

THE VALUE OF PHOTOGRAPHY IN SCIENCE AND EDUCATION

Photography through the lens of two scholars



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Preface

This publication is part of the discussion paper series entitled “Sustainability Transformation and Sustainability Transfer”. The discussion paper deals with the value of photography in science and education. At first glance, one might question the correlation between photography and the complex domain of sustainability. A critical reader could rightfully inquire, "How does photography align with sustainability transformation and transfer?"

We embrace an expansive perspective of transfer that encompasses diverse interactions, the exchange of knowledge, ideas, experiences, and technologies between the spheres of science and society. Within this context, our exploration unveils the role that photography can play in the transfer of innovation and knowledge, in pursuit of sustainable development (Nölting et al. 2021, Göttert et al. 2022).

Photography is more than a mere tool for capturing images; it wields the power to transcend boundaries and evoke emotions that resonate with individuals across cultures and backgrounds (Halfmann & Young 2010). Through its lens, we can witness the natural world, the challenges faced by communities on the frontlines of environmental change (Gibson & Zillmann 2000, Sutherland 2022), and the innovation that propels sustainable practices forward. The visual medium provides a unique platform for scientists, educators, and advocates to communicate complex sustainability issues with greater clarity and resonance.

In this discussion paper, we embrace the amalgamation of photography and sustainability transfer, shedding light on its role in driving progress towards a more sustainable future. We explore how photography acts as a conduit for knowledge transfer, dissolving barriers that once separated academia from broader society. Scientific discoveries and findings, once confined to the laboratories and research journals, can now transcend academic walls through captivating visual narratives.

Moreover, photography fosters a sense of shared responsibility for our planet's well-being. It serves as a catalyst for raising awareness, inspiring action, and fostering a collective commitment to sustainable practices (Trott 2019). Through poignant images, we can portray the consequences of unsustainable actions, ignite a sense of urgency, and mobilize individuals and communities to embrace more responsible approaches.

We affirm the value of photography in science and education but also underscore its potential as a powerful instrument for sustainability transfer. By showcasing successful initiatives where photography has facilitated knowledge dissemination, we hope to inspire readers to envision new possibilities for fostering dialogue between science and society. We invite readers to contemplate the intrinsic synergy between these seemingly disparate fields. We infer that the challenges we face in achieving sustainable development require innovative and inclusive approaches which photography can contribute towards.

Summary

This discussion paper explores the multiple roles of photography in the realms of science and education, celebrating its diverse applications, while offering a cautious perspective on its use. The authors advocate that photography is a useful tool for sustainability transfer underscoring the ways in which photography can transcend barriers in education and research communication. The paper begins by highlighting the value of photography in education and research, providing examples of its use. Light is shed on the utility of photography in report writing and scientific publications, and cautionary notes are provided on some of the limitations of photography in research. Finally, personal reflections and lessons learned along the authors own photographic journeys are shared before some closing remarks are provided. The authors do not aim to give a systematic, near comprehensive or technical overview of the various aspects of photography, instead, they provide impulses and share experiences when it comes to the application of photography in teaching and research. As a fitting tribute to the subject matter, the paper is authored by two scientists who are also passionate photographers. With this paper the authors hope to promote the responsible and ethical use of photography and to inspire others to see its value in enhancing knowledge and sustainability transfer.

Key words: photography, sustainability research, transfer

Zusammenfassung

Dieses Diskussionspapier adressiert die vielfältigen Rollen der Fotografie in den Bereichen Wissenschaft und Bildung und würdigt die zahlreichen Anwendungsmöglichkeiten. Die Autoren sind überzeugt, dass Fotografie ein nützliches Instrument für Nachhaltigkeitstransferaktivitäten sein kann und wollen zeigen, wie Fotografie dabei helfen kann, etwaige Barrieren in der Bildung und Forschungskommunikation zu überwinden. Das Papier zielt zunächst auf den Wert der Fotografie für Bildung und Forschung ab und liefert verschiedene Anwendungsbeispiele. Der Wert der Fotografie bezüglich des Verfassens von Berichten und wissenschaftlichen Veröffentlichungen wird beleuchtet und es werden Limitationen der Anwendbarkeit der Fotografie im Zuge von Forschungstätigkeiten aufgezeigt. Abschließend werden persönliche Überlegungen und Lehren aus den eigenen fotografischen Reisen der Autoren dargelegt und Schlussbemerkungen formuliert. Ziel der Autoren ist es nicht, einen systematischen oder technischen Überblick über die verschiedenen Aspekte der Fotografie zu geben, sondern vielmehr Impulse zu liefern und Erfahrungen auszutauschen, die dabei helfen können, das Potenzial der Fotografie für Lehre und Forschung besser auszuloten. Als angemessene Hommage an das Thema wurde vorliegendes Diskussionspapier von zwei Wissenschaftlern verfasst, die auch leidenschaftliche Fotografen sind. Mit diesem Papier hoffen die Autoren, den verantwortungsvollen und ethischen Umgang mit der Fotografie zu fördern und andere dazu zu inspirieren, den Wert dieser Methode für die Verbesserung des Wissens- und Nachhaltigkeitstransfers zu erkennen.

Schlagworte: Fotografie, Nachhaltigkeitsforschung, Transfer

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1 Introduction

Photography, with its ability to capture moments frozen in time, has become a useful tool in both education and research (Wilder 2009). Its intrinsic value lies not only in its aesthetic appeal but also in its power to evoke emotions and stimulate intellectual curiosity. Through the lens of a camera, the world becomes a canvas upon which educational experiences are etched, and the images produced offer insights into the human experience and the world around us. In research it can document the world and its diversity, transcend language barriers, and tell visual stories, rendering it a useful tool in these domains. As we continue to embrace the power of photography, we unlock new avenues for exploration, learning, and discovery, ultimately enriching our understanding of the world we inhabit.

Within educational landscapes, photography becomes a catalyst, inspiring educators to convey subject matter in captivating ways. Moreover, student photography within the classroom is emerging as a conduit for diverse learning experiences and the documentation of learning journeys. Beyond classrooms, scientists wield microscopic photographs to see the unseen, employing satellite and aerial imagery to attain a landscape level perspective of our planet. Social scientists harness photography to overcome linguistic and cultural barriers, rendering marginalized narratives more vivid, while also fostering collaboration between citizens and researchers in meaningful ways.

In this discussion paper we explore how photography is currently being used in educational settings. This discussion unravels the present integration of photography with within educational settings. Herein, we highlight instances where teachers employ photography to stimulate students, demystify abstract concepts, introduce intangibles, and enrich educational encounters. Furthermore, the narrative extends to students themselves, using photography as a lens to perceive the world in different ways and to chronicle their educational journeys. Our exploration traverses the diverse research terrain where photography plays a vital role, including camera trap technology, underwater, high-speed, aerial, macro, and microscopic photography.

Additionally, this paper navigates the role of photography in reporting across research and education. We delve into how it amplifies the narratives from workshops, conferences, and learning endeavors, presenting a more comprehensive description of events. It empowers narrators to provide a more comprehensive portrayal of occurrences. Our discussions also probe the presence or absence of photographs in scientific publications, envisioning how their inclusion within journal articles could enhance the accessibility of science communication to broader audiences. Within this realm, we underscore our advocacy for photography's utility as a tool for sustainability knowledge transfer. We also provide some cautionary notes on the misuse of photography and the limits of its use within the context of research.

The authors of this discussion paper are educators, scientists, and passionate photographers, who have integrated their hobby with their teaching and research over the years. In this discussion paper they draw on their own photographic repositories, reflect on their own photography journeys and share their first-hand experiences, insights, and the lesson they learned along the way.

2 Photography in education

Photography provides a useful tool for education. Research suggests that photographs, independent of the object, increases visual attention (Barasch et al. 2017) and the overall enjoyment of experiences (Diehl et al. 2016). Photography acts as a visual storytelling tool in education (Robin & Pierson 2005), enabling teachers to explain and illustrate concepts, but also students to narrate their experiences, document their learning journeys (Meek & Buckley 2011), and share their unique perspectives with others. Its intrinsic value lies in its power to inspire, encourage observation, reflection, and engagement with the subject matter. It also empowers learners, fostering creativity and self-expression.

Photography can help to illustrate concepts and introduce the intangible by teachers, instructors, and lecturers. It serves as a bridge between the tangible and the abstract, allowing learners to visualize unfamiliar concepts in relatable and engaging ways (Byrnes & Wasik 2012). For example, the photograph in Figure 1 of fishers using a traditional fishing trap off the coast of Vilankulo in Mozambique can be used to initiate classroom conversation about eco system services and even complex social ecological systems in higher education. Furthermore Figure 2 could initiate a classroom debate about the impacts of tourism on the environment. Photography might serve as a tool to illustrate obvious but also not so obvious things. For example, where two closely related species can be compared and differentiated (Figure 3).



Figure 1. An image of fishers using a traditional fishing trap off the coast of Vilankulo in Mozambique which could be used to initiate classroom conversation about eco system services and complex social ecological systems. Photo: Bianca Currie



Figure 2. Photograph of a street corner in the town of Vilankulo in Mozambique where a fish seller has hung the catch of the day for sale. This image can be used to initiate a classroom debate on the impacts of tourism on the environment. Photo: Bianca Currie



Figure 3. Obvious vs. not so obvious things. Comparing two closely related redstart species: *Phoenicurus phoenicurus* (left) and *Phoenicurus ochruros* (right). It is easy to find diagnostic features to identify these species when looking at an adult male in its breeding plumage (top), however, when looking at subadult individuals of approximately the same age, it is much more difficult to identify the species, especially, if no direct comparison is possible, which is usually the case in the field. Photos: Thomas Göttert

2.1 Using the beauty of nature to inspire and motivate students

The educational value of photography does not only arise from the pure transfer of knowledge, for example through the illustration of diagnostic features of an animal or plant species, or how it can be used in storytelling. In our experience, aesthetic aspects also lead, for example, to greater interest on the part of the students. Aesthetics is to a certain extent in the eye of the beholder and difficult or even impossible to describe. Yet it is an inherent feature of nature. For example, Figure 4 of a water body in a semi-arid region holding a beautiful component, Figure 5 of a white-fronted bee-eater (*Merops bullockoides*) or Figure 6 of a collared sunbird (*Hedydipna collaris*), all of which can inspire, stimulate curiosity, imagination and enthusiasm for nature and the environment.



Figure 4. A water body in a semi-arid region holds a beautiful component: Avis Dam in Namibia. Photo: Thomas Göttert



Figure 5. White-fronted bee-eater (*Merops bullockoides*) in flight captured in the Kruger National Park in South Africa. The image can foster a love for the beauty of nature and its diversity. Photo: Bianca Currie



Figure 6. Collared sunbird (*Hedydipna collaris*) with wings extended. Image was captured in the coastal bush near Chigamane in Mozambique. Photo: Bianca Currie

2.2 Learning through photography

As a creative medium photography encourages students to observe their surroundings with heightened curiosity, fostering a deeper appreciation for the world's beauty and diversity (Seppänen & Väli-verronen 2003, Diehl et al. 2016). Through photography, students engage actively in the learning process, developing their observational skills and critical thinking abilities (Hyde 2015). By capturing and interpreting images, they explore various perspectives, convey emotions, and communicate ideas effectively.

Nowadays, there are numerous programs, apps or other AI-based tools that enable species identification of groups of organisms, for example identification apps for songbirds or flowering plants. One might ask: “Why should I still take photographs that can be used to identify an animal or plant species given these AI-based tools requiring very little effort exist?” However, this perspective only focuses on the end result – the photograph itself, and does not recognize the benefits of the effort. Such an attitude completely disregards the journey and work that is required to create a specific photograph. When we create a photograph, other factors contribute to the learning experience. The photographer has a sense of the time of day, habitat type, smell, temperature, and related sounds, engaging multiple senses in the experience. There are also emotional responses gained from the experience that are then associated to the photograph. This conglomerate of information is memorable and may be recalled when looking at the photograph at a later stage, contributing to a full learning experience. Figure 7 of a wood warbler (*Phylloscopus sibilatrix*) illustrates this point as the only way the species being photographed could be identified with certainty was to hear the bird call out in the field while taking the photograph.

When observing animals, you must often go back to certain points to create a good photograph and also learn a lot about animal behavior and biology. For example, if you want to photograph songbirds during courtship, a period in which the males have the most magnificent plumage, you will learn that the males not only show a high degree of site fidelity during this time but are also “pumped with testosterone” showing much shorter flight distance towards people than at other times. In short: the effort involved in creating the photograph and the associated learning effects are at least as important as the supposed end product (the usable photograph). In our opinion, there is also a value here that AI removes from the equation.



Figure 7. It is not easy to reliably identify a wood warbler (*Phylloscopus sibilatrix*) based solely on a photograph, because the species is phenotypically very similar to its sympatric sister species. However, the species can be identified with certainty since the species-specific singing was also heard at the time this photograph was taken. Photo: Thomas Göttert

Photography sparks emotions that forge a connection with the subject matter, making the educational experience more memorable and impactful. Photography is also opening new pedagogical spaces facilitating contemplation and reflection and in particular, transformative learning. For example, Yang et al. (2021) used contemplative photography for the sake of transformative learning in sustainability management education, they aimed to cultivate a sustainability mindset among students in three different countries. Students were tasked with developing an e-portfolio of photographs, using keywords (e.g. sustainability), and to provide brief introductory remarks associated to their photographs. They were required to contemplate the personal meanings and themes of their photographs.

Pyyry (2016) used “photo walks” to facilitate an encounter for students to engage with their common surroundings in a geography course in Helsinki. The “photo walks” helped students look at familiar places anew by asking them to photograph them. The students were encouraged to explore their everyday “hanging out” spaces by walking and taking photographs in the city in their free time. The aim was to reflect on everyday practices and spaces by concentrating on doing photography. Pyyry (2016) said it helped them craft learning as an embodied experience of “being enchanted”, of being moved by something. The exercise was about making knowledge already known visible, and about deepening the students understanding of the familiar and taken for granted practices and places.

Scott (2014) used a photography competition as a learning experience to stimulate curiosity, imagination and enthusiasm in nature and the environment. Students were asked to submit photographs that focus on people and places, landscapes, and land-uses that exemplify principles and practices of environmental sustainability, and that showcased and developed sustainable communities. The experience was designed to stimulate students to consider the environment and to stimulate understanding of sustainability, to initiate creativity and critical thinking, and to generate ideas.

3 Photography in research

Beyond the classroom, photography plays a crucial role in research. Photographs serve as a compelling and dynamic visual storytelling method in research, transcending the confines of traditional text-based communication. Through carefully composed images, researchers can encapsulate complex concepts, evoke emotions, and convey intricate narratives that resonate with audiences across diverse backgrounds. Visual storytelling with photographs not only enhances engagement but also bridges comprehension gaps, making research findings more accessible and relatable. By weaving together a sequence of images, researchers can construct a vivid and impactful narrative that enhances the understanding of their research, fosters connections, and stimulates meaningful discussions among both expert and non-expert audiences. Figure 8, for example, tells the story of a whole bird species assemblage that can be found at one and the same structure.



Figure 8. Photograph series termed “pole position”. Shown are bird species that were photographed on poles of one and the same structure (hedge) in Berlin. The photographs were taken between 2014 and 2023. Species from top left to bottom right: *Cyanistes caeruleus*, *Parus major*, *Passer domesticus*, *Passer montanus*, *Lanius collurio*, *Oenanthe oenanthe*, *Turdus merula*, *Sturnus vulgaris*, *Turdus philomelos*, *Luscinia megarhynchos*, *Sylvia atricapilla*, *Emberiza citrinella*, *Phylloscopus collybita*, *Troglodytes troglodytes*, *Erithacus rubecula*, *Corvus corone*. Photos: Thomas Göttert

Figure 9 shows wildlife species in different regions of the world that can be found close to, or even within, cities or human settlements.

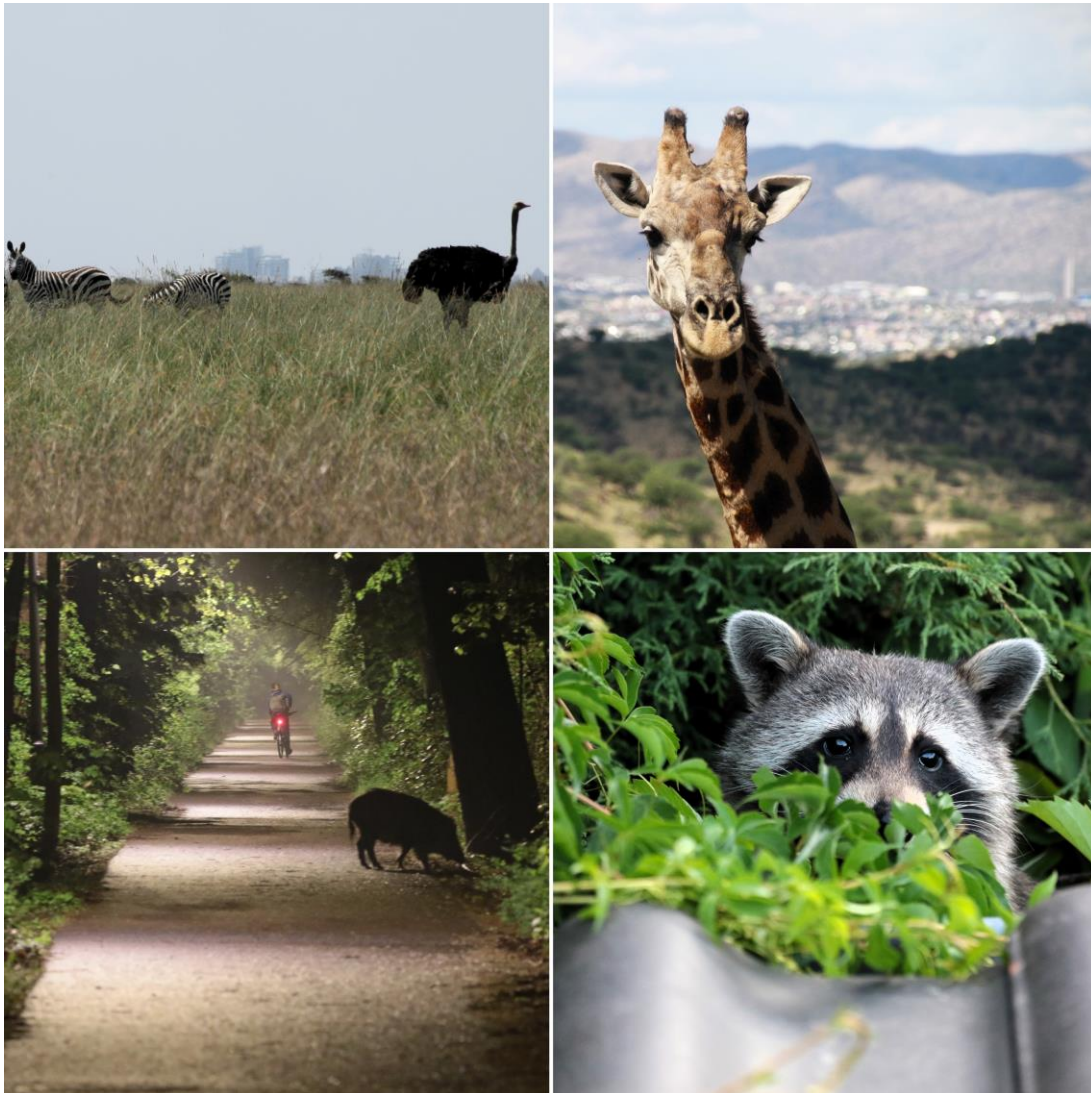


Figure 9. Wildlife living close to or inside cities: top left: plains zebra (*Equus quagga*) and ostrich (*Struthio camelus*) in Nairobi National Park Kenya, top right: giraffe (*Giraffa camelopardalis*) in Daan Viljoen Nature Reserve, Namibia, down left: wild boar (*Sus scrofa*) in the city of Berlin, down right: raccoon (*Procyon lotor*) on a roof in Berlin. Photos: Thomas Göttert

Photography not only serves as a means to better communicate and tell our stories in research but is also used as a research method. In the field of education research Ardoin et al. (2013) used student photography to evaluate a field based environmental education program and to better understand triggers of interest in the field. They conducted an exploratory study which asked learners to take photographs in conjunction with keeping a journal to investigate how youth participating in a weeklong environmental education summer camp in a national park made meaning of their experiences. They explored how certain aspects of the experience sparked interest in the environment and natural world around them.

In the field of biology, for instance, photographs can be used to illustrate or monitor changes over time such as grazing pressures (McDougall 2003) and can also serve as a vital tool for species identification (Meyera et al. 1996, Durso et al. 2021) and differentiation. For example, see Figure 10 of plains

zebra displaying different ecotypes taken in Etosha National Park in Namibia and Masai Mara National Reserve in Kenya. These photographs allow the viewer to carefully study the ecotypes (some colleagues might say “subspecies”) side by side.



Figure 10. These photographs can be used to tell the story of intra-specific variability. Both individuals represent different ecotypes of the species *Equus quagga*. The left photo was taken in Etosha National Park, Namibia, the right photo was taken in Masai Mara National Reserve, Kenya. Photos: Thomas Göttert

3.1 Camera trap technology

Photography, including the innovative use of camera trap technology, has revolutionized wildlife research by offering unprecedented insights into the lives of many species. It enables indirect observations to be made, which at best are non-invasive, allowing the animals to be observed without human interference. See Figure 11 showing camera trap photographs of selected wildlife species in sub-Saharan Africa and central Europe. Unlike radio telemetry, where animals are equipped with transmitters providing information about their life cycle, movements and space-use strategies, camera trapping requires a prior decision as to where the cameras will be placed and where data can be collected. The knowledge gained is therefore only as good as the methodological design and the preliminary considerations about the usefulness of the camera locations prior to the actual start of an investigation. This technology can be used for a variety of purposes: firstly, camera traps enable the detection and visualization of rare or very elusive animal species. Examples are the Okapi (*Okapia johnstoni*) (Kümpel et al. 2015) and Sumatran rhino (*Dicerorhinus sumatrensis*) (Magintan et al. 2010) where camera traps might be the only way to provide evidence of these species existence at a reasonable effort and without undue disturbance. In addition to providing evidence of their existence, many species can also be identified individually on the basis of photographs (Choo et al. 2020), which in turn enables a deeper understanding of the ecological parameters investigated (Burton et al. 2015). However, the method can also be used to record animal movements (e.g., Rowcliffe et al. 2016) and nutritional and health status (Pérez-Flores et al. 2016) to mention a few aspects.

Camera trap photography, deployed along transects, has become an invaluable research methodology for scientists studying animal behavior (Boyer-Ontl & Pruetz 2014, Fournier et al. 2023), population dynamics (Varma et al. 2006), and distribution patterns (Pettorelli et al. 2010, Fiderer et al. 2019, Roque et al. 2021). By strategically placing these remotely triggered cameras along predetermined paths, researchers can capture images of wildlife in their natural habitats. This approach enables the documentation of changes over time and interactions between animals and the environment

(Kays et al. 2009). The utilization of photography in transects offers a unique perspective on ecological processes, allowing scientists to track population trends (Scotson et al. 2017), evaluate the impact of human activities (Brooks et al. 2020), and devise effective conservation strategies (Roque et al. 2021). With its non-invasive nature and the ability to capture candid moments, photography has emerged as a tool in unravelling the mysteries of the animal kingdom, particularly when integrated into transect-based research methodologies.

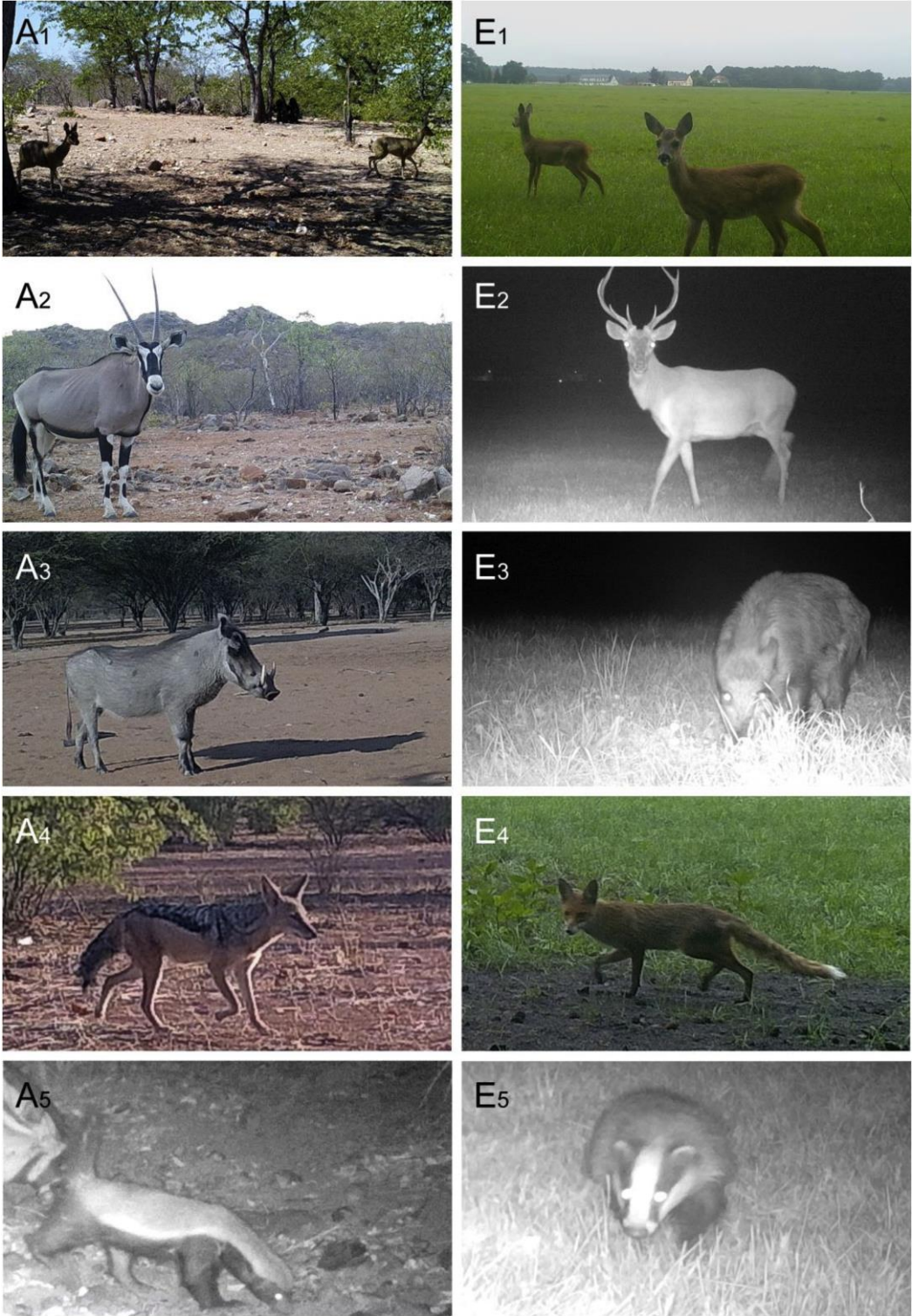


Figure 11. Camera trap photographs of selected wildlife species in sub-Saharan Africa (left) and central Europe (right), this figure was taken from Rottstock et al. (2020): <https://doi.org/10.1016/j.gecco.2020.e01124>

3.2 Underwater photography

Relatively early reflections about the history of underwater photography were made by Rebikoff (1967). In the course of technical developments, underwater photography has become increasingly important in recent years. For example, it can be used to investigate spatial distribution of crustaceans (Gutt et al. 1991), life body forms of Antarctic sponges (Barthel et al. 1991), or for recognizing individual fish (Dala-Corte et al. 2016). Underwater photography has also become a powerful tool to increase public awareness concerning the beauty and vulnerability of aquatic ecosystems not so easily seen. Using photography, a critical review of the impacts caused by recreational scuba diving on coral reefs has been presented by Roupheal & Inglis (2001).

3.3 High-speed photography

Being an effective method for studying instantaneous processes (Qian et al. 2012), high-speed photography is a commonly used tool in the fields of (medical) physics, electrical engineering, photonics and materials sciences among others. In combination with different digital optical measurement techniques, for example, it can be used in geo-mechanical experiments to better understand the mechanical response of geomaterials (e.g. sand, rocks) to extreme environments and conditions like impact loading or pressure magnitude (Xing et al. 2017). It can help to study fractures in weak snowpack layers (Van Herwijnen & Jamieson 2005) or illustrate the potential therapeutic applications of medical microbubbles (Postema et al. 2005).

3.4 Drones & aerial photography

The application of aerial photography is far-reaching. It includes the fields of geology (Ray 1960), forestry (Spurr 1948), archaeology and building reconstruction (Reeves 1936, Verhoeven 2011), phytopathology (Brenchley 1968), ecology (Morgan et al. 2010) and many others. Pioneering work was done by Bernhard and Michael Grzimek who established aerial census methods, including aerial photography, to estimate population sizes of dominant characteristic animal species of the Serengeti-Mara ecosystem (Grzimek & Grzimek 1960). With the development and spread of drones, aerial photography has become even more important for many scientific approaches because this technique is relatively easy and inexpensive to implement. Particular focus on the use of drones is in the field of agricultural sciences (Rejeb et al. 2022), for example precision agriculture (Stehr 2015), including insect pest management (Subramanian et al. 2021), identification and monitoring of agricultural land (Qubaa et al. 2021) or soil residue cover (Raoufat et al. 2020). The application of drones, however, also includes various other fields, such as spatial social sciences (Hall & Wahab 2021), fishery science (Harris et al. 2019) and restoration ecology (Robinson et al. 2022). See Figure 12 of wildlife and livestock photographed from the air in and around Limpopo National Park in Mozambique. These photos were taken as part of a preparatory field trip in order to select possible transects for camera trap experiments (Roque et al. 2021, Roque et al. 2022).



Figure 12. Wildlife species and livestock photographed from a helicopter in or around Limpopo National Park, Mozambique: top left: *Giraffa camelopardalis*, top right: cattle, down left: *Hippopotamus amphibius* and *Alopochen aegyptiacus*, down right: *Loxodonta africana*. Photos: Thomas Göttert

3.5 Satellite imagery

Today there are various remote sensing approaches using satellite imagery. The technique has been used in studies of atmospheric aerosols (Huck et al. 2023), geomorphology and sedimentology (Gilvear & Bryant 2016, Swift et al. 2021), vegetation (Stone et al. 1994), rivers (Gupta & Liew 2007), water quality (Hellweger et al. 2004) and others. There are numerous possible applications for satellite imagery including meteorology (Hanna et al. 2016), environmental impact assessment (Hethcoat et al. 2020), climate (Ichoku et al. 2012) and hydrological modeling (Brown et al. 2008), spatial analysis and even animal movement (Neumann et al. 2015) and vegetation mapping (Xie et al. 2008).

3.6 Macroscopic photography

Since macro photography allows the observation of details beyond the naked eye's capacity, it has become a powerful tool for taxonomic identification of rather small organisms such as insects (Martínez-Gamba & Rincón 2020). It is also an important tool for specimen digitization for natural history collections, including animals (Krueger et al. 2022) and plants (Thiers et al. 2016) and can in certain cases be seen as an alternative to microtomy and X-rays (Griffin et al. 2021). Moreover, macro photography techniques and planimetric image analysis are used to measure the size of stained tissue samples in experimental animal models (Liepinsh et al. 2013) and to illustrate anatomical pathology reports (Leong & Leong 2004). Macro photography can further be applied in the fields of dental materials science (Fuchs et al. 2020), anthropology (Willman et al. 2020) and art documentation and analysis (Cosentino 2013) among other areas of science.

3.7 Microscopic photography

Creating images while using a microscope equipped with a dedicated camera or detector unit works with different microscopy techniques, for example light microscopy (Ikävalko & Gradinger 1997), fluorescence microscopy (Ashwood-Smith & Young 1962), confocal laser scanning microscopy (Figure 13), electron microscopy (Ravines et al. 2016) and X-ray photography (Gordon et al. 1970). Microscopy is particularly widespread in medical research, but is also widely used in many other disciplines, such as comparative anatomy. Corresponding specialist journals often also enable the publication of numerous illustrations of microscope-based images. For further reading, we suggest Morrison & Gardner (2015) for their excellent review of “microscopic image photography techniques of the past, present, and future”. However, the borderline between different disciplines and even genres are fluid as explained by Tyurina (2018) in her paper “Scanning electron microscope: transmigration of scientific photography into the domain of art”.

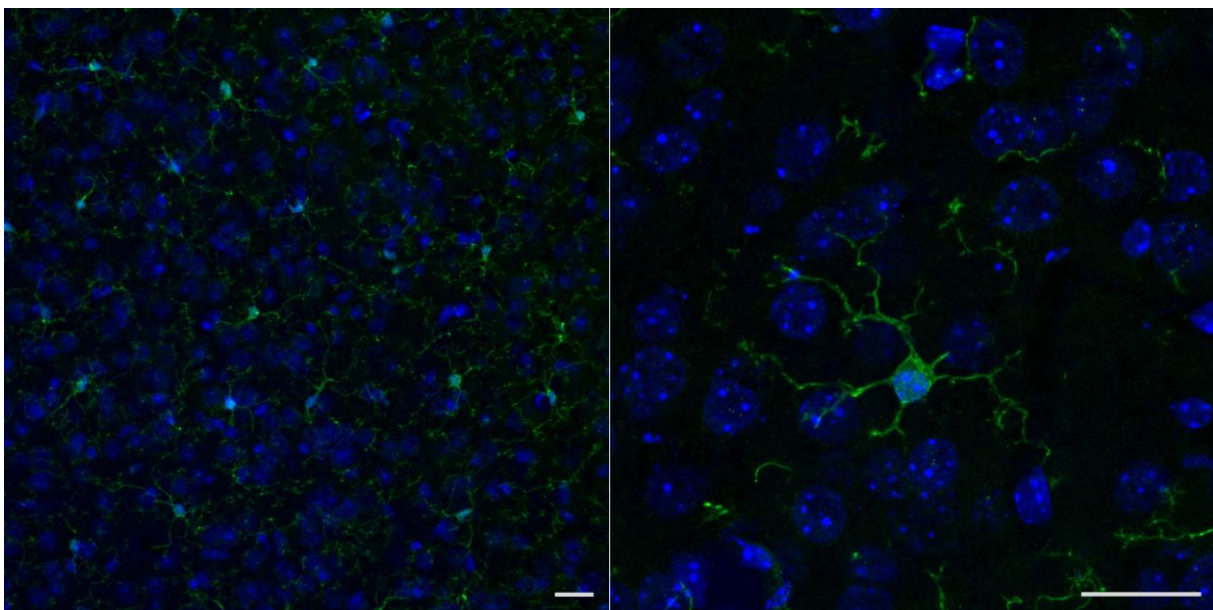


Figure 13. Confocal laser scanning microscopy of the cerebral cortex of a lab mouse (*Mus musculus f. domestica*). Images taken at two different magnifications with Zeiss LSM 700 microscope. Green: immunofluorescence staining using IBA1; blue: nuclear counterstain with Hoechst 33342. Scale bar: 20µm. Images provided by Ria Göttert

3.8 Citizen science

Photography has become a powerful tool in the realm of citizen science, harnessing the collective efforts of individuals armed with smartphones equipped with high-quality cameras. The widespread availability of these devices has empowered a diverse range of enthusiasts to actively participate in scientific endeavors. Furthermore, with the advent of user-friendly platforms like iNaturalist (<https://www.inaturalist.org/>), citizen scientists worldwide can contribute to gathering data on biodiversity by capturing images of plants, animals, and insects encountered in their surroundings (Aristeidou et al. 2021). These photographs serve as valuable records that help researchers track species distribution (Clemente et al. 2019), study population dynamics (McCoy et al. 2018), and detect changes in ecosystems (Sonnentag et al. 2012).

With the ability to capture and share images instantly, citizen scientists can contribute vast amounts of data points to generate species lists quickly and efficiently. As of January 2022, there were 2.5 million observers uploading images to iNaturalist (Callaghan et al. 2022) contributing vast amounts of data points to the platform. By documenting various organisms encountered in their surroundings, these dedicated individuals aid in identifying the occurrence of rare species (Wilson et al. 2020) and expand our understanding of distribution (Serniak et al. 2022). The amalgamation of countless photographs through online platforms and apps enables researchers to analyze and validate observations on a large scale, allowing for more comprehensive and accurate insights into biodiversity. Through the integration of photography into citizen science initiatives, a collective force is harnessed, revolutionizing our capacity to monitor and preserve the natural world.

Despite all the euphoria about the indisputable advantages of citizen science, the following thought should not go unnoticed: the expected knowledge gain derived from (citizen) scientific surveys depends on the methodological design that is adapted to a scientific question. Just because thousands of people generate thousands of photographs with their smartphones and other mobile devices does not mean that per se the gain in knowledge derived from this is huge. Citizen science contributions need to be adequately embedded in scientific concepts and methodological designs, otherwise they cannot shed the aura of "pseudoscience".

3.9 Photography for capturing the lived experience

Photographs can provide a glimpse into the human condition, illuminating untold stories, capturing lived experiences and encouraging a deeper understanding and empathy for the challenges faced by indigenous communities. For example, the photograph series of rural homes in Mozambique seen in Figure 14, which illustrate the lived experiences of the rural inhabitants of the country and which can foster empathy and understanding.



Figure 14. Photograph series of the rural homes of Mozambique illustrating the lived experiences of the rural communities in the country. Photos: Bianca Currie

Photography becomes an invaluable tool to document and preserve intangible heritage, visually capturing customs, rituals, and indigenous practices that might otherwise fade with time. See for example Figure 15, 16 and 17 which provide insights into the local diet of the people in Vilankulo, Mozambique. Figure 15 depicts a photograph series of food types being sold in the local food market, Figure 16 shows the process of making coconut milk and flour and Figure 17, how palm wine is made in Mozambique.



Figure 15. Photograph series of food types being sold in the Vilankulo market in Mozambique documenting the foods of indigenous people in the area. Photos: Bianca Currie



Figure 16. Image of a local Mozambique women producing coconut milk and demonstrating how coconut flour is ground.
Photos: Bianca Currie

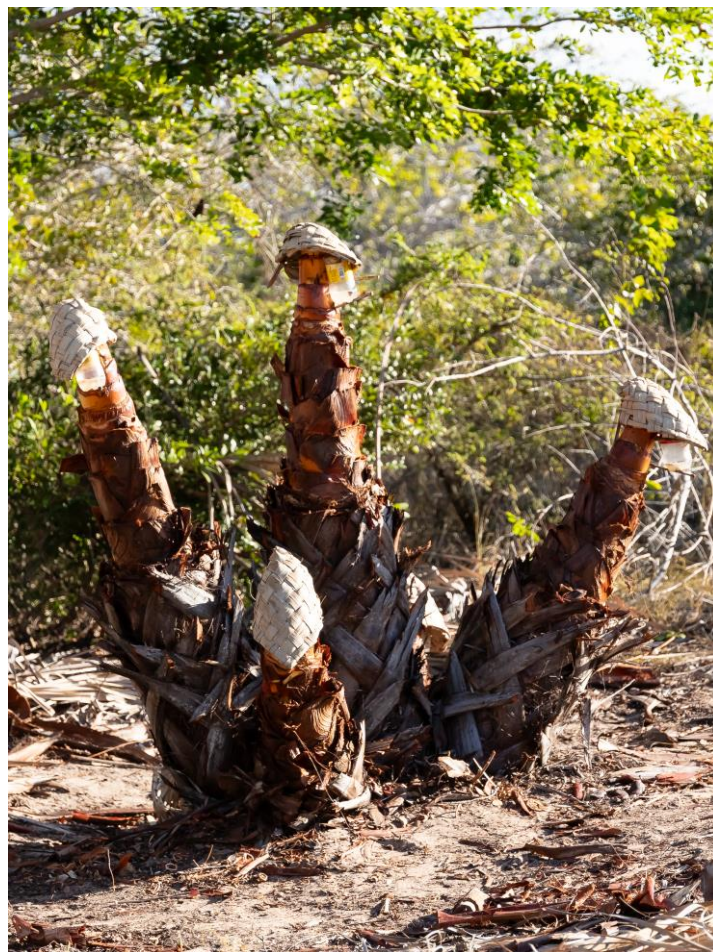


Figure 17. Photograph depicting a step in the palm wine making process in Mozambique. Photo: Bianca Currie

Photography can empower illiterate individuals to actively participate in the research process (Hergenrather et al. 2009, Simmance et al. 2016, Vertigans & Gibson 2020). Researchers can collaborate with community members to curate photo exhibitions, multimedia presentations, or digital storytelling projects, amplifying their voices and advocating for positive change. Researchers can collaborate with community members to create visual archives that not only celebrate their cultural identity but also provide valuable insights for sustainable development and cross-cultural understanding. It serves as a platform for storytelling, enabling illiterate individuals to share narratives of their lives, struggles, and aspirations with a global audience.

3.10 Photovoice and working through language barriers

Traditional methods of data collection and communication can present significant challenges where language or the written word is a barrier. Photography, however, has emerged as a powerful and inclusive tool to overcome these challenges engaging viewers and conveying information that words alone may struggle to capture. Visual communication through photography can become a universal language that transcends literacy levels and provides an accessible and intuitive means of expression, allowing community members and researchers to share stories, experiences, and perspectives without the constraints of written words.

Photovoice in particular is a participatory action research method grounded in transformative sustainability learning theory which uses photography as the basis for problem identification, group dialogue, and social change action (Trott 2019). The research method uses photography to facilitate meaningful engagement, fosters co-creation of knowledge, and amplifies the voices of illiterate communities in research endeavors. By encouraging participants to capture images that resonate with them or by providing visual prompts, researchers can unlock a wealth of information and insights that might otherwise remain concealed.

Through photovoice, individuals become active co-researchers, using photography to advocate for their needs, articulate their aspirations, and reflect on their challenges. By sharing and discussing their images in group settings, participants assert their agency, engage in dialogue, and influence the direction of the research, leading to more inclusive and community-driven outcomes. For example, Beh et al. (2011) used photovoice in a community-based research project in Samburu, Kenya to realize conservation goals. Bisung et al. (2015) also used photovoice as a community based participatory research tool for changing water, sanitation, and hygiene behaviors in Usoma, Kenya. They found that photovoice was an effective methodology for understanding behaviors, creating awareness, facilitating collective action, and engaging with local government and local health officials at the water health nexus.

Having laid the groundwork for photovoice, Wang & Redwood-Jones (2001) assert that its primary goal is to visualize the perspectives of marginalized communities that have historically been excluded or marginalized within decision-making contexts, often due to oppressive power dynamics. Photovoice's core objective is to magnify these voices by employing a critical approach to visual storytelling, allowing the marginalized populations to express their narratives authentically. Consequently, the utilization of photovoice as a catalyst for social transformation, entrenched within theoretical constructs, delves into scrutinizing social systems through a critical lens and amplifies the

previously unheard voices of marginalized groups (Cai & Marks 2021). Thus, photography emerges as a transformative tool when conducting research with illiterate communities, offering a visual language that bridges literacy gaps, fosters agency, and captures the essence of local knowledge and culture. By embracing visual methods like photovoice, researchers can empower community members to actively participate in the research process, ensuring that their voices, experiences, and aspirations are recognized, valued, and integrated into the pursuit of sustainable development and social justice.

4 Photography for reporting in research and education

Photography has emerged as an invaluable tool for reporting, becoming a common practice for documenting workshops, conferences, and teaching excursions. This approach offers a swift and efficient means to capture and record the outcomes of participatory exercises in research and education. Serving as a versatile medium, photography enriches the reporting process, capturing the essence of participatory activities within the realms of science and education. In the dynamic context of workshops, conferences, and teaching excursions, participants engage in collaborative activities and share knowledge. Given the multifaceted nature of such events, effectively and succinctly conveying outcomes and experiences through traditional written reports alone can prove challenging. This is where photography steps in, enabling the visual representation of moments, interactions, and collective achievements. See for example Figure 18 providing a collection of photographs of flipchart captures and notes from participatory exercises in research workshops in a higher education context.



Figure 18. Photographs of flipchart captures and notes from participatory exercises in research workshops in a higher education context. Photos: Bianca Currie

Through well-crafted photographs, the essence of group discussions, brainstorming sessions, and hands-on exercises can be captured vividly. Participants actively engaged in problem-solving, experimenting with new concepts, and collaborating towards a common goal can be immortalized, evoking the emotions and enthusiasm that encapsulate the learning journey. Photography goes beyond being a mere reporting tool; it also contributes to the learning process itself. When participants see themselves in action, collaborating and exploring new ideas, it fosters a sense of ownership and pride in their contributions. This visual validation reinforces the significance of their involvement and cultivates a deeper connection to the subject matter. Visual documentation provides an accessible window into the dynamics of these activities, enabling readers and viewers to grasp the atmosphere, intensity, and impact of the events more effectively (Figure 19).



Figure 19. Photograph of students participating in an educational excursion along the South Coast of South Africa. Photo: Bianca Currie

Photography serves as a bridge between the worlds of education, science, and reporting. Its ability to capture the essence of participatory exercises in research and education, coupled with its efficiency and impact, make it an indispensable tool for modern reporting practices. By harnessing the power of visual storytelling, researchers, educators, and event organizers can paint a comprehensive picture of their activities, disseminate knowledge rapidly, and inspire lasting impact in the pursuit of sustainable development and knowledge production.

5 Use of photography in scientific publications

In the quest to modernize science communication and foster broader engagement, the inclusion of photographs in academic publications holds tremendous potential. Traditionally, scientific research has relied heavily on text-heavy articles, which can be daunting and inaccessible to non-experts (Harold et al. 2016). By integrating visually captivating and informative photographs, academic publications can bridge the gap between technical jargon and wider readership. Photographs have the remarkable ability to evoke emotions, tell stories, and provide tangible representations of complex concepts. They have the power to ignite curiosity, draw readers into the research narrative, and enhance understanding by visually complementing textual descriptions. Moreover, photographs can stimulate interdisciplinary connections, as they transcend language barriers and engage a diverse range of audiences. By embracing the inclusion of photographs in academic publications, we not only modernize science communication but also create a more engaging, accessible, and inclusive platform that piques the interest of both experts and non-experts alike, fostering a deeper appreciation for scientific inquiry and discovery.

Knowledge and sustainability transfer constitute vital elements in the pursuit of societal progress towards a sustainable future. The transfer of knowledge encompasses the exchange of insights, expertise, and innovations between the realms of academia, industry, and local communities. As we navigate complex challenges like environmental degradation and resource depletion, the seamless transition of sustainable practices, technologies, and methodologies is imperative. Through effective knowledge and sustainability transfer, we empower individuals and communities to make informed decisions, adopt environmentally conscious behaviors, and collaboratively shape a more resilient and harmonious future. Photography serves as a bridge for knowledge and sustainability transfer by visually encapsulating complex concepts, showcasing real-world examples of sustainable practices, and fostering cross-disciplinary understanding, thereby facilitating the dissemination and adoption of valuable insights and innovations for a more sustainable world.

However, the extent to which photographs are used in scientific papers varies greatly between disciplines. There are disciplines and associated journals in which authors are explicitly encouraged to publish numerous illustrations (including photographs) in connection with the papers. One such discipline is comparative anatomy. In other disciplines, including ecological journals, we rarely find stand-alone photographs. Our impression is that the use of photographs in environmental publications is often common in gray literature, journals with rather low impact or less extensive formats like perspectives (e.g. Maasri et al. 2023) or editorials (e.g. Göttert 2023), while full articles in the higher-ranking journals produce technical papers that rarely include photographs as illustrations. This could be because many journals have restrictions on the number of possible illustrations per article. Our impression is that scientists tend to show complex diagrams and figures as a result. One might get the impression that a photograph alone does not have enough significance. One way to include photographs in such illustrations is, for example, to produce silhouettes of animals based on the photographs, which can then be incorporated into illustrations (Figure 20).

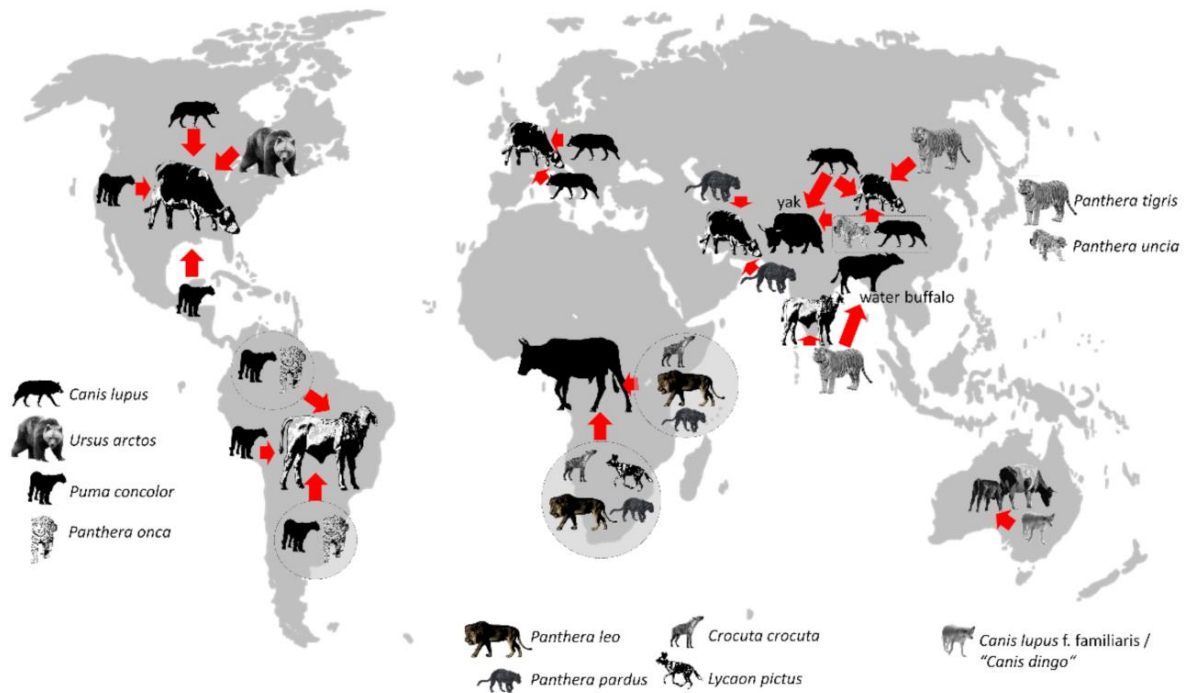


Figure 20. Example of animal silhouettes used for graphic representation in a scientific publication. This figure was taken from Göttert & Starik (2022): <https://doi.org/10.3390/d14050380>

We however argue that the integration of photographs in scientific papers stands as a compelling strategy to enhance knowledge and sustainability transfer. This inclusion of photographs is more than a stylistic choice; it is a strategic approach to democratizing knowledge dissemination, nurturing interdisciplinary understanding, and ultimately advancing the cause of sustainable development by fostering wider engagement and action.

6 Limitations of photography in research

While the inclusion of photography in research offers potential benefits, it is crucial to acknowledge that it is not inherently scientific and comes with methodological limitations. Photography alone cannot provide a comprehensive understanding of complex phenomena or serve as a substitute for rigorous scientific methods. Images can be subjective and or altered, influenced by various factors such as lighting conditions, composition choices, and personal interpretation. For example, see Figure 21 where the photograph is an interesting indication of possible hybridization between geese species, it is however not proof of it. This would require a genetic analysis to determine.



Figure 21. At the borders of the species status: hybridization in geese species is a relatively common phenomenon (Ottenburghs et al. 2016). This photograph shows an adult graylag goose (*Anser anser*) and a Canadian goose (*Branta canadensis*) as well as two subadult animals, presumably the offspring (hybrids) of these two adult animals. The behavior of the adult animals clearly indicated their parenthood. However, while this photo is an interesting indication of possible hybridization between these species, it is not proof of it. This would require a genetic analysis to determine a possible parenthood of these adult animals. Photo: Thomas Göttert

Additionally, photographs may capture a single moment in time, limiting their ability to represent broader patterns or dynamics. For example, Parravicini et al. (2009) compared photography and visual quadrat assessment of damaging human activity on rocky benthic assemblages. The visual quadrats and photography were both able to detect differences between the sampled sites and the controls, but visual quadrats showed high variability among replicates and documented a higher species richness for controls. They showed that differences between the two methods were due to sampling unit size. As a small sampling unit is unavoidable with photography, visual quadrats should be preferred in investigating shallow rocky reefs for their larger size. However, when used in conjunction with other research methods, photography can add value and enhance scientific inquiry. It can serve as a visual aid, supplementing quantitative data and qualitative observations, providing context, and enriching the narrative. By leveraging the strengths of photography while being mindful of its limitations, researchers can harness its potential to augment their findings and foster a more comprehensive understanding of the research subject.

6.1 Photo-based species description – limitations vs. opportunities

When Carolus Linnaeus started to describe thousands of animal and plant species in the 18th century, a valid species description always included one or more type specimens that are kept in scientific natural history collections (Sluys 2021). Thus, a large part of the value of natural history collections and natural history museums derives from the housing of these type specimens, without which the species descriptions would not be valid. According to this procedure, illustrations and photographs can be very helpful for species identification, but they are usually not sufficient for the first description of a species. This traditional method of species description, including housing type specimens in scientific collections, has many advantages but also some disadvantages. Imagine that a previously unknown and undescribed animal species is discovered, of which only very few specimens exist. In such a case is it ethical to insist that the species cannot be described until a dead specimen is available? The answer was provided by Thomas M. Donegan (2008) in his article titled “New species and subspecies descriptions do not and should not always require a dead type specimen”. Moreover, Marshall and Evenhuis (2015) provides a case for photo-based description in their work entitled “New species without dead bodies: a case for photo-based descriptions, illustrated by a striking new species of *Marleyimyia* Hesse (Diptera, Bombyliidae) from South Africa”. Furthermore Aguiar et al. (2017) and Kasalo et al. (2021) provide additional food for thought on the matter.

6.2 AI and misinformation

In an era dominated by artificial intelligence (AI) and the proliferation of visual media, it has become increasingly crucial for humans to recognize that they cannot always believe what they see. The rise of misinformation and the misuse of AI technology present significant concerns (Wilner 2018). While AI has shown remarkable advancements in generating realistic images and videos, it has also opened the door to the manipulation and dissemination of deceptive visual content. Deepfakes, for example, can convincingly alter or fabricate images and videos, making it challenging to discern between what is real and what is synthetic.

The spread of misinformation, fueled by the ease of sharing visual media on social platforms, exacerbates these concerns. False or misleading images and deepfakes (AI-created videos) can rapidly circulate and contribute to the erosion of trust and distorting public perceptions (Botha & Pieterse 2020). This poses a significant threat to areas such as journalism, where visual evidence has historically played a crucial role in verifying and corroborating events.

Amidst this landscape, it becomes increasingly important to value and leverage human-made and human-curated photographs. While they are not immune to manipulation, photographs captured by trusted individuals, photojournalists, and professionals uphold a certain level of accountability and ethics. Their documentation of events, people, and places provides a valuable reference point for factual representation, historical preservation, and storytelling. Moreover, the discerning eye of humans can often detect inconsistencies, contextual nuances, and discrepancies that AI algorithms may struggle to identify.

In a sea of misinformation and manipulated visuals, the critical role of human judgment and verification should not be understated. It is incumbent upon individuals to exercise skepticism, cross-reference sources, and seek reliable information before forming beliefs or sharing content. Additionally, promoting media literacy and educating individuals about the potential for manipulation in visual media is essential to navigate the complex landscape of AI-generated and human-captured images. As AI technology advances and misinformation spreads, humans must remain vigilant in their consumption and interpretation of visual content. Acknowledging the limitations and risks associated with AI-generated media while appreciating the value of human-made photographs can help combat misinformation and preserve the integrity of visual representation in an increasingly complex digital age.

7 Personal insights, reflections and lessons learned

In the context of our work within education and research, both as passionate photographers, we've consistently recognized the significant role that photography plays, particularly in knowledge documentation and transfer. Over the years, we've integrated our photographic interests with our professional roles, yielding insights and practical lessons. In this section, we share some of these learned lessons and our reflections on integrating our passion for photography with our work contexts.

7.1 Photographic expertise is not an imperative

Photography, as an art form and a means of documentation, spans across different classes, accommodating both amateurs and professionals. Amateurs, often driven by their passion for capturing moments and artistic expression, find photography to be a fulfilling hobby and a way to explore their creativity. On the other hand, professionals wield photography as a powerful tool for storytelling, communication, and providing visual content for various industries. While the distinction between amateurs and professionals lies in their level of expertise and experience, both classes share a common goal – to freeze moments in time, preserving memories, emotions, and experiences.

Regardless of expertise, photography offers immense value to students, teachers, and researchers, serving as a versatile and complementary tool to enhance their respective work. For teachers' photography offers an alternative medium for communication and to facilitate learning. For students, photography encourage observation and develops visual literacy, and critical thinking. Through visual assignments, students can explore various subjects, from art to science, with a fresh perspective, deepening their understanding and igniting their creativity. For researchers, photography provides a complementary medium for communication and a method of research. Photovoice has emerged as a useful method in community-based action research involving marginalized and illiterate communities, where it can provide a voice for the traditionally voiceless. The expertise of the photographer whether it be a student, researcher or local community individual is not an imperative or determining factor.

Photography transcends the boundaries of expertise and profession, providing a universal means of connection and expression. Students, teachers, and researchers alike can benefit from incorporating photography into their work, fostering creativity, enhancing communication, and amplifying their impact. Whether through personal photographic projects, educational visual aids, or research documentation, photography enriches the experiences of these individuals, encouraging them to see the

world through a different lens and fostering a deeper appreciation for the beauty and complexity of life. As technology advances and photography becomes more accessible than ever, its potential as a tool for learning, communication, and research continues to expand, leaving an indelible mark on the academic, educational and creative landscapes.

7.2 Plan photography, but embrace the unexpected and the spontaneous

There is much to be said about planning photography excursions which can greatly enhance the overall experience, and the usefulness and quality of the images captured. Targeted and planned excursions allow photographers to research and identify specific locations, subjects, or events that align with their creative vision or thematic interests. This deliberate approach provides a sense of direction and purpose, increasing the chances of capturing compelling photographs that fulfil the desired objectives.

In contrast, unplanned and opportunistic photography, while spontaneous and exciting, may lack a clear focus or intention. While unexpected moments can yield remarkable shots, relying solely on serendipity may result in missed opportunities or less cohesive outcomes. By planning excursions, photographers have the opportunity to scout locations, understand lighting conditions, and anticipate potential challenges or opportunities, giving them an advantage in capturing the desired shots. Identifying and using hotspots or spaces known for sightings of wildlife (e.g., local bird hides) can help.

However, one must acknowledge that expectations and reality may not always align. Despite thorough planning, factors like weather conditions, unforeseen circumstances, or changing environments can affect the outcome. Flexibility and adaptability become crucial as photographers navigate the unpredictability of their surroundings. Being open to serendipitous moments during planned excursions can lead to unexpected and memorable photographs that surpass initial expectations and which can be used in the classroom.

Planning photography excursions provides a structured approach, allowing photographers to target specific subjects or locations, increasing the likelihood of capturing desired shots. However, remaining open to spontaneous opportunities during planned excursions or embracing unplanned photography can lead to serendipitous moments and surprising results. Balancing expectations with the unpredictable nature of photography is essential, as it allows photographers to embrace the journey, adapt to changing circumstances, and ultimately create images that capture the essence of their subjects and experiences.

7.3 Seize the moment, it might not reoccur

Engaging in nature photography offers a valuable lesson in seizing every available opportunity rather than assuming similar chances will emerge again. At times, we've encountered situations where we could capture something remarkable or unique yet hesitated, convincing ourselves that the timing, lighting, location, or viewpoint could be better. This tendency to delay due to assumptions can lead to "photographer's remorse," a feeling of having missed a precious moment and the opportunity to capture something remarkable due to uncertainty. Nature photography distinctly teaches us to capitalize on emerging opportunities and to distinguish exceptional phenomena from the ordinary.

Experienced photographers can deftly classify and accurately assess infrequent occurrences. However, for beginners, our advice is to seize the moment as it presents itself, as the chance might not resurface. This perspective underscores the importance of trusting one's instincts and embracing the uniqueness of each photographic instance, ultimately enriching the visual narrative and mitigating the pang of missed opportunities.

7.4 Species identification does not have to take place in the field

Due to efficient storage media, digital photography can be used for the subsequent determination of species of certain groups of organisms (e.g., birds). While traditional biologists take to the field with binoculars and notebooks to make observations and identify species in the field, photo enthusiasts (like the authors of this publication) use digital photography with the help of telephoto zoom lenses to identify species at later stages out of field. The big advantage here is the fact that the species can be determined afterwards at the desk and on the screen where reference materials are accessible and consulted, and images can be zoomed in. A series of high-resolution photographs enable good identification afterwards by examining diagnostic external features up close (Figure 22).



Figure 22. Two closely related and fairly similar looking red-billed and medium-sized hornbill species, the color of the iris is diagnostic: left: *Tockus damarensis*, right: *Tockus erythrorhynchus*. Photos: Thomas Göttert

7.5 Expect bycatch and unintended observations

A huge advantage of digital photography is the fact that when you look at the photographs afterwards, you often see things that you didn't see in the field. For example, it may be the case that one has photographed representatives of a certain animal species and, when looking at it later, realize that a completely different animal species also occurs in the photo. Another example can be seen in Figure 23 where the ectoparasite status of a carnivore is noticed on retrospective inspection. Only when looking at the photograph of a leopard (*Panthera pardus*) after the sighting it became apparent that the animal had a parasite (probably a tick) in its right nostril.

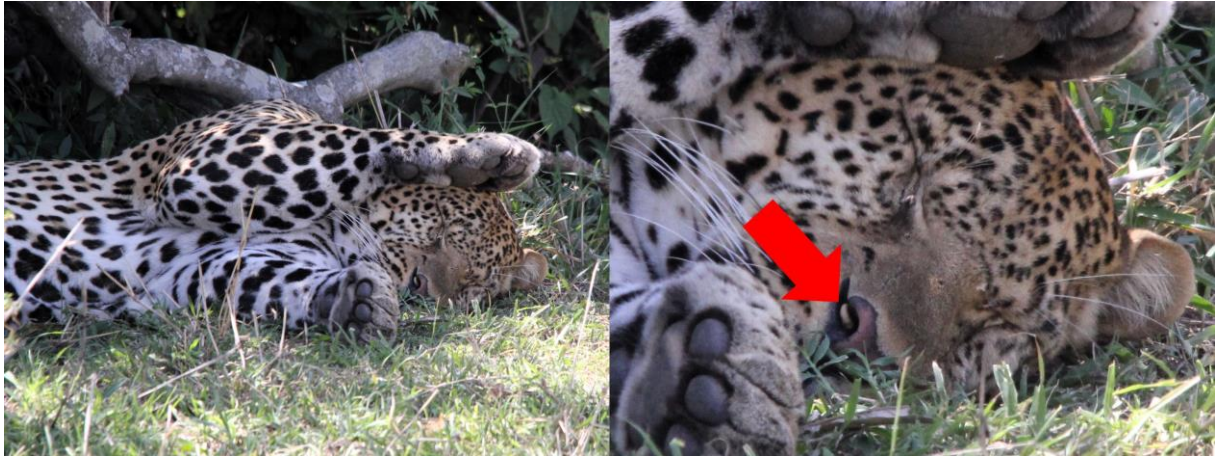


Figure 23. Only when looking at a photograph of this leopard (*Panthera pardus*) it became apparent that the animal had a parasite (probably a tick) in its right nostril. Photo: Thomas Göttert

It can also happen that injuries, lesions or even the absence of a limb only become apparent when you look at a photo afterwards. Other times the photographer can capture unexpected physiology: see Figure 24 for examples of a black redstart (*Phoenicurus ochruros*) missing the right eye, a Cape wagtail (*Motacilla capensis*) without phalanges on both legs, a Cape glossy starling (*Lamprotornis nitens*) displaying the nictitating membrane across the eye and an African darter (*Anhinga rufa*) accessing its uropygial gland located above the tail that produces a diverse range of biochemicals used in chemical protection, water-proofing and maintenance of plumage brightness.

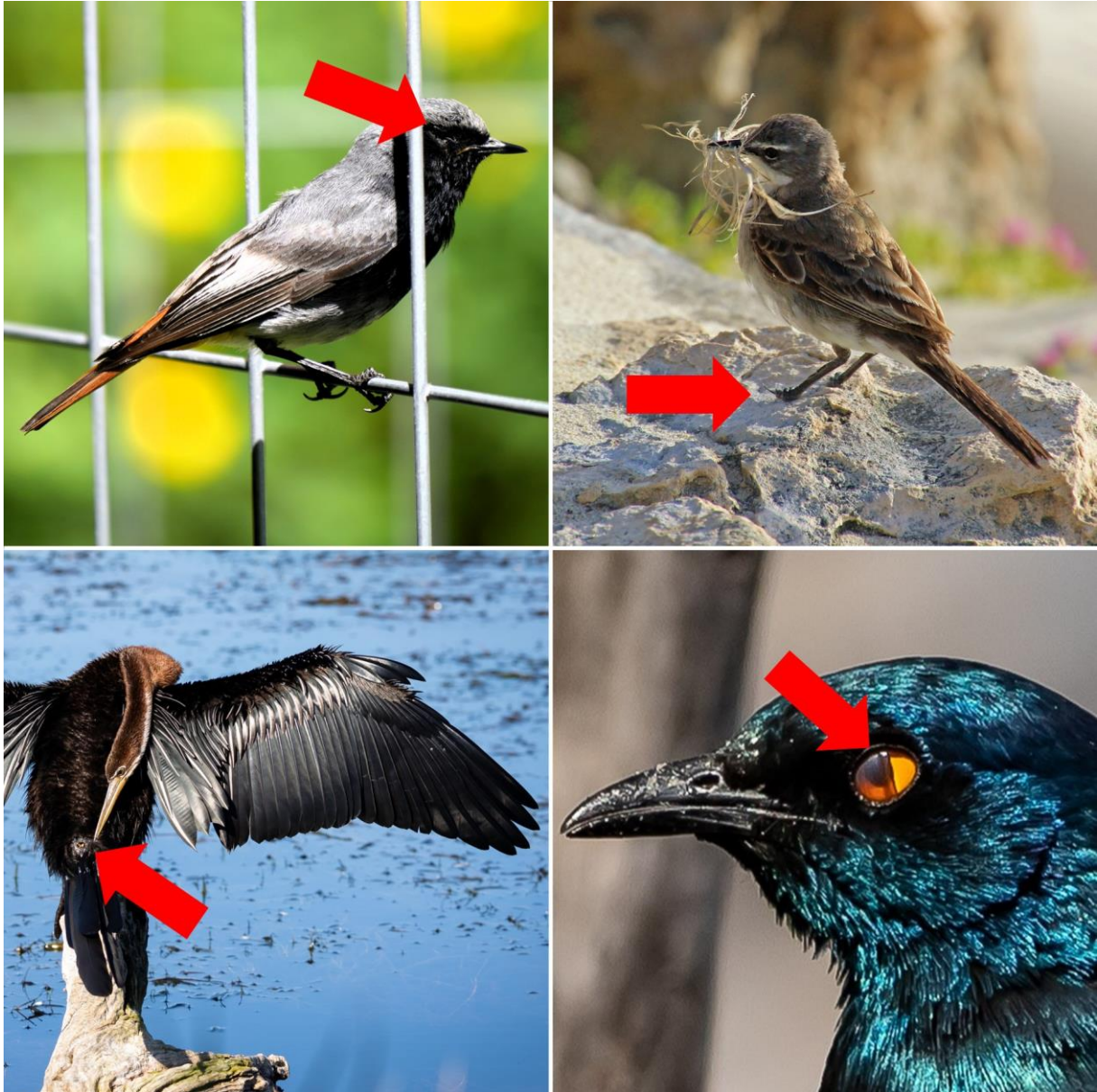


Figure 24. Top left: Black redstart (*Phoenicurus ochruros*) missing the right eye (photo: Thomas Göttert). Top right: Cape wagtail (*Motacilla capensis*) without phalanges on both legs. The nest-building behavior of the wagtail is an indication that the animal is obviously able to show nest-building behavior and possibly even take care of the brood despite this considerable injury (photo: Roland Göttert). Bottom left: African darter (*Anhinga rufa*) accessing its uropygial gland which is clearly visible above the tail. Bottom right: Cape glossy starling (*Lamprotornis nitens*) displaying the nictitating membrane across the eye, photos bottom left and right: Bianca Currie.

7.6 Valuing and respecting (own) photographs

We live in times when almost everyone has a smartphone equipped with high-quality cameras and we experience an inflation of available images and photographs through social media. We can't help but wonder if this has led to a decrease in the appreciation of photographs or a distorted perception of the value of images and photographs, together with a lack of knowledge or understanding of copy rights and ethical sensitivities.

As lecturers, we are required to make information and materials used in teaching accessible and available to students. In this respect, students approach us and ask if we can provide copies, and forward or share our lesson slides, including the photographs contained within. This is not as easy as

it seems as there could be ethical, or copyright issues associated with sharing the images, and there is a need to respect and protect the personal rights of the photographer and photographed. The students argue that we live in times when knowledge should be transparent and freely available, and they do not understand the issues preventing this. To mitigate against the possible infringements upon rights and ethics when using photographs in an education setting, we ideally share slides without the photographs. However, if images are to be shared, only low-resolution copies are provided, and the faces of the photographed are pixilated to protect their personal rights.

8 Concluding remarks

We have celebrated the many ways photography contributes to learning and research, and advocate for a greater integration of photography in science communication and education in the sustainability transfer space. Photography provides a conduit by which knowledge and sustainability transfer can take place. Photographs can provide visual media which can transcend language and cultural barriers, providing real-world examples of sustainable practices, facilitating cross-disciplinary understanding and the sharing of insights, innovations, and experiences for a more sustainable world.

Photography serves as a visual medium that engages and captivates learners, fostering curiosity and a deeper connection with the subject matter. It enables scientists to document and communicate their research findings effectively, promoting transparency and accessibility in the scientific community. Additionally, photography can enhance scientific research by providing visual evidence, aiding in species identification, documenting changes over time, and facilitating data collection and analysis. Its intrinsic value lies in its ability to tell stories, evoke emotions, and bridge gaps in understanding.

However, we recommend approaching the use of photography with caution and an awareness of its limitations. While photographs have the power to enhance communication and comprehension, they can also be subjective, manipulated, or incapable of fully representing complex phenomena accurately. Context, interpretation, and the potential for misinformation must be carefully considered. By striking a balance between harnessing the strengths of photography and acknowledging its limitations, we can leverage its power as a valuable tool in science and education.

Responsible use of photography involves critical thinking, promotes accurate representation, ethical practices and a respect for the rights of those involved. With a mindful approach, photography can enrich our understanding, inspire discovery, and cultivate a greater appreciation for the natural world, while mitigating potential biases and limitations. It is through this thoughtful integration that we can unlock the full potential of photography as an indispensable tool in science and education, empowering learners and researchers to explore new frontiers and make meaningful contributions to their fields.

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About the authors



The authors in “downtown” Lenzen, Elbe, Germany in 2022. Photo: Bob Patrick

Bianca Currie

Bianca Currie completed undergraduate studies in conservation and went on to receive a PhD focusing on social learning in water management in a complex social ecological system in South Africa from the Nelson Mandela University. Bianca has 12 years of teaching conservation communication, environmental education and research methodology at the School of Natural Resource Management while hold the position of director of the Sustainability Research Unit at the Nelson Mandela University until 2020. Since then, she has taken up a position as chief executive of the UNESCO Garden Route Biosphere Reserve where she puts theory into practice and continues to supervise post graduate research related to biosphere reserves as a research associate at the Sustainability Research Unit.

Thomas Göttert

After studying biology at Martin Luther University Halle-Wittenberg, Thomas Göttert conducted research on the post-release spatial ecology of reintroduced African rhinos in Namibia and received a doctoral degree (Dr. rer. nat.) from the University of Veterinary Medicine Hannover, Foundation. Thomas worked for quite some years at the Natural History Museum in Berlin and Humboldt-Universität zu Berlin and is currently affiliated with Eberswalde University for Sustainable Development. He has almost 20 years of international teaching experience and a strong research interest in central European and southern African ecosystems.

Bisher veröffentlichte Diskussionspapiere des Forschungszentrums [NTT]

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- Nr. 8 / 23 Currie B, Göttert T (2023) The value of photography in science and education - Photography through the lens of two scholars. Eberswalde: Hochschule für nachhaltige Entwicklung Eberswalde (Diskussionspapier-Reihe Nachhaltigkeitstransformation & Nachhaltigkeitstransfer, Nr. 8/23). <https://doi.org/10.57741/opus4-636>

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Hochschule für nachhaltige Entwicklung
Forschungszentrum [Nachhaltigkeit – Transformation - Transfer]
Schicklerstr. 5, D-16225 Eberswalde, Germany
www.hnee.de/forschungszentrumNTT

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