COMMUNICATING BIOLOGICAL RESEARCH THROUGH Photos

A Photography Manual

Nisanth H.P. | Vishnu H. | Chinnu Vishwanathan | Biju Kumar A.

Department of Aquatic Biology and Fisheries, **University of Kerala**

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Co-funded by the Erasmus+ Programme of the European Union

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UNIVERSITY OF KERALA
Department of Aquatic Biology and Fisheries

COMMUNICATING BIOLOGICAL RESEARCH THROUGH PHOTOS
- A Photography Manual
by
Nisanth, H.P., Vishnu, H., Chinnu Vishwanathan, Biju Kumar, A.

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FOREWORD

If you take a look at the history of humans on this planet you will see that our ancestors were all born during periods of transition; periods between great revolutions, world wars or great famines. One could even see in the pages of history that civilizations flourished, some even perished under the influence of these transition periods. But fortunately such bad times have changed but transitions continue.

I consider myself very lucky to live in another transition period, a period which I would call 'pre-digital and digital'!

The story of photography is only a few centuries old. The changes in its technology were slow and steady till 1980s. Then the digital era was ushered in, storming the entire field of photography. Thereafter, its evolution was in leaps and bounds. I am one who was witness to this and one who happily swam with the current. Being basically interested in natural history photography I bought my first SLR in 1980. I experimented with all types of films – from Black & White to color transparencies. Long sweaty hours were spent inside dark rooms, developing films and 'editing' images. In the case of color transparencies one had to wait patiently for weeks to see the result of one's photographic adventures; the time professional color labs usually take to process them.

With the advent of digital photography in the early 1990s all this underwent a dramatic change, something which was not even dreamt of by photographers of the 'film era'. In the new scenario, our fingertips became the controlling machine of both pre and post production of images. I bought my first digital camera Canon 400D in 2006. I can still recall and relive the excitement I experienced at Aralam Wildlife Sanctuary when I saw the image I captured of a Srilanka Frogmouth instantly on the LCD screen.

Once you take a plunge into the world of digital photography you will soon realize that you are engulfed by a quagmire of information. It is not at all easy to fish out precise information you wish to know from that vast ocean. It is in this context that this small yet brilliant and concise book 'Communicating Biological Research Through Photos ' produced by the University of Kerala becomes most relevant. The book contains all relevant and useful information that an enthusiastic photographer would need to know on how to successfully use the medium of digital photography for research purposes. It covers a whole range of essential subjects: from basics of digital photography to practical tips on specimen photography, intricacies of flash photography etc. I immensely enjoyed reading the book and so would anyone who has a passion for modern photography.

SURESH ELAMON
January, 2024.

PREFACE

In the vast tapestry of life on Earth, every species, every ecosystem, and every moment holds a story waiting to be told. As field biologists and taxonomists, we aim to unravel these narratives, decipher the intricate relationships between species and their environments, and document the remarkable diversity surrounding us. Photography has emerged as an invaluable tool in our quest, allowing us to capture not only the visual beauty of the natural world but also critical scientific information. " Communicating Biological Research through Photos- A Photography Manual" was born from the workshop organized by the Department of Aquatic Biology & Fisheries, University of Kerala, for the field biologists. This manual bridges the gap between theoretical knowledge and practical application in biological photography, and the readers will find guidance on how to best wield your camera as an extension of your scientific tools.

Beyond the mechanics of photography, this manual delves into the details of light, types of cameras, modes in the camera, types of lenses, shutter speed, ISO, aperture, and other technical information, besides technical requirements for processing images. Further, one section is dedicated to macrophotography and one to taking photographs in the laboratory.

As our world undergoes rapid change, the importance of accurate documentation and exploration cannot be overstated. With habitats shifting, species adapting, and ecosystems evolving, each snapshot becomes a piece of the puzzle in understanding the dynamics of our earth. This manual equips the reader with technical skills for better photography.

This manual is a collaborative effort, drawing on the insights and experiences of professionals who have traversed the globe in pursuit of knowledge. It is an invitation to embrace both the art and science of photography, to immerse yourself in the process of discovery, and to contribute to a growing repository of visual data that will shape the course of science and conservation. We thank Dr Kalesh Sadasivan, Dr Sandeep Das, Shri Dhruvaraj, S. and Mr. Beta Mahatvaraj for the suggestions received during the workshop.

As you embark on your photographic journey, remember that each click of the shutter holds the potential to unveil a story, share an insight, and inspire a new generation of explorers. May this manual serve as your compass, guiding you through the intricate terrain of field photography and empowering you to capture the essence of life in its myriad forms.

Nisanth H.P. | Vishnu H. | Chinnu Vishwanathan | Biju Kumar A.

Dedicated to

the memory of renowned nature photographer

Shri K. Jayaram,

a pioneer in macro photography in India

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A Picture Tells a Thousand Words

The saying "**a picture tells a thousand words**" emphasizes the power of visual imagery to convey information, emotions, and stories. While words can be descriptive, a photograph can capture a moment, evoke emotions, and communicate complex ideas or narratives.

A well-composed photograph will have a visual impact, instantly grabbing attention and leaving a lasting impression. The visual elements such as colours, composition, and lighting can evoke emotions and convey a sense of atmosphere or mood. It can also tell a story by capturing a specific moment in time. It can give viewers a glimpse into a larger narrative or historical event, transporting them to a different time, place, or culture. Visual cues within the image can provide contextual information and prompt viewers to imagine the broader story behind the photograph.

'Water Scarcity' Kakamega, Kenya. A young boy drinks dirty water due to lack of water points in the area caused by deforestation.
Photograph: Dharshie Wissah/2019 Ciwem environmental photographer of the year

Images are symbols and metaphors, and they have the power to convey abstract concepts and symbolism that may be challenging to describe with words alone. Through visual elements, photographs can represent ideas, beliefs, or cultural themes, especially those who think about interdisciplinary research. It can also communicate emotions and empathy required for protecting life and living systems around you. Photographs can simplify complex data or information by visually representing it. Graphs, charts, or diagrams can be transformed into visual images, making information more accessible and understandable to a wide audience.

Of late, the 'tagged' photographs in social media are used to understand their context and the users' emotional state! The analysis of such pictures has also been used for critically understanding the qualities (e.g., Recreational, aesthetic, spiritual, etc.) of natural areas, nature-based solutions for conservation and sustainable development, and interpreting the values of natural landscapes in instilling happiness.

In general, photographs serve as visual records, preserving moments, events, and all elements of living beings (including humans) for future generations. They capture a slice of history, as many photographs are part of natural history and for new species discoveries and environmental changes, photographs provide valuable documentation for research and analysis.

Photography in Research

Photography plays a vital role in research in several ways:
Documentation: Photography is an excellent tool for documenting research findings, as it allows researchers to capture images of research subjects, samples, and experiments. Photographs can provide a permanent record of the research and can be used as evidence to support research findings.

Visualization: Photography can be used to visualize research findings, allowing researchers to share their findings with others. For example, photographs can be used to illustrate the results of experiments, show the effects of environmental changes, or capture the behaviour of research subjects.

Analysis: Photography can also be used as a research analysis tool. For example, photographs can be used to measure the size of objects, the distance between objects, or the degree of change over time.

Rhododendron arboreum subsp. nilagiricum (Zenker) Tagg tree and mist from the Western Ghats (Photograph courtesy: https://ianlockwood.blog/category/western-ghats/page/6/

Communication: Photography is a powerful communication tool that can be used to engage with a wider audience. Researchers can use photographs to present their findings visually compelling, making their research more accessible and understandable to a broader audience.

Biological Photography

Biological Photography, also known as medical photography, scientific photography, nature photography, or biophotography, is still and motion photography for educational, medical, research, or illustrative purposes.

Biological photography is not necessarily something limited to academicians or researchers, but it is a passion for many, especially those who love nature and the biodiversity of the planet. It is part of 'biophilia', the love of the living world around you or the innate human attraction to nature. It is also a way to explore or seek connections with nature and other life forms.

In all the phases of evolution of biological research, photographs played an important role, primarily because it is a 'living' evidence of a species or ecosystem at a particular time scale. With the development of colour photography, it has become a tool for communicating the brilliant colours of each organism, besides celebrating many of them as 'charismatic' species, and impressing the public with the relevance of conserving their posterity. Modern digital photography provides so much evidence on the behaviour of organisms and their exciting ways of life. In addition, several professional photographers provided their excellent photographs to researchers to augment their studies, and such kind of mutualism is essential for the growth of biodiversity science. Above all, photographs help stimulate student and public interest in life/biodiversity, besides influencing public perception of conserving the rich diversity of life on earth.

Umeed Mistry

In modern research, photographic evidence of experiments is also important in revolutionising research, as evidenced in the case of the discovery of the structure of DNA.

For example, Photo 51, projected as one of the most important photographs ever taken, was taken in the lab of Rosalind Franklin and Ray Gosling at the Biophysics Department at King's College, London, in 1952. Though the photograph was not taken using an ordinary camera, this speaks of the importance of photos in biological research. This image gave a final clue that enabled Maurice Wilkins, James Watson and Francis Crick to gather research from the previous two decades and understand that DNA was a double helix, for which they got the Nobel Prize.

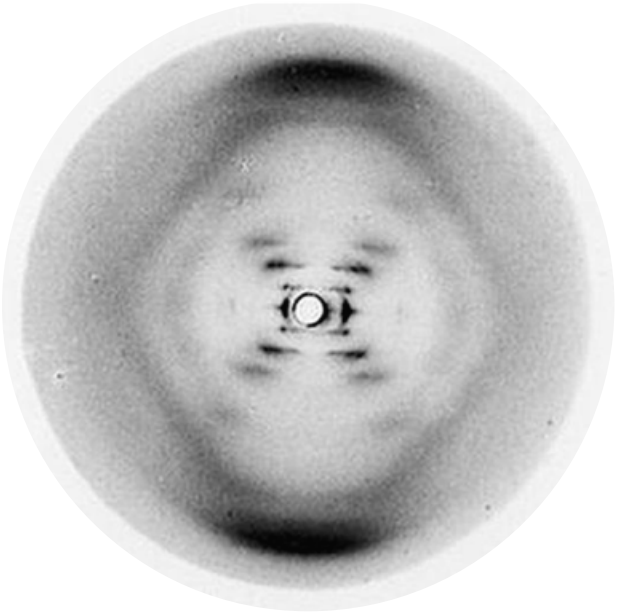


IMAGE SOURCE, KING'S COLLEGE LONDON
Image caption, Photo 51: DNA X-ray diffraction image

Role of Photography in Biodiversity and Taxonomy Research
Photography plays a crucial role in biodiversity and taxonomy research, which involves identifying, classifying, and naming organisms and cataloguing the rich diversity of life on Earth. There are several key reasons why photography is important in this area of research.

Evidence for Documentation and Reference: Photography provides a means to document and preserve visual records of organisms. Taxonomists can capture detailed images of specimens, including their morphological features, colouration, and unique characteristics. These images serve as a permanent reference for future study and comparison.

Species Description: Clear visual documentation is essential when describing a new species or revising existing taxonomic classifications. Photographs can capture the distinguishing features, such as the shape of body parts, patterns, and colour variations, aiding taxonomists in accurately describing and differentiating species. High-quality images can serve as evidence to support taxonomic descriptions.

Specimen Preservation: In taxonomy, physical specimens are often collected and preserved for scientific study. However, some organisms are fragile, difficult to collect, or even endangered. In such cases, photography can be a non-invasive method to record and study the organisms without disturbing or harming them. This allows researchers to gather valuable data while promoting conservation efforts.

Species Distribution and Discovery: Photography helps document species' distribution, abundance, and population dynamics across different geographic regions. Taxonomists can gain insights into their range, habitat preferences, and ecological associations by capturing images of organisms in their natural habitats. Researchers can use photography to monitor changes in biodiversity over time, track the presence or absence of species in specific areas, and study population trends. This information is crucial for assessing the health and conservation status of ecosystems.

Additionally, photographs taken by researchers or citizen scientists can aid in discovering new species or provide evidence of previously unknown species in certain areas.

Photograph: Umeed Mistry

Data Collection and Monitoring: Photographs gather data on species distribution, abundance, and population dynamics.

Habitat Assessment and Mapping: Photographs document and assess habitats, including vegetation types, land use patterns, and ecosystem structures. By photographing landscapes, researchers can study habitat connectivity, fragmentation, and changes due to human activities. This information aids in understanding the relationships between species and their habitats and informs conservation planning.

Public Engagement and Education: Photography has the power to engage and educate the general public about the importance of biodiversity and taxonomy. Well-captured images of diverse organisms can evoke curiosity, appreciation, and concern for the natural world. By sharing photographs and related information, taxonomists can raise awareness about the significance of taxonomy and conservation, fostering a sense of stewardship among the public.

Digital Databases and Online Resources: Digital platforms and online databases have revolutionized the accessibility of taxonomic information. Photographs are integral to these resources, providing visual representations of species for identification, research, and educational purposes. Online platforms also allow taxonomists and researchers to collaborate and share their photographic data, enhancing collective knowledge. By capturing images of organisms, including their physical features, behaviour, and habitat, researchers can create a comprehensive biodiversity database. These photographs serve as a reference for species identification, especially for rare or elusive species.

Citizen Science and Data Contribution: Photography has enabled citizen scientists to contribute to biodiversity research. Amateur photographers can capture images of plants, animals, and other organisms during outdoor activities and submit them to online platforms or participate in citizen science projects. These contributions help expand data collection efforts, cover larger geographic areas, and provide valuable insights into biodiversity patterns.

Conservation Advocacy and Education: Compelling photographs can raise awareness about biodiversity conservation. Captivating images of diverse species, threatened habitats, and ecological interactions can inspire action and promote public engagement. Photography is used in educational materials, exhibitions, and publications to communicate the value of biodiversity and the need for its protection.

Remote Monitoring and Non-invasive Research: Photography, combined with remote sensing technologies such as drones and satellite imagery, allows researchers to monitor remote or inaccessible areas. These tools provide a non-invasive way to study wildlife populations, track migratory patterns, and assess changes in habitat conditions without disturbing the natural environment.

Photographing animals in situ or in their natural habitat is an emerging trend in taxonomy research publications.

Sandeep Das

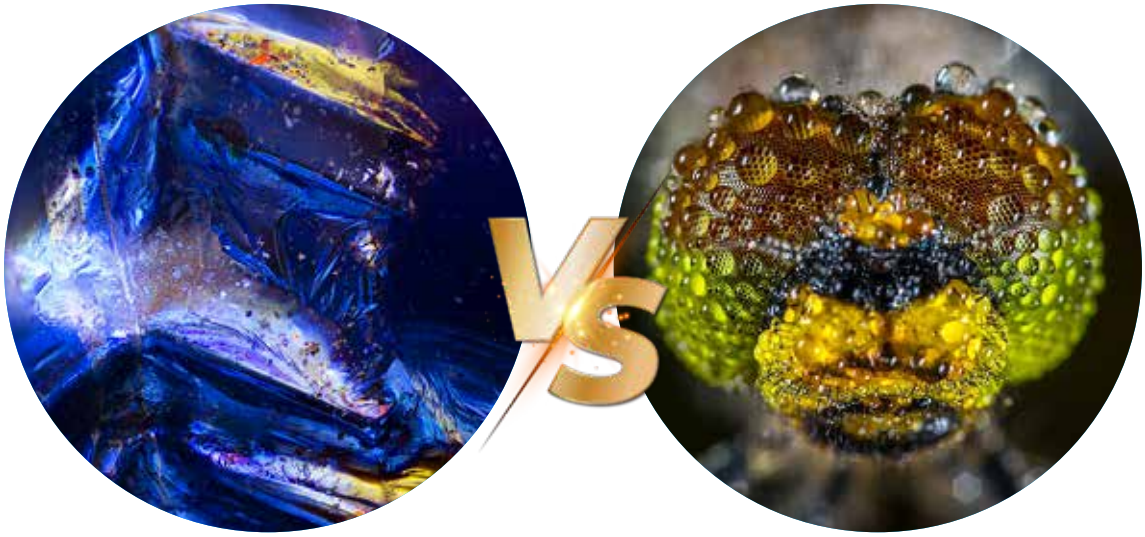
Amphibious photography: Which involves capturing images both underwater and above water, can offer unique and captivating perspectives that are not easily achievable through other forms of photography.

Amphibious photography allows photographers to explore the fascinating and often unseen world beneath the water's surface. By capturing underwater images, photographers can document the diverse marine life, vibrant colours, and mesmerizing textures in aquatic environments. These images provide valuable insights into underwater ecosystems and help raise awareness about the importance of marine conservation. Amphibious photography enables photographers to capture scenes from both above and below the water, resulting in images that offer a distinctive viewpoint. This perspective can create a sense of intrigue and wonder, providing viewers with a fresh and immersive experience. The juxtaposition of underwater and above-water elements can lead to visually striking compositions and storytelling opportunities.

Two halves of the World: Photographs of Umeed Mistry; https://www.natureinfocus.in/author/umeed-mistry

Photomicrography Vs Microphotography

Microphotography is the art of creating photographs that are not visible to the naked eye. You often need a microscope or similar magnifying toy to view these photographs. Photomicrography is used widely by hobbyists, teachers, medical practitioners and scientists to share images of specimens viewed under a microscope. "Macro" means big, and "micro" means small, but in photography, they both refer to making small things look bigger.



Following photographs and photographers!

Several scientists follow professional photographers not only to support their work but also to follow the diversity of life in various ecosystems.

The scientific community also gets to understand the ethology of organisms in their natural habitat, their associations and the threats they face. Further, photographs often showcase critical environmental issues and help bring them to public attention.

This photograph of a cormorant feeding a fish taken by **Dr Kalesh Sadasivan** helps us to understand the presence of the Nearly Threatened indigenous catfish *Clarias dussumieri* in Vellayani Lake of Kerala, where the existence of this fish has not been recorded in the recent past.

Photograph taken at 40-meter depth in Kerala coast depicting the habitats of scorpion fish chocked with plastic debris (Photo by **Umeed Mistry** for Ecomarine Project of University of Kerala)

Often, through photographs, we may get unique opportunities to understand the ethology of organisms in our surroundings, besides appreciating the aesthetics of it!

Sandeep Das

The fireflies at night creating a unique aesthetic splendour in the forest: Photograph of **Sandeep Das**

Umeed Mistry

EMERGING TRENDS IN PHOTOGRAPHY

Composite photography

It refers to the process of combining multiple images or elements to create a single, cohesive photograph. It involves merging elements such as subjects, backgrounds, objects, textures, or even entire scenes to produce a final image that may not be achievable in a single shot.

Composite photography is commonly used in various genres, including fine art, advertising, fashion, and digital illustration. Photographers and digital artists can unleash their creativity by constructing unique and imaginative scenes. By merging different elements, they can create surreal landscapes, fantastical creatures, impossible situations, or other visually captivating compositions.

Composite photography typically involves capturing or sourcing individual images that will serve as the building blocks for the final composition. These images are then edited and combined using image editing software like Adobe Photoshop or other specialized software. Techniques such as layering, masking, blending, and adjusting colours and tones are used to seamlessly integrate the different elements and create a cohesive and visually appealing image. Composite photography requires both technical photography skills and image editing software proficiency. It offers endless possibilities for creative expression and allows photographers and digital artists to push the boundaries of reality and create captivating visual narratives.

The composite titled "Golden State" was created by **Sapna Reddy**
(https://www.sapnareddy.com/collections/favorites#&gid=1&pid=3)
Sapna Reddy relied heavily on focus stacking to create this composite, entitled "Golden State."

Time-Lapse Photography: Time-lapse photography involves capturing a sequence of images over a period of time and then combining them into a video. In life science research, this technique is utilized to observe and document dynamic processes such as cell growth, plant development, and animal behaviour. Time-lapse photography provides a unique perspective on the temporal aspects of scientific research.

High-Speed Photography: High-speed photography enables the capture of rapidly occurring events that are typically not visible to the naked eye. In life science research, this technique is used to study fast-paced processes such as the movement of insects, fluid dynamics, and chemical reactions. It helps researchers analyse and understand phenomena that happen in fractions of a second.

Aerial and Drone Photography: Aerial and drone photography have revolutionized how scientists and researchers study the natural world. Drones equipped with cameras allow for capturing stunning aerial views of ecosystems, landscapes, and geographical features. This technology is precious for environmental research, conservation efforts, and monitoring ecosystem changes over time.

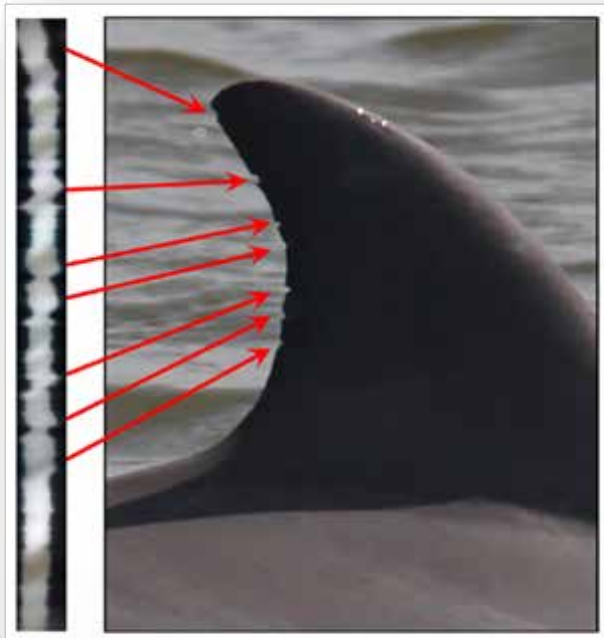
Aerial view of Blue Lagoon Island: Source: Dolphin Encounters Limited

Citizen Science Photography: Citizen science projects involve the general public in scientific research, including photography. Researchers collaborate with amateur photographers to collect valuable data and imagery related to various aspects of life science research. This trend promotes public engagement and helps scientists gather large amounts of data from diverse geographical locations.

Photo identification

Good quality photos and their analyses help identify individual organisms in a species, and this is extensively used in wildlife surveys, especially for tigers, and marine mammals such as dolphins and whales.

This technique relies on the unique natural markings and features on the body of tigers and dolphins. In dolphins, their dorsal fin, fluke (tail), and body scars, which remain consistent over time and allow for individual recognition. For example, the dorsal fin, located on the dolphin's back, is one of the primary features used for identification. It can have distinct shapes, notches, curves, or markings, which are unique to each individual. Researchers capture images of the dorsal fin from different angles to ensure accurate identification. A dolphin's fluke, or tail, also has unique patterns, such as nicks, notches, or markings. These patterns, combined with variations in colouration and shape, help distinguish one dolphin from another. Photographs of the fluke are especially valuable because they provide a detailed and distinctive identifier. Dolphins may acquire scars or markings on their bodies due to interactions with other dolphins, encounters with boats, or natural causes. These scars can serve as additional identifying features, and photographs help capture and document them for accurate identification.



Researchers maintain extensive photo databases containing images of individual organisms. These databases allow for comparisons and matching of new photographs to known individuals. By cataloguing and organizing photographs, researchers can track the movement, behaviour, and life history of organisms over time, and in a few cases, their social dynamics. Through photo-identification, researchers can monitor individual organisms over extended periods, sometimes spanning decades. By comparing new photographs to previously identified individuals, scientists can track their movements, population dynamics, social structures, and reproductive success, providing valuable insights into their behaviour and ecology.

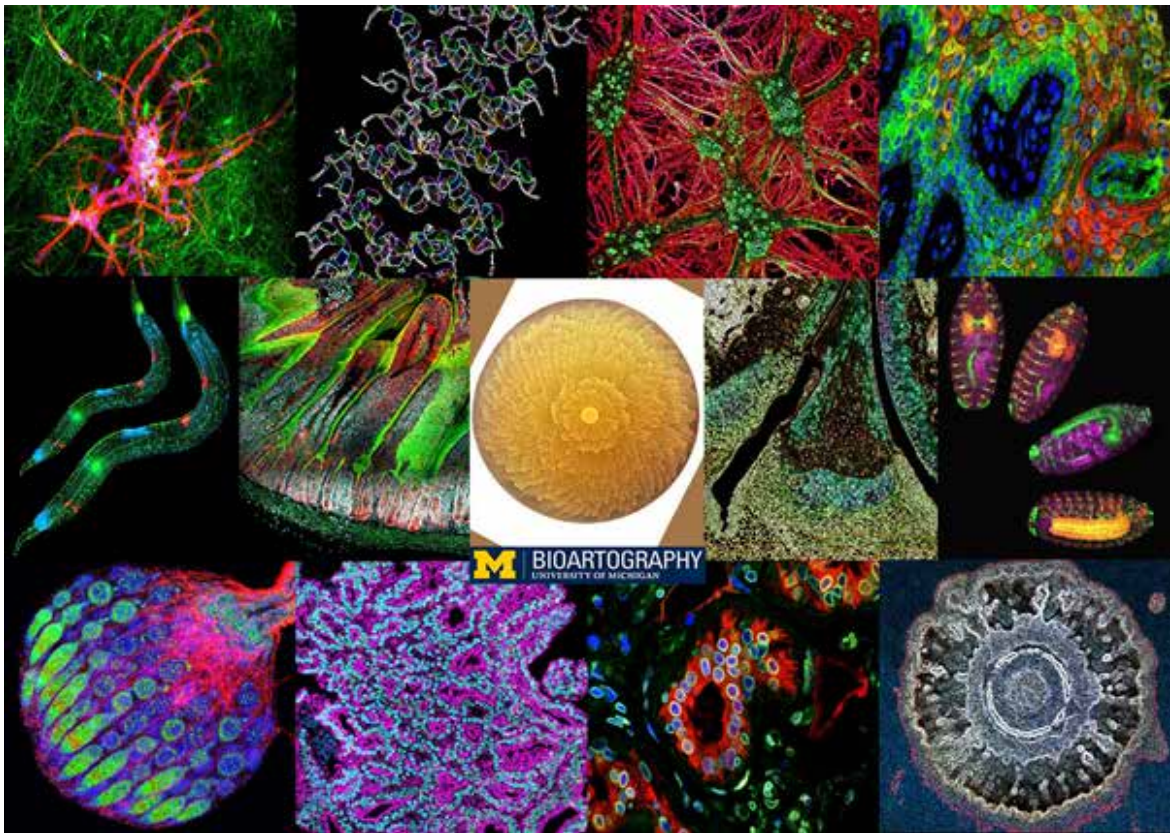
Photo journalism

Photojournalism plays a crucial role in research by providing visual documentation and storytelling that can enhance the understanding and impact of research findings. Photos have the power to convey complex research concepts, data, and findings in a visually compelling and accessible manner. They can capture the essence of a research project, making it easier for both researchers and the general public to comprehend and engage with the subject matter. Research can often be technical and challenging to communicate effectively to a broader audience. By incorporating photojournalism, researchers can bridge the gap between academic jargon and layperson understanding. Visuals can capture emotions, human experiences, and real-world contexts, making research more relatable and engaging.

Photojournalism excels at telling stories. It can provide a narrative structure to research by showcasing the process, challenges, and impacts of a project. Capturing human stories and experiences, helps create an emotional connection, generating empathy and understanding among viewers. Research often tackles important social, environmental, and political issues. Photojournalism has the power to raise awareness and provoke conversations about these issues. Photojournalists can draw attention to research topics by presenting visually captivating images, sparking interest, and encouraging public engagement and discussion.

Compelling visuals can significantly impact policymakers, influencing their decision-making processes. By effectively conveying research findings through photojournalism, researchers can advocate for change, inspire policy reforms, and drive social and environmental action. In summary, photojournalism in research is a powerful communication, storytelling, advocacy, and documentation tool. It adds a visual dimension to research, making it more accessible, engaging, and impactful for diverse audiences.

When a Million Turtles Land: In a small coastal town in India, hundreds of thousands of turtles come en masse to nest in a small stretch of beach yearly. Photo essay by **Kalyan Varma** (https://maptia.com/kalyanvarma/stories/when-a-million-turtles-land)



(Image courtesy: https://bioartography.com/)

WHAT IS PHOTOGRAPHY ?

Photography means 'drawing with light', derived from the Greek words, photo meaning light and graph, meaning to draw. Photography is the process of recording an image – a photograph – on light-sensitive film or, in the case of digital photography, via a digital electronic or magnetic memory.

This was done for the first time in 1826, when Joseph Nicéphore Niépce took a photo out of his window. The image below was entitled View from the Window at Le Gras.

ESSENTIALS TO PRODUCE A PHOTOGRAPH

Light: Light is an essential part of an image, and many different types of light are used to create different moods or feelings in a snap. You need to control the light to get the best results.

Subject: The subject is what we photograph and how we arrange elements within the frame and it also relates to composition, narrative and emotions. There are many compositional guidelines/ rules for creating a meaningful image.

Camera Optics: Optics, or lenses, are what focus the available light so that the sensor can record it. Different types of lenses each have its own characteristics that control the focal length, the angle of view and magnification of the image.

Aperture: The aperture refers to a hole in the lens that allows light to pass through it before reaching the sensor. it controls how much light is recorded and the depth of field (how much of the picture is sharp) in an image.

Time/Shutter speed: The shutter speed refers to how long the shutter remains open and is recorded in seconds, tenths or hundredths of a second (e.g., 1", 1/10 or 1/2000). The slower the shutter speed, the more light that is recorded (and vice versa).

Recording Medium: Once light passes through the lens, aperture and shutter, it reaches a digital sensor that records the image. Modern cameras feature sensors that are either full-frame, crop or medium format.

DSLR CHEATSHEET

for beginners

DSLR

Digital Standard Lens Reflex the mirror that's placed between the image sensor and the lens.

SENSOR

The part of your camera that detects and records your image.

LENS

Used in conjunction witha camera body and mechanism to make images of objects.

APERTURE

Determines the amount of light that gets in. The aperture of your lens is measured in f-stops, such as f/2, 1/11, etc.

DEPTH OF FIELD

Refers to how much ofyour image will be in focus

ISO

Determines how sensitive your image sensor is. High ISO is more sensitive to light. but adds grain.

SHUTTER SPEED

The length of time when the film or digital sensor inside the camera is exposed to light.

EXPOSURE TRIANGLE

Three components of a perfect image: shutter speed, aperture, and ISO.

FLASH

Devices used to add extra light to a scene. They can be attached to your DSLR or held separately.

REMOTE

Completes the same function as the shutter button on your camera, but can be pressed at a distance.

FILTER

An accessory used to change the color or type of light that comes into your lens. Screwed or clipped to your lens.

METER

The stepped bar that looks like a ruler that's on the bottom of your viewfinder or on your display.

BOKEH

The blur effect produced in the out-of-focus parts of an image, taken with a narrow depth of field.

TRIPOD

A three-legged mount that hold your camera steady.

RULE OF THIRDS

Break the image into 9.squares, placing subjects at their intersections.

HDMI

High-Definition Multimedia Interface. Many DSLRs integrate it to transmit crystal-clear digital video.

Source: Creative market

HOW DO HUMANS AND CAMERA JUDGE LIGHT ?

The human eye perceives colour differently than digital cameras. The specific objects under different light sources will still appear as the correct colour of the object. A white object, for example, will appear to have different colours as the light source varies or due to the changing colour spectrum. However, the human brain can still identify the correct colour because the human visual system can adapt to these illumination changes.

Meanwhile, a digital camera uses filters to assign the amount of light from the source and the information from the objects were collected by the colour channels, which helps in image processing. Since the camera sensors cannot recognize the colour temperature, the colour correction were done using 'image evaluation' and 'white balance' features.

TYPES OF CAMERAS

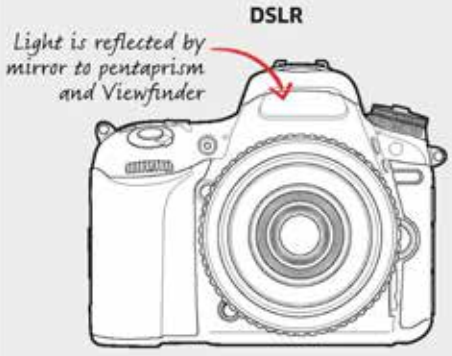
COMPARING CAMERAS

	TYPE	PROS	CONS
	**Cameraphone**	■ Easy to carry around ■ Apps allow you to alter images	■ Fixed focal length lens ■ Resolution and image quality can be restrictive
	**Compact**	■ Easy to carry around ■ Inexpensive ■ Good zoom lens range	■ Limited number of physical controls on camera body ■ Restricted range of shooting modes ■ Low-light capability is lacking ■ Often can't shoot RAW
	**Bridge / Prosumer**	■ More control over exposure than compact or cameraphones ■ Relatively inexpensive	■ Lower image quality than system cameras ■ Zoom lens is fixed, so less versatile than system cameras
	**System**	■ Image quality ■ Expandable capability ■ Versatile	■ Bulky ■ More expensive

Source: David Taylor - Digital Photography Complete Course

WHICH SYSTEM CAMERA?

DSLR



Optical Viewfinder: Image from lens is projected via mirror and pentaprism to the Viewfinder.

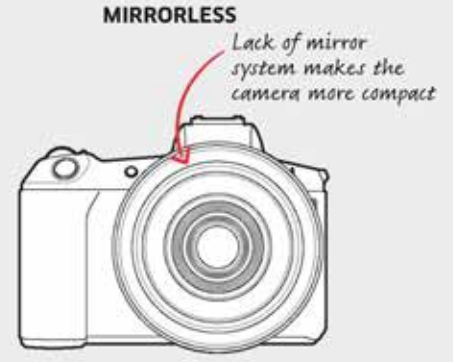
Advantages

- Based on older film-based systems, so wide range of lenses and accessories available
- Focusing is often quicker than in mirrorless cameras
- Excellent battery life

Disadvantages

- Camera bodies and lenses tend to be larger than mirrorless systems
- Need to switch to Live View mode to preview images on-screen

MIRRORLESS



LCD or electronic Viewfinder: Image from sensor is fed directly to the LCD or Viewfinder.

Advantages

- Purely digital system, so lenses are optimized for shooting digital images
- Relatively small size and weight
- Frame rate (the number of shots a camera can shoot per second) is generally higher than dSLRs

Disadvantages

- Battery life less than dSLR
- Not every mirrorless camera has a viewfinder

Source: David Taylor - Digital Photography Complete Course

HOW TO HOLD CAMERA ?
(H A N D H E L D)

Using a camera

HOLDING A CAMERA

Camera shake is unsharpness in a photo caused by camera movement during shooting. Holding a camera incorrectly is the most common cause. The heavier the camera and lens combination, the more important it is to support your camera correctly.

Do

1 **Use** your left hand to support the lens from below.

2 **Grip** the camera firmly.

3 **Look** through the camera's Viewfinder if it has one.

4 **Hold** your elbows lightly against your body.

5 **Stand** upright with your feet shoulder-width apart.

6 **Breathe** in and then slowly out – gently press the shutter button fully down before breathing back in.

A stable, relaxed stance makes camera shake and fatigue less likely

Don't

7 **Let** your camera bag unbalance you.

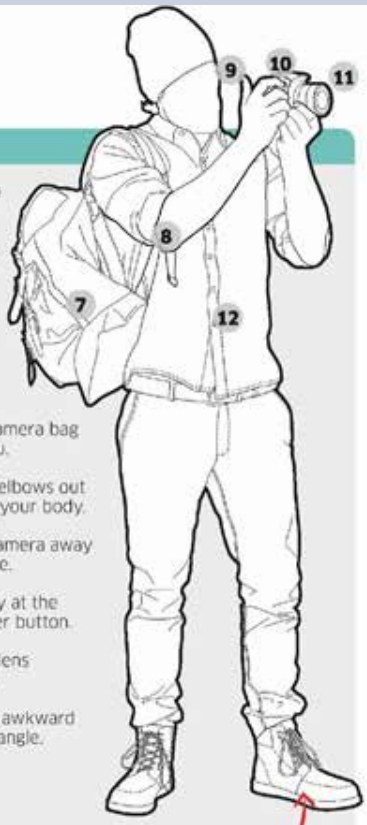
8 **Hold** your elbows out to the side of your body.

9 **Hold** the camera away from your face.

10 **Jab** sharply at the camera shutter button.

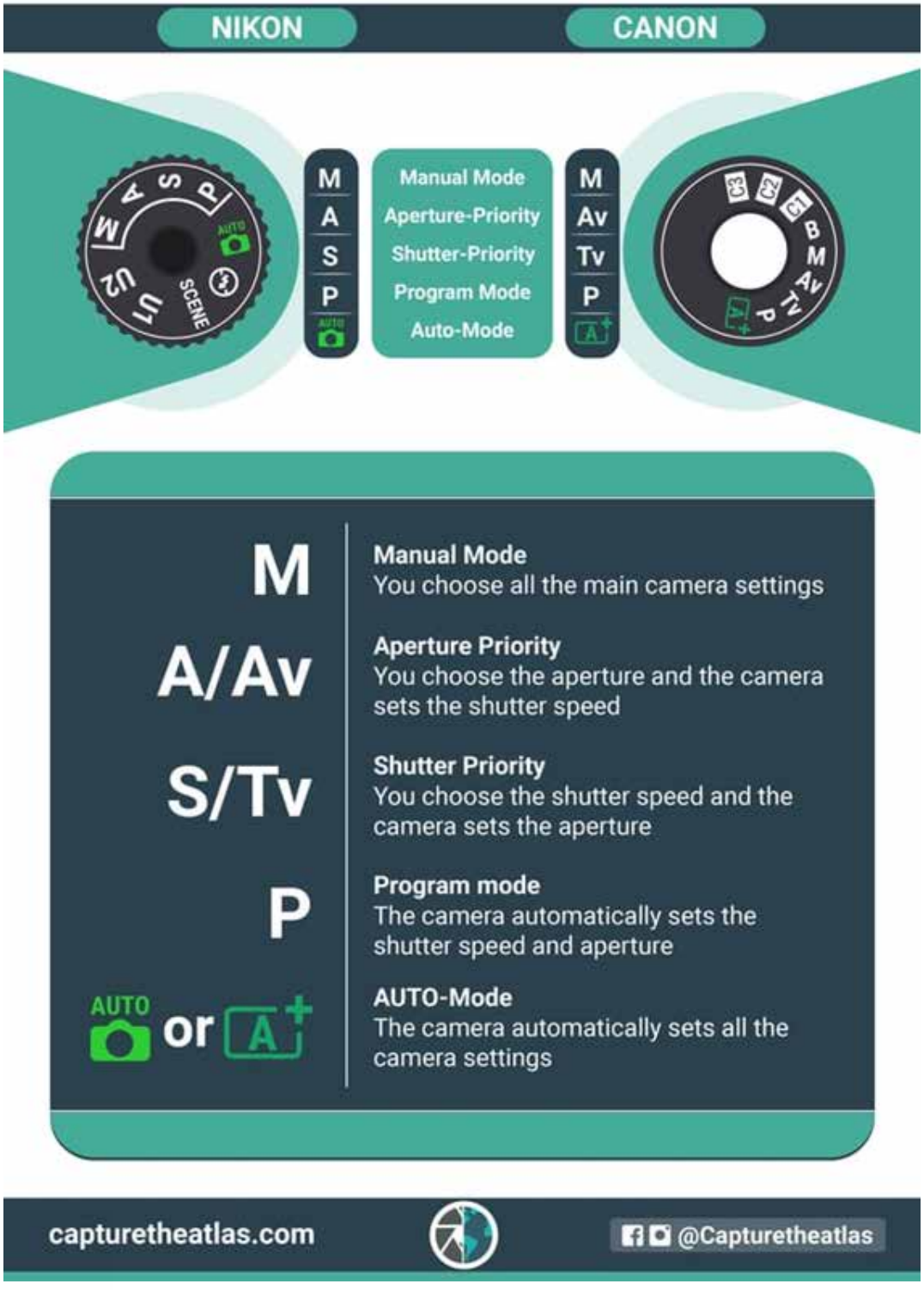
11 **Leave** the lens unsupported.

12 **Lean** at an awkward and unstable angle.



Wear comfortable footwear and keep both feet flat on the ground

Source: David Taylor - Digital Photography Complete Course


NIKON
CANON
M
A
S
P
Manual Mode
Aperture-Priority
Shutter-Priority
Program Mode
Auto-Mode
M
Av
Tv
P
M
A/Av
S/Tv
P
AUTO or A+
Manual Mode
You choose all the main camera settings
Aperture Priority
You choose the aperture and the camera sets the shutter speed
Shutter Priority
You choose the shutter speed and the camera sets the aperture
Program mode
The camera automatically sets the shutter speed and aperture
AUTO-Mode
The camera automatically sets all the camera settings
capturetheatlas.com
@Capturetheatlas

TYPES OF LENSES AND FOCAL LENGTH

The camera lenses are categorised as

1. **Prime lenses/ Block Lenses:** Primes lens have a fixed focal length, making them faster, sharper and lighter. But, prime lenses are less flexible due to the fixed focal length.
2. **Zoom lenses:** Zoom lenses allow different focal lengths from a single lens, making it more flexible but not as fast as prime lens. It contains more glass/ element, which provides flexibility. However, it makes the lens bigger and heavier than prime lenses.

In both prime and zoom types of lenses, a variety of lenses, all with different focal lengths are available.

Macro Lenses

Macro lens is used to create very close-up, macro photographs. It has a unique design that allows production of sharp images at extremely close range with maximum details in one image.

Telephoto Lenses

Telephoto lenses are a type of zoom lens/prime lens. Telephoto lenses are great for isolating a distant subject. However, the great magnification comes with a narrower field of view.

Wide Angle Lenses

Wide angle lenses are used for fitting a large area into the frame. This is especially useful for landscape photography or street photography. With wide angle lenses, almost everything is in focus, unless your subject is very close to the lens.

Standard Lenses

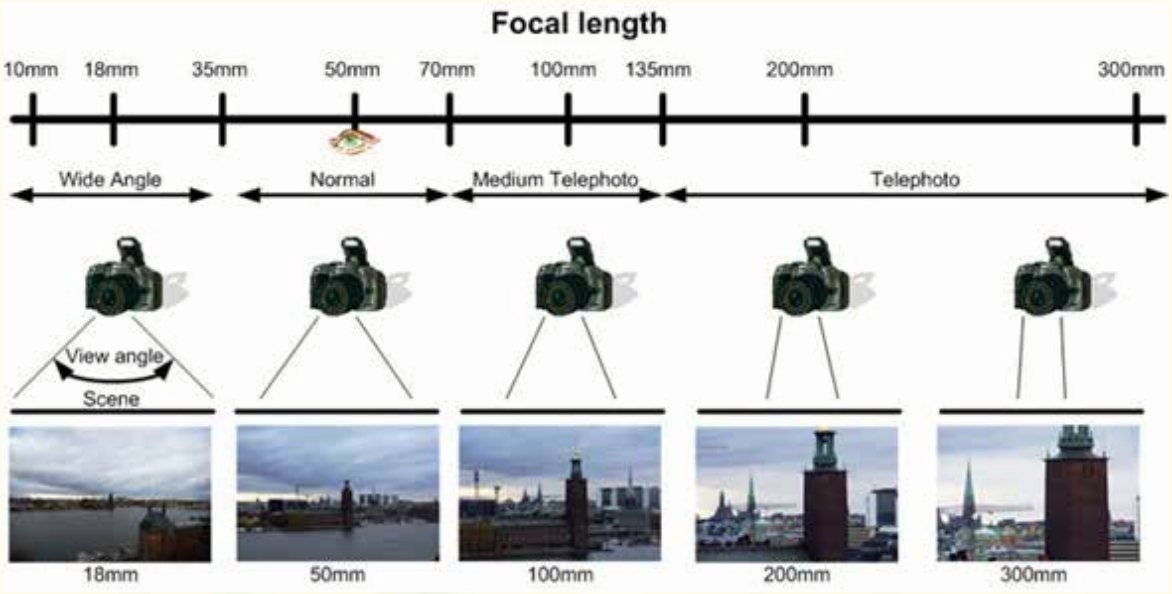
Standard lenses can be used for different types of photography. Its focal lengths fall somewhere in between 35mm and 85mm. A zoom lens within this range will have a small enough focal length to take a wider angle, full-frame photo, and a large enough focal length to zoom in on subjects.

Specialty Lenses

These specialised camera lenses can impart a unique look and feel to the photographs. There are several types of speciality camera lenses,

- **Fisheye lens :** A fisheye lens is an ultra-wide-angle lens that can take in a full 180-degree radius around it. Fisheye lenses are so named because they distort an image's field of view, making even a room in a house look like a bubble.
- **Tilt shift lens:** A tilt shift lens distorts perspective, making things look smaller than their actual size and orientation.

- **Infrared lens:** These lenses consider more light rather than perspective, filtering out all light waves except infrared, which creates a unique visual effect.



Wide-angle to telephoto

Understand the difference between focal lengths, from 10mm to 400mm

Your lens focal length affects the angle of view you can see through your camera's viewfinder. To really see the difference focal length can make to the angle of view, it's good to compare a sequence of shots of the same subject taken at different focal lengths. See our examples for how much or how little of the scene you can capture in your frame, depending on your effective focal length (EFL).

125mm (EFL: 200mm)

35mm (EFL: 55mm)

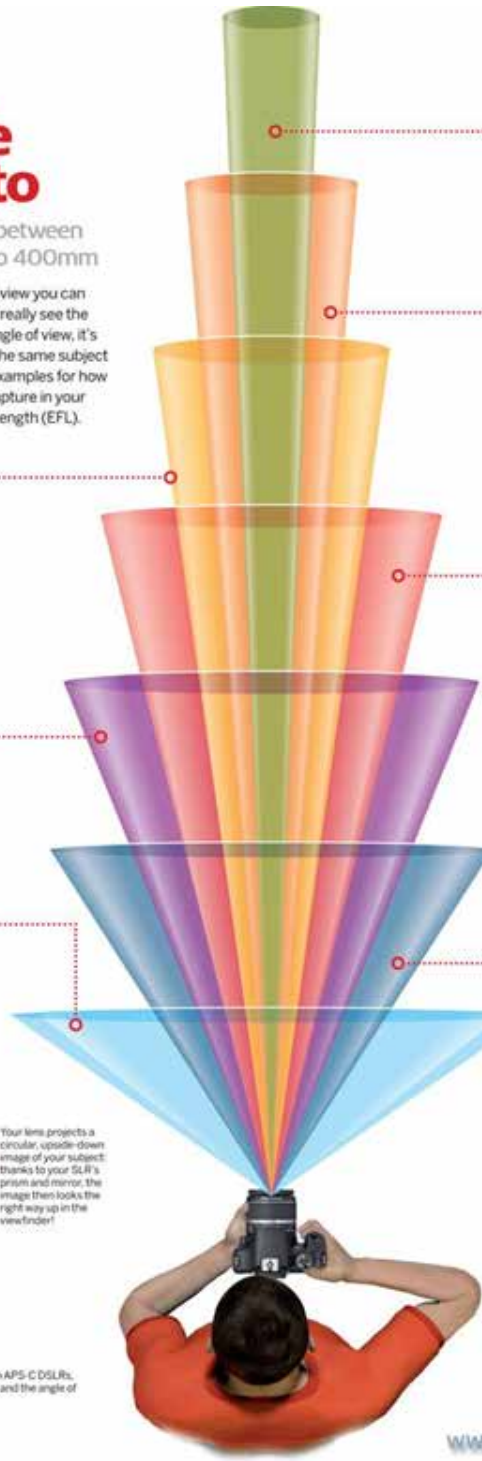
11mm (EFL: 18mm)

400mm (EFL: 640mm)

200mm (EFL: 320mm)

55mm (EFL: 90mm)

18mm (EFL: 28mm)



Effective Focal Length (EFL)

Your lens projects a circular, upside-down image of your subject: thanks to your SLR's prism and mirror, the image then looks the right way up in the viewfinder!

The view on a full-frame camera (sensor size: 36x24mm, same size as 35mm film).

The cropped view on APS-C DSLRs, the EFL is increased and the angle of view decreased.

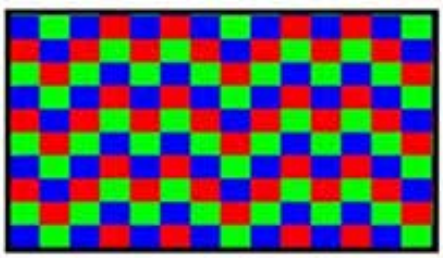
www.digitalcameraworld.com

CONCEPT OF
CAMERA SENSORS

Name	Full Frame	APS-C	Four Thirds	1/1.7"	1/2.3"	1/3.2"
Area						
Size	36 X 24 mm²	23.6 X 13.5 mm²	18 X 13.5 mm²	7.6 X 5.7 mm²	6.1 X 4.6 mm²	4.4 X 3.3 mm²
Camera Type	High End DSLRs	Midrange and Entry Level DSLRs	Olympus DSLRs	High End Compacts	Low-mid Compacts	Mobile Cameras
Cameras	 Nikon D810  Canon 5D MKIII	 Nikon D3300  Canon 1200D	 Olympus E-5  Panasonic Lumix DMC-L10	 Sony Cybershot DSC-HX300  Nikon Coolpix P610	 Sony Cybershot DSC-WX500/B  Canon Powershot SX610 HS	 Apple iPhone 5  HTC One

MEGAPIXELS (MP)

A megapixel is a unit of measurement equivalent to 1,000,000 pixels. Megapixels are often abbreviated as MP. A single pixel is a tiny square of visual information, and digital images or videos comprise numerous pixels arranged tightly together.



24MP Full Frame
DSLR Image Sensor

24MP 1/2.6
Smartphone Image Sensor

SHUTTER SPEED

The camera's shutter speed determines the duration of light which should enter into the sensor. The slower the shutter speed, the longer the shutter remains open. This means the medium records light for a longer amount of time, resulting in a brighter image. The faster the shutter speed, the less time the shutter stays open, which means the medium will record less light.

SHUTTER SPEED SCALE

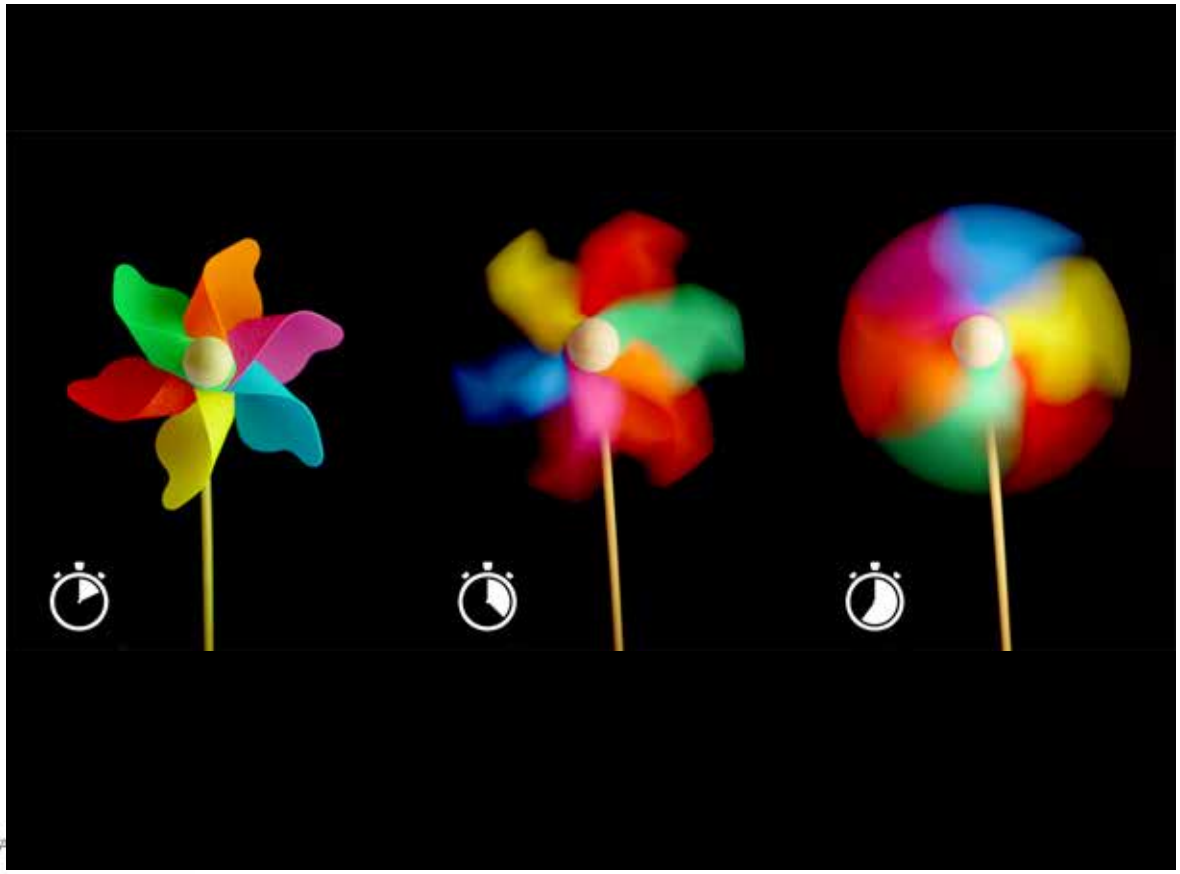
1/8000 1/4000 1/2000 1/1000 1/500 1/250 1/125 1/60 1/30 1/15 1/8 ¼ ½ 1 2 4 8 15 30

Shorter the shutter stays open ⟷ Longer the shutter stays open

Less light strikes image sensor ⟷ More light strikes image sensor

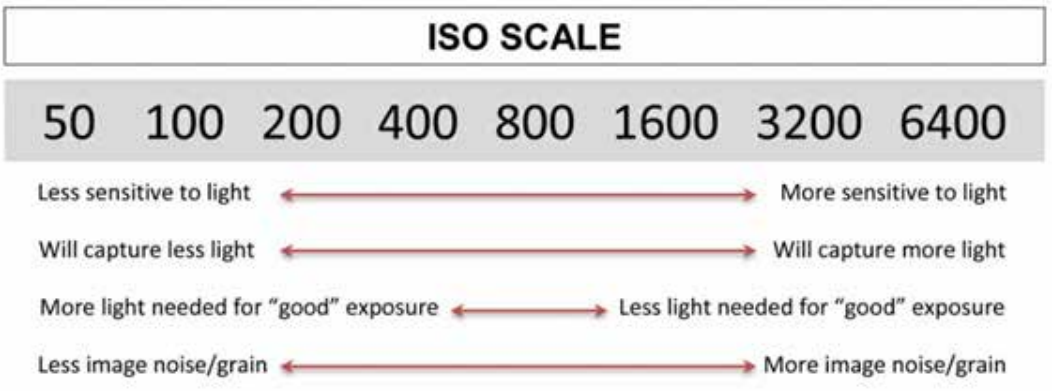
Freezes Motion ⟷ Shows motion

Less image noise/grain ⟷ More image noise/grain



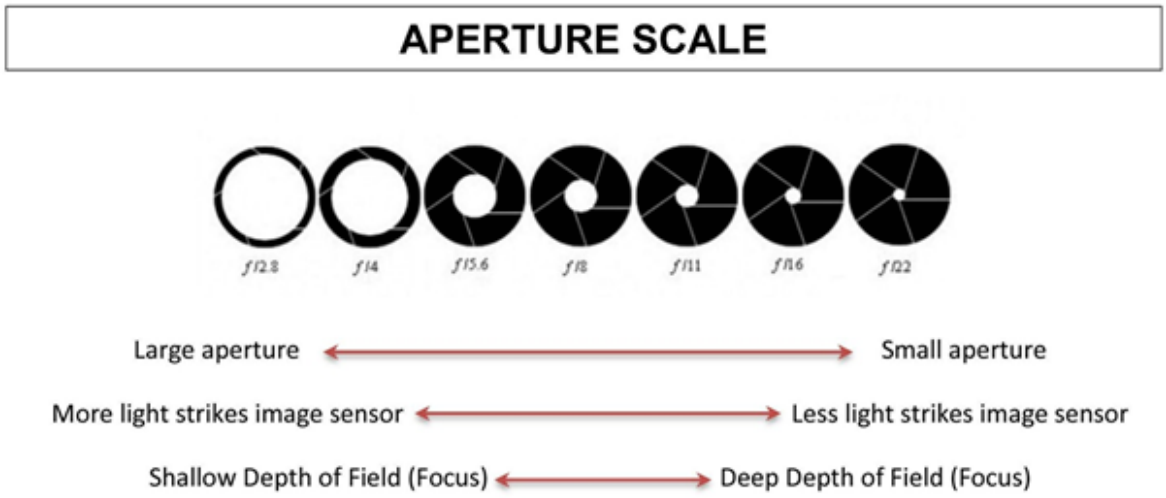
ISO

ISO is the sensitivity of the camera to light as it pertains to either film or a digital sensor. A lower ISO value means less sensitivity to light, while a higher ISO means more sensitivity. It is one element of photography's exposure triangle.



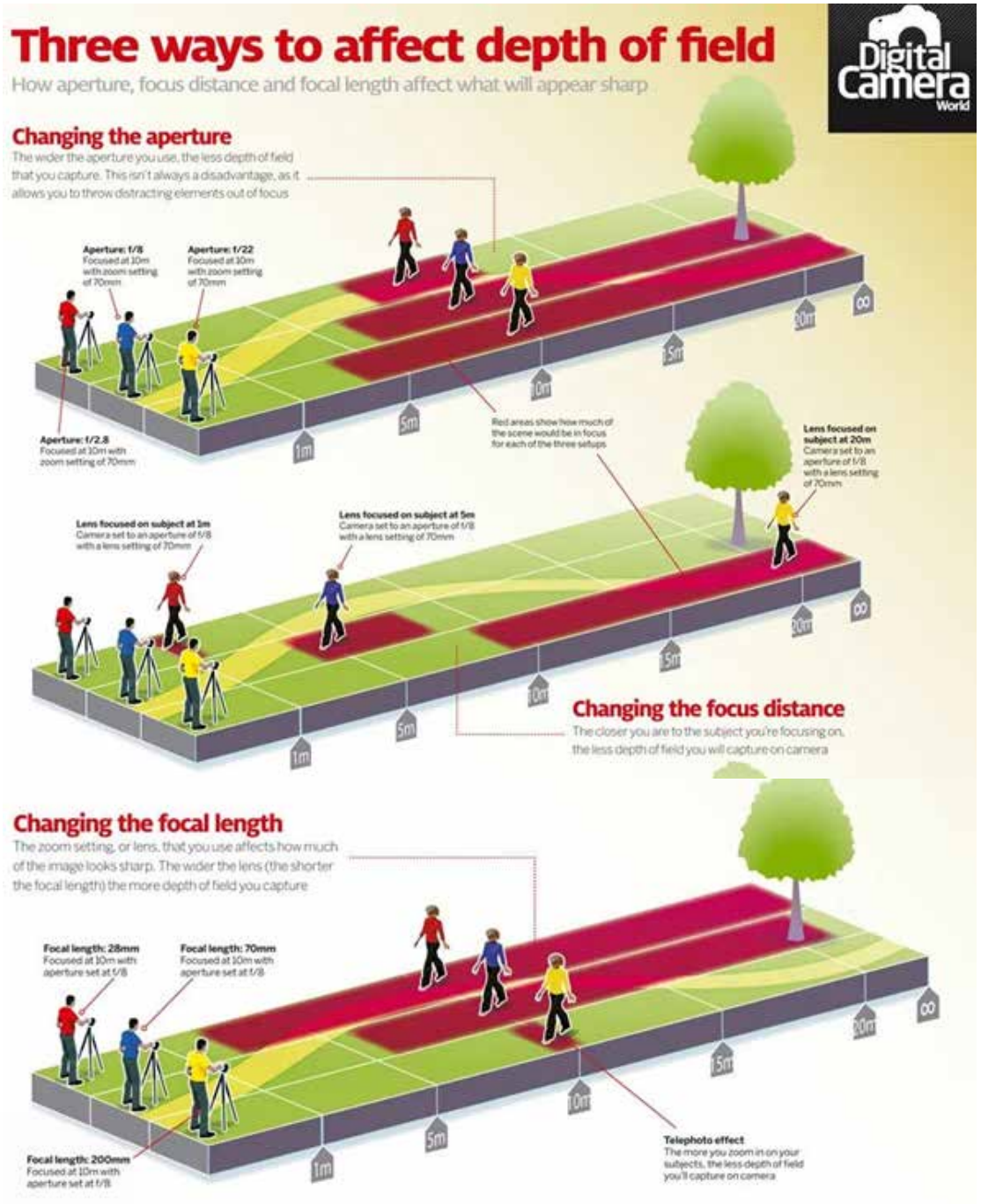
APERTURE

Aperture, which is the opening in the lens that light passes through before reaching the sensor. A larger hole will allow more light to pass through, while a smaller hole will allow less light to pass through. A key thing to remember with apertures is that smaller f-stop numbers (like f 2.0) refer to larger apertures or larger openings in the lens. On a given lens, the lowest f value is the largest aperture, allowing maximum light to enter the lens, while the highest f value be the smallest aperture, allowing the least amount of light to enter the lens. The range or the minimum f value is denoted in the lens.



DEPTH OF FIELD

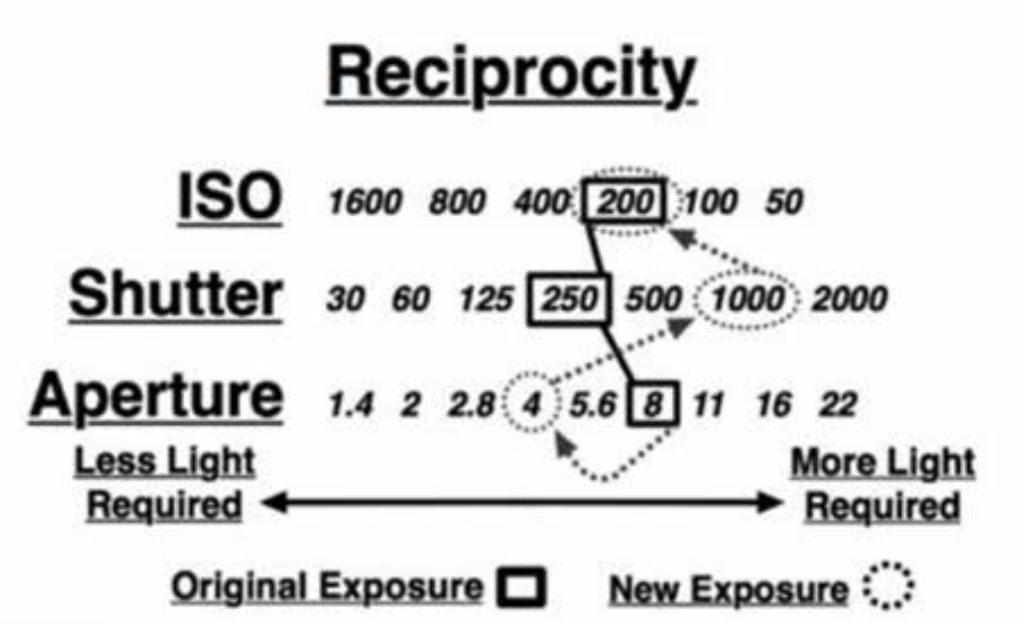
The depth of field determines which parts of the photo are in focus and it is controlled by aperture. The relationship between aperture and depth of field means. A wide aperture gives you a shallow depth of field (only the foreground is sharp) while a narrow aperture gives you a deep depth of field (everything is sharp).



STOPS IN CAMERA

A stop is a doubling or halving of the amount of light let in to the sensor when taking a photo. The amount of light captured while taking a photo is known as the exposure, and it is affected by three things - the shutter speed, the aperture diameter, and the ISO. These are all measured using different units, so the concept of "stops" was invented as a convenient way to compare them.

F – Stop Value (Aperture)	Shutter speed (S)	ISO
45	1/8000	25
32	1/4000	50
22	1/2000	100
16	1/1000	200
11	1/500	400
8.0	1/250	800
5.6	1/125	1600
4.0	1/60	3200
2.8	1/30	6400
2.0	1/15	12800
1.4	1/8	25600
1.0	1/4	51200

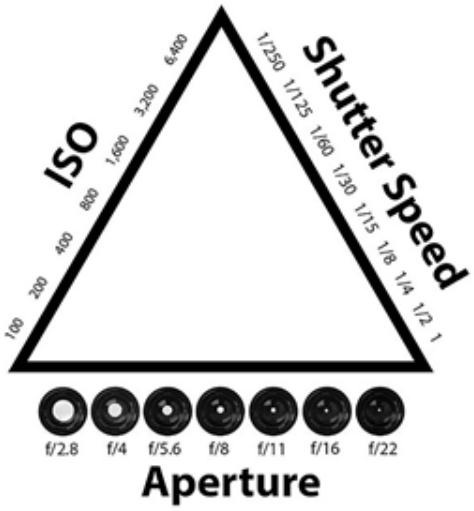


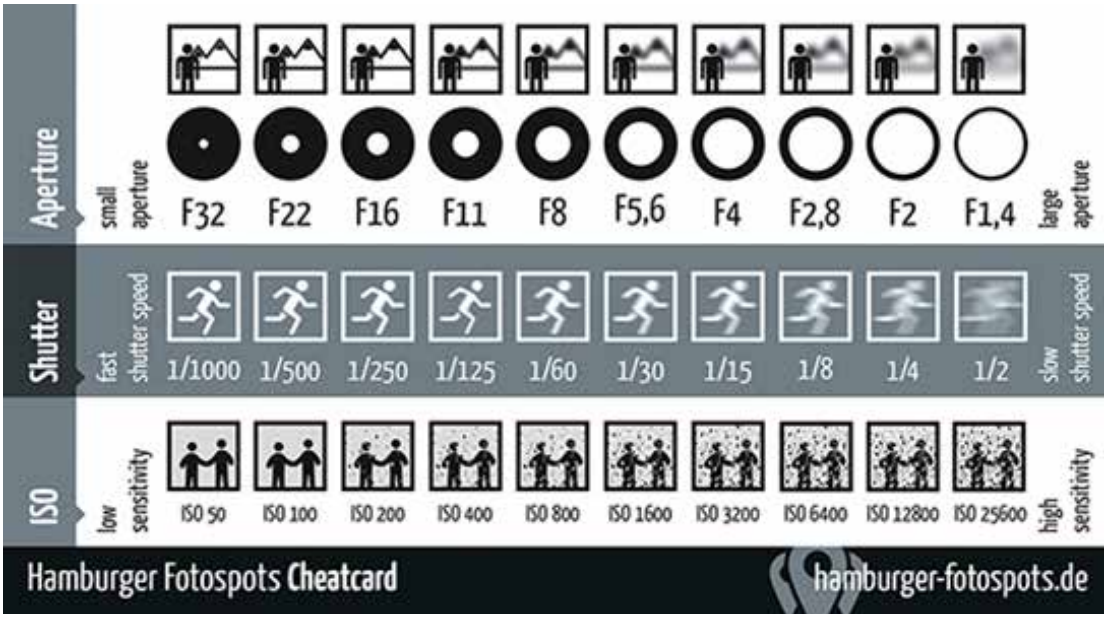
F-STOP CHART

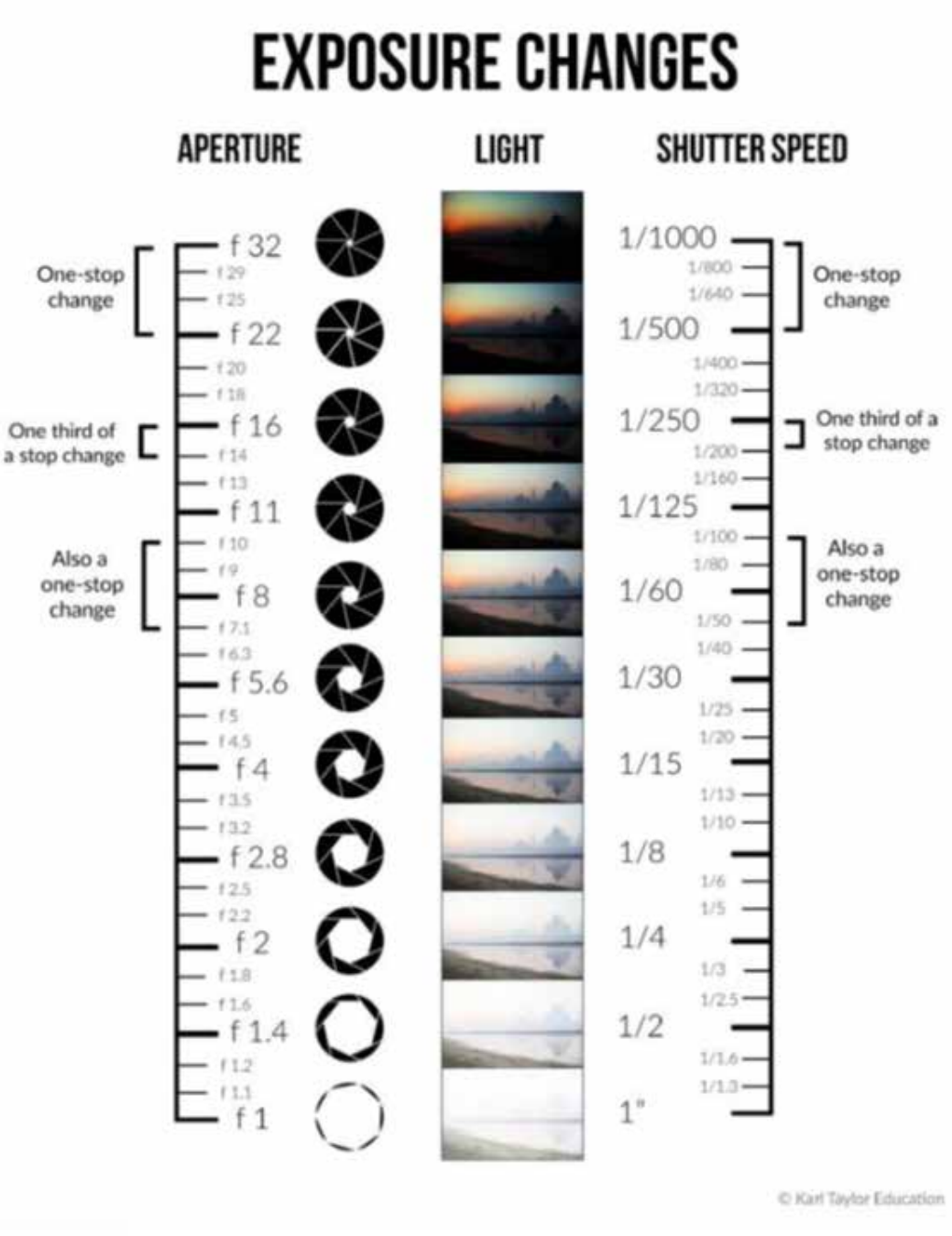
APERTURE	FULL STOP	1/2 STOP	1/3 STOP	DEPTH OF FIELD	LIGHT	SWEET SPOT
	f/1.0	f/1.0	f/1.0			
			f/1.1			
		f/1.2	f/1.2			
	f/1.4	f/1.4	f/1.4			
			f/1.6			
		f/1.7	f/1.8			
	f/2	f/2	f/2			
			f/2.2			
		f/2.4	f/2.5			
	f/2.8	f/2.8	f/2.8			
			f/3.2			
		f/3.3	f/3.5			
	f/4	f/4	f/4			
			f/4.5			
		f/4.8	f/5			
	f/5.6	f/5.6	f/5.6			
			f/6.3			
		f/6.7	f/7.1			
	f/8	f/8	f/8			
			f/9			
		f/9.5	f/10			
	f/11	f/11	f/11			
			f/13			
		f/13	f/14			
	f/16	f/16	f/16			
			f/18			
		f/19	f/20			
	f/22	f/22	f/22			

Source: Phototeraces.com

EXPOSURE TRIANGLE






EXPOSURE CHANGES
APERTURE
LIGHT
SHUTTER SPEED
One-stop change
One third of a stop change
Also a one-stop change
f 32
f 29
f 25
f 22
f 20
f 18
f 16
f 14
f 13
f 11
f 10
f 9
f 8
f 7.1
f 6.3
f 5.6
f 5
f 4.5
f 4
f 3.5
f 3.2
f 2.8
f 2.5
f 2.2
f 2
f 1.8
f 1.6
f 1.4
f 1.2
f 1.1
f 1
1/1000
1/800
1/640
1/500
1/400
1/320
1/250
1/200
1/160
1/125
1/100
1/80
1/60
1/50
1/40
1/30
1/25
1/20
1/15
1/13
1/10
1/8
1/6
1/5
1/4
1/3
1/2.5
1/2
1/1.6
1/1.3
1"
One-stop change
One third of a stop change
Also a one-stop change
© Karl Taylor Education

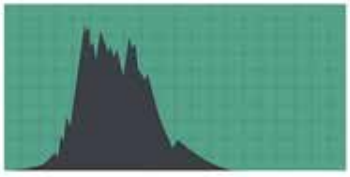
HISTOGRAM

A histogram is a graphic representation of the exposure levels within an image. The purpose of a histogram is to give the photographer a more accurate representation of brightness values. The X-axis of the histogram ranges from pure black to pure white values. On the Y-axis we have the number of pixels that recorded this tonal value. Taken together we get a graphical representation of a histogram.

UNDEREXPOSED

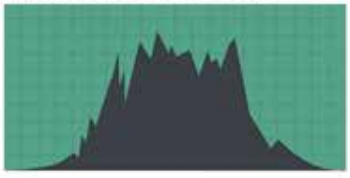
- The histogram is pushed to the left, clipping the shadows and dark tones of the image.
- If you try to recover the shadows in post-processing, you'll find color and luminance noise.
- The best way to correct this is to increase the exposure opening the aperture, using a slower shutter speed, or increasing the ISO.

EXPOSED TO THE LEFT



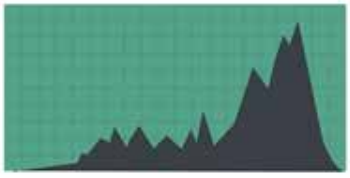
- The histogram is tilted towards the left side, but without crushing the blacks.
- It's the most common histogram in night photography, and you need to be careful raising the exposure/ shadows in post-processing since you could still find digital noise.
- If you don't have a high-end camera sensor, it's recommended to use a more neutral exposure to maximize the detail in your images.

NEUTRAL EXPOSURE



- The histogram falls under the midtones of the image.
- It's the best way to make sure that you are capturing all the information in the highlights and shadows.
- It might look too bright in your screen, but it can be easily adjusted in post-processing.

EXPOSED TO THE RIGHT



- The histogram is tilted towards the right side, but without blowing out the highlights.
- It's a very popular technique to avoid digital noise in your images.
- You need to be very careful since it's very easy to clip the highlights if you overexpose the photo further to the right.

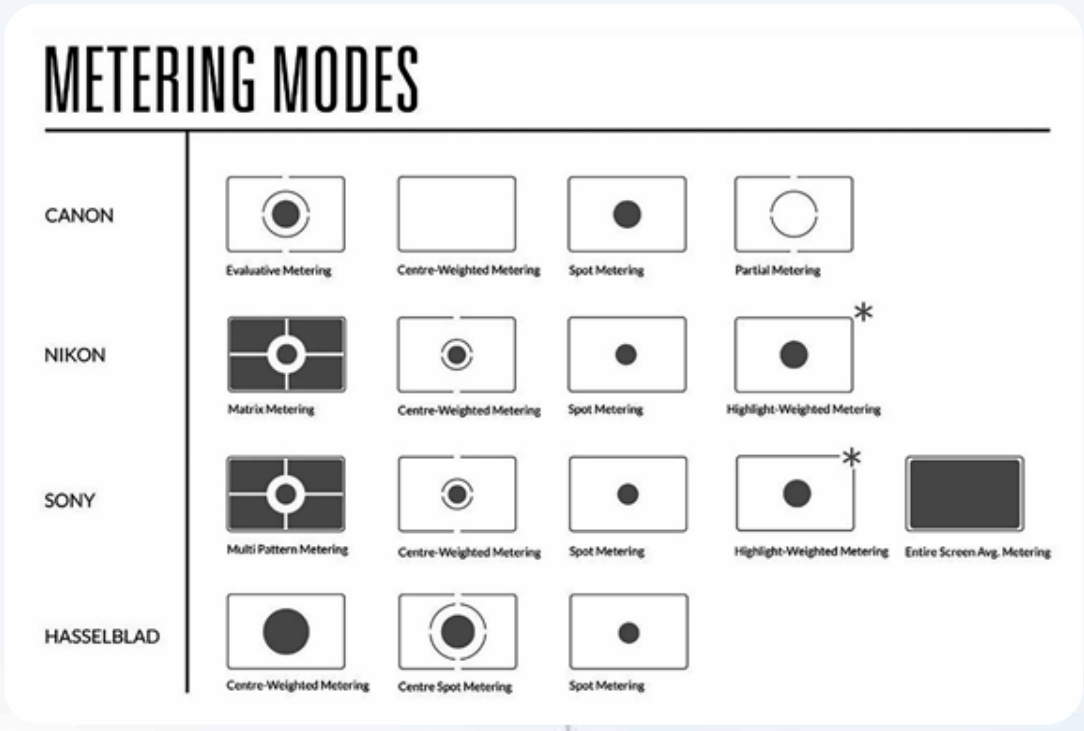
OVEREXPOSED

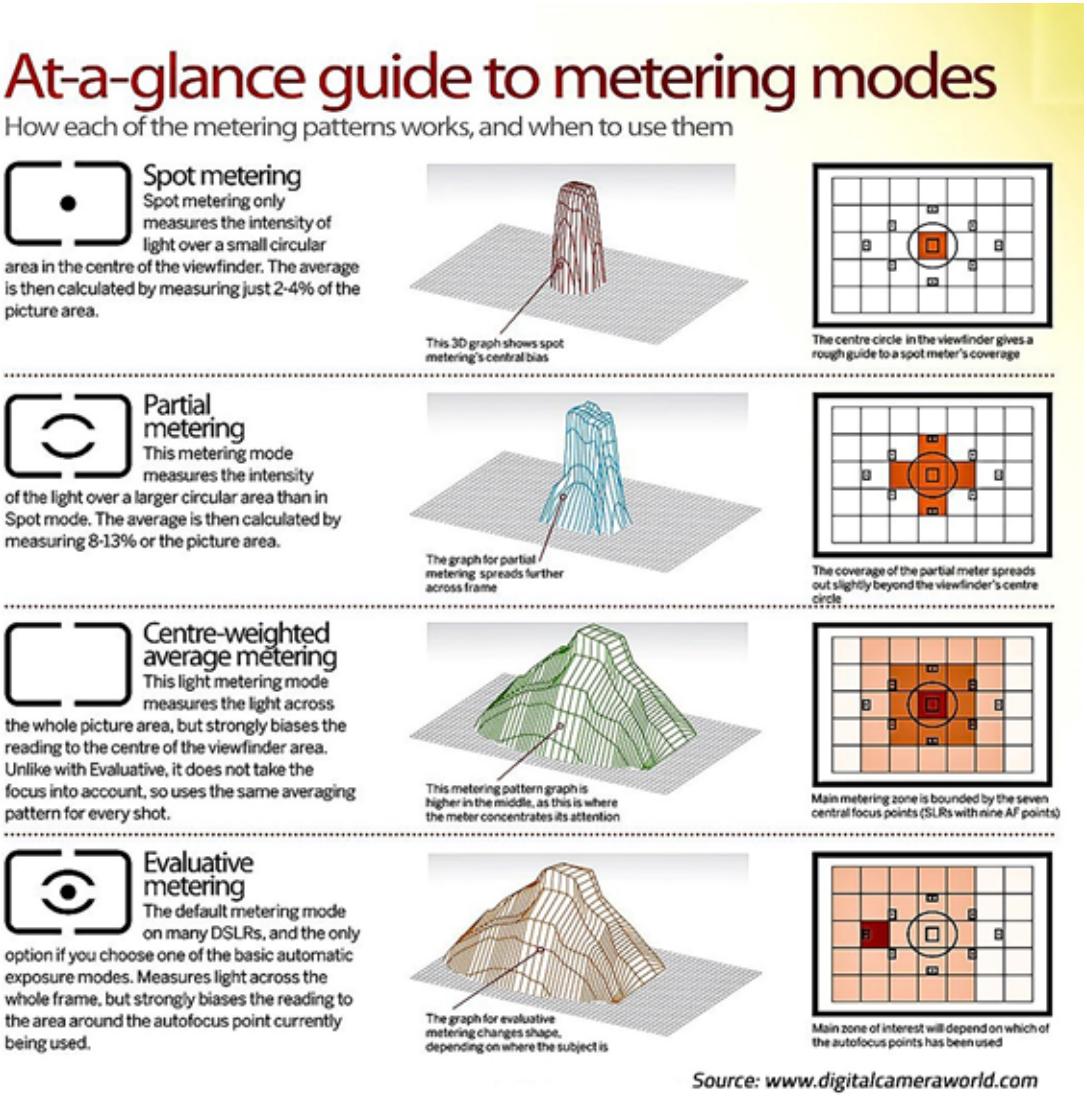
- The histogram is pushed to the right, burning out the brightest tones of the image.
- If you try to recover the highlights in post-processing, you'll find white areas with unrecoverable information.
- The best way to correct this is to decrease the exposure closing the aperture, using a faster shutter speed, or decreasing the ISO.

METERING MODES

Metering is how the camera evaluates the light of a scene to determine the correct shutter speed, aperture and ISO. Digital cameras have an integrated light meter that automatically measures the reflected light and determines the optimal exposure. The most common metering modes are:

1. Matrix Metering (Nikon), also known as Evaluative Metering (Canon)
2. Center-weighted Metering
3. Spot Metering
4. Highlight-weighted Metering





EXPOSURE COMPENSATION

Exposure compensation in the camera helps to find the correct exposure in situations with uneven light distribution, filters, non-standard processing, underexposure or overexposure lighting conditions. Since camera meters work by evaluating light reflected off subjects and are standardized on middle grey (also known as 18% grey), any time a camera is pointed at something very dark, the meter will work the opposite way by brightening up the exposure. In contrast, a very bright subject will cause the meter to darken the exposure, so that the resulting image is not too dark or too bright.

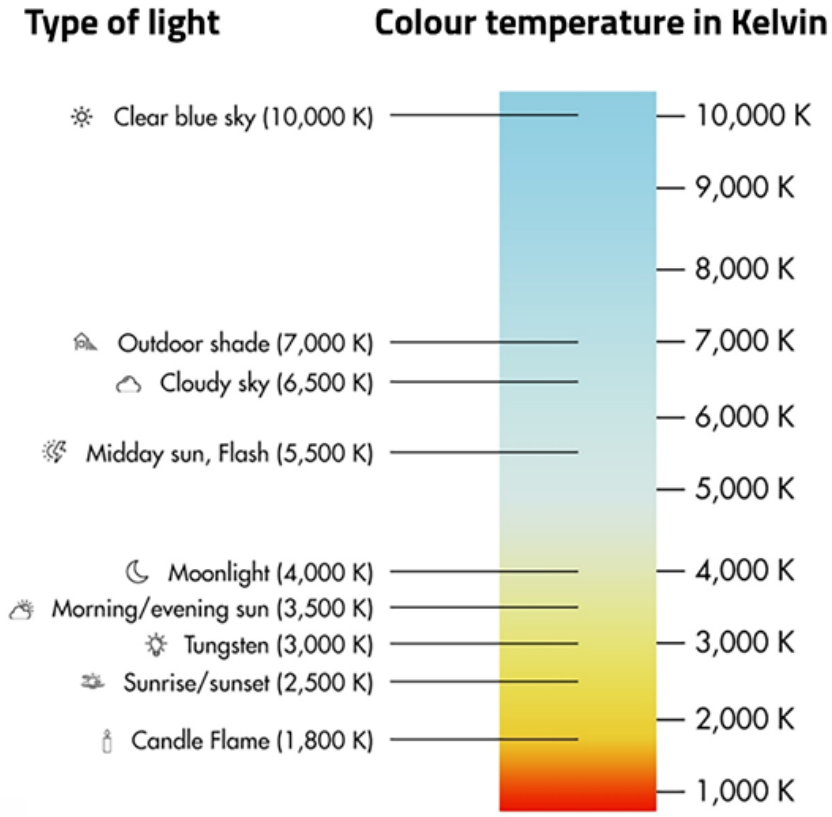
Exposure compensation in the camera is displayed as –1.0, –0.7, –0.3, 0.0, +0.3, +0.7, +1.0, where "+1.0" is one step brighter than the optimal exposure value selected by the camera. The value will be set by the camera by analysing the overall lighting of the subjects. You need to analyse the histogram to correct over-exposure compensation.

The exposure compensation works differently in different camera modes:

- **Aperture priority mode:** This mode manually sets your aperture, while the camera automatically sets a shutter speed. Exposure compensation in this mode works by changing the shutter speed to get the right exposure.
- **Shutter priority mode:** Essentially, the opposite of the aperture priority mode, you manually set the shutter speed while the camera automatically sets the aperture. Exposure compensation then works by changing the aperture to the right exposure.
- **Program mode:** This mode manually set both your aperture and shutter speed. The exposure compensation works by changing the shutter speed.

WHITE BALANCE

White balance is used to adjust colours to match the colour of the light source so that white objects appear white. Subjects may be lit by a number of different light sources. Although all these light sources may appear colourless to the naked eye, they emit light of different colours. The image sensor in a digital camera will reproduce these colour differences just as it is. As a result, without additional processing the colour of the photograph would appear to change according to the colour of the light source.

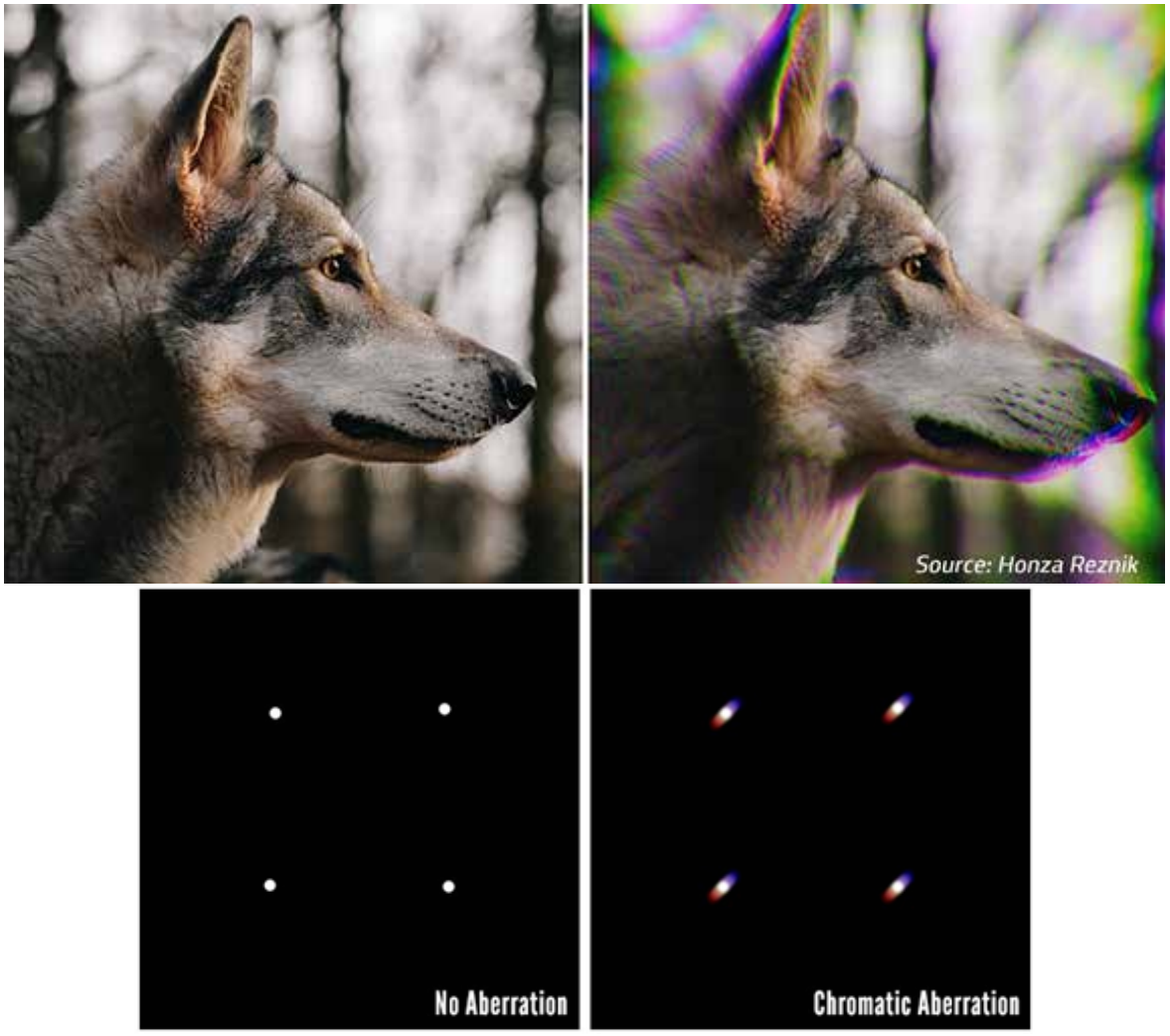


Source: Expert photography

ABERRATIONS

It is an imperfection that occurs during capturing images in the way, the lens fails to converge the rays of light at a single point. Aberrations affect sharpness, focus, magnification, distortion, and colour, adversely affecting the accurate reproduction of the images. Different types of aberrations are there and more than one kind of it may occur in a single event. The aberrations are evidently seen at the margins of the subjects in the frame. The aberrations are broadly categorized into chromatic aberrations and monochromatic aberrations.

Chromatic aberrations



www.lonelyspeck.com/a-practical-guide-to-lens-aberrations-and-the-lonely-speck-aberration-test/

Chromatic aberrations are also known as colour fringing where the lens cannot focus various wavelength of colour at the same point which results in blurred images, especially in the edges of the subjects like a coloured haze, appears on a subject's edges, decreasing clarity and sharpness. Chromatic aberrations still occur in faster lenses and those capturing high-contrast areas, such as a dark subject set against a bright background.

- **Longitudinal chromatic aberration:** "LoCA" or "bokeh fringing" occurs when different wavelengths of colour do not converge at the same point after passing through a lens, leading to colour fringing around subjects throughout the entire image, from the center to the edges.
- **Lateral chromatic aberration:** "Transverse chromatic aberration" occurs when, due to the angle of light entering the lens, different wavelengths of colour focus on the same plane, but at different positions. Lateral chromatic aberrations are visible only at the edges of the frame.

Monochromatic Aberrations

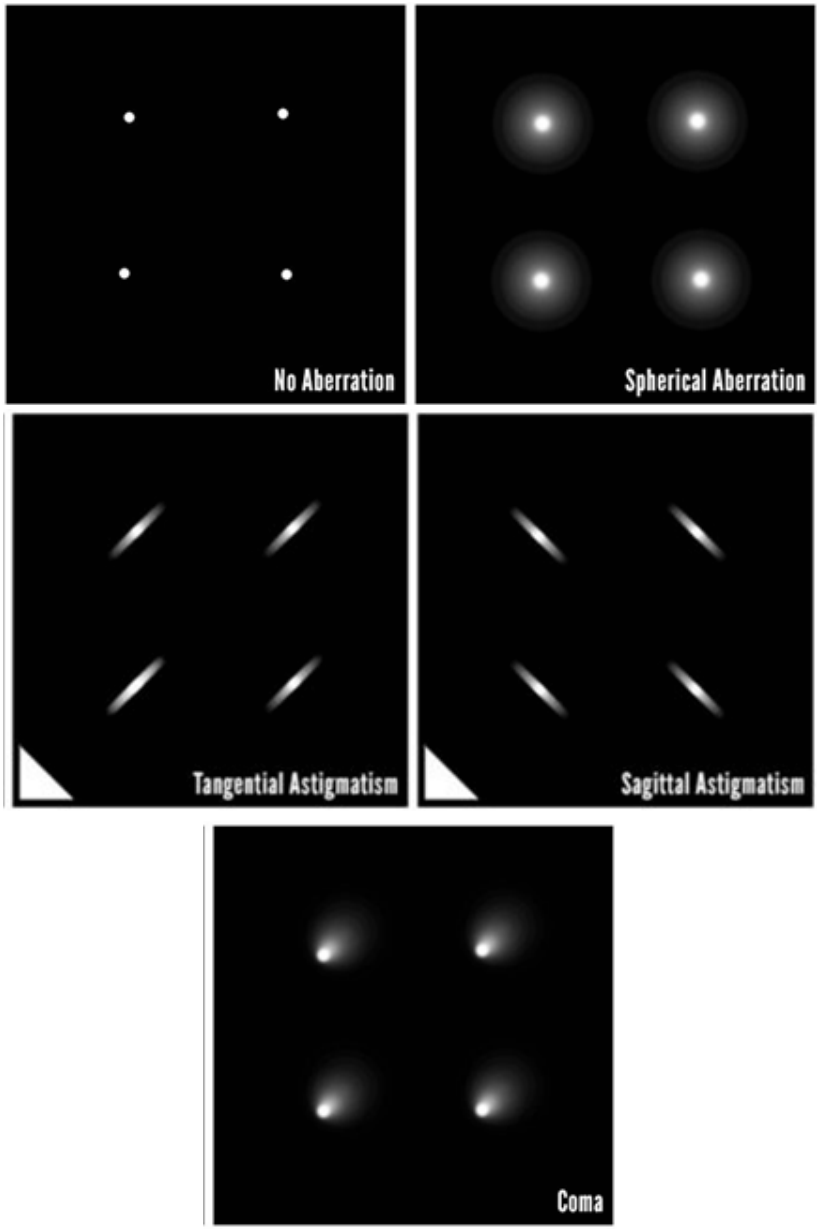
Monochromatic aberrations are due to imperfections in the lens optical system in which lenses fail to focus a single colour of light.
The subtypes of monochromatic aberration are;

1. **Spherical aberration:** Spherical glass elements in the lens cause light to converge at different places on the sensor. The lens will refract light that enters near the edge more than light that enters near the center. Lens element designs and the quality of the lens are the main factors that causes spherical aberrations, controlling the aperture reduces this aberration.

2. **Comatic aberration:** This aberration occurs when a single point of light enters a lens at an angle at its edge, rather than straight on at the center of the lens. Here, the lens is not able to focus angular light rays at the same point, so that the point light sources flare out from the point which leads to the formation of a comet-shaped highlight. Comatic aberrations are more visible at the edges of frames in the images captured with wide apertures.

3. **Astigmatism:** Astigmatism results from rays entering the lens along the sagittal plane and being focused at different points than rays along the tangential plane. Astigmatism creates distortion along the edges and in the corners of an image. In which the light sources at the edges of the frame stretch in a line shape.

4. **Field curvature:** This aberration is the imperfection of the images that occurs when the lens focuses light onto an imaginary curved surface rather than a flat plane. In this kind of aberration, the focus issues across an entire image: The center appears to be in focus, but the edges are out of focus. Stopping down a lens can reduce the effects of field curvature.

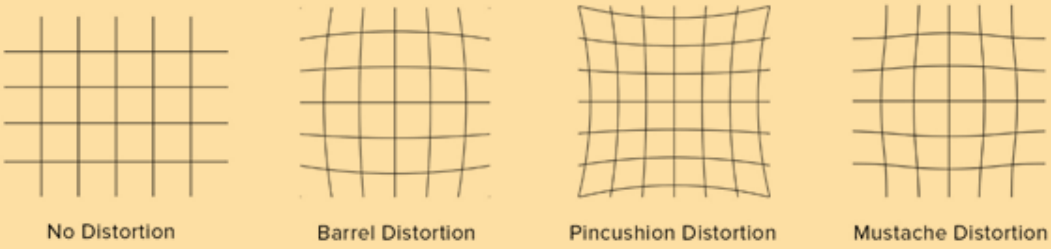


www.lonelyspeck.com/a-practical-guide-to-lens-aberrations-and-the-lonely-speck-aberration-test/

DISTORTION

When the lens projects a wider scene across a sensor or film plane, the image fails to retain its rectilinearity. Distortion, which can happen vertically or horizontally, is most noticeable when trying to capture straight lines.

- **Barrel distortion:** is when the captured scene looks smaller at the edges of the image than in the center.
- **Pincushion distortion:** is when the scene at the edges of the frame looks bigger than the center.
- **Mustache distortion:** is when a lens shows both types and lines appear wavy due to central and edge distortions.



LENS FLARE OF CAMERA

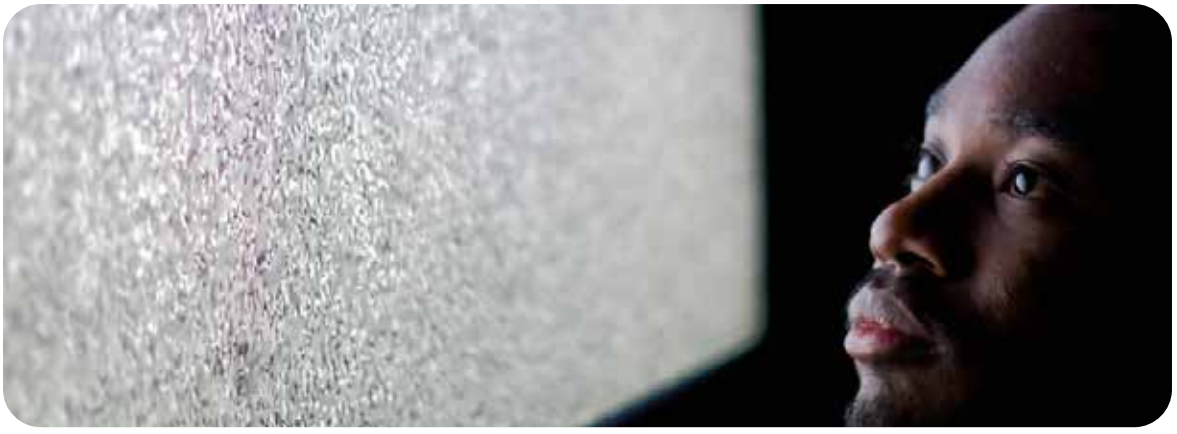
Lens flare is a photographic phenomenon in which bright light enters the camera lens, hits the sensor, and scatters. Lens flare is a response to a bright, non-image forming light or artificial lighting which forms a specular flare presented as orbs or streaks or a veiling flare presented as a haze or blur. Lens flare can be reduced by

- Shoot with the light source behind you which is not hitting direct to the sensor from the front.
- Always use a lens hood.
- Reframe your image to block direct light hitting the sensor.
- Adjust the focal length. Zooming in or out a bit can eliminate or reduce lens flare.
- Keep your lenses clean. Dust in the lens can reflect light inside the lens, which results in flare.

NOISE IN PHOTOGRAPHY

Noise can be defined as a random variation in the image signal. Noise results in the quality of the images and in most cases, details of the images will be lost and make the image appear unclean. It can be caused by a number of factors, including poor lighting conditions, high ISO settings, long exposure times, and heat. Noise can also be introduced into an image during the editing process. Noise can be reduced by considering these factors.

1. Try to keep a lower ISO setting which is optimum to the light conditions. Know the optimum higher ISO level in your camera which can produce less noise images.
2. In long exposure, consider using a noise reduction filter.
3. Using tripod. Tripod keep your camera steady and prevent any shaking that could introduce noise into your photos and also you can set lower shutter speed in low light conditions.
4. Try using a remote shutter release.
5. Shoot in RAW format. This file format captures all of the data from your camera sensor, giving you more information to work with when you're editing.



Reduce noise in Adobe Photoshop

In Photoshop, choose Filter > Noise > Reduce Noise and select your desired options:

Strength — Controls the amount of luminance noise reduction to be applied.

Preserve Details — Preserves edges and image details.

Reduce Colour Noise — Removes random colour pixels.

Sharpen Details — Sharpens the image.

Always keep in mind that Removing noise reduces image sharpness.

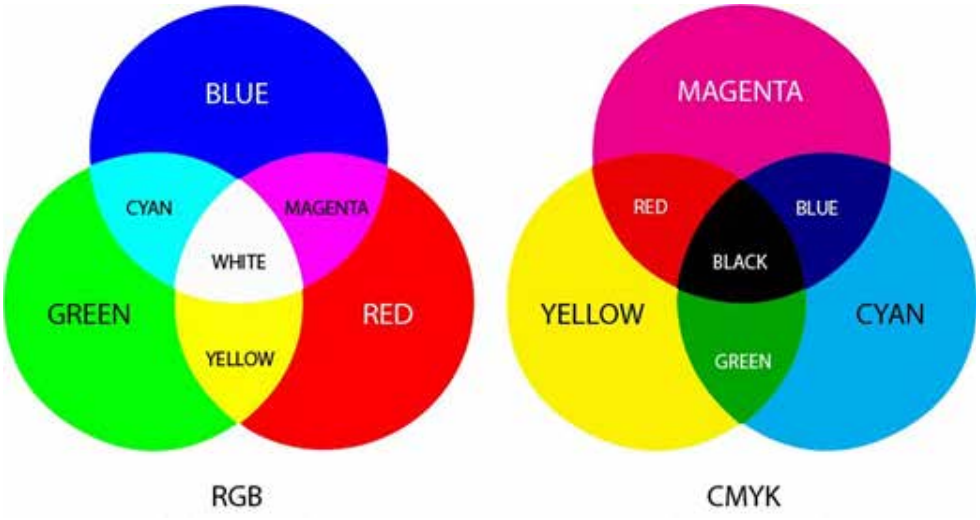
CMYK is a subtractive colour spectrum. This means that these inks mask colours on a lighter background (like a white paper). The CMYK ink subtracts the red, green and blue from white light and leaves the Cyan, Magenta, and Yellow. Black is the absence of colour.

The CMYK colour model works by partially or entirely masking colours on the lighter surface (paper or substrate). The ink reduces the light that would otherwise be reflected.

The RGB colour model works the opposite. RGB is an additive colour spectrum. When RGB colours overlap, the results are subtractive colours (cyan, magenta, yellow) RGB colour model uses transmitted light. Additive colour models use light to display colour, while subtractive (CMYK) colour models use reflected light.

RGB colour space is primarily used on digital displays (computers, tablets, TVs, etc) and uses the light from the device to display the colour. The colours result from transmitted light. When all spectrums from the RGB colour space overlap, the result is white.

CMYK colour space is primarily used for printed material and uses ink to display colour. The colours result from reflected light. When all spectrums from the CMYK colour space overlap, the result is black.



DEFINING MACROPHOTOGRAPHY

Close-up photography: This term has been co-opted by the movie industry. A close-up is generally considered to be a tight shot of a single person or another object of similar size. Close-up is a term that most people can understand.

Microphotography: Microphotography results in microphotographs: that is, microfilm images. You wouldn't apply this term to pictures taken through a microscope although it is sometimes (incorrectly) used.

Photomicrography: This is the correct term for taking pictures through a microscope. Although photomicrography is chiefly within the purview of scientists and researchers.

Macro photography: Macro photography is considered any picture taken from about 12 inches or less from the subject, down to half an inch or even closer. Macro is derived from the Greek word makro, meaning long, it comes to mean large and the exact opposite of micro. However, that's not exactly the case in photography. A macro photograph is not a huge picture (the opposite of a microphotograph) but rather a normalsized photo of a tiny object that has been made to appear large.

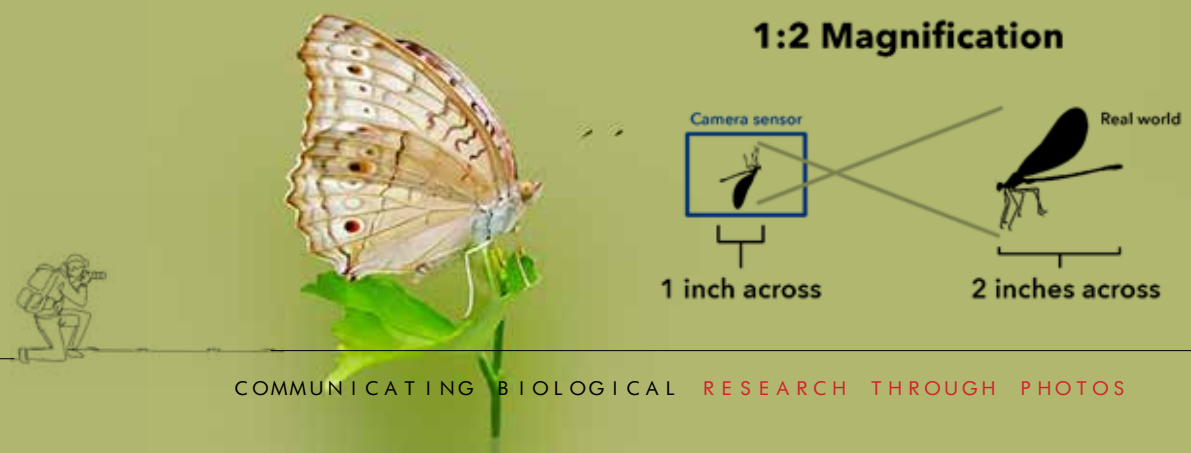
Terms to remember in Macrophotography

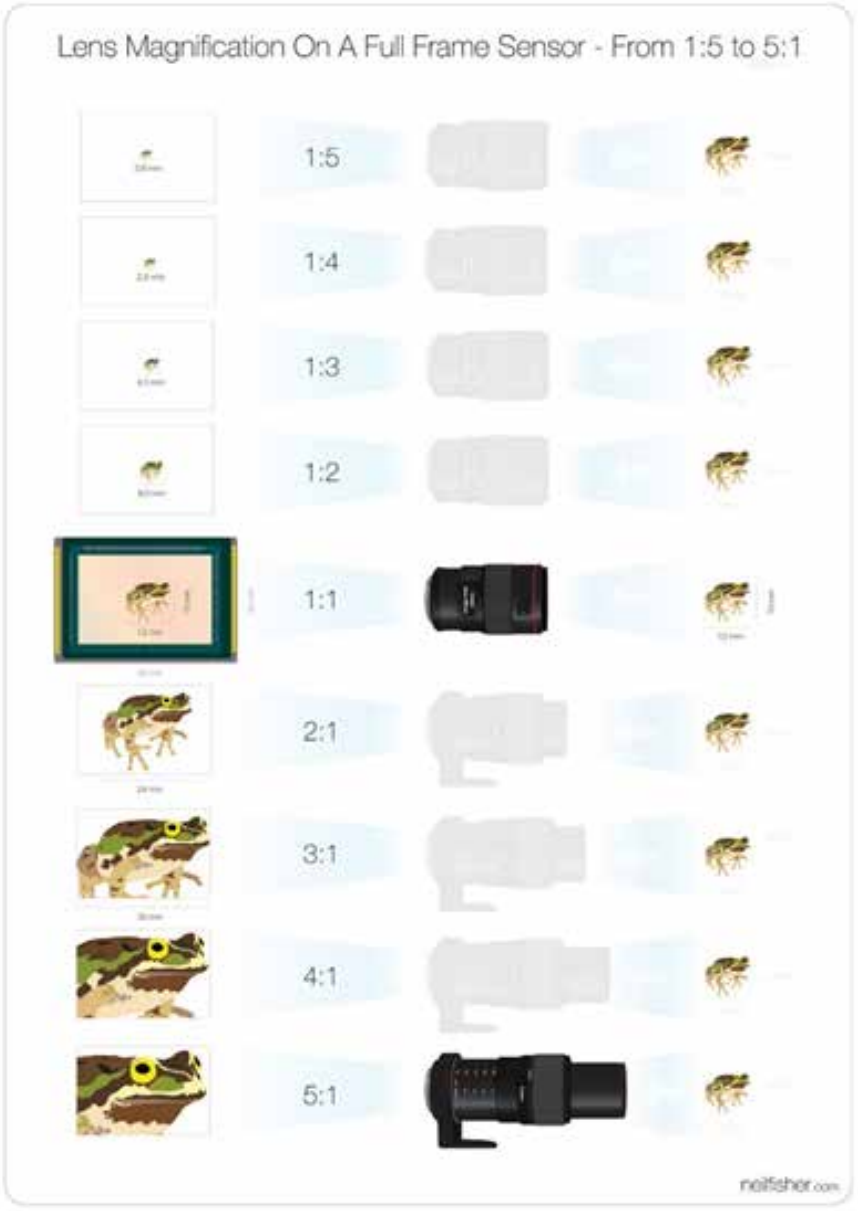
Focal length

Focal length is the distance between the optical center of the lens and the image plane, is one important factor when considering a macro lens. The longer the focal length—the more telephoto the macro lens—the more magnification you can get from the lens. The concept may not be necessarily true, since certain macro lenses of all different focal lengths obtain a 1:1 ratio.

Magnification in Macro Lens

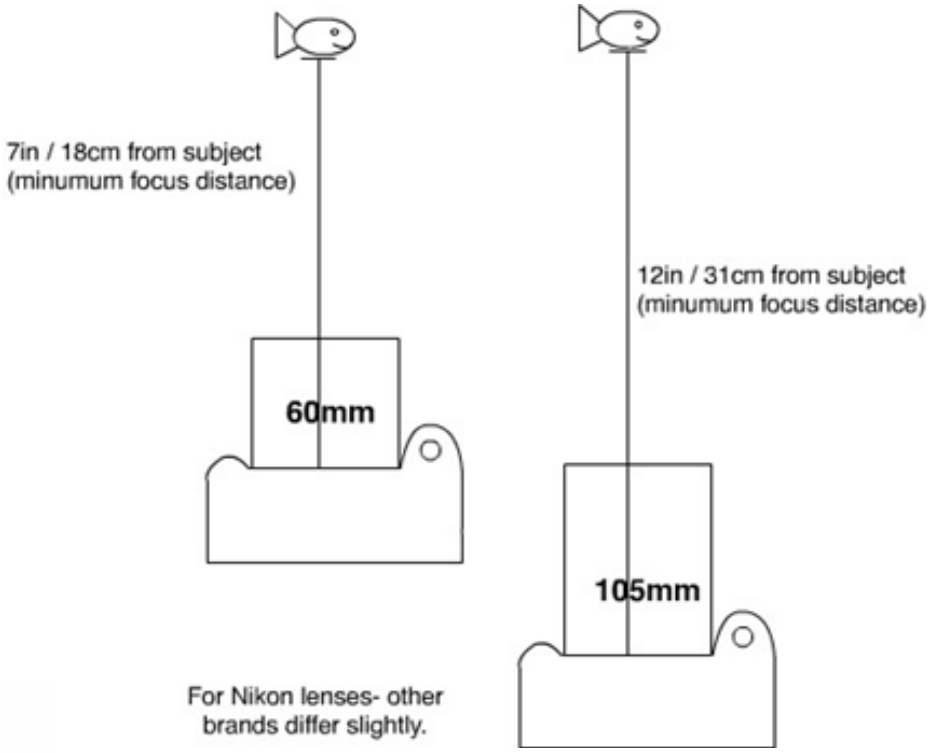
Magnification (reproduction ratio), is a property of a camera lens which describes how closely it is focused. Specifically, magnification is the ratio between an object's size when projected on a camera sensor versus its size in the real world. Magnification is usually written as a ratio, such as 1:2, which is said as "one to two magnifications."





Two macro lenses that provide 1:1 reproduction produce the same image here. The longer focal length lens offers a greater working distance between lens and subject.


100mm Macro Lens
60mm Macro Lens


7in / 18cm from subject
(minumum focus distance)
60mm
12in / 31cm from subject
(minumum focus distance)
105mm
For Nikon lenses- other
brands differ slightly.

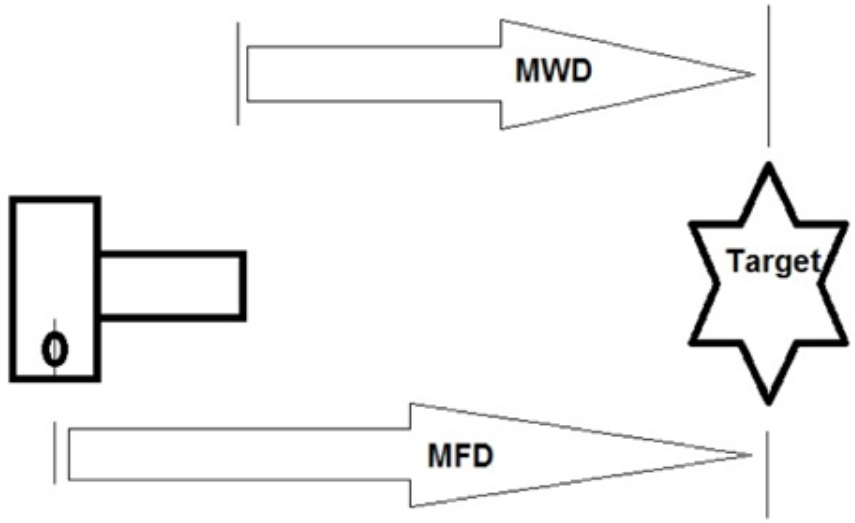
Minimum focusing distance (MFD)

This is a lens's construction characteristic. MFD is the shortest distance at which a lens can focus. In the case of DSLR cameras, the focus distance to the subject is measured from the focal plane mark on the camera body, not from the front of the lens. MFD is important because 1:1 or life size reproduction ration only happens at the MFD of any true macro lens.

Minimum working distance (MWD)

It is the distance from the subject to the front of the lens barrel (excluding the lens hood), while the lens is set to its maximum magnification (that is its MFD).

There are various online tools are available to calculate MWD. MWD is the combination of characteristics of lens and camera, as different cameras contribute differently to the MWD.



MACROPHOTOGRAPHY FOR SCIENTIFIC RESEARCH

Macrophotography is the art of creating extreme close-up photographs of very small subjects, in which the size of the subject in the photograph is greater than life size. You often need a microscope or other magnifying objects to view these subjects. "Macro" means big and "micro" means small, but in photography, they both refer to making small things look bigger than their life size.
The major factors influencing a good macrophotograph are;

1. Equipment

a) Macro lenses

Specialized lenses are needed for taking macrophotographs. Choose lenses of appropriate focal length. Larger focal length lenses have a longer working distance so these lenses are ideal for taking photographs of living organisms which are moving and response to human presence. For example, for photographing a butterfly or a house fly. Smaller focal length lenses (cheaper than longer focal length macro lenses) are used mostly for sedentary/ stationary subjects, so that we can go closer to the subject and hence the working distance is small, for example, for photographing a flower, sedentary subjects. While choosing macro lenses, one should consider the nature of the subject that need to be photographed and the lens components such as the focal length, Minimum focusing distance (MFD), Minimum working distance (MWD) and its Magnification (reproduction ratio).

b) Extension tubes and Macro Bellows

One of the alternatives to lenses is extension tubes or adjustable bellows. They are used with interchangeable lenses to increase magnification. They are plastic or metal tubes that sit between the camera body and the lens without any optical elements. One of the major disadvantages of these extension tubes is shallow depth of field.

c) Close up- lens

Close up- lens are also known as close-up filters or macro filters. They are secondary lenses which allow the primary lens (existing camera lens) to focus more closely. Chromatic aberration is a major disadvantage in using these close up- lenses. Latest close up- filters like Raynox filter is a better option.

d) Flashes

Flashes are devices which are used to emit light momentarily. They are used to compensate for the lack of brightness mainly while shooting in poorly lit conditions like night scene or shooting indoors. Many cameras have built-in flashes, and some models allow external flashes that are more powerful than the built-in ones.

Some of the important flashes used for scientific purpose are:

- **Normal flash and Speedlights**

- **Ring flash:** Ring flashes are used mainly in very close distance shooting. The flash tubes are permanently built-in into a ring in these types of flashes. They are useful in field photography of subjects like butterflies that are two- dimensional and which do not have a reflective surface.

- **Twin flash:** Twin flashes are the best flashes used in macro photographing three-dimensional subjects. They have two flash heads which are freely movable, allowing the photographer to sculpt a macro image's light perfectly.

e) Diffusers

Diffusion of light is the key to a good macro image. A diffuser is a simple light modifier, which softens the harsh concentrated burst of light from the flash before it hits the subject, making the photograph look more natural. They help in avoiding heavy shadows formed by strong lighting due to flashes. The different types of diffusers are, Clip-on Box diffuser, Dome diffusers.

Beetle diffuser

f) Stacking Rails

Stacking rails are accessories that adjust the camera position relative to the subject and enable in taking a series of shots with narrow depth of field, which are combined together using focus stacking.

g) Microscope objectives

DSLR can be mounted with microscope objective lenses to take macrophotographs. But one of the major disadvantages in using a microscope objective is that the images will have a shallow depth of field.

h) Tripods

Tripods help in setting the camera stable and secure while capturing close-up images.

i)Background for photographing macro subjects

In macrophotography the background should always complement the subject. Anything can be a background, from a green leaf to a piece of cloth, but the most important thing is to use it in a creative way to make the background look as good as possible and complement the subject. The photo will grab attention only if the colour contrast of the subject is strong against the background.

2. Lighting

Lighting is a major factor which determines the quality of a macro image. The lighting should always mimic natural lighting. Macro photographs can be taken either using

natural light or by using a flash for extra illumination. While using a flash, always aim at perfect diffusion of light by using a diffuser. Perfectly diffused light gives a good photograph. The convention in scientific illustration is to have the origin of light coming from the upper left-hand corner from about 45° off the surface.

3. Depth of field

Depth of field is the distance between the nearest and the farthest objects in a photo that appears acceptably sharp. In macrophotography, depth of field is important as it ensures that the details of the subject are sharp.

4. Focus

When dealing with a live subject in macrophotography, always focus in its eyes. This gives a more live and meaningful photograph of the subject. Always try to use a tripod to stabilize the camera. Good photographs are always created, not taken. Hence if you can't get the whole subject in focus, take multiple snaps with different parts of the subject focused. During post processing, stack these series of photos (focus stacking) using a suitable software.

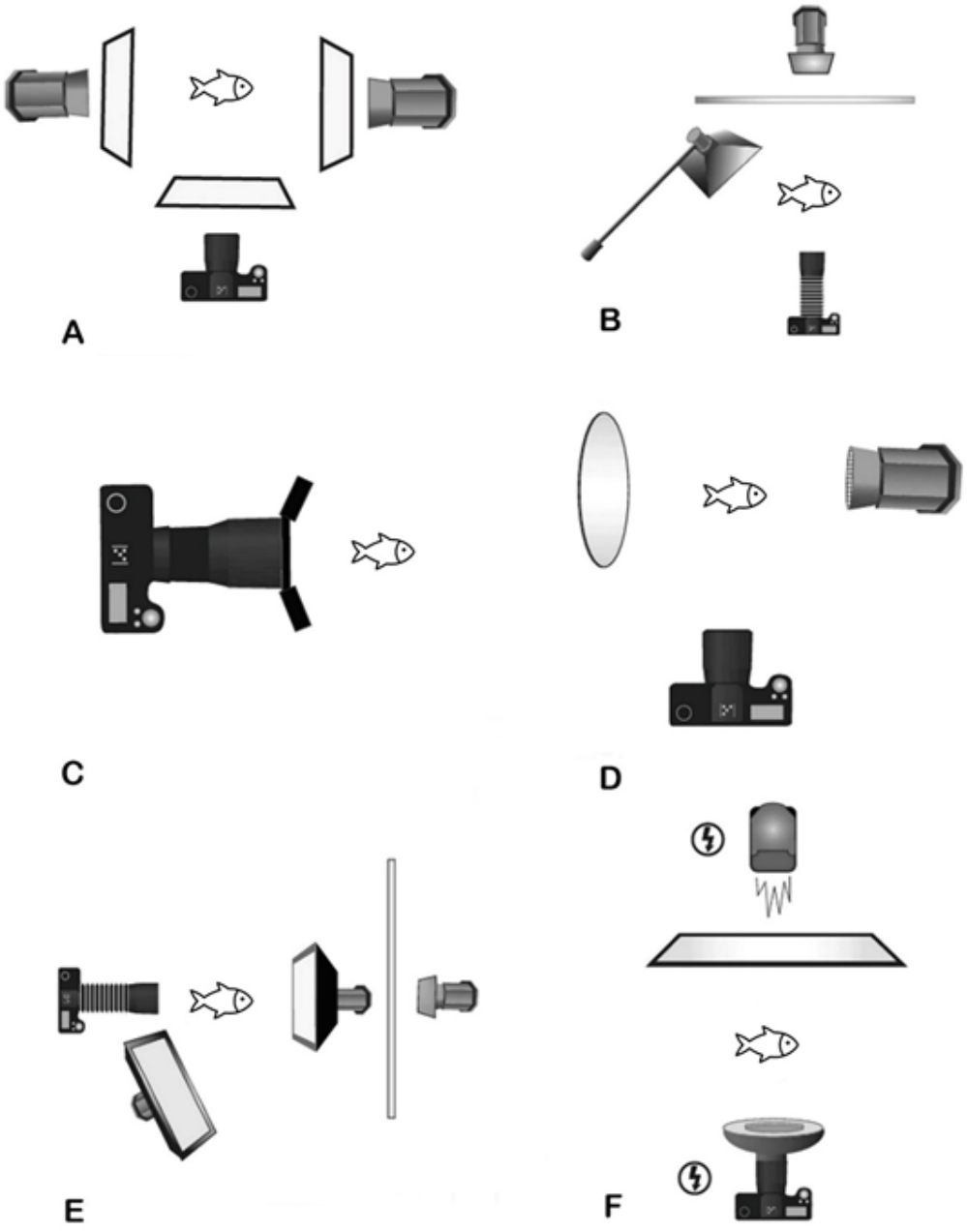
5. Composition

The art of arranging visual elements within the frame while taking a photograph is known as composition. The composition impacts the way a photograph is perceived by a viewer. The concept of "lead room" is important while photographing a live subject, this means that the frame should contain additional space in the direction in which the animal's eyes are looking. The choice of the imaging angle (the Golden Angle) determines how a simple subject can be made visually impressive. Basic rules of composition are useful in aesthetic macrophotography and in nature images for papers, but it is limited in scientific macrophotography. For scientific purposes composing a photograph is not mandatory but the command over composition will help to improve the aesthetics of the subjects.

6. The Subject

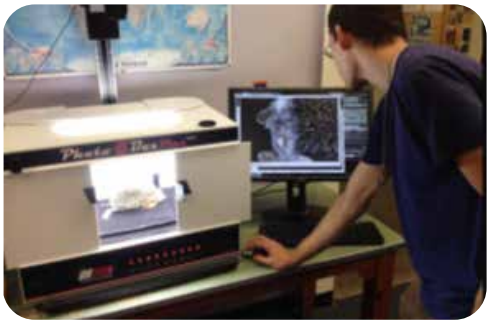
Knowing the subject is an important factor in macrophotography. In scientific research, in order to capture movement and actions of a live subject the behaviour of the subject should be understood first. Understanding the actions and behaviour helps in capturing some rare moments for example predation, mating, egg laying, life cycle etc. in some organisms. This adds scientific and aesthetic value to the work.

Arrangements of Lights and reflectors for macrophotography



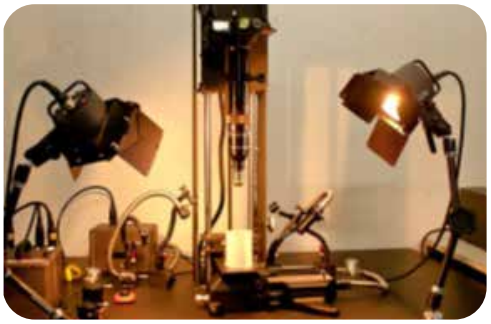
PHOTOGRAPHIC TECHNIQUES USED IN SPECIMEN PHOTOGRAPHY

Photo e-Box (Light Box)



- Box lined with continuous fluorescent lighting and 1-foot LED Light Strip.
- Diffused light eliminating shadows, reflections, and hotspots.
- Camera mounted above the box on a copy stand or in front of the box on a tripod.

Copy Stand

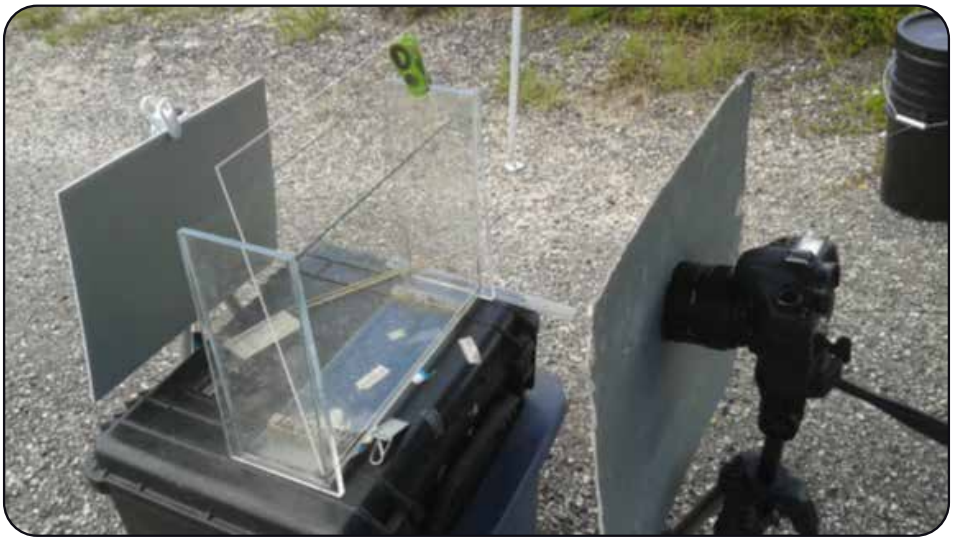


- Camera connected to a lift that can manually be raised or lowered.
- Stationed between light units (flash or continuous) which are placed to its side.
- Option of having direct or diffused lighting.

Copy Stand

- Used for wet specimen mainly for live specimens.
- Glass/plexiglass tank held together with silicone with separate moveable glass plate used to "squeeze" specimen in place.
- Filled with distilled water or 70% ethanol.
- Stationed between light units placed to the sides and slightly above the squeezebox.
- Camera mounted on a tripod in front of tank.

Field setup



GENERAL SET UP FOR AQUATIC LABORATORY PHOTOGRAPHY

- Animals placed in a small tank/Glass plate.
- There are mainly 2 ways of placing a specimen for photography:
    1. The specimen can be placed in a transparent glass tank filled with water.
    2. The specimen can be placed on anti-reflex glass and photographed on land.
- Fishes with many skin flaps, should be photographed in water in order to correctly visualize the dimensions of the skin flaps.
- You can also inject concentrated formalin near to the fin region to keep the fins intact.
- If you prefer to take photographs in tank then there is a chance for air getting trapped inside the abdominal cavity of the specimen (e.g., for dead specimens) and the specimen may float on the water surface or heel over in the aquarium. In this case, puncture the right side of the abdomen with a surgical knife to remove the air. Be careful not to damage the organs, so that water remains clean. If an organ is accidentally damaged, wash with running water.
- When an immersed specimen is photographed, lighting plays a very important role. Provide lighting using flashlights from either side of the specimen, taking care that there is no reflection or shadow on the specimen. It often works well if a diffuser is fixed in front of the light to soften it.
- Mist the specimen frequently with water to prevent dehydration. However, wipe the body surface lightly to remove excess water while photographing in order to avoid reflection due to the water adhering to the body surface.
- Flashes placed on either side to avoid shadows and use diffuser to avoid harsh light flashing on the specimen. The diffuser will also help in producing uniform lighting. You can use reflectors to bounce the light towards the specimen which also provide uniform lighting.
- Tank suspended over wet black velvet/ cloth or keep the background away from the tank. This will help to get the specimen in the uniform background. (Remember the concept of depth

of field which we discussed in Aperture section). If we keep the tank suspended the focus will intact only towards specimen and get a uniform background.

- Water should be periodically cleaned. It helps to avoid the presence of impurities in the background and get the specimen in a uniform background and will also help in post processing.
- Try to maintain a uniform background and remove the impurities and dust from the background. Aovid background with patterns especially in macrophotography.
- You can also use nonreflective sheets in the front of the glass plate to avoid glare or reflection from the photographer/ from the front side.

http://silurus.ansp.org/ACSI/corresp/digital_imaging_tips.html

Background stage

Suitable background color should be decided depending on the skin/scale color of the specimen, although the best way is to photograph the specimen with both backgrounds. Use appropriate background colour for getting the specimens with required features. You can use white/grey/black colours accordingly.

Background Stage – Colour and Material Matters

Black cloth: Even though it forms a unique colour the patterns in the cloth adds a texture to the background and may cause difficulties during editing.

Non reflective Sheet: It provide a uniform background without patterns and give you an easiness while cropping and post processing.

PHOTOGRAPHING THE SPECIMEN

- Fix the camera in the tripod.
- Plan your shot in advance and if needed sketch the orientation before photographing the subject, which helps you in getting proper orientation of the subject and also you will not miss out any specific angle (if needed).
- Always take the photographs in RAW format and make duplicates of the photos.

- While photographing dead specimens or stationary objects, set the camera in aperture priority mode to stop down the lens to focus the specimen. Aperture priority mode will offer you a control over the depth of field. Usually prefer a higher aperture value like keeping f/16 or above to get good depth of field.

- In case of a live specimen, you need to set your camera in Manual Mode and adjust the shutter speed, aperture and ISO to get the required images and give more emphasis on shutter speed to freeze the subject and to get sharp images. You can also use the scope of flash to freeze the subjects. You can start taking photograph initially at shutter speed of 1/500s then optimise accordingly.

- If you take the photograph handheld, try Manual mode and find the suitable exposure. In that occasion, try to keep the shutter speed 1/125 or above to avoid camera shake. Keep an eye on the ISO to avoid noise in the image. In such cases, remember the exposure triangle and try for the maximum output of your camera and if you are not getting the correct exposure, then provide a flash or additional light sources.

- Turn on the light and adjust the white balance. If the light in the photograph is the same as that in the previous photographs, it need not be re-adjusted (the setting does not change even when the camera is switched off).

- If needed use additional flashes with diffuser and angle the multiple flashes in a way that it should light up from all sides which reduce the shadow formation. Try to avoid providing even lighting from all sides which may flatten the image. So, if you want a 3D kind projection, the light should fall on the subject from all sides but with different intensities. The diffuser will provide a soft lighting on the subject it will helps to get maximum details from the subject. Without diffuser the harsh light from flashes will fall directly to the subject and loss the details.

- The Auto Bracket function allows 3 successive shots by clicking the shutter button only once and set the increment level of the exposure of the 3 serial shots as 0.5 steps (OPTIONAL).

- If you are taking the photos using Aperture priority mode then better to use a Remote Release. Since the aperture priority mode is used, the shutter speed becomes slow, and the photograph can be blurred because of a little camera shake when the shutter button is pushed. If Auto

Bracket function is enabled, then the camera will take 3 successive shots and for that the shutter button needs to be kept pressed. If you are not using a remote, use a timer to get a steady shot.

- Take the first shot such that it includes both the specimen and the specimen tag. Next take 3 serial shots, using the Auto Bracket function. When a white background is used, set the initial Auto Bracket level as 0 and then take the photographs (the increment level should be set as 0.5 steps in point 4, so that the photographs are taken at 3 exposure levels: 0, +0.5, and +1.0).

- After 3 photographs are taken with the white background, place a blackboard and take 3 successive shots with the black background. Each specimen should be photographed with both white and black backgrounds.

- These photographs can be modified during post processing, but the overexposed parts cannot be modified because they do not contain any graphic information. So, try to avoid overexposed images. the same is applicable for underexposed images.

- For some specimens, the body colour is silvery grey or slimy, which is easily reflected. Therefore, overexposure should be particularly avoided in such cases. For these types of specimens, it is safe to take photographs using the 3 steps of exposure compensation.

- Pay attention to white balance, and configure the settings such that, the real colour of the specimen is recorded.

Standard Format for Keeping Photographs

7 photographs for each specimen should be saved as follows:

- 1 photograph of the specimen with the tag (with a white/black background).
- 3 specimen photographs (taken in 3 steps of exposure compensation) with a white background.
- 3 specimen photographs (taken in 3 steps of exposure compensation) with a black background.

Storing in Folders

- Always store the photographs with the label and arrange in folder in a periodic order.
- Delete unwanted duplicates.
- Rename image files with unique identifier.
- Associate photo number and specimen number in spreadsheet.
- Archive (Backup the photograph).

Post-process selected images

- Keep the original file in the RAW format and post processing should be done only in the duplicate file.
- The post processed file image should be saved as JPEG/TIFF format. If you post process the image for a publication then you should know the requirement of the journal.
- Most of the journals have a specific configuration for image size (pixels) and resolution (dpi) so set the parameters accordingly.
- Basic processing includes – Cropping, Brightness, Contrast, Saturation, Sharpening, Colour correction, minor tonal enhancement, Noise removal.
- Don't flip the image it will alter the scientific content.
- Always mention the equipment and the post-processed procedures in the materials and methods section of the research paper.
- Keep the unedited file (images), sometimes the reviewers ask for the unedited images.
- Save with different unique identifier.

THINGS TO REMEMBER WHILE PHOTOGRAPHING

- In filed condition: Make sure you can track and record quickly and make sure that the time and date in the camera matches with the correct date and time.
- Prepare the specimen number and order before photographing the specimen.
- Clean the specimen thoroughly and check for identifying characters.
- In case if scale is not with you (Field scenario) keep some objects (eg: pen) near to the specimen so that later the length of the specimen can be determined.
- In case of live animals narcotize the animal if necessary or observe the behavior of the specimen so that you will get a better idea about their movement and also it will help in setting the exposure triangle.
- First photograph of each specimen should include field number and scale.
- Multiple shots to get best lighting and views.

THINGS TO CONSIDER
BEFORE DELETING

Reasons behind in an uncleared image.

1. **Not in Focus**
   - a. Depth of Field
   - b. Need to check the aperture value
   - c. Autofocus is not working properly
   - d. Consider the working distance
2. **Blurred images/ not clear images**
   - a. Need to check the shutter speed
   - b. Camera shake (in handheld condition keep your shutter to 1/125 or more)
   - c. Dust in the sensor or in the lens
   - d. Higher ISO – Noise in the photos
   - e. Aberrations (Chromatic aberrations)
3. **Grains in the images**
   - a. Due to the dust in the sensor
   - b. Due to the dust in the lenses
   - c. High ISO – Noise
4. **Disproportionate images**
   - a. Consider the focal length of the lenses (wide angle may create barrel kind of distortion)
   - b. Distortion of the images

FIELD PHOTOGRAPHY

For live specimens, we need to take photos from the field itself. To get a sharp and proper image, you need to know about your gear, and also need some insight towards the behaviour and habitat of your target species. It will help you to set the shutter speed, aperture and ISO at its optimal level and predict their chances of occurrence also. Unpredictable changes in light and the nature of the background may frequently occur in field photography, so try to shoot in RAW format, which provides wide choices in photo processing, especially in correcting the exposure. Another major challenge in field photography is getting a uniform background. To some extent, the lower aperture will provide a diffused background (Bokeh effect), but it may not always work. To get a sharp image, you need to optimize your shutter speed with the animal movement and it can be achieved through trial and error. Another aspect that you should master is at finding a uniform contrasting background within the existing background where you need to take pictures of your specimen.

Here are some techniques that you can try while you take photographs of your specimen from the field.

1. Change your angle of view or change the plain which you focus

By changing the plain which you focus or moving a bit from where you stand will help you in finding a uniform background and it will help to project your specimen more than in a distorted background with many objects and patterns. So always look for a uniform contrasting background.

2. Judge the nature of your background and wait

Knowing the changes or characteristics of the background will help you to take a good photograph in a uniform background. In most of the cases by judging the nature of the wind, movement of the clouds and duration of the waves will help you in finding a moment which provide a good background and also the time with least distortion from the background. So, while taking the target specimen keep an eye on what is happening around and give some time to clear the distraction.

3. Click at the moment with ID characters

It involves a bit of practice and a better understanding of the behaviour of your specimen. Each species has a set of distinct identifying characters. While shooting from the field you always look for the moment in which the species shows maximum features. It can be also achieved through taking a series of continues shots while they expose their identification characters.

BASICS OF PHOTO EDITING

Photo editing means an act of altering an image in very simple terminology. These images can be digital photographs, illustrations, prints, or photographs on film). Some types of editing, such as airbrushing, are done by hand and others are done using photo editing programs. Photos of models etc are edited to remove blemishes or make the model "better" or a photo is edited for

fixing errors like red eye, contrast, brightness, etc. Photo editing is also used to make completely new images Earlier, when manual photography system was there, the task was broadly categorized in to retouching and finishing. Retouching was performed on the photo films before taking print from those films and photo finishing was carried out after the photo in printed. Both the task was performed to produce a good quality photograph with all the desired modifications. Now a days, in the digital era, the task is now been carried out by Photo Editors before printing or publishing the image, as the case may be. The task of photo editing is still complex but with the use of software and enhanced features, made editing much simpler. Photo editing is also known as

- Image editing
- Image/photo manipulation
- Photoshopping
- Image/photo enhancement etc.

Photo-editing software

Photo-editing software's are software programs used to manipulate and enhance images. There are many kinds of photo-editing software, each with its own costs, features and pros/cons. Cost and features are the main factors when choosing photo editing software. Now a day. With the use of Smart phones, a lot of photo editing apps are also available to at least perform basic editing on your smart phone itself apart from conventional software programs to work on the PC/Laptop.

Some photo-editing software programs:

- Adobe Lightroom
- Adobe Photoshop
- Corel Draw
- Capture One
- Affinity Photo
- Inkscape
- Capture One
- DxO PhotoLab
- Exposure X7
- Luminar Neo
- Pixlr editor
- Canva
- PhotoPlus

Types of photo editing

There are many different types of photo editing. Some are simple and others are more complex. For example, some photo editing techniques are done manually, while others are conducted through automated software. We can easily do simple photo-editing easily and quickly while complex photo editing and digital editing techniques may require specialized software program along with training and experience. It may be divided into three broad categories:

Simple photo-editing may include

- **Noise reduction:** Noise is the occurrence of colour dots or specks where there should be none. It is accomplished by reducing the pixel size to make the picture smooth.
- **White balance:** Is used to colour of the light in the image.
- **Contrast:** Higher contrast makes an image punchier, while lower contrast makes it flatter in colour.
- **Exposure adjustment:** The brightness of the image is adjusted.
- **Colour adjustments:** Is defined as the change the colour of an item or element in the photo. It may be background colour or the component of main object.
- **Image resizing:** Image resize is performed to adjust the dimensions of the image. Image dimensions are the length and width of your image, measured in pixels. For example, when you apply for a job, the recruiter asks to upload an image of 40x60 mm etc.
- **Image cropping:** Cropping makes the image to be in proper size or to remove unwanted parts. Crop feature allows to drag a rectangular shape around an area in the image to cut off the sides.
- **Background removal:** It is used to remove or alter the background from the image to isolate the subject like white background etc.
- **Erasing:** Means to erase areas within your image to leave behind transparency or a background colour. There is also a Background Eraser which provides more control in removing a background to transparent.

Complex & advanced Photo Editing include:

- **Portrait corrections:** Used to fix the complexion of people or objects in images
- **Special effects:** Can be anything from animation to adding weather conditions like cloudy, fog or snow etc.
- **Clipping paths:** It is used extract a subject or element from an image. It may be a person or object also.
- **Adjusting text and visuals:** We may add text and visuals or manipulate the existing one even remove them.
- **Photo stitching:** Technique is used to put two or more images together seamlessly to make it look like they were shot that way.
- **Drop and reflection shadow:** It is used create or adjust shadows.
- **Photo masking and layers:** It is used for hiding and revealing specified portions of an image.

Pixel level editing and parametric image editing

Pixel level editing: Pixel level editing means if an image is altered at the pixel level. These changes are permanent as performed at pixel level and hence considered as a destructive form of photo editing because it's not as easy to undo the changes and restore the original file. This feature permits to make extremely detailed editing to accomplish certain functions like CMYK colour modes etc which other tools even parametric image editing can't do.

Parametric image editing: In Parametric image editing (PIE), edits are recorded as a set of steps to follow to accomplish the final look. It doesn't change the pixels of the image and is a non-destructive mode of photo editing. Mostly the high-level editing is started with PIE, and then using pixel editing to refine the final details.

Display Calibration

Sometimes the colours on the screen may not be the exact match of what they actually are and also may varies on different platforms. Imagine that you took a beautiful panoramic snap and downloaded it to your computer. Only to find out that the blue of the sky or the green of the grass doesn't resemble the one you saw through the viewfinder. Today, it's a lot about watching online movies, snapping digital photos and sharing image files. Colour calibrating your monitor is important to get as close to the real thing as possible and to appear similar across many different devices.

Monitor calibrator tools

- Datacolor SpyderX Pro
- ColorChecker Display Pro
- Wacom Colour Manager.

Monitor calibrator Software

- Calibrize
- Windows Native
- QuickGamma
- Lagom LCD monitor
- CalMAN ColorMatch

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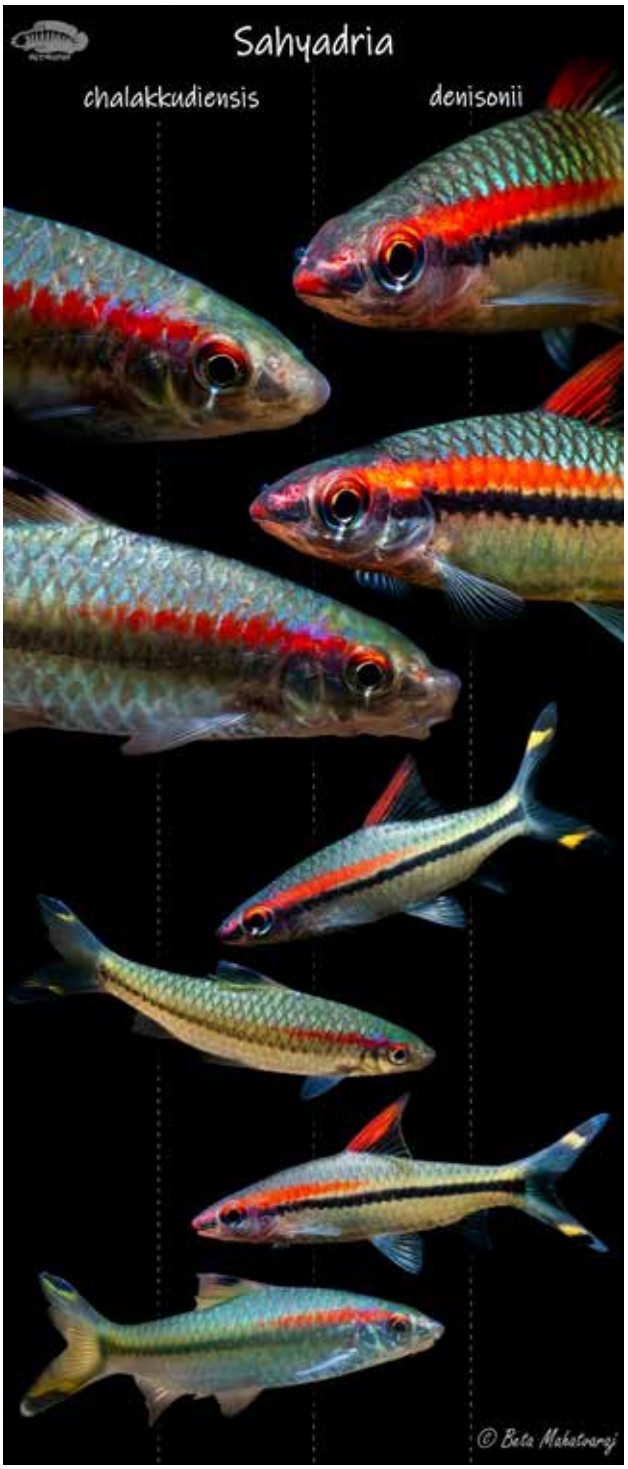
GLOSSARY

1. **Aberration:** A visual flaw in an image caused by the optics of a lens. Aberrations happens when the light waves converges at different points.
2. **Angle of view:** The angular extent of an image projected by the lens onto the camera sensor.
3. **Aperture:** The hole through which light passes to the camera's sensor. The size of the hole can be varied using an iris-like diaphragm.
4. **Aperture Priority:** Semi-automatic shooting mode that allows the photographer to select the aperture manually and the camera will select the required shutter speed and ISO.
5. **Aspect ratio:** The shape of the object in an image expressed as a ratio of the horizontal dimensions to the vertical dimensions.
6. **Autofocus (AF):** Focusing mode in which the camera selects the required focus distance. Usually, the camera autofocus priority towards the moving objects and the subjects with contrast colours.
7. **Bracket:** To shoot a number of sequential photos with a particular camera setting varied during the sequence. The most common type of bracketing is exposure bracketing.
8. **Buffer:** The camera's built-in memory that acts as a temporary store for photos until they are written to a memory card.
9. **Bulb Exposure:** Mode that allows a photographer to hold open the shutter for an indefinite period, usually activated by holding down the shutter button.
10. **Burnt out:** Term describing the way that highlights are rendered as white and lacking in detail due to overexposure.
11. **Camera shake:** Unsharpness or blurred images caused by camera movement during exposure.
12. **Centre-weighted metering:** Camera exposure metering mode that biases metering to a large central area of the image frame.
13. **Chromatic aberration:** Coloured fringing which seen along high-contrast edges in a photo caused by a lens's inability to focus different wavelengths of light to the same point which affects the clarity and looks like it not in sharpe.
14. **Colour temperature:** Measure of the red/blue colour bias of light, measured in degrees Kelvin. If the temperature is high, it adds more red (warms tone) to the image.
15. **Composition:** The way a photographer arranges visual elements within the frame.
16. **Compression:** A method used to reduce the file size of an image. Compression may result in the quality of the image. But to a certain extend no image details will be lost.
17. **Continuous AF:** Autofocus mode that continually updates focus distance until the moment we capture the image /exposure. It will help you to take photos of moving objects.
18. **Continuous shooting:** A Drive mode that allows the shooting of multiple photos, activated by holding down the shutter button until the buffer is full.
19. **Contrast:** Term used to describe the difference in brightness between the darkest and brightest areas in a scene or photo. It can also be used to describe visual difference such as that between colours or textures.
20. **Converging verticals:** Visual effect caused by tipping a camera back to shoot a vertical subject which makes the subject appear to fall backwards.
21. **Crop:** To resize a photo by trimming around any or all of the edges.
22. **Crop factor:** Figure used to calculate the difference between the angle of view of a lens when used on cameras with different sensor sizes.
23. **Depth of field:** The extent of sharpness in a photo. It extends out from the focus point and is controlled by adjusting the size of the aperture. Distance of camera from the subjects also controls the depth of field.
24. **Digital sensor:** Light-sensitive electronic chip able to form a photographic image.
25. **Distortion:** Warping of a photo caused by a lens: makes what should be a straight line in a photo appear to curve.

26. **Drone:** Remotely-operated or autonomous unmanned aerial vehicle (UAV), also known as an unmanned aircraft system (UAS).
27. **DSLR:** Contraction of Digital Single Lens Reflex; a camera system that uses a reflex mirror to direct the view through the lens to an optical Viewfinder.
28. **Dynamic range:** Term used to describe the ratio of the intensity of the darkest and brightest tones that can be captured by a digital sensor.
29. **Evaluative metering:** (Matrix metering)- Exposure metering mode in which a scene is divided into zones with each zone metered independently. The camera determines the final exposure by analysing and evaluating the readings from each zone.
30. **Exposure:** The act of making a photo; primarily controlled by the aperture, shutter speed, and ISO settings.
31. **Exposure compensation:** An adjustment of the exposure values set by the camera. Exposure compensation is either negative (when the exposure is darkened) or positive (when the exposure is lightened).
32. **Exposure lock:** Camera control that lets a photographer hold an exposure reading so that it does not change.
33. **Fill-in flash:** The technique of using a flashgun to illuminate a backlit subject and so reduce contrast.
34. **Filter:** Sheet of glass, plastic, or optical resin that affects light that passes through the filter in a predetermined way.
35. **Focal length:** The optical distance (in mm) of a lens focused on infinity from the point where rays of light begin to converge inside the lens to produce a sharp image at the camera's focal plane.
36. **Focal plane:** Area inside a camera where light is focused. In a digital camera the digital sensor is positioned at the focal plane.
37. **Focus:** To adjust the optics of a lens to produce the correct level of sharpness in an image when it is projected by the lens onto a camera's focal plane.
38. **Frame (camera):** One individual photo; frame is most commonly used to describe how many frames-per second are shot when using a Continuous Drive mode.
39. **Frames-per-second (fps):** The number of photos that can be shot by a camera over the course of a second when using a Continuous Drive mode.
40. **F-stop:** Name used to describe a lens aperture value.
41. **Fully Automatic:** Shooting mode in which the majority of shooting functions are controlled entirely by the camera.
42. **HDR:** Short for High Dynamic Range. Technique used to create a photo with a wide dynamic range by blending photos shot using different exposure settings.
43. **High contrast:** A scene or photo where there is an extreme tonal difference between the darkest and brightest areas.
44. **Highlights:** The brightest parts of an image.
45. **Histogram:** Graph showing the brightness or range of tones in an image.
46. **Horizontal:** Camera orientation in which the camera is held parallel to the horizon. Often referred to as landscape format.
47. **Incident-light metering:** Measurement of the level of light falling onto a scene. It is achieved using a handheld exposure meter.
48. **ISO:** Numerical value that reflects a sensor's sensitivity towards light.
49. **JPEG:** Stands for Joint Photographic Experts Group. A compressed image file type in which some of the image detail is lost.it is one of the commonly used compressed file format in photography.
50. **Landscape:** Genre of photography that takes the natural world as its subject. Also used as a synonym for horizontal when describing a camera's orientation.
51. **Lens:** An assembly of glass or plastic optical elements used to focus light onto the sensor of a camera.
52. **Low contrast:** A scene or photo where there is a narrow tonal difference between the darkest and brightest areas.

53. **Macro:** Term used to describe the close-up shooting of subjects at a 1:1 reproduction ratio.
54. **Magnification:** The process of enlarging the apparent size of a subject.
55. **Manual exposure:** An exposure mode that requires a photographer to physically set both the shutter speed and aperture to obtain the desired exposure.
56. **Manual focus:** Focusing mode in which the photographer turns the focus ring of a lens to achieve focus.
57. **Megapixel:** Term used to denote one million pixels in a digital image.
58. **Memory card:** Storage medium used in digital cameras.
59. **Metering:** The act of measuring the light levels of a scene to determine the required exposure settings.
60. **Midtone:** A tone halfway between black and white with an average reflectivity.
61. **Mirrorless:** Interchangeable lens camera that feeds the image data from the sensor to an LCD screen without the need for an optical Viewfinder.
62. **Monochrome:** A synonym for black and white. It can also be used to describe a photo comprised of a limited range of colours or photos with a single colour tone.
63. **ND filter:** Semi-opaque filter that is neutral in colour and reduces the intensity of light passing through the filter. Usually used to extend the shutter speed.
64. **ND graduated filter:** Filter with a semi-opaque top half and clear bottom half. Commonly used in landscape photography to balance the exposure between the sky and an unlit foreground.
65. **Noise:** Grainy pattern that reduces fine detail in a photo. It is most commonly seen when either a high ISO setting or very long shutter speed has been used. It is depended upon the quality of the sensor.
66. **Orientation:** The angle at which a camera is held when shooting. The two most common camera orientations are vertical (portrait) and horizontal (landscape).
67. **Overexposure:** The result of letting too much light reach the sensor during an exposure. This is usually accidental, but can be done deliberately.
68. **Perspective:** A term used to describe the apparent distances between the various elements in a photo.
69. **Pixel:** Short for Pixel Element; the smallest block of image information in a photo.
70. **Polarizing filter:** Filter that polarizes light that passes through it. Commonly used to reduce reflections from non-metallic surfaces and deepen the blue of skies.
71. **Portrait:** Genre of photography that takes people or animals as its subject. Also used as a synonym for vertical when describing a camera's orientation.
72. **Post-production:** The act of adjusting an image after shooting using either tools built into a camera or specialist software on a computer.
73. **Predictive AF:** Autofocusing mode that constantly updates focus distance by tracking how and where a subject is moving within the image frame.
74. **RAW:** A RAW image file containing all the image data captured by the camera at the time of exposure. Uncompressed format referred as digital negative.
75. **Red eye:** Visual effect seen in the pupils of human or animal subjects when direct flash is used. The pupils turn red due to flash light reflecting from the blood vessels at the rear of the eyes.
76. **Red-Eye Reduction:** Flash mode in which a pre-flash is fired to reduce the risk that a human or animal subject will suffer from red eye.
77. **Reflective metering:** Measurement of the level of light reflecting from a scene to reach the exposure meter inside a camera.
78. **Reflector:** Sheet of light-coloured material that can be used to redirect light into shadow areas to lower contrast.
79. **Resolution:** A measure of the pixel dimensions of an image that corresponds to how sharp the picture looks.
80. **RGB:** Short for Red, Green, and Blue – the primary colours used by digital cameras and computer monitors.
81. **Shadows:** The darkest areas of a photo.
82. **Shutter:** Light-tight curtain in front of a sensor. During an exposure the shutter is opened and then closed. The length/duration of time the shutter is open is known as the shutter speed.

83. **Shutter Priority:** Shooting mode in which the photographer selects the required shutter speed with the camera automatically selecting the correct aperture.
84. **Single shooting:** Drive mode that lets a photographer shoot only one photo per press of the shutter button.
85. **Spot metering:** An exposure metering mode in which only a small area of a scene is measured.
86. **Standard lens:** Also known as a normal lens. Reproduces an angle of view that closely matches human vision.
87. **Telephoto:** Long focal length lens commonly used in wildlife and portrait photography.
88. **Tone:** A level of brightness. Commonly split into three broad categories: shadows, midtones, and highlights.
89. **TTL:** Short for Through The Lens. Used to describe a flash metering system where flash exposure is determined by the camera rather than the flash.
90. **Underexposure:** The result of letting too little light reach the sensor during an exposure. This is usually accidental, but can be done deliberately.
91. **USB:** Short for Universal Serial Bus; a standard connection cable used to connect digital devices.
92. **UV filter:** Filter that cuts out the effects of ultraviolet light. Commonly used to protect the front glass element of a lens.
93. **Vertical:** Camera orientation in which the camera is held at right angles to the horizon. Also commonly referred to as portrait format.
94. **Viewfinder:** Optical or electronic device that shows a photographer the scene through the lens that will be captured by the camera during exposure.
95. **Vignette:** Darkening of an image's corners that is either accidental – such as when using a lens at maximum aperture – or applied deliberately in post-production.
96. **White balance:** Camera function that compensates for any potential colour bias in a light source.
97. **Wide-angle lens:** A lens with a diagonal angle of view greater than 65 degrees.
98. **Working distance:** The distance between the camera and the subject when shooting macro.
99. **Zoom lens:** A lens with a variable focal length.



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COMMUNICATING BIOLOGICAL RESEARCH THROUGH Photos

A Photography Manual

Tailored for researchers and naturalists of all levels, this manual delves into the art and science of capturing captivating macro images and documenting organisms in their natural habitats. Covering the fundamentals of photography and the intricacies of photographing museum specimens, this book demystifies the process, enabling readers to create mesmerizing visuals that showcase the beauty of living organisms and ecosystems.

Beyond the basics, this manual encourages readers to transition from mere snapshots to scientific storytelling, employing captivating images to convey the essence of their research. Packed with stunning examples and practical insights, it serves as a bridge between the scientific realm and the wider public, making complex concepts accessible. Whether you're a biologist seeking to enhance the impact of your discoveries or a photography enthusiast fascinated by the natural world, this guide is designed to inspire and navigate you through framing the intricacies of life through the lens of your camera. Elevate your communication of biological research through the artistry of photography with this indispensable manual.

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