Choosing a Camera and Lens for Bird Photography: a Primer – Simon Pelling

For a newcomer, selecting any camera and lens is a daunting task which can involve a significant financial commitment, possibly several thousand dollars. Entering a camera store, or searching online, a person is presented with a bewildering array of brands, cameras and lenses. In this article, I aim to provide some pointers, based on my experience and research, on the things to consider in selecting and purchasing photographic equipment that is up to the task of photographing birds.

I have generally pitched this article at the level of someone who is interested in trying bird photography but who has relatively little photographic experience, even though they may own a basic DSLR or other equivalent camera, and basic knowledge of photographic concepts such as aperture and shutter speed. However, I hope that many of the points raised will be helpful to photographers at all levels.

I do not propose to recommend specific cameras and lenses. In any case my direct experience is limited to certain brands, and camera bodies and lenses within these brands. I suggest that those who want specific advice on the pros and cons of particular cameras/lenses should use the BLP Forum. BLP has members with direct experience in a range of cameras and lenses, who are able to give readers specific advice and opinions.

There is also a wide range of advice about bird and wildlife photography equipment on the internet, as any search will quickly reveal. I would also encourage readers to look at the equipment listed by other members when they submit photographs to the web site, where it will become clear that there are a range of camera bodies and lenses which are used by experienced photographers.

As will become evident in reading this document, purchasing a camera and lens is a matter of compromise. There is no such thing as the perfect camera system that is optically excellent, does everything, is really light, and really cheap. The important thing is for the purchaser to understand these compromises and to decide which are the most important features to look for.

DSLR or Mirrorless

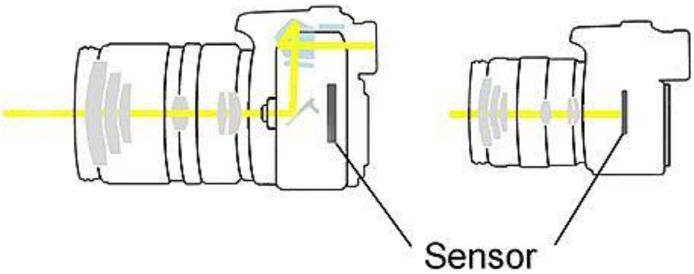
You will likely be aiming to purchase an interchangeable lens camera – that is, the lens is detachable from the body. You may also be familiar with 'superzoom' cameras, which are 'all in one' devices; that is, they have a zoom lens permanently attached to the camera body. I will mention this type of camera at various points and at the end of this article, but the article will generally focus on interchangeable lens cameras.

Interchangeable lens cameras come in two general types. The first is the *digital single lens reflex camera* (DSLR). DSLRs continue a very successful and versatile design first developed during the film era, which uses a system of reflecting mirrors and prisms (hence the 'reflex') to allow the photographer to look directly through the lens using a viewfinder, to compose the picture. As the photographer gets a direct view of the scene, these cameras are said to have an 'optical' viewfinder. When the picture is taken, the primary mirror in front of the main picture sensor flips up, temporarily blocking the viewfinder, and a shutter behind the mirror opens allowing light to hit the sensor. The most common DSLR brands include Canon and Nikon, and (in much smaller volumes) Pentax. Modern DSLRs also allow 'live view' on the rear screen, as an alternative way of composing the picture. To allow this, the mirror needs to be continuously in the up position, exposing the camera sensor (and blocking the viewfinder).

The second type is generally known as a *mirrorless camera*. Mirrorless cameras do away with the relatively complex, heavy and noisy opto-mechanical mirror system of the DSLR, and in one case (the Nikon z9) have even done away with the mechanical shutter entirely. The camera's digital picture sensor is used to provide the basis for viewing the picture, as well as other functions such as exposure measurement and focusing. The absence of a mirror means that the user cannot look directly through the lens to view the scene. Most mirrorless cameras incorporate electronic viewfinders. These use a small electronic display inside a viewfinder, which displays the scene as 'seen' by the camera's sensor, rather than allowing you to look directly through the lens. These cameras also allow viewing on the rear screen. All major brands now have mirrorless interchangeable cameras as a substantial part of their line-up, and some brands (such as Sony, Olympus[1], Panasonic and Fujifilm) only make mirrorless systems.

Traditional Single Lens Reflex Structure

Mirrorless Structure



For over a decade, DSLRs dominated the digital interchangeable lens camera scene. Their long history and extensive technical development mean that current generations of DSLRs represent the pinnacle of what the DSLR concept can deliver. They are also at the heart of huge systems of lenses and other ancillary equipment, with strong industry support and large user communities. But their history and analog film heritage is also a weakness, with a relatively heavy mechanical mirror and shutter system which adds weight, is relatively noisy, limits the functionality of their autofocus systems, limits their development as video cameras, and is an extra point of possible long term mechanical failure.

When I wrote version one of this article, the market was dominated by DSLRs, and mirrorless cameras represented an excellent alternative for many purposes, but were perhaps still lacking in a few areas compared to DSLRs, particularly at the enthusiast end of the market. However, the era of the DSLR now seems to be ending. Those camera manufacturers that still make DSLRs are shifting

[1] As a result of recent changes of ownership, the company now owning the Olympus camera brand is OM Systems. It is understood that the brand name Olympus will transition over time to a new brand, OM System. The name Olympus will continue to be used in this document, for the time being.

their manufacturing, and research and development, to mirrorless systems and the lenses which use them. Many industry commentators now predict that there will be few new models of DSLR in the future.

There are many reasons for this, such as the contracting market for stand-alone cameras over the last few years in the face of ever better mobile phone cameras and, in recent years, the economic impacts of Covid19. It is likely that camera manufacturers can simply no longer sustain innovation in two different markets. In addition, mirrorless cameras can now pretty much do everything that DSLRs can do, and in many cases do it better.

One exception to this change is Pentax, which still seems to be focussed entirely on DSLRs. However it holds a tiny proportion of the overall camera market, and it is not clear how long this will still be sustainable for its parent company

Is a DSLR a bad choice in 2022? Not necessarily; there are still some excellent models available at reasonable prices, and a huge second hand market now that many people are upgrading to mirrorless. A top quality DSLR with a good lens will give you years of solid service, and there continue to be excellent lens choices for nature and bird photography. Also, at least in the near future there will likely be a strong second-hand market in both DSLR cameras and lenses. However, there is a risk that a photographer making a significant DSLR investment now will be faced with few or even no upgrade choices (if needed) in the future, other than to replace the DSLR and lens with mirrorless models (also see the section on *Camera systems* below).

I recommend you research and, if possible, try different systems to see which suits you better. The choice between the two types of systems (mirrorless and DSLR) is very much a personal one and you will find strong views and robust arguments in favour of both.

Camera systems

When you purchase your first interchangeable lens camera and lens, you are essentially buying into a unique *system*. Traditionally, camera brands such as Canon and Nikon have developed different systems which are not interchangeable across the brands. A key part of what defines a system is the lens mount – i.e., the system of joining the lens to the body. Canon DSLR lenses will not fit Nikon DSLR bodies, and vice versa. Other secondary devices such as flashes are unique to brands.

To make matters more complicated, some brands now have multiple systems – for example, Canon’s DSLRs (the EOS cameras) have a different lens mount from its two mirrorless systems (the M and R cameras), each of which is also different from the other. As a result, each mount has a unique set of lenses which are not interchangeable unless there is some form of adaptor to allow attachment of a lens on a body for which it is not designed.

Does this matter? It’s something you should be aware of, because a decision to purchase a particular system, e.g., a Canon camera and lens, will to some extent limit your choices of additional lenses and other ancillary equipment, such as flashes, to items which fit the Canon. The more you commit to one brand, for example by buying multiple pieces of equipment, the more expensive and complicated it will be to change later. The same generally also goes for different systems within one brand. Fortunately, major brands such as Canon and Nikon have comprehensive sets of photographic tools ranging from the cheaper end of the consumer market to very expensive, high quality professional equipment. Also, there are third-party lens manufacturers such as Sigma and Tamron which offer a wide selection of lenses to fit different cameras, together with multiple manufacturers for smaller devices such as flashes. Mirrorless cameras also often have adaptors which allow you to use lenses originally made for DSLRs, including some from other manufacturers. For example, if you purchase a Canon R series camera (or similar types of models from other manufacturers) you can purchase a relatively inexpensive Canon adaptor that allows use of DSLR lenses with the camera.

Making sense of numbers

Anyone researching cameras for purchase will be confronted with a lot of numbers and specifications around lenses and sensors. In order to make good purchasing decisions, it is important to understand in broad terms what these mean, and their implications for your choices. In the interests of space and simplicity I will only provide a high-level explanation of these features.

Bear with me here, because this stuff gets a bit technical.

I will illustrate some of these terms with reference to the specifications of a superzoom camera, the Nikon Coolpix P1000. (This camera was released in 2018 so, at the time you are reading this article, it may have been superseded, but the principles will still apply). Key relevant features of this camera (from the Nikon website) are:

- The digital sensor is described as a “1/2.3-in. Type” with 16 million pixels
- The lens is described as being a “125 x optical zoom” with a *focal length* of 4.3 mm to 539mm, and a *field of view* equivalent to that of 24 to 3000 mm lens in 35mm [135] format.

The *focal length* of a lens is a number inherent in its physical structure. In simple terms, it is a measure of how much the lens converges or diverges light. For example, a simple magnifying glass will focus the sun’s light at a single bright point, and the focal length is the distance of this sharply focused point from the lens, in millimetres. Camera lenses actually combine multiple pieces of glass (‘elements’) but the principle is the same; the focal length of the lens is the combined ‘light bending’ power of these elements. Focal length is a key physical property that affects how wide a view you can capture in your picture, and how much the lens magnifies objects within that view. That is, the focal length is linked to the *field of view* (also known as *angle* of view).

Lenses are either *zoom* lenses such as that on the Nikon P1000, which allow you to change the focal length of a lens, or *prime* lenses with a single, fixed focal length.

The field of view refers to the apparent breadth or scope of the image ‘seen’ by the camera. A lens with a short focal length provides a wide field of view, and is generally known as a *wide angle lens*. Smart phones have wide angle lenses – if you look at the picture on your screen you will see it covers a wide area from edge to edge. Unless you are very close, objects seem relatively small and far away and there is lots of depth to the image between nearest and furthest focussed objects. Wide angle lenses are therefore used in situations where you want to capture a large area, for example a landscape, or a group of people without having to stand back too far.

In contrast a *telephoto* lens is a long focal length lens, with a narrow field of view as well as a relatively high level of magnification. Objects appear much nearer to the camera through such lenses, as in a telescope or binoculars, and the image overall has a compressed sense of distance between near and far objects; distant objects seem to be closer to near objects. For bird photography, telephoto lenses are needed.

As I explain below, the size of the sensor also impacts the field of view.

The *zoom number* is a generally unhelpful number primarily used as a marketing tool for consumer zoom lens cameras. It is simply the ratio of the shortest focal length of the zoom compared to the longest length. To put this in the context of our Nikon example, the lens has a focal length ranging from 4.3mm to 539mm. The zoom number will thus be 539/4.3 = 125.3 – hence the "125 x optical zoom" reference. This tells you that the lens can zoom a lot (which might be an important characteristic in a 'one size fits all' type of camera), but it tells you nothing about the quality of the lens, nor how 'wide' or 'long' it reaches in absolute terms.

Sensor size

In making a purchasing decision you will be confronted with a range of labels which refer to sensor size. These include names such as 'full frame', 'APS-C' and 'Micro Four Thirds'. As noted above, the Nikon P1000 referred to a '1/2.3" sensor. What do these mean and are they important? Also, to what does the reference to 'equivalent to 35mm format' in the Nikon's description (above) refer?

Digital cameras evolved in a world where the predominant film standard was '35mm' or '135' film. The area exposed in each 35mm film frame is 36mm long, and 24mm wide. To this day, the dimensions of 35mm film form a basic reference standard, even for digital cameras. Cameras which use a sensor which is approximately the same size as a 35mm film frame are known as *full frame* cameras (often abbreviated to FX).

However, many digital cameras, including interchangeable lens cameras, use sensors smaller than FX size. Smaller sensors came to dominate early in the history of digital cameras because of the high cost and complexity of making full frame sensors at that time. The commonest non-full frame sensors in digital cameras (not including mobile phones) are:

- *APS-C* (also known as DX), about 40% of the size of a full frame sensor (in terms of surface area) used by manufacturers including Canon, Nikon, Pentax, and Fujifilm
- *Micro Four Thirds*, about 25% of the size of a full frame sensor, developed and used by Olympus and Panasonic
- *1 inch (1"),* about 14% of the size of a full frame sensor, used mainly in a range of advanced compact cameras such as the Sony RX 100 series, the Sony RX10 superzoom cameras, and some Canon and Panasonic compacts and superzooms, and
- *1/2.3"*, about 3% of the size of a full frame sensor, used in many cheaper compact cameras and superzooms such as our example Nikon P1000.

Of these, the first two (APS-C and Micro Four Thirds) are the main alternatives to full frame sensors in interchangeable lens cameras.

Sensor size is important for at least two reasons. First, other things being equal, larger sensors generally produce better quality digital images than smaller sensors. A sensor is a device for converting light into electrical energy, which is then turned into digital data to form the final picture. More light is captured by a large sensor simply because it has a larger surface area. Moreover, the larger surface area can allow for bigger pixels (individual light-gathering units) which operate more efficiently in terms of capturing light than smaller pixels. Overall, these factors combined mean that larger sensors generally result in better quality digital data. They have lower levels of unwanted digital noise than small sensors (noise shows up as speckles and blotches in a digital image) and better dynamic range (a camera with large dynamic range is better at revealing details in very dark and very bright parts of an image).

The differences in performance between the different sensor sizes will be relatively small in good light, but their impact will become much more significant when photographing in lower light. Larger sensors are simply better at collecting the available light.

The second reason why size is important is that sensor size also affects the field of view. For the more technically minded, I have provided a more detailed explanation of this in an Appendix to this paper. Essentially, when used with the same lens, a smaller sensor captures a smaller part of the image that the lens projects onto it, compared to a full frame sensor. This has the effect of making the image produced by the smaller sensor appear as if it is taken with a longer (more telephoto) lens.

Manufacturers developed a measurement known as the *crop factor* which is a number based on comparing the size of a sensor relative to the sensor in a full frame camera. This enables all digital camera and lens combinations to be described in terms of '35mm equivalence' or 'full frame equivalence'. Because the full frame sensor is used as the underlying basis for comparison, full frame sensors have a crop factor of 1. The crop factor for an APS-C camera is generally 1.5 or 1.6, for a Micro Four Thirds camera is 2, and for a 1/2.3" camera is 5.64. Reflecting that their sensors are 'cropped' compared to full frame cameras, cameras with smaller sensors are sometimes known as 'crop sensor' cameras.

For the purposes of this article, the crop factor is really only important in understanding the comparative visual effect of different telephoto lenses with different camera bodies. For example, if you were to use a full frame camera with a 600mm lens, you would get a particular view of (say) a bird, with the bird occupying some of the frame and background, branches etc occupying the remainder. If you put the same lens on an APS-C camera, you would get a different view. A smaller area of the scene would be visible/recorded. The bird would seem larger in the frame, with much less background. To get roughly the same view with each camera, you would put a 400mm lens on the APS-C camera - 400 mm equals 600mm divided by the crop factor (1.5). Likewise, if you used a Micro Four Thirds camera, you would get the same view with a 300mm lens (600 divided by 2).

Unfortunately the crop factor has led to the ongoing myth that it buys the photographer extra focal length. This has often been a selling point for smaller sensor cameras, such as APSC and Micro Four Thirds cameras. As I explain in the Appendix, this is not the case; such a camera simply records less of the scene. The more important measurement to consider is the pixel density of the sensor - that is, how many pixels it uses to cover the scene.

So which system should you get?

Purchasing a full frame camera gives benefits in terms of ultimate image quality but you will need to purchase a longer, heavier, more expensive lens to 'get in close' to the bird. Purchasing a Micro Four Thirds camera will allow you to purchase a comparatively smaller, lighter, (in some cases) cheaper lens, but you will lose something in terms of low light capability and overall picture quality, particularly in low light and at high ISO values. APSC cameras sit somewhere in the middle.

Lenses

The lens is probably the most important long-term investment you will make when purchasing a DSLR or mirrorless camera. There is no point in buying a top-notch camera body but then purchasing a cheap lens that does not make the most of the camera body's capability. A good lens will earn its keep for years. In contrast, manufacturers regularly update bodies with new capabilities, new sensors etc, to tempt buyers to upgrade – and, with more moving parts, bodies will tend to wear out quicker, particularly if heavily used.

At the cheaper consumer end of the market, manufacturers often sell camera 'kits', comprising a camera body and one or two inexpensive lenses. These can include a basic 70-300mm zoom, which provides a reasonable telephoto range particularly when paired with an APS-C or Micro Four Thirds camera. While these provide a cost-effective way of starting a photographic journey, the lenses are often cheaply manufactured with lots of light plastic components, flimsy build, and often only modest quality optics. In the long term you are likely to want something more substantial.

There are a number of considerations in relation to lenses. Important considerations include focal length, maximum aperture, zoom vs prime, weight and cost.

As I have hinted already in this article, in my experience, ideally you would be looking to get a field of view equivalent to at least a 600mm lens on a full frame camera. This will mean a 300mm lens on a Micro Four Thirds camera, or a 400 mm lens on an APS-C camera. It's possible to make do with shorter focal lengths, but it becomes much more challenging to get a close enough view of the bird.

Focal length sometimes can be extended by focal length extenders (additional lens units which are inserted between the body of the camera and the main lens) although these reduce the maximum aperture available, and can also have an effect on the overall sharpness of the lens. These typically come in 1.4-times or 2-times magnification. For example, using a 2x extender with a 300mm f/4 lens would result in a 600mm f/8 lens. This reduction of aperture will not only limit the lens's use in low light, but could also affect the accuracy and speed of autofocus, as well as the number of focusing points the camera can select. Care should be taken in purchasing extenders because not all lenses are compatible with their use, and using one with the wrong lens can end up doing damage.

The quality of a lens both in terms of its optics (e.g., its sharpness) and construction are critical factors and have a significant impact on picture quality as well as factors such as weight and cost. Importantly, not all lenses are created equal, and just because a lens is made by a major manufacturer does not always guarantee its excellence. I strongly recommend that you conduct thorough research on lenses before purchasing.

It is possible to measure the sharpness of a lens, which is generally done by determining the capability of the lens to separate fine pairs of black and white lines distinctly under carefully controlled conditions. This gives rise to perhaps the commonest way of reporting lens sharpness, the 'MTF number', which you will often come across in lens reviews or indeed in manufacturer's promotional material. MTF numbers provide useful information about a lens' quality, but are not simple to interpret, and care needs to be taken in using them in comparisons between different lenses on different camera bodies.

At the top of the tree, in terms of quality (and price and weight!) are the large prime (fixed focal length) lenses by major manufacturers (e.g., the 400, 500 and 600 mm lenses by Nikon and Canon). These are of supreme quality with top quality glass, and impeccable construction with lots of metal. Equally they are very heavy and expensive. For example, Nikon's 600mm f/4 DSLR lens weighs 5 kg and costs (at the time of writing) around $13,500. However, manufacturers are developing ways of reducing weight using new types of glass and other changes to construction.

Fortunately you don't need this level of quality and expense to get excellent bird pictures. For example, there are a number of very good telephoto lenses for perhaps a fifth of this price. These include a range of 'professional quality' zoom lenses with maximum focal lengths of 400-600 mm, by the major manufacturers, as well as third party manufacturers such as Tamron and Sigma. While zooms do involve some quality compromises compared to the best prime lenses (because they try to cover a range of focal lengths as well as possible rather than one focal length extremely well), these lenses can still perform with distinction.

Prime lenses often have larger maximum apertures compared to zooms. For example, virtually all long telephoto zoom lenses have relatively small maximum apertures (i.e. the widest apertures) of f/5.6 or smaller when extended to their maximum focal length. In comparison, many primes have f/4 maximum apertures or greater. These primes will have advantages in low light situations as a result, allowing faster shutter speeds to be used and faster focusing. This can make the difference between capturing or not capturing an image.

Focusing

Focusing systems are one of the most significant areas of innovation in interchangeable lens cameras. Having a reliable autofocus system particularly when tracking moving subjects, is an important feature for bird photography.

Providing a detailed description of autofocusing systems is beyond the scope of this article. Essentially (obviously!) the object of an autofocus system is to focus accurately on the subject, and also to be able to adjust as the subject moves or flies to ensure the subject is kept in focus. Mirrorless and DSLRs achieve these objectives in quite different ways, technically.

Historically, DSLRs had the advantage, particularly in terms of focusing speed, which is essential for bird photography. Early mirrorless cameras had accurate, but quite slow focusing systems which had a great deal of difficulty in achieving continuous autofocus on moving subjects. While there has been only modest development in DSLR autofocus systems in the last decade, there have been huge strides in mirrorless cameras to the point where (at least in the most advanced models) they match DSLR speeds and far surpass their ability to track subjects.

A key feature in wildlife photography has always been to have the subject's eye in focus. Several advanced mirrorless models are now able to track animal and bird eyes with uncanny accuracy, simply by pointing the camera in the direction of the subject - a feature which no DSLR has ever achieved with total reliability. It has totally transformed this aspect of photography. While the role of the photographer in tracking a moving subject will always be important, it has now become much easier to keep the subject in focus simply by keeping it within the frame of the viewfinder as it moves.

At the time of writing this sort of autofocus capability has not fully transformed into lower cost cameras, and is still the domain of high-end systems. Over time, this will hopefully change. However, for those with pockets deep enough to purchase leading edge cameras, this is a highly recommended feature.

Image stabilisation

Image stabilisation is a feature of most modern camera systems. Stabilisation systems can be located in the lens itself (e.g., Canon lenses), or in the body (e.g., Pentax DSLRs) or in both (increasingly being found in advanced mirrorless cameras). Image stabilisation can be a great boon on long telephoto lenses, helping to compensate for the photographer's movements and thus allowing slower shutter speeds, and also helping freeze the image in the viewfinder, making it easier to compose the picture. However, these systems don't compensate for subject movement – no amount of stabilisation will freeze a moving bird! In general, however, stabilisation is very beneficial and is highly recommended, although some study will be necessary to fully understand the different modes of stabilisation offered by different manufacturers, and which type of stabilisation to use in which circumstance.

Cost

With photography equipment, like many areas, you generally get what you pay for. Unfortunately there is no getting away from this – if you want a good quality kit it is not cheap.

In general, you will pay more for a full frame camera than an APS-C camera body, although this difference is reducing as full frame cameras become more common. As noted above, the price premium for very high-end lenses is substantial. However, there are many different options available. For example, major manufacturers such as Canon and Nikon offer a range of camera bodies ranging from around $1000 for the cheaper end of the consumer level, all the way to in the region of $9-10,000 at the professional end of the market. Apart from sensor size, different body prices generally reflect things like more features, much better focusing, much more robust construction, weather sealing etc.

That said, cheaper bodies still offer excellent image quality, provided the other compromises in features are acceptable to you. Indeed, many low end DSLRs have the same sensors and 'image production pipelines' as their more expensive cousins.

Equally, there are a range of lens options available. Basic 70-300mm zooms are quite inexpensive – sometimes under $500. However, more robust lenses of more suitable focal length would be substantially more.

You will also need to consider keeping something aside for extras – an extra battery, memory cards (with fast data load speeds), possibly a specialised strap (given the weight), a secure, sturdy camera bag for travelling, and maybe a separate flash.

Used equipment is worth considering as a means of reducing costs. As always, it is 'buyer beware' on places like eBay, but some reputable 'bricks and mortar' retailers often sell good quality used or refurbished equipment for somewhat less than new equipment. Most recent DSLR and mirrorless cameras from the last few years will provide decent-to-excellent image quality. Beginners may also be able to borrow or rent equipment from local photographic clubs or societies to try out different models and features. Occasionally, BirdLife Photography members may advertise used equipment on the BLP forum.

Weight

An important consideration, if you intend to carry your camera any distance on foot, is weight. As noted already, one of the penalties associated with quality full frame or advanced APS-C cameras, and high quality lenses, is weight. Robust construction, use of metals rather than plastic, larger glass pieces in larger-aperture lenses, all contribute to greater weight. In purchasing a camera, an important consideration is whether you are prepared to carry all that weight for an extended period of photography or bird watching, on top of your binoculars, water bottle etc. Heavy camera/lens combinations can also be difficult to hand-hold in the field for extended periods. So, in looking at possible options, add up the weight! This is one factor which leads some photographers to look at smaller, lighter options such as the Micro Four Thirds sensor models offered by Olympus, which can offer real weight savings due to the crop factor as well as their compact form. As a general rule, mirrorless cameras are usually lighter than DSLRs, though the difference may not always be substantial.

Other features

I have already alluded to other features which can be important in choosing a camera. Some key features to consider are the following:

Burst speeds (the ability of the camera to take a number of pictures in very fast succession) can also be an advantage, particularly when shooting moving targets like birds in flight. Generally cheaper bodies can shoot fewer frames per second than more advanced, up market models. For example, Nikon's D3500 DSLR can shoot around 5 frames per second, whereas the company's D500 DSLR can shoot 10 frames per second. Equally, mirrorless systems can be faster than their equivalent DSLRs, because they don't have a mirror to shift up with every frame. It is worth remembering that published burst speed figures by manufacturers are often at the heroic end of the scale; that is, the maximum rate possible in ideal measuring conditions. In practical terms cameras often are restrained to lower frame rates, particularly when continuous autofocus and/or subject tracking is engaged.

Dust and moisture sealing on both bodies and lenses can be critical to the performance and longevity of your equipment, if you shoot in areas with high humidity, spend a lot of time shooting at the beach, travel in the bush on dusty tracks, or go on pelagic boat trips. These are features of more up-market models.

General ergonomics and user friendliness can also be important. If possible, you should handle equipment to see how it feels. For example, can your fingers reach the key buttons easily? Is the viewfinder easy to use, clear and bright (for example, if you use glasses), how much of the scene does it show compared to what the sensor actually records? Is the rear screen articulated or fixed in position, if this matters to you? Are the menus easy to navigate?

Communications – can the camera connect to wireless, or transfer images to a phone? Does it have GPS? These might be important if you are the kind of person who likes to post quickly onto social media and record locations of images.

Is there a place for superzooms?

Superzooms represent an interesting type of camera which, purely on lens specifications alone, can seem tempting for bird photography. For example, the Nikon P1000's 3000mm '35mm equivalent' lens will bring you very close to distant birds, and a lens of that size would be a practical impossibility for a full frame camera.

Against this is the fact that this apparent focal length is achieved by using a very small sensor, with very small pixels, which involves some significant compromises in image quality. Sensors this small have a much reduced capacity to handle the extremes of light, particularly in bright areas or heavy shadow areas of the picture, and don't function particularly well once the light level drops. Also, the lens has a very small maximum aperture (f/8) at the telephoto end which means that it really can only be used in bright light. Its focal length also means that high shutter speeds are needed to get sharp photos even with image stabilisation, unless a good tripod is used.

Other factors also come into play: for example, these types of cameras can be quite slow to focus and to extend the zoom (the zooms usually extend and retract using motor drives), and the shutter response time may be considerably slower than a DSLR or mirrorless camera. All these factors mean that such cameras can be quite restricted in the field for practical bird photography. Moreover, not all of them can shoot in raw format, although this has become more common in recent, more expensive, versions. Raw files give you greater ability to adjust the photo in post-processing software.

I don't want to sound too negative about these types of cameras. Many photographers had their first bird or nature photography experience using these types of cameras, and they are a lot better than no camera (and of course have much better lenses for telephoto photography than, say a mobile phone). Operated within their limitations, they can certainly achieve good quality photos. For those primarily interested in smallish 'one size fits all' cameras for (for example) travel, without being too fussy about ultimate photo quality, they can work quite well. However, I expect that after the novelty of the extreme equivalent telephoto wears off their other deficiencies will become apparent when used primarily for bird photography.

One type of superzoom that stands well above the others are those with '1 inch' sensors, made by Sony and Panasonic. These offer significantly improved photo quality compared to 1/2.3" sensors. Also, these models can have very good lenses, relatively speedy operation, and can be very powerful photographic tools. They sometimes have autofocus systems which mirror those in high-end mirrorless cameras. However, they are also quite pricey (in some cases around $2000), more than a budget DSLR or mirrorless camera, and also are quite large in size with their substantial high quality zoom lenses.

Where to from here?

As I stated at the beginning of this article, purchasing a camera system is all about compromises. For a photographer who has deep pockets and a passion for uncompromising quality regardless of weight, with the best modern autofocus and other technology, there will be no substitute for a full frame body, long prime telephoto lenses, and possibly a focal length extender or two - for the price of a small car. However, these photographers are unlikely to be beginners! For those who want a good middle of the road option, one of the many 'advanced amateur' APS-C models or a more budget friendly full frame might suit, coupled with a good quality telephoto zoom. For those whose prime consideration is for light weight without too much compromise on image quality, one of the Micro Four Thirds models from Olympus or Panasonic could be considered.

At the time of writing camera systems are in a process of transition, as manufacturers consolidate and develop their mirrorless options. Prospective purchasers need to be aware of changes that are occurring in the market.

As I noted at the beginning of this paper, one of the best tactics in considering photography equipment is to explore what other people are doing and using. It will become evident that certain makes and models are favoured, and that certain focal lengths of lenses give good results. Do your research, then do some more. Keep an eye open for bargains; manufacturers regularly offer discounts on their products particularly as they approach the end of life of the model. However, with even a basic body and a cost-effective 75-300 lens you can begin your bird photography journey and get some really pleasing results – but you might just catch the bug and start poring over catalogues or Black Friday deals!

Finally, be aware that long telephoto lenses and high-megapixel cameras can be extremely challenging in terms of your photographic technique. Getting the ultimate image quality from your expensive investment takes a lot of practice. It is tempting to blame equipment for failures, and to think the way to improve is to invest in yet more equipment. Allow yourself time to learn, and take advantage of the experience and advice of others.

Appendix

Impact of Sensor sizes and Pixel Density

Crop Factor and Field of View

Sensor size affects the field of view, and therefore the overall capacity of the camera and lens to isolate and 'get in close' to the bird forming the subject of the photograph.

To understand this, imagine a camera lens projecting a circle of light onto a rectangular full frame sensor. The lens is designed to cast a circle of light big enough to cover the whole sensor. In the diagram (right) the grey circle represents the light projected by the lens. The photograph framed in black represents the field of view captured by the full frame sensor.

Then imagine that the full frame sensor is replaced by a smaller APS-C sensor (using the <u>same</u> lens). The rectangle in red represents the coverage of the APS-C sensor (I have not drawn these to exact scale).

You can see that the photograph which would be recorded by the smaller-sensor camera covers a smaller part of the scene and thus a smaller field of view. As a result the scene *will appear as if a longer telephoto lens was used*. The lens is not actually magnifying the image more nor does its focal length magically change. Rather, the sensor is just recording a smaller part of the same scene. If a still smaller sensor was used such as Micro Four Thirds or a 1/2.3" sensor the apparent effect will be greater still.

The *crop factor* is a number based on comparing the size of a sensor relative to the sensor in a full frame camera. This enables all digital camera and lens combinations to be described in terms of '35mm equivalence' or 'full frame equivalence'.

The crop factor is determined using the diagonal dimension of the sensor. A full frame sensor has a diagonal length (from corner to opposite corner) of about 43 mm. A Canon APS-C sensor has a diagonal length of about 27mm. The crop factor of the Canon is thus 43/27 = 1.6. APS-C sensors by Nikon, Sony, and Fuji are slightly bigger than the Canon, and have a crop factor of 1.5. The crop factor for a Micro Four Thirds camera is 2, and for a 1/2.3" camera is 5.64. Smartphones have very small sensors, for example the iPhone has a sensor with a crop factor of about 7.

To go back to our Nikon P1000 camera described in the main article, at the shortest focal length of the zoom the focal length is 4.3 mm. This figure multiplied by the crop factor (5.64) gives 24mm. In other words, to get approximately the same picture of a scene on a full frame DSLR, you would need to use a 24mm lens. At the other end of the scale, the longest focal length of the lens is 539mm, which gives an astonishing full frame equivalent focal length of around 3 metres!

To use another, possibly more relevant example, if I used a Nikon D7500 DSLR, which has a 1.5 crop factor sensor, and a 400mm lens to photograph birds at a wetland, and my friend used a full frame camera, e.g., a Nikon D850 DSLR with a 600 mm lens, we would both get about the same field of view of the bird we were photographing. The Olympus user in the next hide over would get the same field of view with a 300mm lens, due to the 2 times crop factor.

Pixel Density

The crop factor is only part of the story in terms of how a camera records a scene. One further number that has to be considered is *the number of megapixels*. This, in turn, gives rise to what is termed the *pixel density*, which in bird photography terms can be more simply described as 'how many pixels are on the bird'. It is this, rather than the crop factor, which determines the real ability of the camera to record the scene.

If you have a 24 megapixel APS-C camera and a 24 megapixel full frame camera, both will record the entire picture in the same amount of detail (I'm equating 'detail' here simply to the number of pixels or 'data points' recording the image, not other factors such as lens quality). The pixels on the APSC camera are smaller, to fit into the smaller area of the sensor, but both cameras record the image using 24 million separate points.

However, if the same lens is used with both cameras, the APSC camera will 'get in closer' to the bird. It will capture a smaller area of the scene, meaning it will use more of its 24 megapixels to capture the bird, rather than the surrounding background. To go back to our diagram above, the full frame will cover the area in the black boundary with 24 million pixels, whereas the APSC will cover the smaller area in the red boundary with 24 million pixels. The full frame camera will have the advantage of <u>bigger</u> pixels (recording better quality digital data by gathering more light per pixel), but the APSC will have the advantage of <u>more</u> pixels per unit of sensor area (recording more information about a smaller area of the scene).

But what if the full frame sensor has substantially more megapixels than the APSC sensor? Clearly there will be a point where the pixel size is similar to the pixel size on the smaller APSC sensor. So, in this case, the advantages of the smaller field of view of the APSC sensor disappear because both cameras will get the same number of pixels covering the bird; the full frame camera will simply record more background with its wider field of view, which can be cropped away if desired. However, by having smaller pixels the full frame camera may lose some of its digital noise and dynamic range advantages over the APSC camera.

Now the decision about camera and lens becomes more tricky. It is not quite as simple as saying the choice is (for example) full frame camera body plus 600mm lens vs APS-C camera body plus 400mm lens. A high-end, high-megapixel full frame camera could do just as well as an APS-C camera, with both using the 400mm lens, in terms of capturing detail of the bird in the frame.

With high megapixel full frame sensors, the perceived ‘focal length’ advantage of a smaller sensor largely disappears. For example, the Canon R5, with a 45 megapixel full frame sensor, can be operated in a ‘crop sensor’ mode, which simply reduces the framing of the image in the viewfinder. Turning on the cropping mode effectively makes it into a roughly 17 Megapixel APSC camera. The camera probably still records all the data of the sensor, but just produces a raw file with a smaller number of pixels. A 17 megapixel file is not that different from the 20 megapixel file produced by (for example) a Nikon D500 or an Olympus. You can use the same focal length lens on each camera, resulting in a file which gets a roughly equivalent number of pixels on the bird regardless of sensor area.

Perhaps the only remaining advantages of the smaller-frame systems is the modest weight advantage from the smaller equipment, together with cost.