Digiscope applications for shorebird studies

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Digiscoping successfully marries the conventional function of spotting scopes (or telescopes) with technologically advanced digital cameras to produce high quality images without compromising routine ornithological procedures, thus offering biologists, researchers, and the like a highly convenient and economic tool to document sightings and observations. This paper addresses fundamental aspects of this hybrid technology, field applications, equipment criteria, trouble-shooting, image processing and provides an appendix of Internet sources for more in-depth information.

INTRODUCTION

In 1999 when Laurence Poh of Malaysia discovered that he could take digital images of birds through his spotting scope and subsequently shared this news over the Internet, he gave ornithologists worldwide a revolutionary new tool for documenting avian subjects and behaviour. Soon dubbed "digiscoping", this hybrid technology allows owners of spotting scopes and (certain) digital cameras to receive dual service from both devices. By combining high power scopes with cameras featuring internal optical and digital zoom lenses, it is now possible to obtain images comparable in quality to those formerly requiring a highly expensive arsenal of cumbersome, fragile and heavy telephoto lenses and cameras as well as endless quantities of costly film.

Searching for an economic and convenient means to document my own sightings of rare and banded shorebirds in NE Florida, I recently purchased a Nikon Coolpix 990 for use with my 82 mm Kowa scope. My timing was fortunate, because within days of receiving the camera, a southbound flock of 1,500 Red Knots *Calidris canutus rufa* stopped over in a local inlet and, among them were a few banded individuals worthy of documentation.

My initial efforts to digiscope these birds proved remarkably simple and straightforward, as was the subsequent viewing and editing of collected images on my home PC. Another significant benefit of digital photography became manifest when the images were expeditiously and conveniently transmitted via the Internet. Within days of their arrival in Florida, Patricia Gonzalez in far-distant Argentina was able to recognize and identify birds she had banded there and the images documented Florida's first record of South American banded Red Knots.

In subsequent months, digiscoping facilitated the documentation of other banded birds in wintering populations of Piping Plovers *Charadrius melodus* and Semipalmated Plovers *Ch. semipalmatus* and, like the Red Knot images, many of these photos were conveyed to biologists and researchers across North America to support their studies and resolve discrepancies in band codes or identification. The latter function has been especially valuable to differentiate and document similarly banded birds within the same regional population or migratory flock. In a few cases, the high resolution and magnification of band images has revealed engraved codes or faded colour not readily evident in the field (Fig. 1). Further images collected throughout the wintering period also documented the progression of moult and changes in plumage coloration as spring migration neared.

Through the circulation of these images, another regional researcher expressed a desire to document Piping Plovers in his study area and I am currently engaged in systematically cataloguing banded birds within his population. On occasion, the expediency of digiscoping has facilitated the documentation of fleeting behaviour like the predator response depicted in Fig. 2.

In late winter, when Red Knots reappeared, I resumed my population surveys, digiscoped flagged and banded birds and again transmitted their images to distant researchers. Given recent declines in rufa Red Knots visiting Delaware Bay, researchers there became very interested in our sightings of South American banded birds in NE Florida and digiscoping made it possible to share observations of marked birds on a daily basis. Remarkably, one image refuted a concurrent, but clearly erroneous sighting of the same bird far to the north. Through this expeditious exchange many contacts became aware of the high value and function of digiscoping for field research (Fig. 3).

In addition to its digiscoping duties, the 'unattached' digital camera functions well to document flock size, habitats and site features, invertebrate prey, disturbances and more. Given its compactness, convenience, image storage capacities, ease of application with the spotting scope and elimination of commercial film processing, my digital camera has proven to be a highly versatile, invaluable and economical research tool.

NECESSARY EQUIPMENT

A broad range of scopes and cameras are employed for digiscoping, but higher quality scopes and cameras produce superior images. Although an inexpensive spotting scope coupled to an economical camera may be functional, the resultant images will not compare to those taken with better equipment. However: in comparison to conventional film photography that demands a camera body and a multitude of expensive telephoto lenses, digiscoping simply requires the single purchase of a high quality camera. (A PC with applicable software is also required to view, edit, process, store, copy and transmit images.)

Spotting scope features

Two basic scope features are of greatest relevance for digiscope applications. Because increased optical magnification requires greater light transmission, scopes with larger objective lenses (~80 mm) are more serviceable for digiscoping then smaller (60 mm) scopes. Most contemporary models are available with either straight-through or angled eyepiece alignments. Straight-through is the most convenient for typical shorebird applications since it facilitates the timely location, centring and focusing of the subject; attachment of the camera; and subsequent image taking. The single advantage of angled eyepieces applies when digiscoping birds or subjects well above the horizon that requires users of straight-through scopes to crouch well below their tripods to obtain similar views. Given the foregoing, potential digiscopers must consider their predominant method of observation/perspective and select eyepiece alignment accordingly.

Because of their versatility, many people use multi-power zoom eyepieces and these are readily applied for digiscoping. When combined with the internal optical and digital magnification of contemporary cameras, some truly remarkable, long-range images have been made. However, such imaging is impractical under typical field condition because high power photography demands extreme steadiness of gear, stillness of subject and ideal light and atmospheric conditions.

I have experimented with a variable zoom (20–60×) and a fixed power (32× wide-angle) eyepiece with the latter proving to be more functional for digiscoping. The improvised joining of two high power optical devices is inherently problematic and the fewer distractions the greater the chance of obtaining a good image. Increased eyepiece magnification also reduces the field of view (making it difficult to locate a subject in the camera's LCD (Liquid Crystal Display), exacerbates camera shake (blurring the image) and reduces light transmission to the camera (contributing to vignetting and slower shutter speeds and underexposure).

The best cameras for digiscoping offer a range of internal optical and digital magnification that, to a large extent, compensates for any reduction in eyepiece versatility and magnification.

The diameter of a scope's eyepiece will directly affect its mechanical connection to a digital camera and the better the diameter of scope and camera match, the fewer the problems of joining the two (see Accessories below).

Scope mounts and tripods

All forms of high power photography are adversely impacted by tremor or camera shake that result in blurred images. Therefore it is important to use a firm support.

A 'liquid' tripod head that offers smooth vertical and horizontal movement is ideal for digiscoping and, when mounted on a conventional tripod with telescopic legs, is quite adequate. Light-weight tripods are less desirable and heavy-duty models, though better at keeping the equipment steady, are burdensome to carry in the field. Conventional, pointed tripod feet serve well on mud and sand substrates and allow the legs to be pushed into the ground to reduce wind vibration and provide a more stable platform.

Digital cameras

For digiscoping applications the quintessential prerequisite of all serviceable cameras is internal focusing and zoom magnification. Because they meet this essential requirement and provide other highly desirable features, the Nikon Coolpix 900 or 4500 series of digital cameras have long been favoured by digiscopers. The split, rotating body and lens of these cameras is particularly beneficial since it facilitates convenient coupling while allowing full view of the LCD screen and ready access to all essential controls. However, a variety of digital camera makes and models are currently employed for digiscoping and, as technology advances, new models continuously appear in the market. (See Appendix for Internet sites offering lists of scope and camera makes and models currently employed by individual digiscopers.)

It should be noted that for digiscoping applications, the photographer uses the camera's large LCD screen rather then the viewfinder. Although the LCD image is identical to that rendered in the scope's eyepiece, it will be somewhat dimmer and less sharp. Furthermore, bright sunlight tends to wash out the LCD image, but sufficient clarity is (usually) retained to permit one to centre and zoom on a subject prior to tripping the shutter and often one's headwear provides sufficient shade to view the screen (see Accessories).

Virtually all digital cameras are loaded with a mind-boggling array of functions and options, but little time or experience is required to master routine procedures. Perhaps the function of most concern to digiscopers is the selection of automatic vs. manual mode of operation. In my experience, photographing both roosting and foraging shorebirds, the automatic mode serves well. Digiscoping is highly problematic and the more adjustments required in the field the higher the likelihood of failure or missed opportunities. As with conventional photography, superior results are best attained in good light (preferably with the sun behind the camera) in close-proximity to the subject and with camera and lens held motionless. Occasionally, insufficient light for automatic operation has compelled me to switch to manual mode and I have made a few acceptable images in this way.

This experience suggests that digiscopers in higher latitudes or in less sunny climates might obtain better results using one or more of the manual operation modes. Given the multiplicity of options typically provided by modern digital cameras, most digiscopers should have little difficulty determining which modes serve best for their most typical environmental conditions.

Camera settings

The camera settings of most concern to digiscopers include: image quality (file size), metering, operational and program modes, sleep cycle period and ISO equivalent. Various, interactive, combinations of these selections will determine important aspects of imaging and the interval required to store data on the memory chip, relative size of images collected, data processed from the field of view and so forth. To a degree these are discretionary and subjective choices, but in my experience, the following settings serve well:

Fig. 1. Piping Plover with faded bicoloured band engraved with alpha-numeric code (photo taken with 82 mm Kowa scope and 32W× eyepiece coupled to Nikon Coolpix 990 – full optical zoom).

Fig. 2. Piping plover in "hunkered" defensive posture on open beach watching predator high aloft (photo taken with 82 mm Kowa scope and 32W× eyepiece coupled to Nikon Coolpix 990 – full optical zoom).

1. Operational mode: AF continuous (permanent autofocus – this minimizes focus time)
2. Image quality: Fine (combined with next)
3. Image size: 3:2 (same aspect as 35 mm film)
4. Program mode: P (least adjustments required)
5. Metering mode: Matrix (general use applications)
6. ISO: AF equivalent to 100 ISO

For a protracted period I never exceeded the file capacity of a 64MB flash memory chip and the 8× speed seemed adequate for my needs. However, a singular experience with a satiated card convinced me to upgrade to 128 MB and 12× speed. Given their diminutive size and ease of replacement, spare cards are conveniently transported into the field for expanded capacity. The same applies to batteries; consequently, I endeavour to begin every outing with fully charged batteries in the camera and a complete set of spares carried along for extra security.

Optical zoom vs Digital

Most digital cameras possess optical lenses equal in resolution to those in spotting scopes. Theoretically, an 80 mm scope fitted with a 20–60× zoom eyepiece coupled to a digital camera with 3× optical zoom and 4× digital zoom should produce extraordinary images. However, the natural environment offers a host of adverse conditions that conspire to frustrate the photographer and spoil one's images.

In my experience, the sharpest resolution digiscope images are obtained with a fixed magnification, mid-range, scope eyepiece (such as 30×) and within the optical zoom range of the camera. Digital zoom is highly problematic and typically produces grainy, unsatisfactory images. On occasion, I have used this function to document band details or inaccessible subjects at very long range, but the clarity of the image is never very good. The unavoidable reality is that, as magnification increases, less movement is required to distort the image. In some circumstances, digiscopers might experiment with scopes and cameras removed from tripods and "nestled" in a firm cushion or similarly padded receptacle placed on the ground or on a wall or rock to reduce or eliminate vibration. Cliff-side locations or elevated dikes and berms might also provide such opportunities and be more conducive to photography in adverse conditions.

Fig. 3. Uniquely colour-banded and flagged Argentinean Red Knot recorded May 2004 in NE Florida (photo taken with 82 mm Kowa scope and 32W× eyepiece coupled to Nikon Coolpix 990 – full optical zoom).

Accessories

As digiscoping has grown in popularity and expanded in application, several accessories have been manufactured to address various problems inherent with the hybrid technology. Chief amongst these are mechanical connectors to facilitate the critical joining of camera to scope and consumers should have no difficulty obtaining the appropriate-sized connector for their equipment. Because all commercial connectors are rigidly constructed they may be less suitable for ornithological applications that require the camera to be connected to the scope very quickly. Conversely, improvised connectors, like those fabricated from film canisters, dust caps, etc. are less cumbersome and often more convenient for alternating between conventional scope mode and digiscope mode. However, they may require a steadier hand to minimize camera shake. When fabricating these, some experimentation is required to determine the optimum distance between the camera and eyepiece. My dust cap connector provides a glass-to-glass separation of 12 mm, but this will vary between cameras and eyepieces. A too spacious gap between camera and scope is likely to exacerbate vignetting and contribute to undesirable movement between all components (see Appendix).

Devices to shade (hood) the sensitive LCD screens are also available, but their careless employment carries the risk of inadvertently overheating the screen if the hood's viewing lens is directed toward the sun. This risk might be eliminated by removal of the 2–3× lens, but this practically negates its designed function. Hoods are worthy of consideration for certain digiscope applications since they accommodate focus adjustments to the scope *while the camera remains attached.* Otherwise, a shifting subject requires removal of the camera, relocation and refocusing of the scope, and re-attachment of the camera – a fundamental problem of digiscoping and a source of great frustration.

Efforts to reduce or minimize camera shake or equipment vibration have lead to the development of extension rods, mounting plates and similar attachments to secure or brace the camera/scope connection. Some are designed with clever pivots to swing the camera on and off the eyepiece for alternative service, but their employment requires one to become accustomed to the bulk of a digital camera adjoining the eyepiece during routine observations and the alignment of all components is critical.

Frequent exposure to wind resistance would also seem to preclude their use for many field applications. Because of harsh marine conditions, I prefer to store my camera in a secure pouch on my hip and deploy it only when necessary. I cannot foresee how such cumbersome devices would expedite the simple joining process I currently employ and digiscoping pioneer and innovator, Laurence Poh expresses a similar view on his personal website (Fig. 4).

Also to be considered is a rare but significant hazard associated with the semi-permanent joining of camera and scope and subsequent exposure to direct sunlight. As with LCD hoods, there is at least one account of serious damage to a camera's shutter from direct sunlight focused through the scope while it was inadvertently pointed at the sun. Apparently, this occurred during transport when the owner carried his equipment over his shoulder with the scope pointing skyward!

DIGISCOPING IN PRACTISE

Digiscopers can be separated into two general groups: serious photographers that securely join their equipment and accessories in advance; and biologists, researchers, birders and the like who use their unencumbered scopes for routine observations and attach their cameras on a when-required basis. I include myself in the latter category and my experiences exclusively reflect this circumstance.

Typical digiscope opportunities blend seamlessly with routine field activities. The observer is usually in close proximity to his subject and often little effort is required to stalk into a more favourable position. Once a subject has been selected, the scope and the tripod's central column should be lowered and well secured with the head adjustment knobs tight but with some minor movement possible. If additional stalking is anticipated, hold the camera in one hand (lens cap removed) and carry the tripod with the other. Alternatively, lower the tripod to kneeling level and approach in like manner with the scope at a comfortable height and position to accommodate digiscoping.

Once optimal distance to the subject is attained:

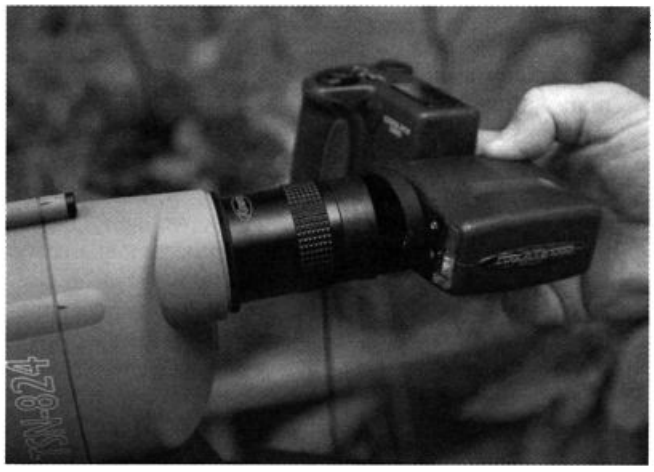

Fig. 4. Author's digiscope equipment showing modified dust cap connector on camera lens slipped onto scope eyepiece (rubber to rubber).

1. Firmly settle the tripod in the substrate.
2. Locate, centre and *sharply focus* the subject in the scope.
3. Turn the camera on (typically requiring a few seconds) and carefully slip it onto the eyepiece, *taking care not to move or shift the scope.*
4. View and compose subject in the LCD screen. Occasionally, the image will be surrounded by a black "halo", but this effect rapidly diminishes when you:
5. *optically zoom* into the subject, stop where desired, hold the camera steady and depress the shutter button.
6. If the subject remains stationary, take several images in quick succession.
7. Remove camera, adjust scope focus and repeat steps 4–6.

Trouble shooting

1. Should the subject move out of view in the LCD, *leave the camera switched on*, remove it from the scope and repeat steps 1–5. If this process continues without success, remove the camera and turn if off until the next available opportunity. (Some cameras will cycle off or 'lock up' when left on for protracted periods and, in such cases, they must be turned off and reactivated before an image can be taken.)

2. For moving subjects, endeavour to track them at a right angle where the focus will remain relatively constant and several exposures might be taken in succession as the bird progresses (a common situation along shorelines).

3. Vignetting (the most common problem inherent to digiscoping) derives from discrepancies in the relative convergent points of light passing through the camera lens and scope. If optical zooming does not eliminate the halo effect, some adjustment of the connector may be required and/or the camera settings require adjustment. Insufficient ambient light may require switching from AF to M-REC mode, opening a Pandora's box of options with variable consequences. Rather then progressing by trial

and error in the field and missing valuable opportunities one is advised to consult the camera manual/guide and experiment at home to become well familiar with the many adjustments and their potential applications in varying field conditions (see Appendix).

4. Image quality and quantity. Fortunately, digital technology accommodates the expedient of collecting numerous images that are economical to store, process and archive. Digital cameras permit the immediate retrieval, review and discarding of undesirable images. In practice, ambient light in the field seldom permits satisfactory evaluation of images via the LCD screen. Regardless of an image's apparent quality in the camera screen, one is better served to collect a series of images of one subject and reserve analysis via processing software on a PC. Personal experience suggests that 10–12 images per subject is typically required to produce one acceptable image and even greater quantities may be desired when digiscoping highly animated subjects.

Practitioners are advised to collect images in abundance and frequently check scope focus and continuously refine adjustments to obtain optimum image quality. Seemingly sharp images projected in the tiny LCD screen can prove disappointing when viewed at larger scale on a PC. Even the most sophisticated imaging software cannot make a silk purse out of a sow's ear, consequently, endeavour to collect the highest quality raw files for later processing.

Equipment maintenance

Regardless of the quality of one's equipment, it is essential that all lenses exposed to the elements be well maintained for optimum imaging. Consequently, digiscopers must be ever vigilant for the subtle but obstructing films that accumulate on all glass surfaces and, because of the ubiquitous presence of fine, abrasive, sand in marine environments, cleaning duties demand special attention and care. The wise approach is to always clean lens surfaces with a fine-haired brush prior to removing film deposits with an optically safe cloth.

Most modern tripods are constructed of lightweight aluminium or alloys that are resistant to corrosion. However, other components and hardware may not possess such attributes. To ensure trouble free function, one should routinely spray down and lubricate all joints and adjustment knobs following every application in marine environments. Following these simple but essential practices will significantly reduce undesirable mishaps.

Image processing and storage

Although a camera's playback feature permits immediate view of a collected image, the absolute value of an image cannot be determined until it is loaded and reviewed on a PC via an appropriate software program. Even the most basic programs allow for enlargement of the image where any flaws or deficiencies readily become apparent.

Various versions of Adobe Photoshop offer a multitude of adjustments, manipulations and special effects. The most useful applications permit fundamental adjustments to sharpen and enhance the original image through light and contrast settings and reduction of file size for Internet transmission to colleagues and associates. To a degree, most over- and under-exposed images can be salvaged, but little improvement is possible with poorly focused images. Cropping can be an effective tool to eliminate irrelevant material and reduce file size for archiving and email transmission.

Processed images can be stored on a PC hard drive, but given their unreliability, one is well advised to obtain a CD or DVD burner and save all valued images on disk. Such devices greatly facilitate the copying and sharing of images and their dispatch to distant contacts. Digital technology also accommodates the printing of images onto conventional photographic paper for exhibits, posters and the like.

APPENDIX

It is helpful to recognize that digiscoping has many devotees and some sources are more appropriate for professional photography as opposed to practical field application. Although all practitioners may strive for ideal image production, professional photography demands greater refinement of gear and technique than is practicable in typical field conditions. A recent Google search revealed more than twenty pages of digiscope sites.

www.md.ucl.ac.be/peca/test/a.html *(multiple topics and links)*
www.shortcourses.com/now/digiscoping/digiscope.htm *(multiple topics and links)*
www.digiscope.co.uk/
www.digiscopingukbirds.homestead.com
www.laurencepoh.com/ *(Digiscoping's pioneer but out-dated – see next)*
www.angelfire.com/pe2/digiscoping/index.htm *(Update on Laurence Poh's equipment)*
http://kotisivu.mtv3.fi/mr/ds/ds_combination.htm *(Index of digiscopers and equipment)*