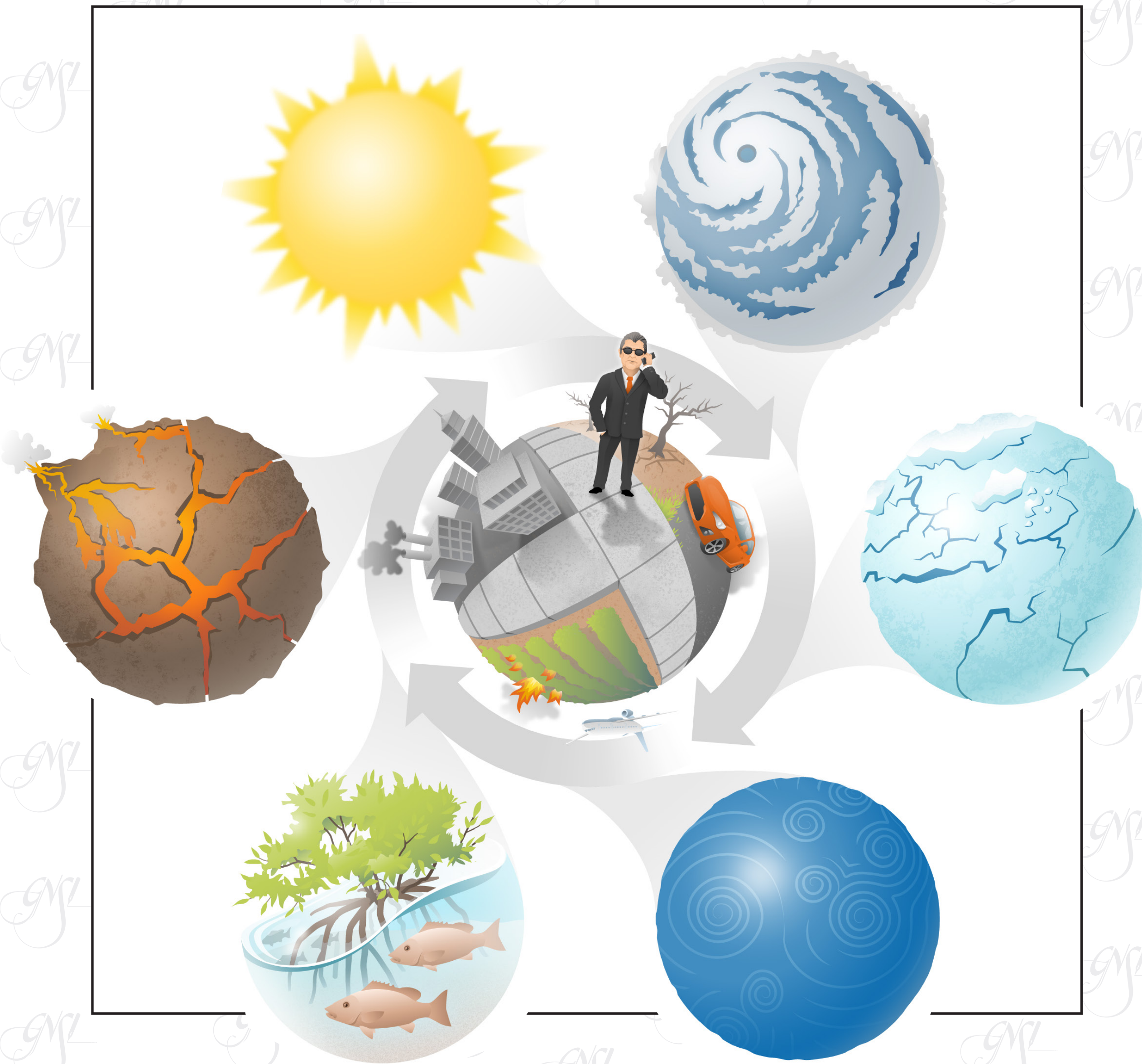
Journal of Natural Science Illustration

GUILD OF NATURAL SCIENCE ILLUSTRATORS



VOLUME 57 • NUMBER 2 • 2025

Note from the Editor

The Guild of Natural Science Illustrators continues to be a wonderful source of creativity, knowledge, and community. This past summer's annual meeting once again demonstrated the depth of talent within our membership. Attendees shared projects, research, art and insights that underscored the vital role of visual communication in understanding the natural world. The enthusiasm and generosity of presenters and participants alike were truly inspiring, and we look forward to capturing and sharing many of those ideas and conversations in upcoming issues of the *Journal of Natural Science Illustration*.

In this issue, we present the second installment of a collaborative book chapter created by five co-authors for the open-access eBook *Communicating Climate Science: Storytelling to Accelerate Climate Solutions.* Part 2 explores strategies for creating effective visuals in the climate space. We also feature a story about the preparation needed to teach an online vertebrate anatomy course—an increasingly relevant topic in today's remote learning environments. In addition, this issue includes a review of the book produced for the National Gallery of Art "Little Beasts" exhibition, sketchbook pages by member Jen Lucas, and an article on medieval skull reconstruction, offering a fascinating look into the creative processes behind scientific illustration.

The *Journal* is, at its core, a collaborative effort. It thrives because members are willing to share their expertise, curiosity, and time—whether through contributing articles, serving as editors or designers, or supporting the production and review process. Each contribution strengthens our shared mission to advance visual science communication and celebrate the artistry behind it.

We warmly encourage every member to consider submitting a project profile, a career reflection, research findings, or perspectives on teaching and professional practice. Every story enriches the collective understanding of what it means to build a life and career in the visual sciences—and to champion the power of illustration in revealing, explaining, and preserving the natural world.

—Britt Griswold, Senior Consulting Editor

CONTENTS

Cover: A novel perspective of the earth's seven spheres. Clockwise from top left: heliosphere, atmosphere, cryosphere, hydrosphere, biosphere, and geosphere. Center: The anthrosphere, representing humans, has had a disproportionate impact on the rest of the earth's systems. ©2021 Fiona Martin

Back cover: GNSI 2025: Fundraising for the Future

NATURAL SCIENCE ILLUSTRATORS GNSI

The Guild of Natural Science Illustrators is a nonprofit organization devoted to providing information about and encouraging high standards of competence in the field of natural science illustration. The Guild offers membership to those employed or genuinely interested in natural scientific illustration.

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GNSI JOURNAL

Volume 57, Number 2/2025 • © 2025
JOURNAL OF NATURAL SCIENCE ILLUSTRATION (JNSI) (ISSN 01995464) is published at 2201 Wisconsin Ave., NW, Suite 320, Washington, DC 20007, by the Guild of Natural Science Illustrators, Inc.

This paper meets the requirements of ANSI/NISO Z39.48-1992 (Permanence of Paper).

POSTMASTER: CHANGE OF ADDRESS

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(Above left): Trip with Women Sharing Art group to Parrish Art Museum And Southampton Art Museum, NY, for an exhibit made with ocean plastics.

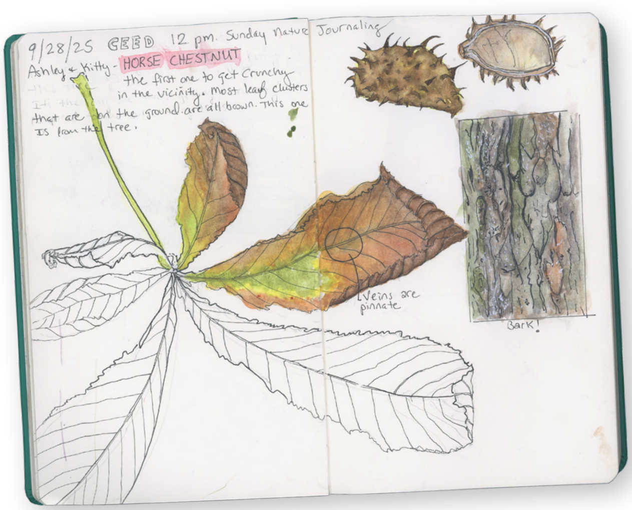
(Above right): Reconnecting with family at the Irish Coffee Pub Islip, NY. Both micron pen, Arteza Watercolor pens in Hahnemühle sketchbook

Pages from my Sketchbook

JENNIFER LUCAS

My sketchbooks are like a visual diary where observation, reflection, and memory come together. I use them to record the places I visit and small, everyday moments — since the days can sometimes blur together without clear boundaries or memories. When I take time to sketch, it helps make those moments feel more grounded and memorable. The "nicer" pages usually come later, based on photos I've taken or objects I've found during walks in the parks near my home and work. (P.S. My early project or painting sketches aren't exactly pretty and often include grocery lists, bill calculations, or personal notes that aren't meant for sharing!)

(Right): On one of my weekend walks at Brookhaven National Lab, Upton, NY. Pine Tree with old handpainted sign. Watercolor and gouache in a Handbook Trav-e-logue.



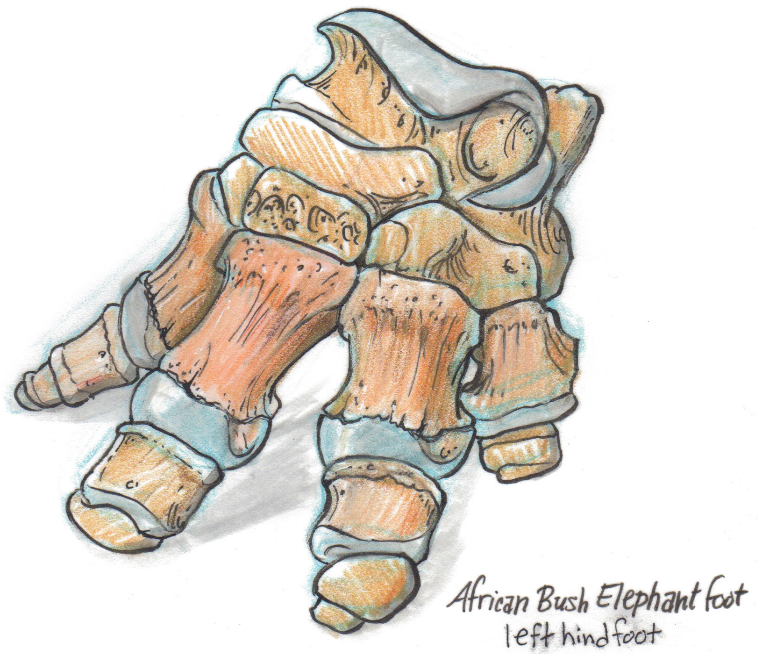
(Above): Sketch done while teaching nature journaling at Center for Environmental Education and Discovery, Brookhaven, NY. Micron pen and watercolor in Jalen's Art Creation sketchbook.

(Left): In my back room on our online conference 2021 with Lex the cat. Micron pen, Arteza Watercolor pens in Hahnemühle sketchbook.

(Below): Visiting family in Ditch Plains, Montauk, NY. Micron pen, Arteza Watercolor pens in Hahnemühle sketchbook.

(Left): Found Racoon(?) skull Southaven Park, Brookhaven,NY. Watercolor in Hahnemühle watercolor journal

(Below): Skunk Cabbage and log on sketching trip, Hedges Creek Park, East Patchogue, NY. Micron and watercolor in Hahnemühle book.



Teaching Comparative Vertebrate Anatomy

— *by Dino Pulerà*

Dino Pulerà developed and taught a new online Comparative Vertebrate Anatomy course for artists through the Yale Peabody Museum's Natural Science Illustration Program. Combining traditional and digital media, original illustrations, and classic references, the course emphasized anatomical understanding through drawing.

Figure 1: (*above*) Elephant foot bones study sketch using mixed media with colored pencils, brush pens, design markers on Clear Print vellum.

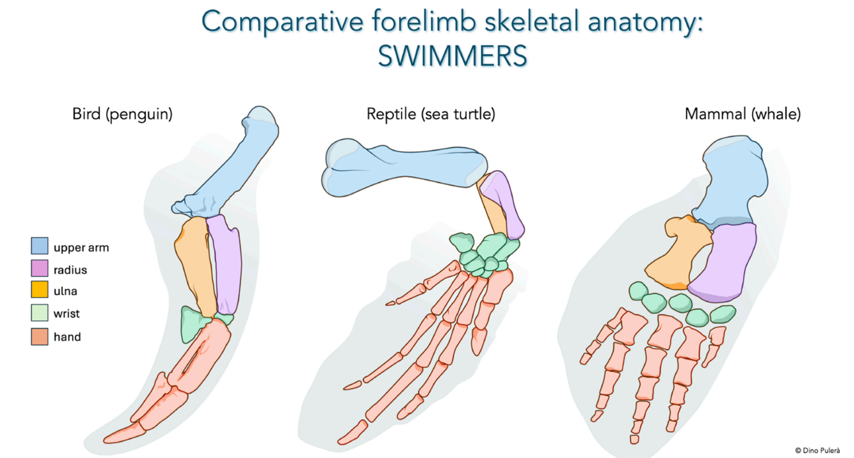
I've been studying and illustrating comparative vertebrate anatomy (CVA) for about 30 years. For many years I've wanted to share what I have learned and teach a CVA course for artists. This opportunity presented itself in the Fall of 2024 when I joined the Yale Peabody Museum Natural Science Illustration Program (YPM NSIP) teaching staff. Even though there was an established curriculum to use, I took a chance and created a new course with the goal of not only making it more comparative, but also, in the end, my own. This was a remote learning, eight-week course which met for three hours each class. My first session of teaching CVA ended in June 2025. Based on the students' positive feedback, overall, the course was a success.

Despite having almost three decades of experience illustrating CVA, I understood teaching this subject would bring new and different challenges. Chief among them would be conveying my knowledge of anatomy to new students and demonstrating various illustration techniques via an exclusively online platform.

APPROACH

My approach to teaching this subject was to encourage students to see the vertebrate body through a new critical anatomical lens. Students were challenged to apply what they learned in class and try to 'see' and understand what lies beneath the skin of the animals being studied.

Since this would be my first time teaching a vertebrate anatomy course, I thought it would be imperative to go back to the basics and revisit the material as if I were a student again. This meant literally going



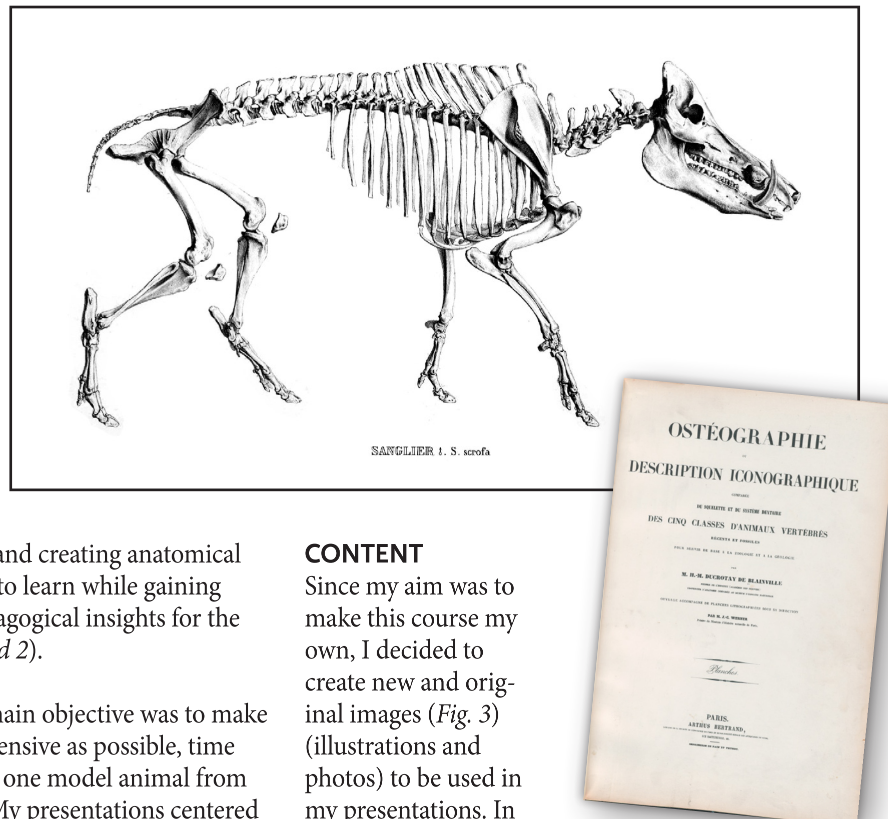


Figure 2: (*above left*) Study sketch of the skeletal anatomy of a walrus forelimb flipper created with mixed media in sketchbook.

Figure 3: (*top right*) Excerpt from PowerPoint slide showing the comparative forelimb anatomy of swimmers created specifically for this vertebrate course.

Figure 4: (*above right*) Example of a classic anatomical illustration from a an anatomical guide, incorporated with lessons.

back to the drawing board and creating anatomical study sketches from which to learn while gaining artistic inspiration and pedagogical insights for the upcoming course (*Fig. 1 and 2*).

Even though this course's main objective was to make the curriculum as comprehensive as possible, time constraints meant selecting one model animal from which to base my lessons. My presentations centered on mammalian anatomy, more specifically feline osteology and its superficial muscles.

CURRICULUM

The curriculum included an introduction to the diversity of vertebrates and their general body plan, cranial anatomy, post-cranial anatomy, superficial muscles and intro to label design. Students were welcomed to ask questions during and after each lesson. One-on-one meetings between myself and the students were also built into the second half of the lesson plans. Each week students were encouraged to share and discuss their illustrations and sketches as part of an open, informal and friendly critique.

CONTENT

Since my aim was to make this course my own, I decided to create new and original images (*Fig. 3*) (illustrations and photos) to be used in my presentations. In addition to original material, I also included classic images that were published 100+ years ago (*Fig. 4*). These vintage images not only served as inspiration for me, and hopefully the students, but were also excellent references for demonstrating beautiful and accurate anatomy.

REMOTE SET-UP

Zoom was used as the online platform along with a document camera, which was extremely helpful in sharing reference materials and performing demonstrations with traditional media. Overall, it worked well. One advantage of offering an online anatomy course is that a larger audience can be reached because it is more accessible to many more

Superficial Muscles of the African Lion (*Panthera leo*)

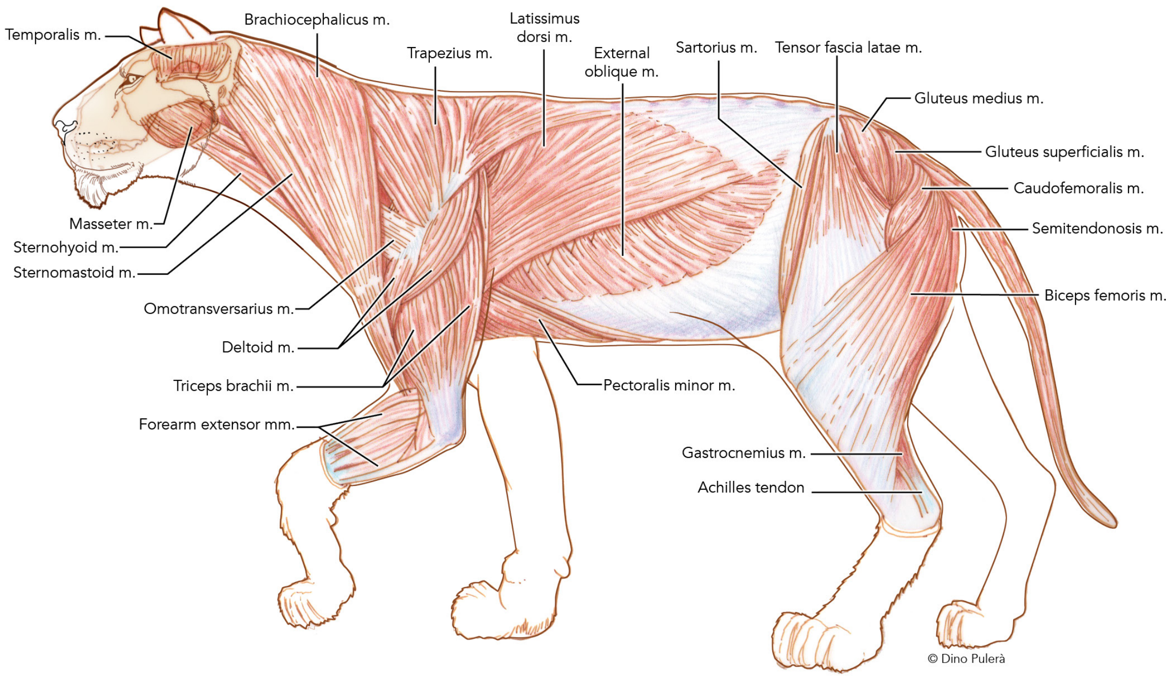


Figure 5: Anatomy of the African lion created with colored pencil and brush pens on Canson vellum.

people. The main disadvantage of teaching anatomy virtually is not being able to handle, study and draw from physical and tangible learning materials like 3D printed models, skulls, skeletons, bones, anatomical models, taxidermy, live animals, etc. But there are several excellent web sites, such as Sketchfab, that provide high quality and accurate virtual models of skull and skeletons from which student may study and sketch.

ASSIGNMENTS & EXERCISES

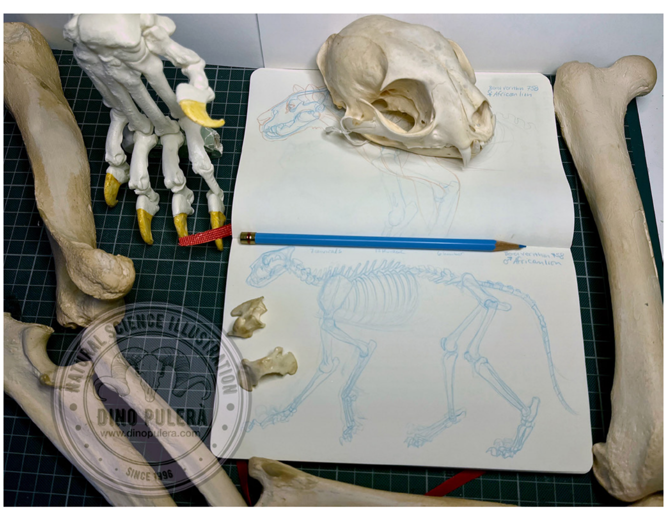
Student assignments included the depiction of a labeled feline skeleton with accompanying illustration of its superficial muscles (*Fig. 5*), a labeled feline skull, and the final project involving the illustrations of the skeleton and superficial muscles of an animal of the students' choice. Some other assignments included coloring and labeling exercises.

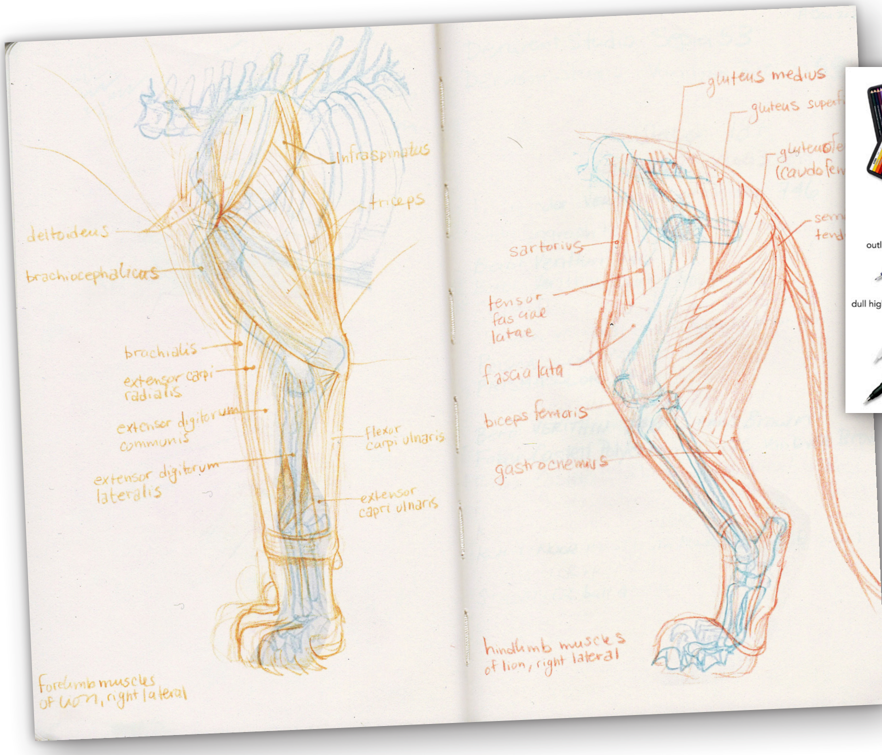
RESOURCES

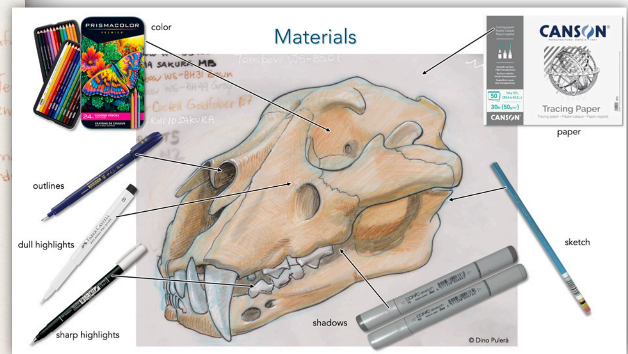
I used various resources from which to create the content for my course and used similar ones for my study sketches including reputable texts, online references, real skeletal material, 3D printed models, and animal dissections (*Fig. 6*). Sketching from dissection was possible thanks to my good friend, Dr. Gerry De Iuliis, CVA instructor at the University of Toronto, and co-author of our book, *The Dissection of Vertebrates*, which is currently being updated for a fourth edition. Having the opportunity to discuss anatomy and dissections with Gerry while creating some of my study sketches was invaluable (*Fig. 7*).

Figure 6: (*bottom left*) Various resource/reference materials used for study sketches, including real skulls and bones, 3D printed models, and anatomy models.

Figure 7: (*bottom right*) Dino sketching a cat muscle dissection in the zoology lab at the University of Toronto.







colored pencil (*Fig. 9*). This strategy allows me to see both bones and muscles simultaneously without using a second sheet of semi-transparent paper in my sketchbook.

For students wanting to work digitally, I also gave demonstrations with Photoshop and InDesign.

Figure 8: (*top right*) Lion skull mixed media study sketch on Canson heavy tracing paper.

FIgure 9: (*top left*) Study sketches of lion muscles using non-repro blue and terra cotta pencils in Moleskine sketchbook.

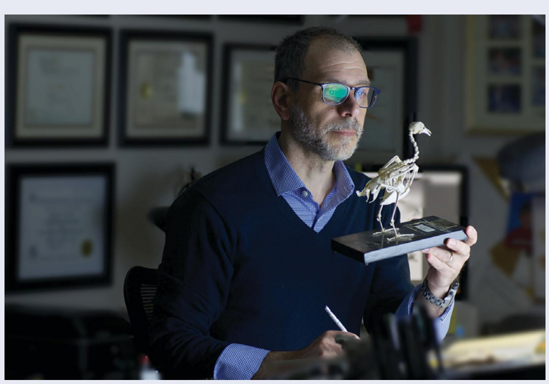
TECHNIQUE & MEDIA

The primary focus or goal of the course was teaching/learning anatomy through drawing. Since drawing was secondary, the students were free to choose their preferred media. As an option, I introduced a mixed-media technique using colored pencils, brush pens, design markers, and white ink brush pens on heavy tracing paper or vellum (*Fig. 8*). Even though most of my work is digital, my favorite medium is still graphite and color pencil on paper which I used to create my sketchbook drawings.

Most of my study sketches involved depicting skeletal anatomy using non-repro blue pencil and adding an overlay of muscles using a 'terra cotta' or 'sepia'

FUTURE

The creation of this course was a labor of love which was a tour de force that took six months and hundreds of hours. The impetus for investing so much time and effort was to teach this course for many years to come. Unfortunately, due to recent budget cuts, the YPM NSIP has been canceled shortly after celebrating 15 successfully years (see JNSI 2024 v. 56 no. 2 pp. 17-18.). I immensely enjoyed teaching this course and would like to find a new venue or means to do so. If you're interested in taking my CVA course or know of a program that is looking to include a virtual vertebrate anatomy course, please contact me directly and I can add you to mailing list to let you know when my next course will be available.



ABOUT THE ARTIST

Dino is a natural science illustrator specializing in animal anatomy and paleontology. He is the illustrator and co-author of the internationally renowned and award-winning comparative anatomy dissection manual entitled *The Dissection of Vertebrates*, currently being updated to a fourth edition. His work has won numerous awards and has been displayed in many international exhibitions. Dino is a Board Certified Medical Illustrator (CMI).

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Jan van Kessel the Elder, *Insects and a Sprig of Rosemary*, 1653, oil on copper. 4.5" x 5.5" (11.5 x 14 cm)

National Gallery of Art, The Richard C. Von Hess Foundation, Nell and Robert Weidenhammer Fund, Barry D. Friedman, and Friends of Dutch Art. 2018.41.1

Book Review

Little Beasts: Art, Wonder, and the Natural World

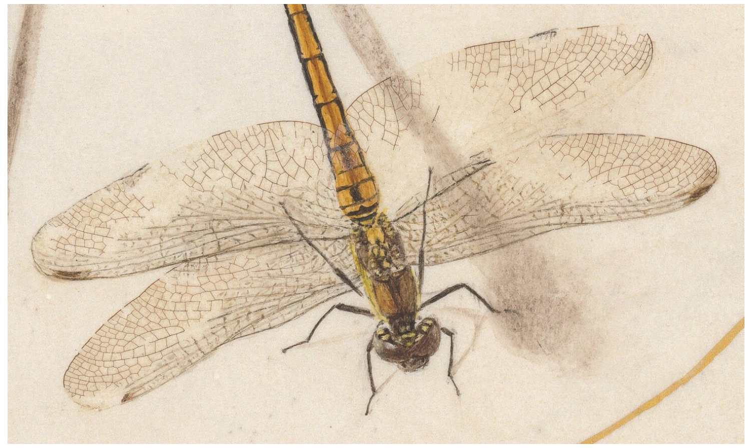
BY ALEXANDRA LIBBY, BROOKS RICH, AND STACEY SELL (EDITORS) WITH ESSAY BY BRIAN W. OGILVIE

— Review by Julianne Snider, Member GNSI

More than two thirds of this lovely publication is filled with full pages of images and details of the watercolors, oil paintings, etchings, engravings, and woodcuts selected to illustrate *Little Beasts'* central themes: the evolution of natural history in Europe beginning in the 15th century, and the work of Joris Hoefnagel and Jan van Kessel the Elder, two Flemish artists and contributors to the discipline of descriptive natural history during the 16th and 17th centuries.

Several illustrations of work by Dürer, Hooke, Aldrovandi, Gessner, Bol, di Liagno, and others are included in the publication to highlight the types of images that were being produced and incorporated into the growing number of books being acquired by universities, naturalists, collectors, catalogers, and classifiers of animals, plants, and minerals as interest in natural history grew during the Renaissance period of Western Europe. These illustrations and books played a significant role in disseminating information about exotic, non-European flora and fauna that were being brought into Europe from all over the world. Illustrations, reprinted in multiple publications and copied multiple times by multiple artists, were sought after by collectors and creators of cabinets of curiosity.

Hoefnagel (1542–1601) and van Kessel (1626–1679) accessed these prints and publications as they



(above left): Joris Hoefnagel, *Hairy Dragonfly and Two Darters* (*Ignis*, Plate 54), c.1575/1590s. Transparent and opaque watercolor, dragonfly wings, oval border in gold on parchment. 5.625"x 7.25" (14.3 x 18.4 cm). National Gallery of Art, Gift of Mrs. Lessing J. Rosenwald 1987.20.5.55

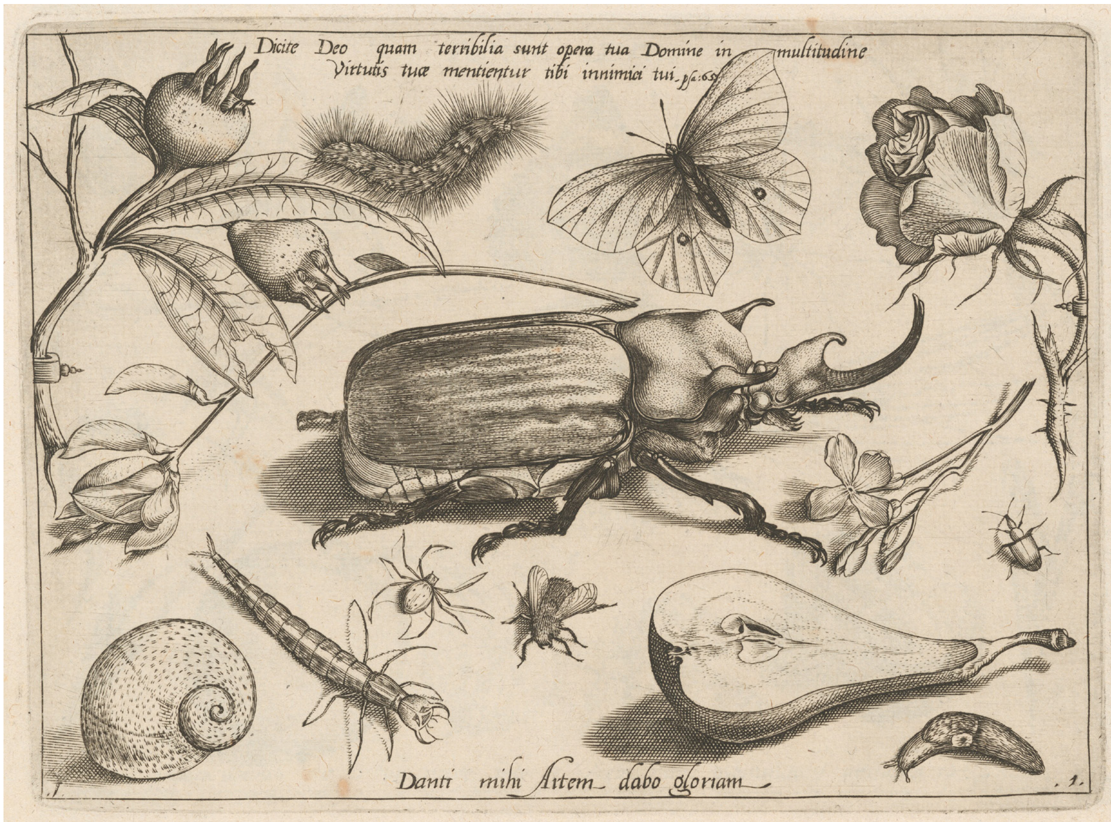
(above right): Detail of *Ignis*, Plate 54, (lower right Darter) showing dragonfly wings (degrading) adhered on top of watercolor painting of body and shadow.

explored the intersection of art and science through their interests in depicting denizens of the natural world—insects, reptiles, mammals, fish, birds—as realistically as possible. Images from these artists' brushes are included as endpapers, as hidden double fore-edge paintings under the gilt edges of the book block, as delightful little beasts crawling across pages of text, and as full-page cited illustrations plus details from their works of art.

Little Beasts: Art, Wonder, and the Natural World was published as the companion to the National Gallery of Art, Washington D.C., exhibit of the same name. The exhibit, curated by Alexander Libby, Brooks Rich, and Stacy Sell, was comprised of specimens from the collections of the Smithsonian National Museum of Natural History, 80 works of art, and *The Four Elements*—four volumes containing hundreds of Joris Hoefnagel's original watercolors on parchment from the drawing collection of the National Gallery. Several images and details of Hoefnagel's original watercolor paintings from the volumes are included in *Little Beasts* the book. The original paintings in the volume *Ignis* (fire) are life-size depictions of insects, sometimes incorporating complete dragonfly wings or transfer prints of butterfly wings—a technique known as lepidochromy. Images in the other three volumes, *Terra* (earth), *Aqua* (water), and *Aier* (air), are miniatures of multiple animals depicted in somewhat naturalistic settings and classified by the element in which they were found. *Terra* covers "elephants to insects", *Aqua* has "water animals", and *Aier* includes birds and bats. *Ignis*, inexplicably, is the element containing primarily insects. The illustrations in *Ignis* were painted directly from live or preserved insects. Animals depicted in the other volumes were copied mostly from other sources and arranged to create vignettes enclosed in ovals drawn with gold paint. The insects are also arranged aesthetically and framed in gold ovals. *The Four Elements* was created as a personal project by Hoefnagel that he shared with friends and colleagues.

In his opening essay "Natural History in the European Renaissance" Brian W. Ogilvie, professor and chair of the Department of History at University of Massachusetts Amherst, takes the reader through the origins and early advancements of natural history. Ogilvie reminds us of the fundamental role art played in the development of the new science of studying the natural world while pointing out that the curiosity and wonder driving the growth of science and art during Europe's Renaissance period were fueled by the flood of unfamiliar plants, animals, pigments, and other goods coming into Europe from colonial and commercial expansion and exploitation—there is a moral cost of curiosity that deserves awareness and recognition.

Stacey Sell, associate curator of old-master drawings at the National Gallery, provides an overview of the artists and scientists who influenced the life and work of Joris Hoefnagel in her chapter "'Through Such Variety, Nature is Beautiful': Joris Hoefnagel, *The Four Elements*, and Natural History". Sell covers details about the references, techniques, and materials Hoefnagel used to create his paintings in *The Four Elements*. For *Ignis*, Hoefnagel departed from the then-customary themes of natural history to concentrate on the uncharted topic of little beasts, i.e., insects. Along with his use of watercolors to illustrate these little beasts, Hoefnagel experimented with the use of metallic paints to create the look of iridescence, the use of tinted resins and gums to impart shine to insect eyes and wings, the incorporation of wings and scales in depictions of Odonata and Lepidoptera,



Jacob Hoefnagel, after Joris Hoefnagel, part 1, plate 1 from *Archetypa studiaque patris Georgii Hoefnagelii*, 1592, engraving 6.125" x 8.1875" (15.5 x 20.8 cm). National Gallery of Art, Gift of Mrs. Lessing J. Rosenwald. 1987.20.9.2

and painting insects on blank backgrounds where the shadows they cast were painted in to create a life-like quality to the illustrations.

In the chapter "Survival of the Finest: Animals in Early Modern Intaglio Print Series", Brooks Rich, associate curator of Old Master and 19th century prints at the National Gallery, looks at Hoefnagel's move toward monetizing his original work through use of the intaglio printmaking techniques of etching and engraving. Working with his printmaker son, Jacob Hoefnagel, the images printed were not direct copies from images in *The Four Elements* but compositions depicting animals and little beasts with plants and other creatures. The Hoefnagels' approach diverged from the style of animal prints of the time with the inclusion of "flower, fruits, and nuts" and a selection of other organisms. Beginning in 1592, a series of these compositions were reproduced and made accessible and affordable to a wide audience including print collectors. Hoefnagel was just one of several artists of his time to embrace working with printmakers. Rich provides a history of the growth of printmaking and use by artists through the 17th century and points out how creating and distributing prints of original work provided many artists with a source of income, increased fame, and contributed to their legacy. The distribution of printed images also contributed to growth and transfer of knowledge and natural history as a discipline.

Alexandra Libby, senior administrator of collections and initiative for the National Gallery of Art, provides the closing chapter "'Monstrous Creatures and Diverse Strange Things': The Art of Jan van Kessel". Van Kessel was a talented painter, a member of the renowned Brueghel family of artists, and was registered as an apprentice in the Antwerp Painters Guild when he was eight years old. Born well after Joris Hoefnagel's death, van Kessel was nonetheless influenced by Hoefnagel's work and became a celebrated painter of insects and little beasts in his own right. Van Kessel painted his insects life size on postcard-size copper plates using oils and metallic pigments. Painting from real, possibly some live, specimens van Kessel depicted insect behaviors, sexual differences, life stages, non-European insects, and groups of different species together along with plants, shells, and other creatures. Although it is not known what magnification tools van Kessel may have used, it is likely that he had access to advanced optical technologies that were not available during Hoefnagel's life. Van Kessel worked during a time of "early modern luxury culture" when premiums were paid for rare, foreign, and finely crafted items that collectors wanted to include in their rooms and cabinets of curiosities. About 120 van Kessel small paintings on copper are known to still exist out of the more than 700 he created. Libby points out that van Kessel's work in natural history was an extension of

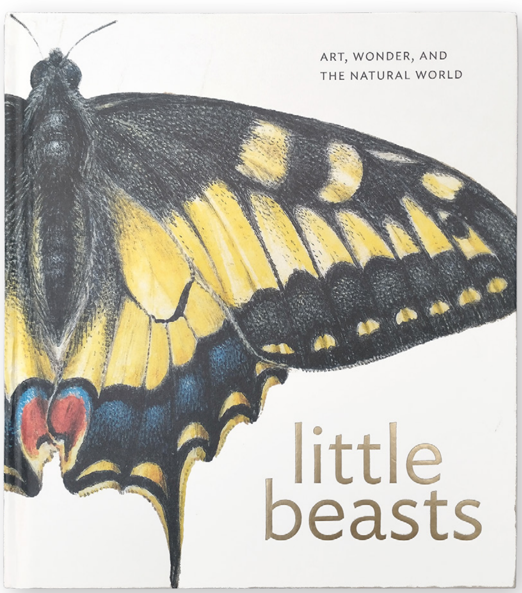
Edge painting on the pages of the book.

Circle of Jan van Kessel the Elder, *Study of Birds and Monkey*, 1660/1670, oil on copper, 4.25" x 6.75" (10.5 x 17.2 cm). National Gallery of Art, Gift of John Dimick. 1983.19.1

the tradition of exchanging of ideas, observations, and knowledge between artists and natural scientists.

This book, *Little Beasts: Art, Wonder, and the Natural World,* is a pleasure to hold, flip through, closely look at the multitude of illustrations, as well as read. The list of illustrations provides useful information on materials used by the various artists represented.

Little Beasts should be of interest to artists, illustrators, art historians, historians of science and natural history, and book arts enthusiasts. Available as a hardback and in electronic formats, *Little Beasts* the book will remain relevant and memorable long after *Little Beasts* the exhibit has been taken down and packed away.



Book Cover, *Little Beasts: Art, Wonder, and the Natural World*

Little Beasts: Art, Wonder, and the Natural World

By Alexandra Libby, Brooks Rich, and Stacey Sell (editors)
with essay by Brian W. Ogilvie

Published: May 20, 2025 by The National Gallery of Art in association with Princeton University Press

224 pages, 150 illustrations, Size: 8 x 9 inches

Hardcover: ISBN 978-0-691-27130-9

Ebook: ISBN 978-0-691-27131-6

Available in hard copy or electronic form from: The Gallery Shop, National Gallery of Art. *https://shop.nga.gov/little-beasts-art-wonder-and-the-natural-world*

and Princeton University Press. *https://press.princeton.edu/books/hardcover/9780691271309/little-beasts?srsltid=AfmBOopmXWec-n7nuJ_5GXoDX7_7dAdiw2dzGsGg7TNtoUokYNw2_xrX*

The exhibit Little Beasts: Art, Wonder, and the Natural World was on display at the National Gallery in Washington, D.C. 18 May–2 November 2025.

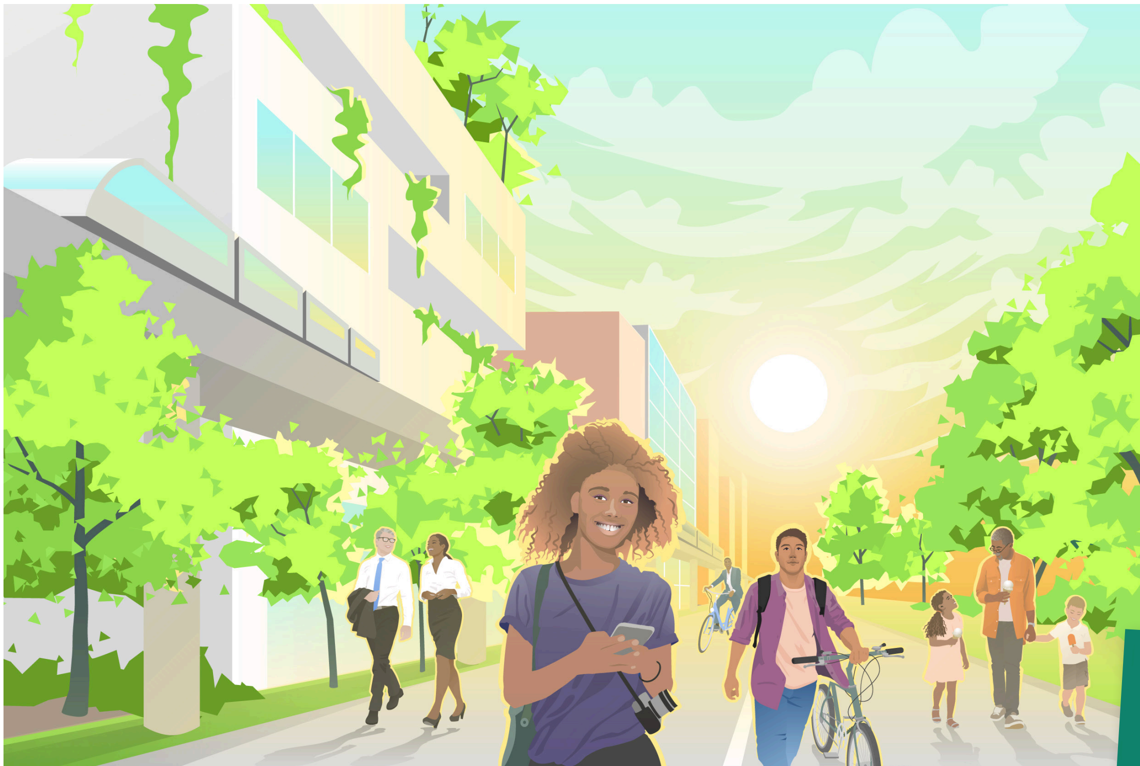
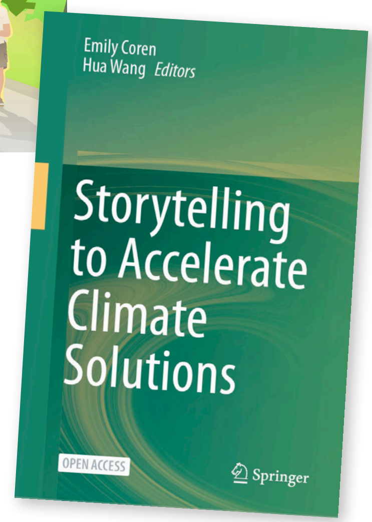


Figure 1: (a) The NOAA's Climate Program Office features illustrations on the cover of their *2024–2028 Strategic Plan,* envisioning a future where all peoples, economies, and environments are resilient to climate impacts and work together to sustainably mitigate climate change. Illustrations by Fiona Martin of Visualizing Science LLC, in the public domain.

Below: Cover of the open-access book *Storytelling to Accelerate Climate Solutions*, edited by Emily Coren and Hua Wang and published by Springer (2024). ISBN: 978-3-031-4789-8; eBook: *https://link.springer.com/book/10.1007/978-3-031-54790-4.*



Visuals as a Catalyst for Climate Science Communication

PART 2: WHAT MAKES EFFECTIVE VISUALS

— *by Kalliopi Monoyios, Kirsten Carlson, Taina Litwak, Tania Marien, and Fiona Martin*

The following pages contain excerpts from a chaper written by five GNSI members and published in the open-access book Storytelling to Accelerate Climate Solutions. As visual science communicators, we have the power to transcend language and cultural barriers, learning differences, and knowledge or skill gaps. We have the opportunity to broaden and deepen engagement as quickly as possible, improving understanding and uptake of mitigation and adaptation skills.

Visual science communicators dedicate their careers to thinking about strategies and considerations to take into account when distilling complex ideas into intuitive visuals that people connect with. When done well, graphics serve as a universal, accessible language, translating complex scientific concepts into infographics or illustrations that can be understood "at a glance" by anyone and anywhere. They provide a way for abstract or distant concepts to be visible, quantifiable, and relatable. They may employ narrative, emotion, analogies, and even humor to disarm people and open their minds to the possibility of change. They may provide glimpses of the future, whether hopeful or not (*Fig. 1*).[1] In our age of information overload, novel, targeted images cut through the noise, relieving "climate fatigue," offering solutions, and inspiring citizens to get involved.[2] They provide a window into the world of scientists, increasing transparency and building trust with local communities. Ultimately, our best research revelations are fruitless if we do not utilize our full tool kit as we strive to increase climate science literacy and resilience.

PART 1 of this article (*shared in the previous issue*) covered the benefits of having professional science artists on communication teams. See *JNSI Vol. 57 No. 1*, available online at *https://www.gnsi.org/journal-of-natural-science-illustration.*

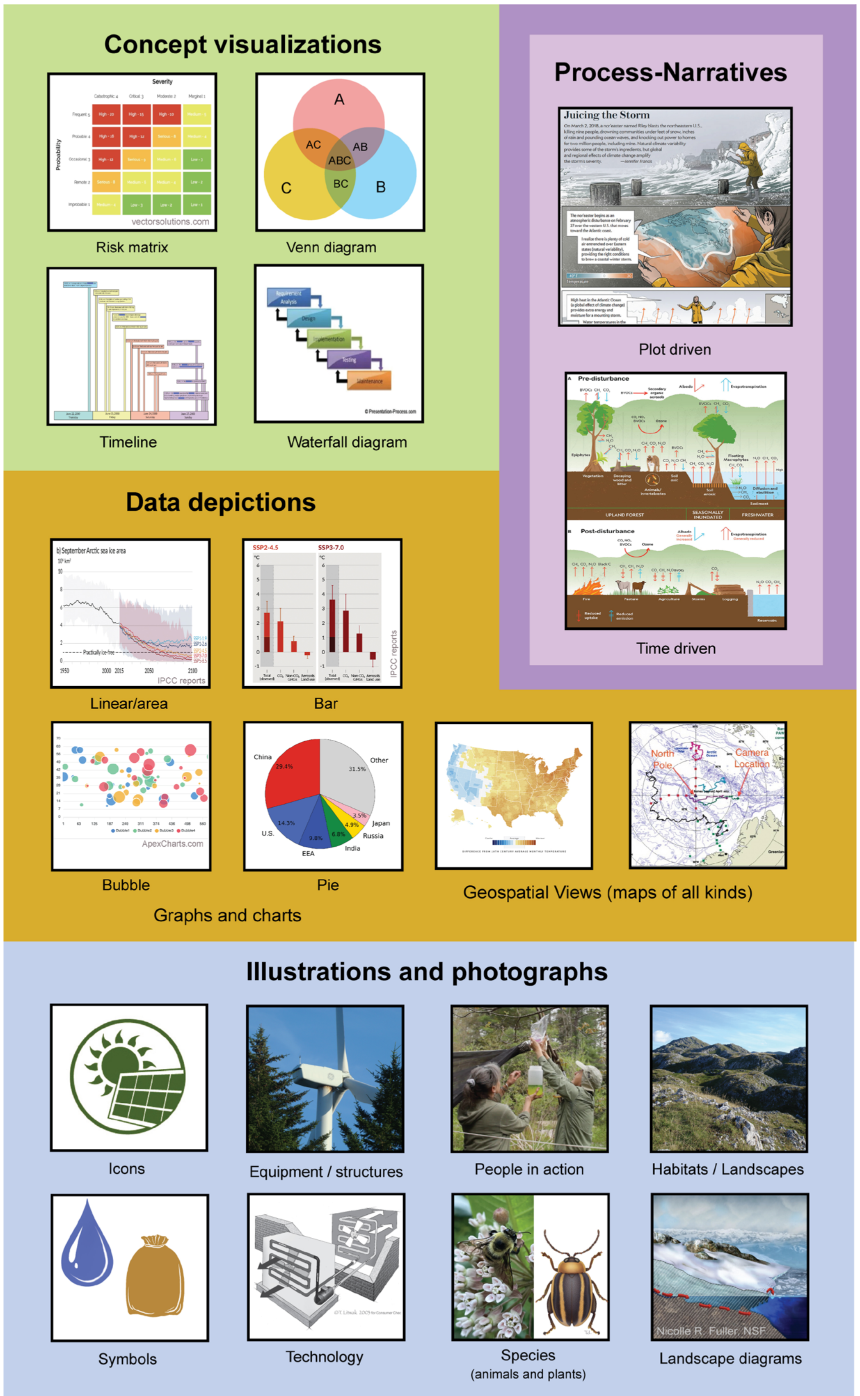


Figure 2: A wide array of elements can be used to create visual narratives. The most successful graphics often use several types of visual elements in one piece. Concept visualizations (top) can arrange data in easy-to-digest, visual formats, where relationships become clearer than numbers or words can communicate alone. Similarly, data depictions (middle) simplify and compare complex data sets (e.g., weather patterns), using universal visual elements we can understand at a glance. Illustrations and photographs (bottom) can range in detail from graphic icons to realistic illustrations to photographs. This is just a subset—there are many other visual tools not shown here. Figure arranged by Taina Litwak and Emily Coren. Thumbnail images are copyrighted and included with permission.

Whether you are a practitioner or are collaborating with one, it is useful to be aware of and think critically about the elements that contribute to the best communication efforts so that we may always be learning and adapting to the cultural shifts that unfold at an ever-accelerating rate. As Jordan Collver and Massimiano Bucchi rightly point out in their pithy Lifeology course *Style in Science Communication*, there is no single formula that will produce a winning graphic every time.[3] Rather, each communication attempt represents a complex interplay between various considerations, the most important of which we attempt to collect in the sections that follow.

Visual science communication has a language, in this case comprised of visual elements, some of which are broadly recognized across cultures and others that are more effective with people who have specialized knowledge or training (*Fig. 2*). Knowing which elements to use entails defining a specific goal that can generally be answered by questions like "Who am I trying to reach?" and "How do I want people to react?" Answering these critical questions will go a long way toward narrowing down the myriad options available when creating an effective visual. Social psychologist Jonathan Haidt's research indicates that "intuitions come first, strategic reasoning second,"[4] so it's important to remember that visual science communication is more than just information transfer. Effective climate visuals must engage people, give them a reason to change their behavior, and leave them feeling empowered to do so.

JUDICIOUS USE OF PHOTOGRAPHY

In Part 1 of this article (*JNSI 2025 Vol. 57 No. 1*) we lament the missed opportunities for meaningful communication presented by poorly chosen stock imagery. However, the practical appeal of stock imagery is real. Faced with limited or nonexistent budgets, the low cost of a licensed image is hard to beat. Additionally, licensing terms and pricing on stock image aggregators are crystal clear, providing time savings and avoiding steep learning curves that can present themselves when working with independent image creators for the first time. If stock imagery is the only feasible option, collections such as ClimateVisuals.org are an excellent resource for images highlighting communities modeling positive climate adaptations. What they avoid, and what anyone perusing stock imagery for climate communications should resist, is the temptation to feature only signature species and faraway places being altered by climate change. These generic images can contribute to "climate fatigue," causing people to disconnect from the problem and any possible solutions.[5] Better images feature communities around the world modeling positive climate adaptations they are making locally (*Fig. 3*).

CULTURAL CONNECTIONS AND TWO-WAY ENGAGEMENT

Diverse audiences—with varying levels of trust in science, let alone scientific literacy—will interpret information in different ways. Making sense of climate

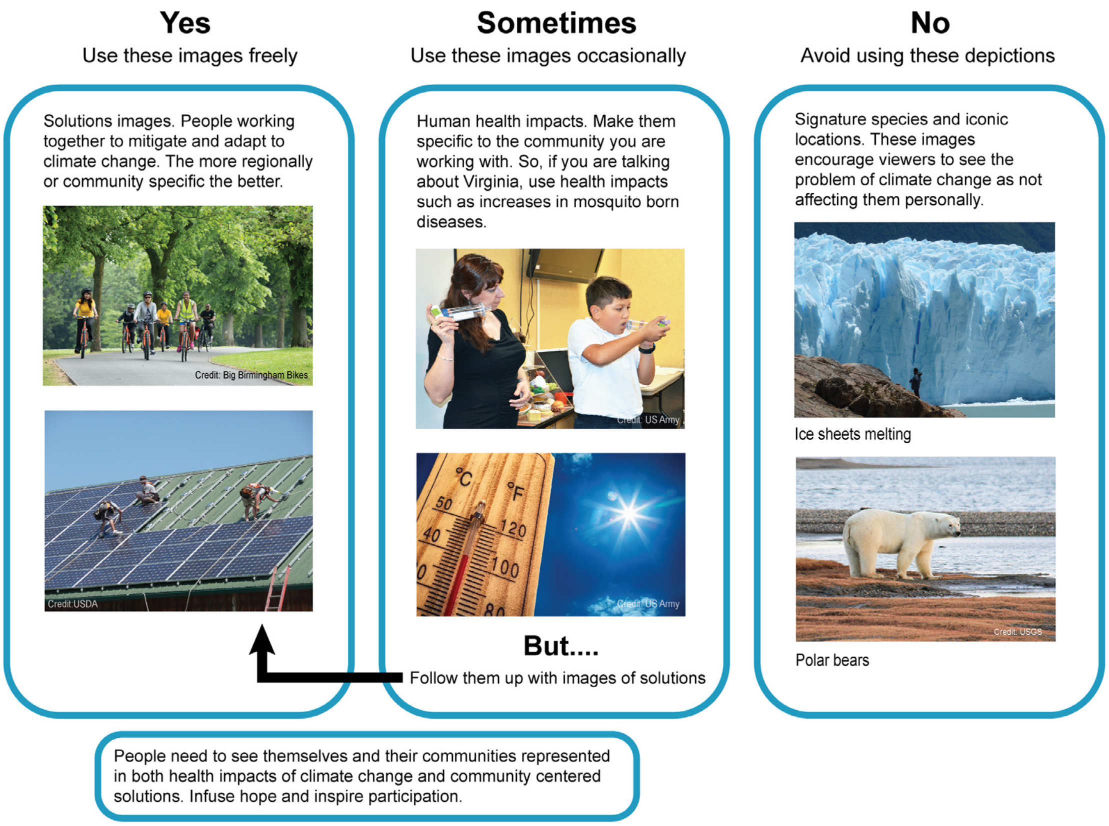


Figure 3: Imagery chosen with care and consideration of specific communities can increase communication quality and connection with an intended audience. Graphic arranged by Emily Coren and Taina Litwak. Images used with permission.

concepts, or meaning-making, is subject to cultural norms, group identities, values, and past experiences of each individual or community.[6]

> **Science is a search for evidence, but science communication must be a search for meaning.**
>
> —ELSHAFIE, 2018[7]

A shift in scientific communication to recognize this fact is currently underway. Dr. Maja Horst, Professor of Science Communication at University of Copenhagen, suggests reframing science communication as an aspect of culture.[8] The resulting science communication is positioned not just to teach knowledge from the top down (the "deficit model"), but instead to foster "two-way engagement," coordinating with existing community values and serving community needs. The deficit model assumes that scientific literacy is a knowledge problem and that sharing more information will enable critical thinking and better decision-making. However, simply sharing knowledge is not enough to change behavior.

Katharine Hayhoe's work embraces this approach. Hayhoe, the Chief Scientist for The Nature Conservancy and a Distinguished Professor and Endowed Chair at Texas Tech University, has made impressive inroads sharing climate science with audiences who would be politically turned off by phrases such as "global warming" and "climate change." In an article for *Foreign Policy* titled "Yeah, the Weather Has Been Weird", she shares an anecdote in which she was careful not to say the word "climate" followed by "change" in a routine lecture on climate science to a politically right-leaning audience in the U.S.[9] With this tiny alteration, she went on to present the climate science data in a way that was relatable and nonthreatening and received no pushback at all. Afterward, a woman approached her and said, "You know those people who are always talking about global warming? I don't agree with them at all. But this? *This makes sense*." What is her secret? By her own admission, she is dishing out grim news. But she understands the issues that matter to her audiences and follows her stark dose of reality with common sense actions these communities can take immediately: "Make smart water choices, plan ahead, and prepare for a water-scarce future." Her audiences leave feeling empowered, not defeated, and she is widely praised for her science communication efforts as a result.

What would a similar approach look like in visual communications? Being culturally responsive begins with understanding that people don't just receive

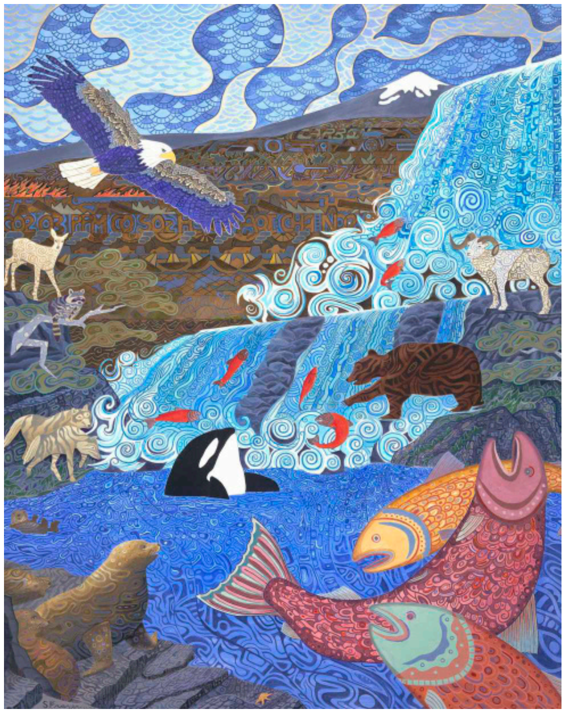


Figure 4: *Stream of Consciousness*, painted with oil on canvas by Spencer Frazer. Artist's statement: "My painting depicts the results of human impact on nature and has us question what is and will be. The work bridges the literal and the imaginative, informed by Northwest Indigenous art, as well as that of other traditions." Featured in *Climate x Art* gallery in *The Fifth National Climate Assessment* (2023) by the U.S. Global Change Research Program. Art © 2020 Spencer Frazer

information passively; instead, it is filtered through their own lens of life experiences and communities of trusted peers. To fully achieve this goal, representation matters, among people of color and marginalized groups, rural and urban communities, as well as in conservative and liberal-leaning sections of society. People are more likely to listen to leaders and scientists who look [and communicate] like them, reflecting the demographics of their local community and circle of trust.[1,10,11,12] For this reason, we should all be on the lookout for ways to understand and involve the communities we are communicating with (*Fig. 4*). Then, logically, our images should reflect those communities so that people can see themselves in them. They see themselves as part of the solution and know what to do next.

REVEALING THE PROCESS OF SCIENCE

Those of us trained in science understand what a powerful tool it is to help us make sense of our world. We trust the process of inquiry, discovery, and building consensus. We understand that what we think we know today may change as new, better data clarify concepts and processes. We are comfortable with the fact that science is self-correcting—as we gather new information, we form new conclusions (or become more certain of the conclusions we'd previously drawn). But large sectors of the public don't understand science this way—they don't see it as a process but rather a set of facts. They mistake scientists' certainty in the *process* of science (we know this thing because our best data support it) with a misconception that scientists think they know it all and are never wrong. So when experts talk about "global warming" and citizens are experiencing an arctic blast with record low temperatures in February, it's no wonder scientists get labeled as out of touch and untrustworthy.

Every science communicator has an opportunity to underscore the process of science with each story they tell, and visual science communicators are no different. Being transparent about the nature of research and unknowns can help build trust. Images showing scientists working in the field and data visualizations including known and unknown variables (e.g., white/gray areas on a map) help keep the communication open, honest, and more complete. Additionally, in framing our narratives, we can look for opportunities to explain why recommendations change when new findings emerge, such as with the CDC's changes in mask-wearing recommendations during the COVID-19 pandemic.

> **Scientists get tempted to pretend that they know something with certainty. You have to be willing to embrace the idea that science is uncertain and why you love it anyway.**
>
> —MCINTYRE, 2021 [10]

THE ROLE OF EMOTION, EMPATHY, AND HUMOR

Scientific communication in academic circles often favors professionalism and a high degree of specialization. Experts create utilitarian graphs and tables to explain their findings; these displays fare well enough in academic circles and peer-reviewed journals, but are often unintelligible or uninteresting to the general public. Communication that is emotionally moving, in tune with local communities, and solution-oriented might be more effective—consistent with the two-way engagement model mentioned previously.[4,10]

The power of visual storytelling to engage the reader or viewer on an emotional, "gut" level is well documented. Numerous studies and academic papers have weighed in on the impact of visual narratives on fostering emotional engagement.[13,14] Art ranging from fine art to editorial art, realistic representations, and data visualizations has the power to convey subtle emotions that connect to human experiences through the deliberate application of color, tone, rendering style, and composition.[15] Our evolutionary instincts lead us to gravitate toward the esthetic, the unusual, and the compelling,[16] no matter how our cultures or subcultures define them. The skillful visual science communicator learns about the community they are attempting to communicate with and takes care to catch attention, arouse curiosity, and heighten learning by picking up on and establishing meaningful connecting points.

W. Sean Chamberlin, writer and oceanography professor at Fullerton College, knows that creating emotional connections can heighten engagement and retention. With 25 years of experience teaching, he saw a need for editorial figures students could relate to on an emotional level that would help them connect better with the terminology describing the earth's seven spheres. In June 2021, he hired visual science communicator Fiona Martin of Visualizing Science® LLC to create oceanography e-textbook figures with novel perspectives, geared toward young college students in urban Los Angeles (*Fig. 5*).[17] Her resulting figure is colorful and dynamic and takes care to relate the Earth's seven spheres to humans by placing the "anthrosphere" centrally, suggesting it has a disproportionate impact on the other six natural domains. There is no text in the figure itself, inviting students to interpret the figure on their own. This is significantly different from the approach taken by traditional illustrations of this concept that center on equally weighted geospatial views of the earth. Importantly, this framing is justified by evidence that suggests images are more memorable, and consequently better understood, when they include people and familiar objects or symbols.[18]

Lastly, a little humor goes a long way in an age of information overload and existential crises. Fear, distrust, or skepticism about climate science can evaporate when we have a shared appreciation for hilarious cartoons, memes, or deadpan humor. Science comics such as the wildly popular *xkcd* and the YouTube channels MinutePhysics and MinuteEarth have been leading the way for over a decade in this realm and have amassed millions of followers each. Another website and Facebook page, I Fucking Love Science, boasts 23 million followers, sharing science images with a dose of humor and encouraging social interaction and a sense of community.[7,9] Beyond these examples, successful science comic strips such as Karen Romano Young's *Antarctic Log* abound and are an excellent example of how visual science communicators can seek out individual communities and highlight climate actions being taken today (*Fig. 6*).[19]

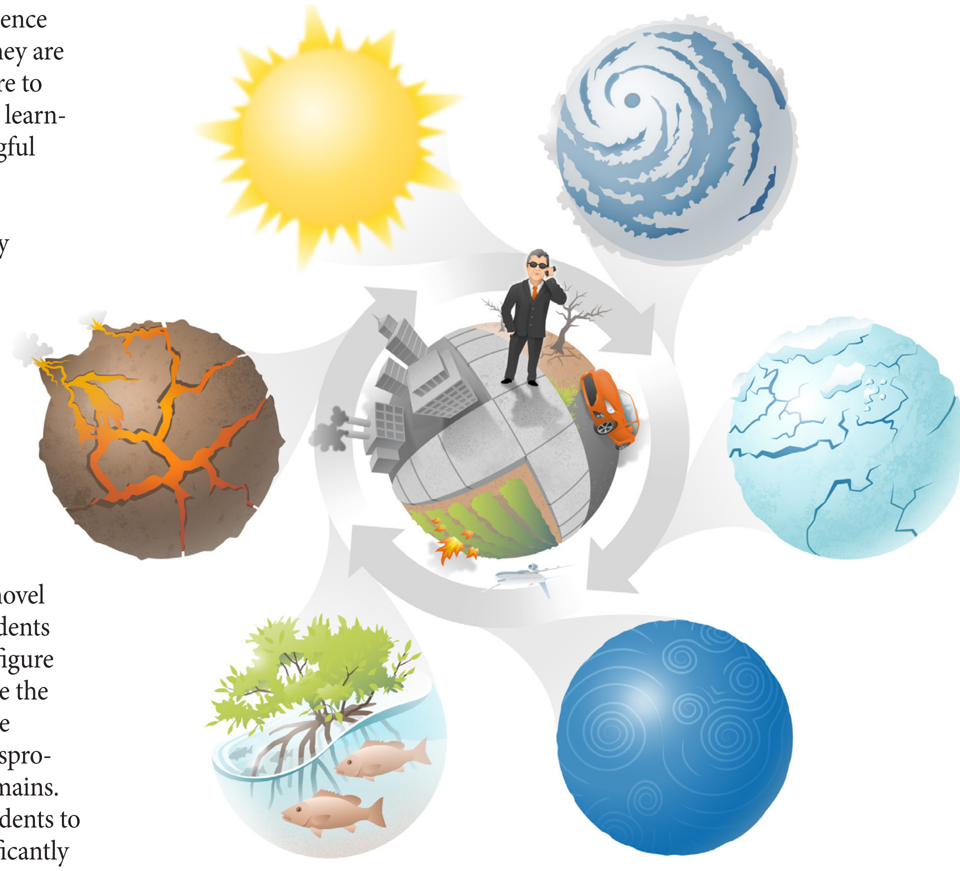


Figure 5: A novel perspective of the Earth's seven spheres. Clockwise from top left: heliosphere, atmosphere, cryosphere, hydrosphere, biosphere, and geosphere. Center: The anthrosphere, representing humans, has had a disproportionate impact on the rest of the earth's systems. © 2021 Fiona Martin

VISUAL ANALOGIES AND METAPHORS

Using metaphors and comparisons to everyday objects makes science relatable and interesting, especially for abstract concepts we can't see with our own eyes such as public health threats or carbon emissions. Visual science communicators regularly use metaphors from everyday life to help get a point across. For example, the Swiss cheese diagram, originally devised by James T. Reason in his book *Human Error*, explains how an accumulation of errors can lead to adverse events.[20] It has since been used widely by safety analysts in industry. Virologist Ian Mackay revived it recently to explain how single interventions against the spread of COVID-19 are not as effective as combining several layers of protection. Each intervention (layer) is imperfect and has holes. But by combining personal and shared responsibilities, there is a better chance of success. Incidentally, the mouse represents the potential for misinformation, which can erode protections.[21,22] The figure is simple enough that it could be understood by children and adults and is a brilliant example of the power of metaphor in communicating complex ideas (*Fig. 7*).

"Carbon Emissions in New York" by Real World Visuals cited in part 1 of this article (*JNSI 2025 Vol. 57 No. 1*) is another powerful example of the "concretization" of an abstract concept.[23] "The problem

Figure 6: *Antarctic Log* is a science comic created for middle-school-aged kids and features actionable messages, often with a climate change focus. ©2015 Karen Romano Young

is that some people are very cut off from quantitative information. You put numbers and graphs in front of people and they bounce straight off," said Real World Visuals' creative director, Adam Nieman. "Our [goal] is to make the cause of climate change visible because very few other people are approaching it like that."[24] Interestingly, their approach centers around assessing whether intended audiences fall into the categories of "push" or "pull" audiences. Whereas "pull" audiences come already interested in the topic and are able to navigate more complex graphics because of their own intrinsic motivation to learn more, "push" audiences need more coaxing. By creating graphics that use analogies to "draw on our wider experience of the world," they are able to appeal to the coveted "push" audiences.

> **In the charged atmosphere of climate politics, analogy enlivens deadening data.**
>
> —HOUSER, 2020 [1]

ADDRESSING INFORMATION OVERLOAD

To a nonscientific audience and students, the sheer amount of climate information received from the news and other media can be overwhelming. Too much confusing, negative, seemingly conflicting evidence of climate change can leave people in a state of paralysis or defeat, not knowing what to do.[1] In a *Climate Outreach* study,[25] researchers found that participants were more likely to respond to emotional images of climate impacts, especially local events, and clearly, this has been the strategy of environmental activists for decades. However, we also know intense emotion can lead to disillusionment and feelings of being overwhelmed; ultimately, this is a recipe for inaction. To combat feelings of despondency, *Climate Outreach* suggests following images of climate impacts with images of climate solutions, giving viewers actions they can take to prevent or mitigate disasters.[4,24] At least on the topic of climate change, it would seem hope is a better motivator than fear.

In October of 2001, *Scientific American* published the article "Drowning in New Orleans" by written Mark Fischetti, which turned out to be eerily prophetic of the disastrous consequences that followed Hurricanes Katrina in 2005 and Ida in 2021.[26] The article begins with an ominous warning in large blue text:

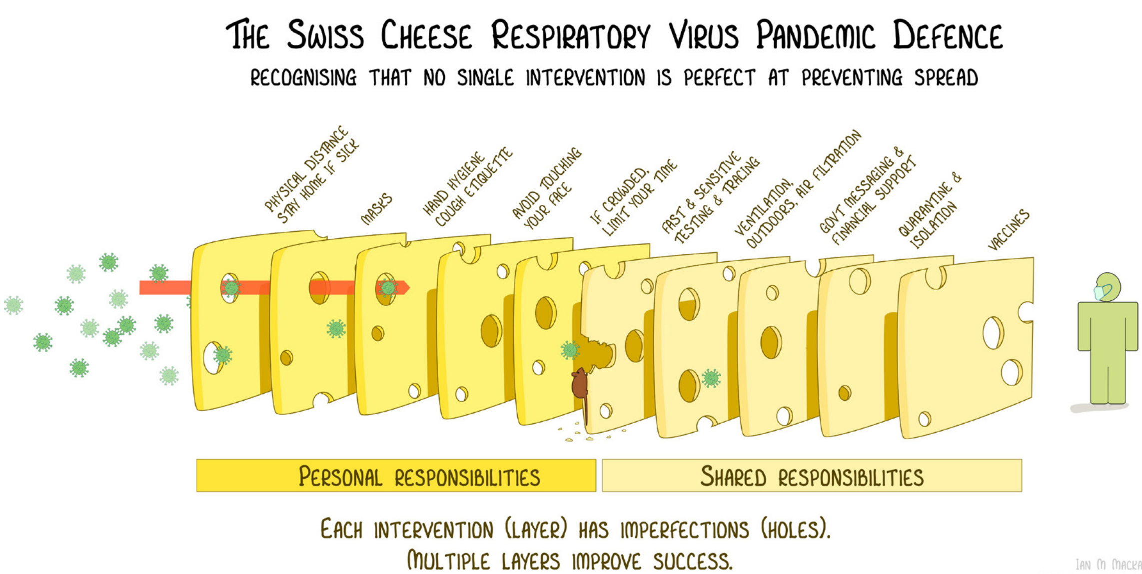


Figure 7: Swiss Cheese Respiratory Virus Pandemic Defense (version 4.3). © 2021 Ian M. Mackay

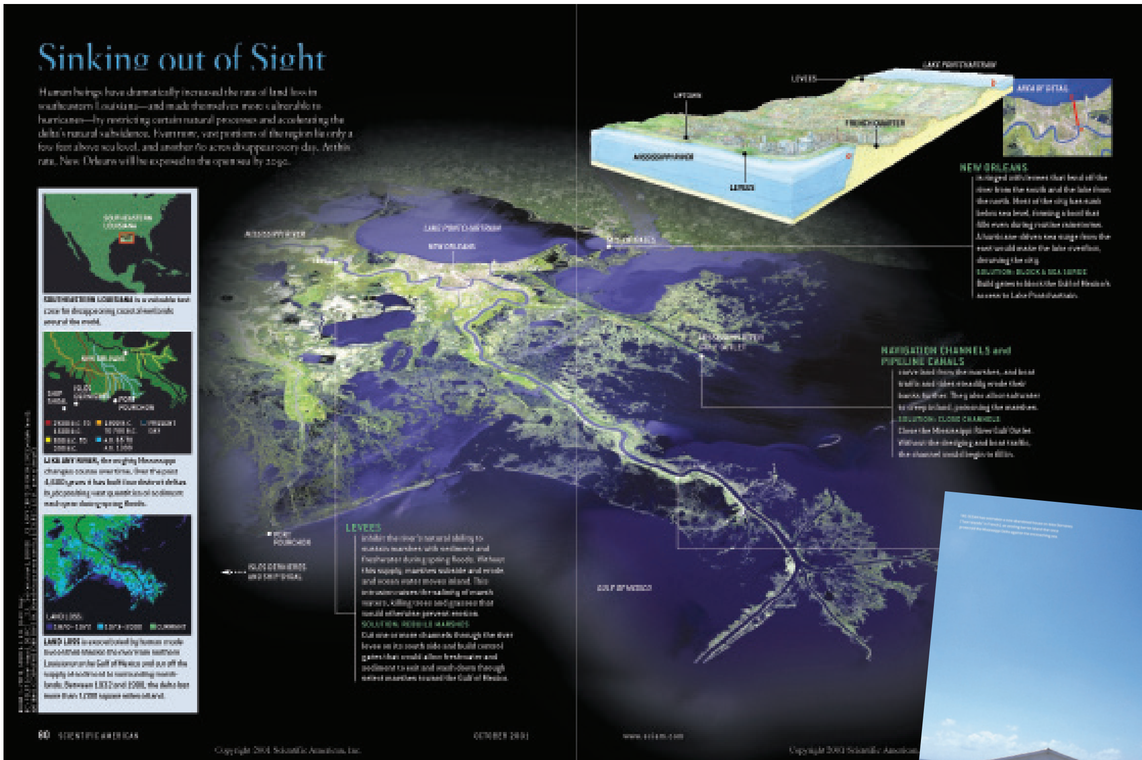


Figure 8: (*Left*) A spread of detailed graphics and (*below*) ominous opening pages from the print version of "Drowning in New Orleans" (published in *Scientific American* in October 2001). The article turned out to be eerily prophetic of the disasterous consequences following two major hurricanes in 2005 and 2021, but didn't provide manageable action items that policymakers and ordinary citizens could take. © 2001 *Scientific American*

> *A major hurricane could swamp New Orleans under 20 feet of water, killing thousands. Human activities along the Mississippi River have dramatically increased the risk, and now only massive reengineering of southeastern Louisiana can save the city.*

Then a paragraph into the text:

> *New Orleans is a disaster waiting to happen.*

It is not hard to see how such a dire prediction could be overwhelming enough to shut people down. The opening figure describes the rate of land loss due to human-made levees that restrict the flow of sediments into the marshlands. An inset cutaway of New Orleans shows the city sits in a "bowl" below sea level, ringed with levees. Solutions are offered, but only in blocks of text below each impact. And the price tag on the suite of infrastructure improvements that might mitigate the risk is stated as a whopping $14 billion. To residents of a city with a median income of $27,133 in 2000, this number must have seemed impossibly large. And the cool, academic, and distant visual depictions of their city may have done little to connect with how the people of New Orleans experience their city (*Fig. 8*).

In the case of this article, it's worth considering whether it might have been more effective to visualize what a climate-resilient New Orleans would look like on a human scale in addition to the warnings about impacts and the call for large-scale structural changes. A hopeful depiction of what an actively adapting city could be—with manageable action items that policymakers and ordinary citizens could take—may have done more to nudge residents toward action.

Naturally, we are not suggesting that altering the approach of one article could have stopped the disasters that unfolded with Katrina and Ida. But when applied across all the media we have to communicate climate resilience, this sensibility may help communities "see" solutions and see themselves in them, ultimately getting people to make them happen.[24] In short, climate solutions—including smart infrastructure, green technology, sustainable food production, and positive public health measures—should outnumber disaster imagery. And importantly, though there is room to dream about a future of resilient cities, we must remember to follow the examples set by skilled communicators like Katharine Hayhoe and provide common sense steps that people can start with today: conserve, prepare, and adapt.

ADOPTING A COLLABORATIVE MINDSET

Rather than keeping disciplines and tasks divided, artists and scientists should collaborate in a more organic fashion. In some cases, the artist's role is to break down conventional methods so that science can make leaps. They can also help scientists make information more compelling so that it generates awareness, cultivates support and helps the general population feel that they are a part of scientific progress.[27]

Scientists have a long track record of collaborating with peers on research projects. Encouragingly, many are also interested in distributing their work in nontraditional ways, by collaborating with professionals in fields outside academia.[28] Successful collaborations of this sort have resulted in animations and two-dimensional art, social media content, multimedia, storytelling, and programming at national parks too numerous to name.[5,26,29,30] From 2011 to 2016, The Scientific American Blog Network hosted *Symbiartic*, a blog written by Glendon Mellow, Kalliopi Monoyios, and Katie McKissick that documented this growing field of "Science-art," or "SciArt." They documented hundreds of scientists and artists using art as a medium to spark conversations and educate ever more general audiences on various aspects of science—and that was just the tip of the iceberg. As these science-art collaborations showed, the possibilities for partnerships between scientists and informal science educators are exciting and near endless.

Science communicators looking to expand their reach can share their work in existing public programs or they can become involved in detailed projects such as the design of exhibits, museums, and nature centers.[31] Potential partners may also be found at gardens, zoos, aquariums, and through independent professionals working in related and sometimes entirely different fields. When looking for these collaborations, we encourage communication teams to be open to working with content developers, cultural interpreters, artistic directors,[32] environmental educators, authors,[33] game designers,[34] advocates,[35] food system experts,[36] natural resource specialists, consultants, and visual science communicators. In addition, people can look to organizations such as SciArt Initiative[37] that are creating formal ways for scientists and artists to collaborate through innovative residencies like *The Bridge*.

The search for new partners takes time, but we have much to gain from this investment of energy. Those who develop these cross-disciplinary partnerships have the opportunity to change public perceptions about who scientists are, increase interest and trust in STEM disciplines, and reframe what an individual thinks about a particular topic.[38] All of this has the potential to influence policy decisions and enact change.

INSPIRING ACTION

Adoption of climate solutions will happen faster if our climate science communication inspires citizens worldwide to act. Activism takes many forms and may mean writing letters and calling on government representatives to vote a certain way. It can mean organizing postcard campaigns to other voters, signing and delivering petitions, organizing and/or showing up for rallies, volunteering for local conservation groups' physical efforts, or making small personal changes in daily choices such as eating less meat, taking public transportation, or buying an electric car. In the book *Empowering Climate Action* by Bowman & Morrison,[39] authors repeatedly stress the need for massive climate change education and "bottom-up" public engagement/activism. Katharine Hayhoe points out that even the most vocally opposed politicians understand the gravity of climate change but won't act until their constituency demands it.[40] If visual science communicators are consistently included in science communication teams, our stories will move people and inspire them to take action. We trust decision-makers to take it from there.

CONCLUSION

Effective communication of climate change solutions will require a suite of adaptations. Science communication efforts need to take into account accessibility, cultural sensitivity, representation, emotional engagement, and relevance. We must also find ways to overcome information overload and "climate fatigue," maintain transparency in climate research, and demystify the scientific method. This will involve building trust with local communities, building bridges between academics and the public, and convincing decision-makers to support climate mitigation. Visuals serve as a powerful universal language that can interpret science, transcend barriers, invoke empathy, and inspire citizens to implement practical solutions. Our communication efforts can improve by systematically incorporating well-designed, compelling diagrams, illustrations, infographics, data visualizations, graphic novels, and more into climate science outreach at every level.

About the authors

Kalliopi Monoyios is driven by the conviction that science communicators operating in all spheres are a critical part of creating a scientifically literate public. After graduating from Princeton University with a degree in Geology, she built her career as a science illustrator for the prominent paleontologist Neil Shubin at the University of Chicago. Her illustrations have appeared inside and on the covers of *Nature* and *Science* and in four popular science books, including *Your Inner Fish* by Neil Shubin.[41] In 2011, she co-founded *Symbiartic*, a blog covering the intersection of science and art for *Scientific American*. From 2020–2022, she served as President of the GNSI. She is currently developing new avenues of public engagement via her own art and curated exhibits that highlight the complexity of our relationship with plastic. Portfolio: *www.kalliopimonoyios.com*

Kirsten Carlson is an illustrator, designer, photographer, and writer. She interprets topics relating to the ocean and sea life through the lens of science and art. Her focus is to develop creative ways to connect different audiences to nature. She strives to produce works that speak to audiences with diverse educational backgrounds—scientists, educators, children, and the public. She is a graduate of the University of California, Santa Cruz Science Communication Program, an alumni of the Artist-at-Sea Program with Schmidt Ocean Institute, and a grantee of the National Science Foundation Antarctic Artists and Writers Program. Her work can be seen at Fathom It Studios. Portfolio: *www.kirstencarlson.net*

Taina Litwak has been a working illustrator since 1979 and a board-certified medical illustrator since 1994. She is currently the staff scientific illustrator with the USDA's Systematic Entomology Lab at the Smithsonian Institution's Museum of Natural History. Her illustration work includes a wide spectrum of scientific subject matter. Hundreds of her illustrations have appeared in magazines and scientific journals, trade and textbooks, advertising campaigns, nature centers, and medical-legal exhibits. She works primarily in digital media. Taina is currently a board member of ASCRL, the American Society for Collective Rights Licensing. She has also served as President and Treasurer of the GNSI, and as a board member of the Vesalius Trust. Portfolio: *www.litwakillustration.com*

Tania Marien is a podcast producer and educator. Her projects draw on her experiences working as an independent environmental education professional, first as the full-time editor, educator, and bookseller at ArtPlantae and now as a podcast producer, writer, researcher, and network builder. Tania connects independent environmental education professionals with new audiences to build partnerships and enhance environmental literacy in communities. She believes that independent professionals are overlooked and that their professionalism and contributions to lifelong learning need to be recognized. Documenting their work is important because it fills the knowledge gap about how people learn about science and the environment outside of the classroom. Tania has an interdisciplinary studies master's degree in Biology and Student Learning and a professional certificate in Free-Choice Learning, which addresses the learning that occurs outside of the classroom throughout one's life. Tania is a contributor to *The Carbon Almanac* and The Carbon Almanac Podcast Network. Portfolio: *www.talaterra.com*

Fiona Martin appreciates visual communication because it is like a universal language—transcending barriers and facilitating understanding of complex ideas "at a glance." Despite being born almost deaf, Fiona defied expectations, graduating at the top of her high school and college class. She holds a bachelor's degree in Marine Biology (summa cum laude) and a graduate certificate in Scientific Illustration from the University of California, Santa Cruz. Fiona is currently a visual journalist at *The Seattle Times,* producing explanatory graphics for climate, health, and other science stories. She also freelances from her studio Visualizing Science LLC. Since 2005, she has produced illustrations for government agencies such as NOAA's Climate Program Office and the National Park Service, as well as authors of scientific articles, reviews, and books, including *Growth and Decay of Coral Reefs* by Peter Vine, marine biologist and adjunct lecturer at the National University of Ireland, Galway.[42] Portfolio: *www.visualizingscience.com*

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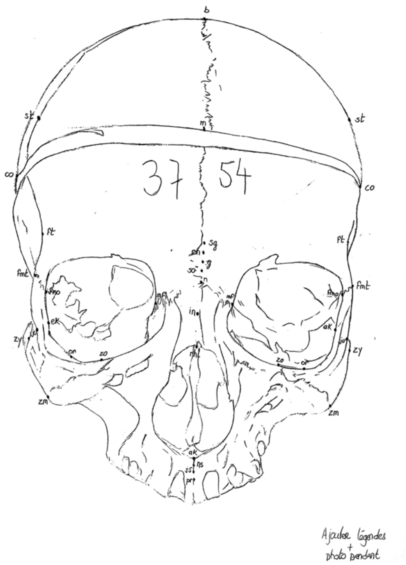


Resurrecting the Past

FROM MEDIEVAL SKULLS TO 3D FACES

— *by Victoria Kayser-Cuny, FLS, FRAI*

Scientific illustration is often described as a bridge between careful observation and clear communication. It transforms complex scientific data into visuals that can be both understood and remembered. In my own work, illustration also becomes a bridge between disciplines.

I was trained as a scientific illustrator through the Yale Peabody Museum of Natural History's Certificate in Natural Science Illustration. But I also specialize in molecular genetics, with additional training in the bioarchaeology of human remains, paleogenetics, and evolutionary genetics. This unusual combination of skills led me to a project that brings together hand drawing, digital modeling, 3D printing, and genetics: the reconstruction of a medieval skull and, ultimately, its face.

THE MEDIEVAL SKULL PROJECT

1. Osteometry and Ancient DNA

The project began not with drawing, but with direct scientific analysis of the skull itself. I performed precise osteometric measurements, documenting cranial indices, sutures, and morphological features. At the same time, I trained in techniques for extracting ancient DNA from inside the skull—procedures that require sterile methods and careful handling to avoid contamination. This first stage grounded the project in empirical data, ensuring that every later reconstruction was anchored in measurable reality.

2. Observation and Drawing

The drawing component of the project began with traditional illustration: sketching and drawing the skull in graphite and ink. Observational drawing forces slowness and precision. It is not only a way of documenting but also of learning the subtle language of bone surfaces—the grooves, sutures, and asymmetries that tell a story. To produce the sketches, I first took numerous photographs of the skull from every angle, then created the drawings based on these images as part of my final project with the Yale Peabody Museum of Natural History, under the supervision of Ikumi Kayama, who verified proportions, positioning, and overall accuracy. I used a grid system as well as various techniques learned during my certificate training.

Ostemetric analysis: *(top left)* A first draft of the skull is drawn, marking the various points that need to be analysed and measured.

Ancient DNA analysis: *(top right)* Once the ancient DNA is extracted, it is mixed with an elution buffer and transferred into a tube. From there, it is ready for the subsequent analyses that will allow us to reconstruct the phenotype of the individual (eye colour, hair colour, skin pigmentation, etc.).

Ancient DNA extraction: (*right*) Ancient DNA extraction performed directly inside the bone — using a Dremel tool! Only about 50 grams of bone material are needed. The best-preserved ancient DNA is generally found in the petrous portion of the temporal bone.

3. Digital Reconstruction

From the drawings, I moved into 3D modeling. Using digital software or website as *https://www.3daistudio.com*, I reconstructed the skull virtually, correcting for small distortions and exploring its anatomy from every angle. The osteometric measurements I previously conducted mainly helped me determine the individual's age at death, sex, cranial capacity, and whether they might belong to a specific genetic cluster, particularly due to the presence of a rare metopic suture. However, to generate the 3D model, I used the drawings shown as well as photographs. I also rescaled the skull to real-life dimensions during the printing process. Digital tools allowed me to manipulate the model in ways impossible with fragile archaeological remains. The skull studied is part of an early 20th-century collection used by bioarchaeology French students as part of their training (generally at the master's level and above). It is a medieval skull belonging to a French man who died in his sixties and was part of a very tight genetic cluster—likely the result of cousin kinship or closely related ancestry.

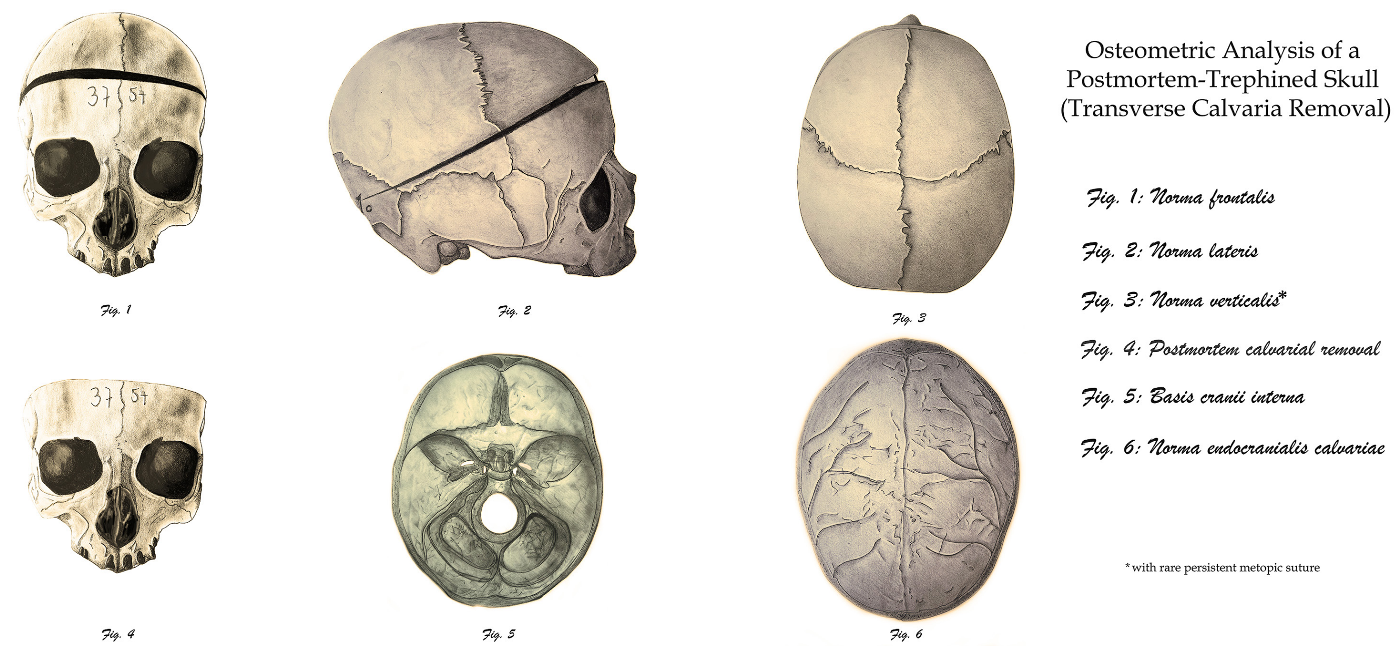
4. 3D Printing

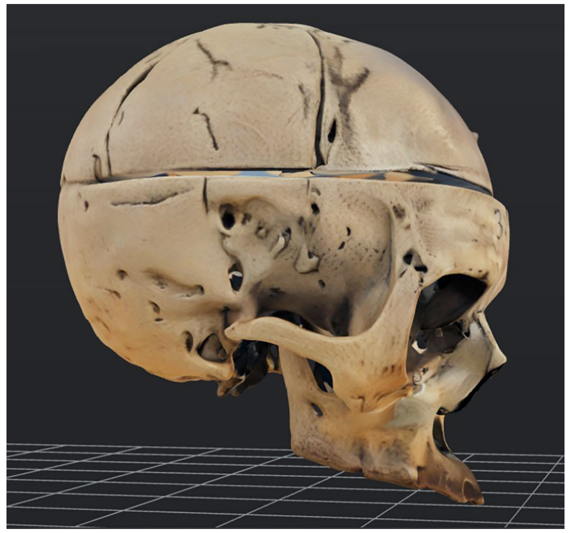
The digital reconstruction then became tangible through 3D printing. Holding the replica in hand was transformative. It was no longer only a subject of study but a physical object that could be measured, compared, and even used for teaching. I use a BambuLab® X1 Carbon 3D printer, which provides high-quality and highly precise prints, along with white PLA filament, which in my opinion is the best medium for this type of work. I didn't need to adjust anything—the first print came out exactly as intended.

In the image generated during the 3D printing process, several colors can be seen, but these are only used to distinguish the areas that will be printed from the areas generated as "supports" (the supports ensure that the model prints accurately and doesn't collapse). They have no connection to the original color of the model.

Once printed, it is possible to apply a layer of acrylic gesso to protect the skull, followed by a mixture of pigments and tylose (bookbinding adhesive) diluted with water to give it the appearance it had during the original study.

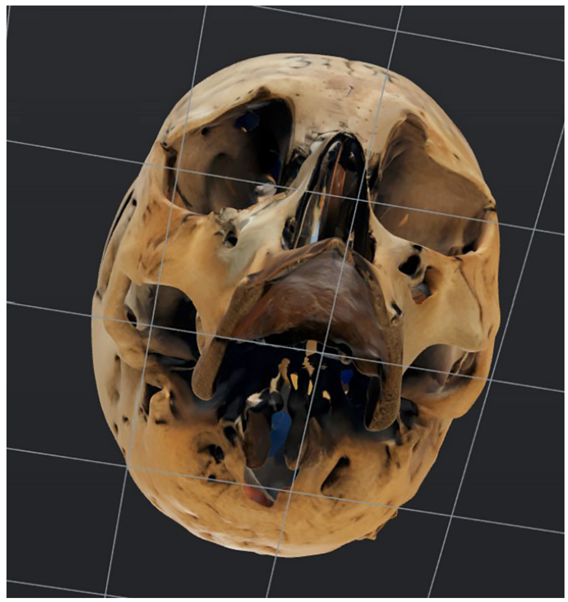
Sketching the skull: (*below*) This step makes it possible to create more detailed drawings of the skull from different angles, including the interior. The endocranium, in particular, allows for a reconstruction of the brain based on the impressions left on the inner surface of the skull.





Digital Reconstruction Part 1: (*left*) Thanks to photogrammetry, I can now reconstruct the skull in 3D.

Digital Reconstruction Part 2: (*right*) This skull shows a post-mortem opening that I chose to preserve. However, I decided to remove some sutures, as they are not needed for facial reconstruction.



Digital Reconstruction Part 3: (*left*) The 3D-generated model allows me to visualise the skull without handling it, which could otherwise cause damage. Here, I can view it from underneath.

5. Toward Facial Reconstruction

After that, the process continues normally. This step applies principles from forensic science and bioarchaeology: tissue depth markers, musculature layering, and anatomical accuracy. The aim is not only to rebuild a face but to reintroduce a human presence, suggesting identity, age, and individuality.

For the moment, this work is still in progress, but I'm confident since I found a great clay (Laguna EM-217). This clay allows for very refined sculpting, but it will not represent the final result.

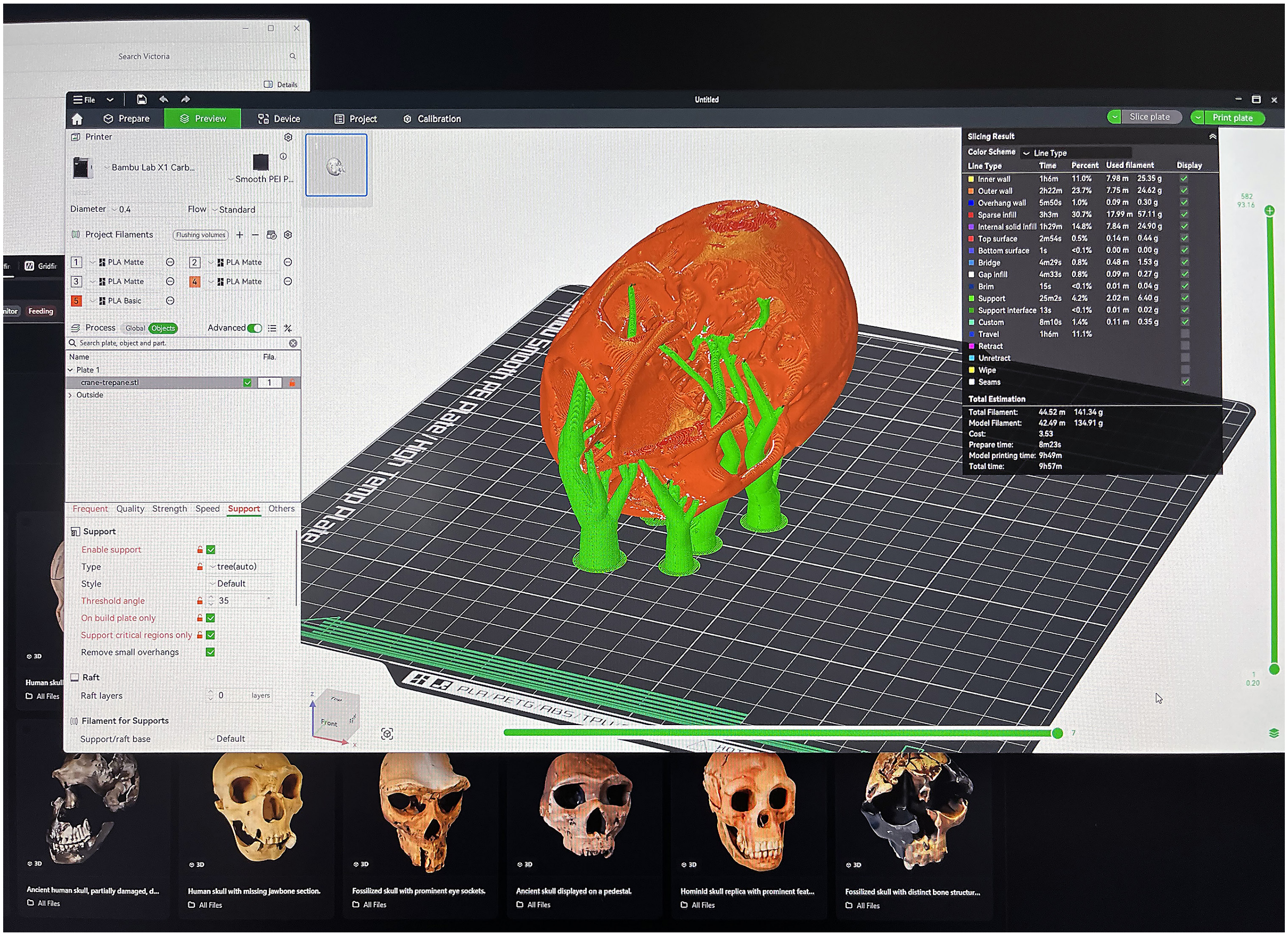
The sculpture will need to be molded and then cast afterward. All these steps are clearly explained in Jordi Schell's course Human Head Anatomy and Sculpture, available at *https://www.stanwinston-school.com*.

ART, SCIENCE, AND HUMAN STORYTELLING

While the techniques are important, the deeper meaning of this work lies in its narrative. A skull is not just a specimen; it is a trace of a lived life. Scientific illustration here becomes a form of storytelling, one that bridges centuries and gives a face back to someone whose name is long forgotten. This dialogue between art and science has always been central to illustration. But when combined with genetics, it gains new layers. DNA can reveal ancestry, diet, or disease. Illustration can translate those invisible data points into visible features. Together, they tell a richer story than either discipline could alone.

BEYOND THE PROJECT: GENOMATHEMATICS AND MIRROR-TWIN RECONSTRUCTIONS

My medieval skull project is part of a larger research direction I call genomathematics, which has no connection whatsoever with geomathematics (geology). This approach studies hidden arithmetic patterns—"invariants"—within DNA sequences. By inverting and recombining these patterns, I generate "mirror genomes" that suggest what evolution could have produced but did not. When I perform a 3D reconstruction, I can draw on my Mirror-Twin theory because it is based on a fully systematic and transparent genome transformation (A–G, C–T), which allows me to test the stability of a phenotype under an extreme genetic constraint. Mirror genomes are often seen as controversial because they appear to suggest an alternative biology or an "impossible organism."



3D print preparation: (above) The files generated during the digital reconstruction will allow me to 3D print the skull directly in PLA (a corn-based plastic).

In my work, however, I do not claim that these genomes exist in nature: I use them as experimental tools to explore erased genetic trajectories and to visualize, through 3D modeling, the limits of human craniofacial plasticity. My approach remains rigorous and grounded: it does not attempt to create a real biological double, but rather a virtual genetic twin, mathematically generated and fully reproducible, which serves as a comparative framework to better understand the actual skull and its range of possible variations. This approach becomes particularly meaningful when comparing skulls from different historical periods—for example Neolithic, medieval, and modern—since their cranial capacities, proportions, and biomechanical constraints differ significantly. The mirror-twin model allows me to test how the same systematic genetic transformation would express itself across very different craniofacial templates. This helps reveal which traits are truly genome-dependent, which are constrained by period-specific skull morphology, and how far a phenotype can vary while still remaining biologically coherent.

When projected into 3D reconstructions, these mirror genomes create "mirror faces": virtual humans that explore the boundaries between what was, what is, and what might have been.

I developed this framework in three recent articles (*see Reference section*). This work extends the role of the scientific illustrator. We are not only documenters of what exists but also visual explorers of hidden possibilities—bringing into view the erased or alternative trajectories of human evolution.

CONCLUSION

The combination of illustration, genetics, and digital technology opens a new horizon for natural science illustration. From hand-drawn sketches of a medieval skull to mirror-genome facial reconstructions,

the common thread is the act of making visible: rendering both the tangible past and the invisible genetic codes that connect us to it.

In this sense, illustration does not simply accompany science—it expands it. It is a tool for recovering memory, bridging art and genetics, and giving voice to the silent witnesses of history.

3D print, three views: Here is a first draft of the 3D-printed skull. If it isn't perfect, it can be sanded, and a lower jaw can be added, etc. *Next steps:* It is possible to print two versions: one that will be used for the facial reconstruction, and a second one that can be tinted using a mixture of tylose (bookbinding adhesive) and pigments to give it an aged appearance. If everything is correct with the 3D print, the next step is facial reconstruction using the American clay Laguna EM-217, which is commonly used in animation studios.

Victoria Kayser-Cuny

Trained between France, the United States, Canada, and Switzerland, I spent many years struggling to choose between science and art. I eventually realized that these two fields do not stand in opposition—they enrich one another. Today, I try to weave them together whenever possible, allowing each discipline to inform and deepen the other.

I hold a certificate in natural science illustration from the Yale Peabody Museum of Natural History, and I am a molecular geneticist by training, with specializations in paleogenetics, evolutionary genetics, primatology, and 3D reconstruction in bioarchaeology. This dual background profoundly shapes my practice: I am drawn as much to invisible biological structures as to the forms that bring them to life. My illustrations and reconstructions aim to make visible what is often too small, too ancient, or too fragile to be directly observed.

I also practice bookbinding and the restoration of rare and antique books, a craft that nurtures my attention to detail, texture, and the materiality of scientific objects. Whether I am creating a botanical plate, reconstructing a skull, or restoring a scientific book, I strive to convey a sensitive, attentive view of the living world—one where scientific precision meets visual poetry.

Portfolio (scientific illustrations): *https://sites.google.com/view/victoria-from-quantumland*

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NOTE: Parts I and II of this article series, which focus on biological and anthropological chimeras, provide the conceptual foundation that enabled me to take the next step and create computational chimeras. By examining how two distinct genetic lineages can coexist or recombine within a single organism, I identified underlying principles of genomic plasticity and transformation that can be extended into the digital realm. This theoretical framework gave me the tools to formalize the mirror genome and to generate calculable alternate phenotypes—virtual chimeras that rigorously echo the mechanisms observed in real biological chimeras.

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