and learn how to read it. On my Canon 80D, there is a scale in the bottom of the viewfinder (and also on the LCD panel on the top of the camera) that tells me if I'm under or over-exposing.

Figure 8. The meter reading on the top of my Canon 80D (same as the scale shown in the bottom of my viewfinder). The current reading shows the exposure is about one and a third EV over-exposed. (One EV is the equivalent of a doubling or halving of light reaching the sensor).

If you do use aperture priority, shutter priority or manual with auto ISO options, the camera will be determining final exposure for you. There are two additional settings that will help get the right exposure. The first of these is which part of the viewfinder is used to set exposure. There will usually be a few camera options here. The simplest is centre spot metering. The exposure is set using a small area in the centre of the frame. Some cameras have an option to expand this to a slightly larger area in the middle of the frame (centre zone). Another common option is to measure exposure across most of the frame but weight it for the centre of the frame. Any of these can work but the best one for any particular situation will vary. To decide this, remember that that the camera will assume that the metered area will have an even mix of light, midtone and dark areas - overall, the average will be a mid-grey value. So, for example, if you had a strongly backlit subject, the subject will be quite dark and you'd be best with centre spot metering such that the centre of the frame was over your subject. This will produce a normal exposure and tonal range across your subject and a washed out background. Another situation might be photographing a very dark bird such as a male satin Bowerbird or a Raven. Since the bird is black, the camera won't get the exposure right if you use centre spot metering over the bird as it will assume you want the bird to look mid-grey in the final image. Instead centre-weighted might be the best option.

Here are some examples of different subject and lighting conditions:

Figure 9a shows a grebe against a bright background. This is a case where centre spot metering with the spot over the bird is likely to give the best exposure reading.

Figure 9b shows a black bird which the camera will attempt to expose as mid-grey if the centre spot is used for metering. Instead, this is a case where centre-weighted is likely to give a better result.

Figure 9c shows a white bird against a midtone background. This is another case where centre-weighted metering will probably give the best exposure, since centre spot will try to expose the bird as mid-grey.

Another possibility for setting exposure in one of the auto exposure modes (including auto ISO) is to use centre weighted evaluative metering but tell the camera to deliberately over-expose or under-expose the photo depending on the situation. Most cameras will allow you to do this. It's usually called something like 'exposure compensation'. For a backlit subject, you'll want to deliberately over-expose, while for a black bird that takes up a significant part of the frame, you'd need to deliberately under-expose. The opposite will apply if you're photographing a white heron, for example; you'll want to deliberately over-expose a little that so the bird will be white, not grey in the final photo.

If you don't get it quite right, this can be fixed to a degree in post-processing. Your chances of doing so will be much greater if you set your camera to record images in RAW format. That's because they contain a much wider range of tonal information than a jpeg image. In particular, detail that may be invisible in highlight and shadowed or dark areas of a photo can often be recovered from a RAW image. It's virtually impossible to do so from a jpeg because the additional information needed simply isn't there. In fact, the photos shown in Figure 1 at the start of this article are all from one frame recorded in RAW. I've simply processed this to bring out the detail that would not normally be recorded if the camera had been saving only jpeg files.

So one of the best things you can do to get your exposure under control is to switch to RAW images and learn how to process RAW image. It's not hard and I have covered this in other articles on basic processing.

As mentioned, I personally set shutter speed, aperture and ISO manually. That gives me the maximum possible control over how the final photo will look. I resisted going fully manual for a long time as I thought it might be too much to think about every time I took a photo. In reality, it's no worse than having to think about metering mode or exposure compensation and setting those. In fact, provided I'm working in consistent light, once I set my exposure, I can simply forget about it and be confident that my shots will all be well exposed. Even in changing lighting conditions, such as a bird moving from the open into shadows, I still find full manual exposure no worse than

all the other things you'd have to think about when using auto ISO. Having said that, I still use aperture priority exposure on occasion where light conditions are changing quickly and I don't have a difficult lighting situation such as a black or white bird or a strongly backlit background.

How do you actually know if you've got a well-exposed shot? Start by reviewing the image you've just taken on the camera's screen. The overall appearance will give you a rough idea. Most cameras can display a histogram of the image, although it is not for the RAW image but the default jpg that is created from the RAW image in-camera; it's therefore quite misleading in my view.

One problem with histograms is that If a small portion of the image is exposed as completely black or white and that portion happens to be somewhere you'd like to see some detail – like a bird's head – it might be too small to show up on the histogram. There is, in my opinion, a much more useful tool. It shows which parts of an image are over-exposed and it's called the 'highlight alert' or 'highlight warning'. Many people call it the 'blinkies' because when this function is turned on during image review, it shows up typically as blinking black and white on the part of the image that's over-exposed. Highlights are generally more important to get right for exposure than shadow areas. Like the histogram, this warning is only for the standard jpeg image created from the RAW, so this warning might show even if the RAW version doesn't have a highlight problem.

In spite of these limits, the 'blinkies' are still a go-to test for correct exposure. You'll need to take an initial test shot. If the blinkies are showing in a critical part of the photo, such as the bird's head, take another test shot after reducing the exposure by half or two thirds of an EV. Find the exposure when the blinkies just disappear. That setting will produce an acceptable exposure. But to get the most from the camera's dynamic range, or if you've got an older camera, it can pay to over-expose by maybe 1 EV as this will give better shadow detail and lower noise while still preserving highlight detail.

So that's exposure in a nutshell. Like anything, the more you gain familiarity with your camera and the more you practice, the better you will get.