How To Get Sharp Images - Simon Pelling

Image sharpness is generally an important objective for photographers.

High levels of visible detail (such as hairs and feathers) in the subject are usually important in bird and other forms of nature photography, particularly in critical parts of the photograph such as the head and eye of the subject.

Of course, we need to qualify this general statement. When we use the term 'a sharp image' we seldom (if ever) mean the entire image (from side to side, or back to front) needs to be sharp. Indeed, with long telephoto lenses (which have very shallow depth of field at wider apertures) this is seldom possible even if it were desirable. Creative use of depth of field is a key element of a lot of bird photography. Creative judgements will always need to be made about which parts of the subject and scene have to be sharply defined.

In this article I will outline some of the things that go towards getting sharp and detailed images in bird photography (or, indeed, any photography).

What Makes a Sharp Image?

Sharpness is primarily a matter of *perception*. We perceive an image (or part of an image) as *sharp* if it has certain visible characteristics such as lots of clear discernible detail (such as the barbs of a feather, or leaves on a tree), with different elements being clearly distinguished one from another, as well as a 'crispness' that comes from clear, sharp edges and well-defined transitions (e.g., between dark and light details) within the picture.

Two main things influence this. The first is how small an object the camera can 'see' (that is, its ability to resolve elements in the scene distinctly). This depends on the performance of the lens in transmitting information about the scene to the camera's sensor, and the ability of the sensor to record that information accurately. This ability to separate out details is the *resolution* of the camera system. Every camera and lens combination will have a resolution limit beyond which it is impossible to separate out details.

The second is the contrast in the scene. The human eye is quite sensitive to contrast, and images with higher contrast - that is, a greater range of tones from dark to light - will generally appear to be sharper than images with smoother tones. One aspect which will influence this is the abruptness of the changes from dark to light at the edges of elements in the scene - which is what is known as *acutance.* Soft or low contrast transitions in an image (eg the feather structure on an all-white bird, or a misty landscape) will generally be perceived as less sharp than harder transitions between contrasting areas of brightness or colour.

Controlling Sharpness in an Image

It follows, therefore, that in order to achieve sharp images, the photographer needs to record adequate levels of detail, with sufficient contrast between elements of the detail to ensure they are clearly able to be distinguished.

Clearly, the camera's sensor and the lens used will be the key to achieving this. However, sharpness in the final photo also depends on other factors including:

- inaccurate focus, or focusing on the wrong part of the scene

- movement, including both the photographer's movement (camera shake) and subject movement
- sharpness, contrast, detail and noise reduction settings, either in camera or in post-processing on a computer or other device, and
- the way the image is viewed, including whether on screen or in print.

These aspects will be explored further in subsequent sections.

People often blame the camera and lens for sharpness problems - that is, problems with sharpness arise because the camera doesn't have enough megapixels, or because the lens isn't good enough. However, for most people, photographic technique, particularly movement and focus issues, are likely to be more important in terms of managing sharpness in the field. Most of the issues with sharpness that BirdLife Photography image moderators come across can be put down to technique problems.

How Do I Go About Improving the Sharpness of My Images?

1. Keep your camera still, and freeze subject motion

Bird photographers use long telephoto lenses. Because these lenses have high magnification and a small (narrow) field of view, any small movement of the camera and lens will be exaggerated in its effect on the final image. Keeping the camera as still as possible is critically important to sharp images.

Use of a rigid tripod is ideal, but often impractical in the field, being both heavy and cumbersome to move about, as well as inflexible for fast moving birds. However, there is a type of tripod head called a *gimbal head* which allows much greater freedom of movement of the camera such as panning for birds in flight, but still minimises random camera shaking. Alternatively, the use of a monopod will provide some support, but have greater flexibility and portability compared to a tripod. Other support systems (such as beanbags) can be used, for example when shooting from a car window.

However, many bird photographers still prefer to shoot hand-held for increased speed and flexibility in the field. In these circumstances, the key issue is to ensure the shutter speed is fast enough to freeze movement. This will involve corresponding adjustments to aperture and ISO to compensate, meaning that for lenses with a relatively small maximum aperture (e.g., a lens with an f/5.6 or f/6.3 maximum aperture) using a high ISO will be required in anything other than good light.

The traditional '*reciprocal rule*' for shutter speeds states that, in order to counteract camera movement, the minimum shutter speed used when hand-holding should be the reciprocal of the focal length; for example, when using a 400mm lens, the 'rule' says that the minimum shutter speed should be 1/400 seconds. This rule applies to full frame cameras, and needs to be adjusted to take into account the smaller field of view of APS-C and Micro Four Thirds sensor cameras. For example, for an APS-C the appropriate shutter speed would be 1/600 s (ie 400 multiplied by the APS-C crop factor of 1.5). Obviously, this is a guide only and with practice, people with steady hands may be able to shoot successfully at lower shutter speeds than this. Equally the reciprocal rule doesn't take into account image stabilisation.

In addition to using shutter speeds to compensate for *camera* motion, it is also important to consider the appropriate shutter speed for freezing the *subject's* motion. Birds in flight need quite high shutter speeds - typically over 1/1000s. However, very few birds are fully still even when perched. Many small birds will preen, look around for prey, or be constantly looking for predators and competitors for food, so the head will seldom be still even if the bird is perched. It is easy to underestimate the shutter speeds needed to fully freeze all motion in these situations.

Image stabilisation, used properly, can play an important point in helping manage camera movement. The stabilisation systems of modern cameras are often so good that there is a risk that photographers become over-reliant on them, using them without thinking. Good quality stabilisation will significantly reduce the shutter speeds needed to get sharp images *where the subject is static*. Image stabilisation only stabilises the camera and lens, and if the subject is moving (such as a bird preening, or flying) a suitably high shutter speed is still needed to freeze subject motion. It is also necessary to use the appropriate mode of stabilisation where the camera or lens offers a choice of operational modes for different situations (for example, Canon has a mode/setting for general use, and a different mode for panning with birds in flight).

2. Get to know your camera's focus system

Although modern autofocus systems can be very accurate, focus problems are common as a source of blurry photographs. Understanding how a camera's focus system works, and its strengths and weaknesses, is critical to getting sharp photos.

In simple terms, cameras use distance and contrast information to achieve sharp focus, measured at a number of distinct focus points. Some high-end mirrorless cameras have over 1000 points, whereas some more consumer-focused DSLRs have fewer than 100.

In cameras with subject tracking, eye autofocus or similar, the camera combines this with shape and colour information to enable the camera to identify and follow subjects with specific characteristics.

The user sees these focus points as dots or squares in the viewfinder (or on the screen on the back of the camera). One or more of these focus points are positioned over the subject, which the camera then uses to focus the lens. Cameras also offer two main modes of focusing: single focus mode, where the camera focuses once on the subject and then stops the autofocus mechanism (suitable for static subjects); and continuous or servo autofocus, where the camera continually focuses on the subject, allowing the photographer to follow a moving subject.

When tracking is engaged, the selected point (which may be chosen by the photographer or selected automatically by the camera) follows the subject around the viewfinder, with a greater or lesser degree of accuracy depending on the camera involved. The best tracking systems involve a large number of autofocus points coupled with 'well trained' algorithms that can recognise objects quickly and are very 'sticky', staying with the chosen subject and not being distracted by similar but unwanted subjects.

It is easy to blame focusing problems on inaccurate or wrongly calibrated focusing systems. However, the reality is that most focusing problems can probably be put down to using the autofocus system wrongly. Also, it is very hard to track birds in flight or otherwise moving fast, and it takes a lot of practice to get it right. I strongly recommend those who are not familiar with the focusing modes of their camera to take time to experiment and read the manual thoroughly. Modern cameras often include lots of different focus settings, for different situations, and developing a good understanding of them can help considerably in making the most effective use of autofocus systems.

A common source of focus problems is over-reliance on automatic modes where the camera does all the work. While high end cameras, particularly mirrorless cameras, can have very good subject tracking, they still sometimes get it wrong. Those who are not so fortunate as to have a camera with a top notch tracking system will find that focus modes which use multiple points in the viewfinder can often be a bit hit-and-miss. They may not focus on the right thing (for example, the bird) or the right part of the subject (eg the bird's head). The resulting photograph may have lots of things in sharp focus (eg leaves, branches) but a rather out of focus, blurred subject.

In addition autofocus systems can be defeated by certain scenes, for example low contrast scenes with no clear high-contrast edges such as clouds in the sky, subjects in very low light, subjects with very fine detail, and subjects where near objects and far objects are very close together in the viewfinder (eg the bars on a cage, and the bird in the cage). In these situations, the camera might continuously try to find something to focus on, and 'hunt' backwards and forward without settling on an object. Even if it does settle on an object, it might not be what the photographer is trying to capture.

Many photographers adopt a 'focus - shoot - refocus - shoot' technique involving focusing, shooting a burst of photos, then re-focusing and shooting another burst, etc. This approach can maximise the chances of getting precise focus on the right part of the bird, as well as provide the opportunity to capture the bird in interesting poses that a single shot might miss.

3. Upgrade your camera body or lens

I'm not about to suggest that everyone go out and buy new equipment! Rather this section is intended to outline the role of camera bodies and lenses in terms of capturing detail, and therefore perceived sharpness in an image.

Lenses

The traditional way of reporting on the performance of a lens is the use of the 'modulation transfer function' or MTF. A full explanation of MTF is beyond the scope of this paper, although interested readers can find many different tutorials online. However, I am mentioning it here because photographers who want to assess the sharpness of a lens will often find references to MTF measurements in lens reviews and on promotional material on manufacturers' websites.

MTF measurements (often shown as graphs) essentially plot the performance of the lens at different points from its centre to its edges, in terms of resolution and contrast, against a theoretically perfect lens that transmits 100 percent of the light passing through it.

MTF measurements can provide useful information on a lens but need to be used with care. As noted above, the lens is only part of the equation, and in terms of ultimate 'real world' resolved detail, both lens and sensor need to be considered. To quote from the Nikon website:

> "*While a MTF chart can be used to compare two similar lenses from the same manufacturer it can be difficult to compare across different manufacturers due to testing and display differences. Further, a MTF chart measures theoretical optical performance of a lens only. Many factors (camera imaging sensor, camera software settings, filters, subject matter, subject/camera motion, etc.) can greatly affect the final image quality so MTF charts should only be used as a starting point when comparing and purchasing a lens.*" https://www.nikonusa.com/en/learn-and-explore/a/products-and-innovation/what-is-a-lens-mtf-chart-how-do-i-read-it.html

The resolution of the lens comes down to its optical design (eg the number and shape of individual glass elements inside the lens, and the quality of their manufacture) as well as things like the quality of construction. Lenses can vary considerably in terms of their ultimate resolving power, as well as their micro-contrast levels.

In a practical sense, some features of lenses to bear in mind in terms of maximising sharpness are:

- Due to the properties of light, the performance of all lenses is affected by *diffraction*. Simply put, light passing through small holes or slits is 'bent' or 'spread', and this effect is greater the smaller the hole or slit is. With camera lenses, diffraction increases blur, which will degrade the lens' sharpness and contrast particularly when lens aperture values are small (for example f/16 or f/22). If ultimate sharpness is desired, very small apertures should be avoided, unless a large depth of field is required (see next point).
- Aperture affects *depth of field*. All lenses have a point (or a plane) where they are in focus (i.e. focus is at its sharpest). In front of, or behind, that point the subject will be out of focus and details will become increasingly blurred with distance from the plane of focus. However, there will still be an area in front of or behind the plane of focus in which the picture is *acceptably* (as opposed to *perfectly*) in focus (i.e. acceptably sharp), which is the depth of field. Knowing what this for a particular lens and subject distance will be important in circumstances where the intention is to capture all parts of the subject in focus (for example, ensuring a bird is in focus from wing tip to wing tip), or, alternatively, to use a lot of background blur to clearly separate out the subject or parts of the subject from other parts of the image. For any lens, the extent of the depth of field depends on the aperture used, and is greater with smaller apertures. Depth of field is ultimately a matter of perception. Traditionally, numerical values attached to depth of field are based on visible detail in prints of a particular size, and perceived depth of field will be much shallower (i.e. one's tolerance for out of focus objects will be less) with a digital image viewed at 100% on a screen.
- At very wide apertures (small F numbers such as f/2.8), lenses tend to be less sharp because of the slightly different way light bends at the edges of the lens compared to the centre, making it more difficult to achieve a sharp focus point. Modern lens design generally minimises this, but often lenses have a 'sweet spot' of maximum resolution which is one or two aperture stops smaller than their maximum aperture. Despite this, using a lens wide open might be preferable to increasing the ISO to very high levels, in order to keep shutter speed high, as high ISO's can have a substantial effect on detail in an image.
- In zoom lenses, resolution depends on the focal length used. As lenses zoom, different internal glass elements shift position. As a result, zoom lenses always perform differently depending on the extent to which they are zoomed. Unfortunately, telephoto zoom lenses typically perform the worst (in terms of resolution) at the longest focal length, which is how they are most likely to be used for birding. That said, many 'pro' quality long-telephoto zooms are still excellent optically, even if not up to the absolutely high standards of their single-focal-length cousins.
- The quality and suitability of a lens for a particular purpose depends not only on its overall resolution, but also a range of other optical properties such as colour fringing (chromatic aberration) and vignetting (darkening in the corners). Sharpness is important, but these other less desirable characteristics also need to be well controlled in a lens. Higher quality lenses minimise these optical aberrations (and to some extent they can be corrected in post-processing software).

Sensors

Obviously, the sensor can only resolve as much detail as it has pixels, as each pixel essentially represents one 'data point' or 'sample' in a digital image. Crudely, this will mean that a sensor with more megapixels has the capacity to record more detail.

Perhaps a more relevant number than the absolute number of megapixels, is the pixel density – that is the number of pixels per unit area of the sensor. This goes to how many pixels can be 'placed on the subject'. For example, if your subject is a bird, the more pixels you can have recording that bird, the better in terms of ultimate viewable sharpness and detail. Put crudely, the bird image is broken down into more dots, so each dot records a smaller part of the bird which when put together, creates a more detailed image.

So, for example if you are shooting with a full frame camera with 45 megapixels compared to one with 24 megapixels, using the same lens and exposure values and standing at the same distance, the 45 megapixel camera will get more pixels on the bird, potentially recording more detail[1]. However, having more megapixels on the sensor has other trade-offs. Smaller pixels capture less light, and as a result have higher digital noise levels, which can reduce the amount of detail recorded at high ISO values.

In terms of decisions about cameras and lenses, some observations are:

- always get the best lens you can afford; in terms of absolute detail, getting a better quality lens will usually result in an image with more resolution for a given sensor. The step up from a 'consumer' quality lens to a 'pro' quality lens can be dramatic, but step improvements will likely become smaller and less visible as you go up the price/quality scale
- having more megapixels will increase image detail with a given lens, but you may get less 'bang for your buck' than with a lens upgrade. You need a reasonably substantial increase in megapixels to see significant differences in detail. That said, I think more megapixels are worth having provided the compromise in terms of image noise and high ISO performance is not excessive
- using megapixels as the sole or even the main reason for choosing a camera body is not a wise option. Choosing a camera and lens for bird photography involves a range of other matters (such as overall performance, focus speed, robustness etc) which together can be just as important as out-and-out resolution.

4. Get a good quality raw photo development product, and learn how to use it

Fortunately we can do a fair bit in software (or inside the camera) to increase the emphasis of details in an image.

Any image will have a range of detail within different parts of the frame. This will range from relatively few changes in tone/contrast in some areas, to areas where there is lots of fine detail. Another way of describing this is to refer to the 'frequency' of details - in other words, the number of contrast changes per unit of area. Simplistically, if there are few changes of contrast - for example, the side of an evenly lit building - we can refer to the area as having low frequency detail.

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1 Note that doubling the total number of megapixels does not double the resolution of the sensor. A 24 mpix sensor such as in the Nikon D7500 is 6000x4000 pixels. Nikon's D850 approx 45 mpix camera is 8256x5504 pixels. While this is nearly double the overall pixel count of the 24 mpix camera, each edge of the sensor is only 37% longer, so the 45 mpix sensor only provides a bit more than one third more resolution in each axis.

Other areas - such as the fine repeating patterns in bird feathers, or the leaves on a tree - can be referred to as having high frequency detail. In practice, of course, areas of the picture will probably have a mixture of both.

Ultimately the goal of sharpening is to adjust the emphasis on detail in the image, in ways which are appropriate to that image.

In bird photography a key objective is normally to emphasise finer and perhaps more random structural detail in the bird image. This includes emphasising feather structure, skin textures, smaller details on beaks and feet etc. In these circumstances sharpening aims to increase the level of contrast in the mid-range to high frequency detail of the image.

It may be helpful to think of sharpening as analogous to the adjustment of treble (high frequency sounds) in a music system (for those who remember such adjustments) using a treble knob or a graphic equaliser. A perfect lens would have equal levels of volume from the bass end through the mid-range to the treble end. However, in the real world lenses transmit low frequency detail with good contrast - in music terms, they have good bass levels. At higher frequencies, contrast between details decreases - they are not so good at the treble end. An objective of sharpening in bird photography is to increase the 'mid-range' and 'treble' levels of contrast to make fine details in the picture appear sharper.

Sharpening tools come in different forms and most good software has more than one sharpening option. In terms of the broad types of sharpening, software generally uses one or more of three kinds of technique.

The traditional way of sharpening is the *unsharp mask* tool. Some form of this tool is available in most common post-processing software packages. It works by applying increased levels of contrast (acutance) at edges in the image by brightening the lighter side of the edge, and darkening the darker side of the edge. It is usually accompanied by other adjusters which allow the user to set the amount of adjustment applied, and the number of pixels on either side of the edge that are brightened or darkened. One of the problems with Unsharp Mask tools is that they introduce artifacts at edges that may actually end up obscuring fine (high frequency) detail rather than enhancing it. As such it needs to be carefully applied, and is perhaps better suited to images that need strong edge enhancement.

Second, some software has sharpening which operates more by boosting the contrast, mainly at the mid to high frequency level detail. For example, Canon's Digital Photo Professional, used by a number of BirdLife Photography members, has a 'Sharpness' tool in addition to the unsharp mask tool. This tool effectively acts as an amplifier for low contrast fine detail, rather than focusing primarily on edges, which makes it well suited to (for example) feather detail.

A third type of sharpness enhancement involves a computational process aimed at correcting certain aspects of the way lenses transmit light. This is known as *deconvolution* sharpness. Essentially, a calculation or series of calculations is applied in software to correct the physical aberrations in the lens to approximate a theoretical perfect lens. This process can be enhanced considerably if the properties of the lens are known beforehand.

For example, Canon's Digital Photo Professional uses predetermined measurements for Canon lenses, which are applied to images generated with those lenses. As the manufacturer of the lenses, Canon is able to use its own data. Other software may have similar functionality.

It can be confusing to users to know exactly what type of sharpening is being applied with different tools, because sometimes software developers use different labels for what may be broadly the same tools. Also, the slider and other adjustment interfaces can have slightly differing effects depending on how they are set up, and some software has 'smart' sharpening functions that are automatically applied.

Both sharpening and clarity tools can significantly enhance an image, but must be used with care. Raw digital images tend to be fairly 'flat' straight out of the camera, and some sharpening is usually needed. However, using these tools - particularly unsharp mask - too liberally can have the opposite effect, making the image appear quite unattractive and creating what are known as 'haloes' around high contrast edges (clearly visible unnatural-looking bright or dark fringes).

Excessive sharpening can also make digital noise more visible, as it starts to act on noise speckles as if they were genuine detail in the image, making them stand out more. To go back to the audio analogy used earlier, turning up the treble also increases any unpleasant hiss and crackle (unwanted noise) from the recording playback. It is essential that noise reduction and sharpening are adjusted together in raw image development.

Sharpening needs to be considered at both the input and output stages. Input sharpening is the sharpening applied during development of the raw image. Output sharpening is additional sharpening which needs to be applied when the image is exported, particularly if it is downsized. Downsizing an image file involves a process of combining and averaging adjacent pixels to produce an image with fewer pixels (and a corresponding smaller file size). An advantage of this process is that it gives a 'free kick' in terms of noise reduction, but also slightly blurs the image. Additional sharpening therefore needs to be applied to the final smaller image.

We have several articles in our 'Our Articles' section of the website that deal with post-processing and optimal sharpening of images, which I recommend readers review (search for 'sharpening' or 'downsizing', for example).

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