phosphorus, food and our future

a collaboration between artists and scientists
Contents

Elizabeth Kennedy Bayer, 2
Edgar Cardenas, Genevieve Metson and Sandra Rodegher, 3
Cristine Cassano, 5
Angela Cazel Jahn, Frances McMahon Ward and Cory Dunnington, 6
Ericka Cero Wood, 8
Emmanuel “Man Ray” Covarrubias, 10
Molly Danielsson and Mathew Lippincott, 11
Adam Farcus, 12
Todd Daniel Grossman, 13
Sarah Kriehn, 14
Blake McConnell, 15
Sue Norton-Scott, 16, 17
Erik L. Peterson, 18
Patricia Sahertian, 19
Lisa Corine von Koch, 21
Joshua White, 22
Juri Yamashita, 23
Randy Zucker, 24
Elizabeth Kennedy Bayer

*Crust*

**Scientific Collaborator:**
*Valeria Souza*, Professor, Instituto de Ecologia, Universidad Nacional Autónoma de México

**Description of Artwork:**
*Crust* tells a familiar story. A sustainable system - forged by time and the elements - thrives. Like all things, this system may evolve, but when an outside element is forced into play, the system is thrown off balance and struggles to find an equilibrium. Runoff from fertilizer made from phosphorus alters water systems in devastating ways. And although this can be stopped, the changes made cannot be undone.

**About the Artist:**
Elizabeth Kennedy Bayer completed her undergraduate degree in composition at Baylor University with Scott McAllister (Black Dog, X, Tarkus) and recently finished her masters in composition at Arizona State University. She has studied with Roshanne Etezady, Glenn Hackbarth, Rodney Rogers, Gabriella Lena Frank, Forrest Pierce and Chris Theofanidis.

Elizabeth primarily writes for chamber ensembles with a few choral and solo pieces on the side. Her works have been heard coast to coast in the United States and in Italy.

She is currently working with Lance Gharavi and the Tetra String Quartet on a project called Dreaming Darwin, a play that centers around Darwin's loss of his daughter Annie and the first publication of Origin of Species. Her new work *Crust* for base trombone, organ, and fixed media will premiere at ASU's Sustainable Phosphorus Summit in February 2011. Elizabeth is also working with Arizona poet David Allen on the libretto for her first chamber opera, *Be Mine*. The all-male cast opera takes place in a candy hearts factory and touches on love, masturbation and cooperate greed.

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*Elizabeth Kennedy Bayer*

Detail from score of: *Crust*; acoustic instruments with electronic fixed media
7-8 minutes, 2011
Edgar Cardenas, Genevieve Metson and Sandra Rodegher

Description of Artwork:
Although phosphorus (P) is necessary for our survival and consumed daily (most notably every time we eat), it is not often discussed or even considered. The video seeks to narrate the way P cycles through our daily lives and explore the disconnect that exists between most people and this cycle.

P is a mineral resource found in deposits and soils. It then gets mined or weathered, eventually becoming biologically available for plants. P is an essential nutrient for plant growth and gets incorporated into their tissues. Plants are then eaten by animals which also require P for growth. Once it is consumed, P returns to soils, but also to water sources. P can then travel all the way to the ocean, where, eventually, it will form new sediments, which will be weathered and go through the cycle again.

Humans have altered landscapes, and the movement of P through them. We highlight how people have increase the amount of P moving though our global system, speed at which P moves, and the increased linearity of this movement. Phosphorous gets concentrated where humans concentrate. While such amassing can eventually result in pollution downstream, ultimately, P will get diluted in the ocean, where we cannot efficiently recover it for human use. Thus, P is a concern because of its concentration imbalance; currently, it is both scarce and overabundant.
Throughout the piece, we overlay the response of people to questions regarding the importance of P: What is P? Where does P come from? Why is P important? When will we run-out of P?

About the Artists:
Edgar Cardenas is a photographer and a Ph.D. student in the School of Sustainability at Arizona State University. Edgar’s work explores the intersection of art and science. He is interested in how this space can engage questions, dialogue, and decision-making regarding human environment interactions and socio-ecological systems.

Genevieve Metson is a second year Master’s of Science student in the School of Sustainability at Arizona State University. She studies sustainability issues related to biogeochemistry, food systems, and urban ecology. Her thesis work focuses on how phosphorus movements have changed in cotton and alfalfa production in Maricopa County, Arizona over the past 30 years and how the metropolitan region of Phoenix may play a role in sustainable phosphorus management in the future of these crop production systems. She received her dance training at L’École Supérieure de Ballet Contemporain in Montreal, Canada, which she graduated from in 2005.
Description of Artwork:
Three horizontal panel represent cycles within the use of phosphorus from an agricultural standpoint. From extraction to its uses in agriculture to the inevitable run off of phosphorus into our streams and oceans, these pieces create a dialogue regarding the relationship of those processes. The vertical panel visually corresponds to all 3 horizontal panels, but examines potential problems along with sustainable solutions while evoking more questions than it does to provide answers for the viewer.

About the Artist:
Christine Cassano was born and raised in Virginia, she attended Old Dominion University in Norfolk, VA where she obtained her BFA degree in 2001. Immediately after graduating she moved across the country to Phoenix, Arizona to pursue a life in the arts.

Christine has exhibited regularly during the last decade at several Phoenix galleries and has been a full time artist since July 2009. In 2007, Christine’s shifted her medium from oil painting and resin casting over to working primarily in the process of casting concrete. This new exploration of medium changed the direction of her work significantly and brought a new layer of underlying content into the works as she continues to create an ongoing dialogue of visual elements that explore ideas related to human behavior and environmental adaptation.
Our Floating Days

Sketch of: Our Floating Days, mixed media sculpture, 8’x8’x7”, 2011.
Scientific Collaborators:
James Elser, Professor, School of Life Sciences, Arizona State University
Roberto Gaxiola, Professor, School of Life Sciences, Arizona State University
Marcia Kyle, Senior Research Associate, School of Life Sciences, Arizona State University

Description of Artwork:
Our Floating Days is a whimsical metaphor of how we entertain uncertainty and vague premonitions of disruption or change. While big problems like peak oil, climate change, and phosphorus scarcity loom ahead, most of us live our everyday lives immersed in the routine and circumstance of our time and place: It can be beautiful here. Unprecedented numbers of people have water, air, food, shelter, beauty, culture. Awhile later, the same environment made of the same materials might look and function very differently.

Early phosphorus use in agriculture was the happy consequence of erosion. As humans learned to raise crops more efficiently we began to supplement soil with collected phosphorus fertilizer. Then as need increased, we began to pull it from the ground, resulting in benefits and problems that will be discussed at the summit. Just as people of the past could not have predicted the tangle of horrible and awesome that is the human condition today, we look ahead and have a hard time discerning what will be worse, and what will be better, and how they will be jumbled up together. Phosphorus sustainability impacts everyone, in conditions ranging from cutting-edge scientific laboratories to sustenance farms.

What happens next in the story of phosphorus sustainability is going to depend on how it is told and who is telling it to what audience. Participants in this summit will influence that story, so the words they will choose are important. Their remarks and perspectives may eventually define the messages that will change policy, advance industrial practices, and be broadcast to the public.

At the first exhibition site at the Desert Botanical Garden, glass containers support wooden planting troughs. The troughs are filled with soil and growing things. The glass is filled with sediments, living plants and marine life, images, data, and messages. The glass and old wood forms a 7’ x 7’ x 8’ hollow structure reminiscent of a greenhouse. Light shining through activates living processes and reflects colored shadows that change throughout the day. Viewers can leave their impressions about phosphorus sustainability, in writing or audio documentation.

At the second exhibition site in ASU’s Step Gallery, several days will have passed. The piece will be completely rebuilt into a 2’ x 2’ x 6’ structure from the same materials: wood, cubes and panels of glass (broken and re-fused), particles of plants and artifacts. The impressions left by conference participants and viewers will be composed into a digital looping collage, visible through a translucent glass window embedded in the structure. In this way the diverse perspectives represented at the conference will be projected back into the exhibit through a process that represents ongoing experimentation, growth, reconstruction, and change.

About the Artists:
Angela Cazel Jahn makes spaces and images for people to play in and think about. Her work is project-based, and often involves viewers as participants. After graduating from Arizona State University with a Fine Art Degree, she veered into the non-profit field for nearly a decade to serve as co-founding Artistic Director of the Children’s Museum of Phoenix. Now she collaborates with individuals, organizations, and institutions to explore questions and illustrate ideas.

Frances McMahon Ward is a visual storyteller working primarily in the areas of video and installation. Her work comes from personal experiences and observations of the world. She has a tendency to latch onto an idea and when thoroughly researched begins to construct a narrative, which serves as the backbone for a work. Frances holds a Masters in Fine Arts - Intermedia from Arizona State University. Currently, she holds a position at Xavier College Preparatory where she teaches courses in the Digital Arts Department and serves as curator/preparator for Xavier’s Stark Gallery.

Cory Dunnington grew up in Vancouver and now makes her home in Phoenix. She is a full-time firefighter for the City of Phoenix but has been exercising her creativity by working with kiln-formed glass since 2005. Dunnington enjoys the endless possibilities of melting, manipulating, and molding glass into different shapes and forms. She attended Pilchuck Glass School in 2009 and was awarded a scholarship to Pilchuck in 2010. Her art reflects her passion for color and light patterns as well as the patterns and textures found in nature and in industrial urban life.
Ericka Cero Wood
*Lake Atitlán, then and now*

**Scientific Collaborator:**
Jessica Corman, Ph.D. student,
School of Life Sciences, Arizona State University

**Description of Artwork:**
My scientist collaboration was with Jess Corman, a Ph.D. student in the School of Life Sciences at ASU. Her studies focus on how elements (including phosphorus) cycle in ecosystems. Jess is involved with researching the green algae blooms at Lake Atitlán in Guatemala and the potential link to Phosphorus in agricultural run-off and untreated human waste water discharge. Lake Atitlán is the source of fresh water for 400,000 people, yet currently there is little to no solid waste treatment facilities and waste is instead released directly into the lake. Ideas to address this issue range from the obvious waste treatment plants, to natural wetlands, and new technology such as waste water ash fertilizer. With the use of nitrogen and phosphorus in commercial fertilizers, agricultural pollution has become a major issue for all fresh water and Lake Atitlán is no exception. When water containing an excess of nitrogen and phosphorus is coupled with a warming climate, it creates perfect conditions for the algae blooms of cyanobacteria that deplete oxygen, killing fish and creating a stench of rotting plant material. Lake Atitlán has encountered ecological turmoil for over 60 years which included the introduction of non-native Black Bass that decimated native fish and led to the extinction of the Giant Grebe bird. Algae blooms may become a permanent part of Atitlán unless something is done to control pollution entering the lake. The blooms have become so large that in November 2009, NASA satellite images show the entire 12 mile long, quarter mile deep lake covered in the pea-green algae. Phosphorus is needed by all living things, but too much and it becomes toxic. There needs to be a balance. The algae blooms are telling us that things are not right. My art depicts Lake Atitlán as it was, and how it may be in the future, with phosphorus now a part of the water forever.

**About the Artist:**
"Blow it up! Make it bigger! Even small things are beautiful. You don't have to paint the whole thing." These were the words from Ericka's high school art teacher, and they have inspired her to capture the details that create the big picture. Always passionate about the earth and it's web of life, Ericka looks forward to the day when environmental protection includes not only the "wilde" but the urban places where we live and work. Clients include the Maricopa County Libraries Summer Reading Program, Sedona Jazz on the Rocks, Best Western, and numerous private collectors.
Ericka Cero Wood

Lake Atitlán, then and now

acrylic/mixed media, 16" x 20", 2011.
Emmanuel "Man Ray" Covarrubias

Description of Artwork:
Because I was new to the element Phosphorus, I asked scientist, Jessica Tew where Phosphorus was found and what it did. She told me that Phosphorus is needed in every living organism and that it is found in different places on Earth. A bit of Phosphorus is found in the air, but mainly where Phosphorus is located is in the rocks, in the water, and in trees and plants. I decided to then make my theme for my photographs locations where Phosphorus is found to teach the public how close this vital element is to us.

About the Artist:
Emmanuel "Man Ray" Covarrubias: I am a student attending Polytechnic, majoring in Graphic Information Technology. I have always been a fan of art and its ways it could be represented. During my high school years, I came across photography and saw that it could be used to make art. It was inspiring. Since then, I have been photographing anything that gives me a sense of art. The name "Man Ray" came from an artist and photographer, who's first name was Emmanuel. I am currently working on publishing a book of portraits of ASU students. The book will show how unique we are in our own way.

...The Man Ray of the Day
Molly Danielsson and Mathew Lippincott

The Nitrogen Cycle; Aerobic Decomposition; Portland's Sewer System; Portland's Composting System; Prominent Decomposers; Human Toilets and Urinals

Description of Artwork:
In order to explain the importance of unseen elements we created a series of 6 posters. We begin with the importance of phosphorous for bacteria to oxidize organic compounds for respiration and lead you to see all the higher systems that depend on that simple process. Then we take you through the current methods of re-using phosphorous and nitrogen in our environment: the sewer and composting systems for Portland, Oregon. We made our posters specific to Portland, because we live here and Portland has some of the best practices towards nutrient recovery in the nation and they’re still fundamentally flawed. We end with an introduction to the toilets of the world some of which re-use organic waste for soil and some of which pour it into our water ways, but we let the viewer decide in the face of so many options what makes sense.

About the Artists:
Molly Danielsson and Mathew Lippincott are artists and founders of the Cloacina Project which seeks to create open source ecological alternatives to waterborne sewage in the urban West based on science and research instead of fear and ignorance. Mathew and Molly live in Portland, Oregon. Molly and Mathew are currently working to develop portable ecological sanitation set ups for special events and festivals.
Adam Farcus
*Weight of the World (1 / 3.05E+28 grams)*
phosphorus rock bought on Ebay, .5” x .5” x .5”, 2010.

**Scientific Collaborator:**
Rebecca Cors, Ph.D. student, Swiss Federal Institute of Technology

**Description of Artwork:**
I try to instil in my work the magic and poetry that I find in everyday life. For this piece I decided to represent the urgent need to solve the widely unknown global problem of phosphorus depletion. The fraction in the title is the mass of this piece of phosphorus over the mass of the Earth. By referencing the weight of the world, the piece of phosphorus acts as a metaphor for the importance of phosphorus.

**About the Artist:**
Adam Farcus currently lives in East Garfield Park neighborhood of Chicago and teaches at the University of St. Francis since 2009. His work has been exhibited at the Gallery 400, Chicago; University Galleries, Normal, IL; Hyde Park Arts Center, Chicago; Second Bedroom Project Space, Chicago; the Miami Bridge Art Fair, Miami; and the Urban Institute for Contemporary Arts, Grand Rapids; among many others. Adam received my M.F.A. from the University of Illinois at Chicago, his B.F.A. from Illinois State University, and A.A. from Joliet Junior College. In the summer of 2010 he co-chaired a panel discussion at the Performance Studies International 16 at OCAD in Toronto, Ontario.
Todd Daniel Grossman

*P is for Pail; P is for Preservation; P is for Phosphorus*(three piece series)

**Scientific Collaborator:**
Robert Mikkelsen, Director, International Plant Nutrition Institute

**Description of Artwork:**
When I was working on the concept for this piece, I asked Dr. Mikkelsen what image stood out for him when he thought about phosphorus sustainability. He said, simply and beautifully: “A farmer in Africa with extremely P deficient corn plants… He was struggling to grow sufficient food to provide for himself and his family. A bucket of P fertilizer would drastically change their lives. The simple things we take for granted can be a matter of life or death elsewhere.”

This series of three paintings represents the physical aspect of phosphorus (P is for Pail), the human need for phosphorus (P is for Preservation), and the chemically finite aspect of phosphorus (P is for Phosphorus).

**About the Artist:**
Todd Daniel Grossman is a painter specializing in miniature drybrush watercolor works. A graduate of Pomona College, with a degree in English literature, he is a classically-trained pianist, composer and lyricist, currently finishing an original opera. He and his husband of fourteen years live in an historic Phoenix 1920’s Craftsman. A published professional photographer, he also teaches piano, voice, art, and gymnastics. In his spare time, he knits.

**Todd Daniel Grossman; Detail of: P is for Pail, P is for Preservation and P is for Phosphorus; Watercolor, 4” x 6”, 2011.**
Sarah Kriehn

*P-15; Bone Tissue; Depleting*

**Scientific Collaborator:**

Lara Reichman, Ph.D. student, School of Life Sciences, Arizona State University

**Description of Artwork:**

“Soil phosphorus (P) content is large but only a small fraction is available to living organisms, after the weathering of minerals. Despite its relatively low geochemical abundance, P has unique ionic properties that give it an important role in biochemistry. For example, at the molecular and cell level, P serves as energy transfer in ATP, constitutes part of DNA, and cell membranes. The three art pieces were inspired by different stages of P within its global cycle. “Depleting” refers to P largest pool that is found in unweathered rock and soil, and how human P mining for fertilizer production is currently enhancing the turnover of the P global cycle. “P15” and “Bone tissue” refer to P found in living organisms at a micro- and macroscopic level, either within the 3D shape of proteins (“P15”, tertiary structures), or in bones (“Bone tissue”), the bulk of P reservoir in humans.” ~Lara Reichmann

**About the Artist:**

Sarah Kriehn was born and raised in Winslow, Arizona and lives in Phoenix. She earned her degree from ASU. Prior to her career as an artist, she was an art teacher in Phoenix and received the Arizona Elementary Art Teacher of the Year award. Sarah is the recipient of an Artist Grant award from the Phoenix Office of Arts and Culture and the Arizona Commission on the Arts.

Sarah is an innovative, contemporary artist who merges the fields of printmaking and painting. She creates unique works which do not include multiples or reproductions.

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Sarah Kriehn

*P 15*

Monotype,

13” x 36”, 2011.
Scientific Collaborator:
David Iwaniec, Ph.D. student, School of Sustainability, Arizona State University

Description of Artwork:
The Ptown Constellations create a dynamic portrait of a theoretical world, like our own, facing a shortage of usable phosphorus. This compound, essential to agriculture, food production, and the fabrication of many materials, lies at the center of a growing debate about sustainable practices as they relate to economic and political priorities. Inspired by the PlanPHX visioning process, these constellations, while introducing the user to different types of sustainability strategies at different parts along the human phosphorus cycle, allows them to rank phosphorus conservation methods and see how resulting consequences compare to each other. Through interaction, they learn about phosphorus conservation issues and how personal, political and economic choices affect others.

Users rank conservation methods using a physical game board, choosing from 5 choices represented in an LCD projection onto a table--investment in mining technology, phosphorus taxation, reduction of demand through consumer choices, genetic engineering, and closing the loop through recycling. Icons in a second display--representing increased cost, environmental pollution, political fallout, and even unknown consequences--portray the intensity of potential consequences to the user's ranking by growing or receding from view. This feedback alerts the user to consequences beyond phosphorus scarcity, allowing them to experiment with different strategies and resulting outcomes in pursuance of a normative state.

Each conservation method and consequence is represented by an icon. These icons, “sampled” from ancient Celtic artifacts and “hacked” using contemporary photo doctoring techniques, incorporate a design aesthetic that emphasizes interconnectedness. Mirroring the complexity of the human/ phosphorus cycle, Celtic knots connect in unexpected ways, requiring close inspection to perceive their true path. These images, which reference human and animal forms, also recall patterns attributed to clusters of stars. Whereas our ancestors saw figures emerge from points in the night sky, we see them arise from our complex resource extraction and allocation systems. Do these figures appear as angels or monsters? The PTown Constellations let the viewer decide.

About the Artist:
Blake McConnell is an media artist, musician and activist. Originally from the Atlanta suburb of Marietta, Georgia, and a long time resident of San Francisco, CA, he now resides in Phoenix, AZ. His creative work manifests in various ways, though the intersection of media, technology, and society serves as its fulcrum. The confluence of the implications of form and the infinite variation of perception fuel his inquiry. Inspired by years of local organizing, he embraces the frontiers of new media while respecting their incumbent responsibilities.
Sue Norton-Scott

*Puzzling Out Phosphorus*

**Scientific Collaborator**
Laura Schreeg, Ph.D. student, Department of Biology, University of Florida

**Description of Artwork:**
The piece explores two versions of the phosphorus cycle: a “natural” phosphorus cycle, which emphasizes the recycling and the reuse of phosphorus, and an incomplete human-driven cycle where phosphorus is not being recycled. In the natural cycle, phosphorus is released through the decay of plant matter and subsequently reused by plants. In contrast, in the human-driven cycle, phosphorus is mined, applied as fertilizer and then lost from the agricultural system through crop harvesting and run-off/leaching/erosion. Scientist/collaborator Laura Schreeg is pictured in the piece doing research in a peruvian Amazon Jungle.

Viewers can physically move puzzle pieces, which symbolize phosphorus, along a wire from one location to another within the cycles. Incomplete wire connections represent possible solutions for better completing the human-driven cycle in the future, thus illustrating ways to manage the element for a more sustainable future.

**About the Artist:**
Sue Norton-Scott creates mixed media art that asks people to think differently about contemporary topics. After graduating from Crane School of Music in Potsdam, NY, the young teacher moved cross country and planted roots in Chandler, Arizona. Now, thirty years later, she is retired from the Mesa Public Schools and lets her creative side flourish. Her surrealistic, 3-dimensional art has been displayed in New York City, Chicago, and Sacramento; as well as in the Mesa Contemporary Arts Gallery. Norton-Scott holds a Master’s degree in Interdisciplinary Humanities and teaches art classes online at Rio Salado College.
Sue Norton-Scott
Growing Interest
Oil and Mixed Media, 28" x 22" x 1", 2008.

Description of Artwork:
“Growing Interest” asks viewers to think about the relationship between ourselves, the earth, and money. Phosphorus is present in the bones, flower, soil, and the “green thumbs.” The foot is stepping on the currency, making the figure immobile. I want viewers to ask themselves the same questions that scientists are asking: How does money influence the decisions we make today about our earth’s future? Can we develop a “P-neutral” bioenergy economy?
**Erik L. Peterson**  
*Pristine Lack: Patagonian Lakes*

**Scientific Collaborator:**  
Cecilia Laspoumaderes, Ph.D. student,  
Universidad del Comahue-CONICET, Argentina

**Description of Artwork:**  
Dr. Laspoumaderes’ work in Argentina’s Patagonia region reveals the awesome power of species survival in inhospitable, nutrient-poor lakes, whose untouched beauty and clarity is caused by that deficiency. It is striking to me that the very thing that makes the Patagonian lakes pristine, clear, and beautiful (the absence of phosphorus) actually denotes a lack. This paradox made for a very interesting opportunity for my “Pristine Lack : Patagoinian Lakes” drawing. Defining lack (the deficiency of nutrients) in terms of clarity (the transparency of the lakes) is manifest in the field of drawing as “negative space.” Negative space is an artistic and graphic design term that denotes the space between marks that the artist makes on paper, or can be understood as the white space between black letters on a page. Using an X-Acto knife, I have incised this lack, or “negative space” directly into the paper to create an aerial view of the region of Patagonia in which Dr. Laspoumaderes works. The white expanse of the paper stands in for land and the lakes are represented by their absence from the page. When lit, the “clear” lakes will show on the wall behind the paper as pure light and will also offer glimpses of viewers on either side of the work, illustrating our own complicity in the care and destruction of aquatic ecosystems.

**About the Artist:**  
Erik L. Peterson's work intervenes in the interstitial spaces of public discourse, activating both the physical fabric of urban topography and investigating contemporary mythology. Artworks like “Self-Serve Soft-Serve,” a municipal pipe that pumps frozen yogurt, introduce play into the public space of the city, while projects like “Qeej Hero,” a video game that reanimates a 4,000 year-old Hmong musical instrument, show his commitment to collaboration. Peterson has presented his artwork and design projects internationally at a wide range of academic and industry conferences spanning the fields of graphic design (AIGA, 2008), ethnography (EPIC, 2009) and performance studies (PSi, 2010).
Patricia Sahertian; Top: enables him to cultivate; farmers’ fertilizer company; a matter of highest importance; Middle: nelson’s pop corn; “p” pee; efforts of science for its improvement; Bottom: desirous and peculiar; control over animal life; Mixed media collage on paper, all are 5” x 3.5”, 2010

Patricia Sahertian
Minding Your “P”s (eight piece series)

Scientific Collaborators:
Elizabeth Cook, Ph.D. student, School of Life Sciences, Arizona State University
Rebecca Hale, Ph.D. student, School of Life Sciences, Arizona State University
David Iwaniec, Ph.D. student, School of Sustainability, Arizona State University

Description of Artwork:
Artist Patricia Sahertian had no idea what she would be creating when, a little intimidated, she signed up to participate in the Sustainable P Summit's “Phosphorus, food, and our future: A collaboration between artists and scientists”. She thought, “Now, that is something really intriguing.” She was assigned to work with Elizabeth Cook, Rebecca Hale and David Iwaniec,
Ph.D students working on the budget of phosphorus in the city of Phoenix. Sahertian felt a sigh of relief when she realized she already knew Elizabeth through mutual friends. There was no need for the worried anticipation, for when she did get to meet with her scientists, she found they were helpful and enthusiastic about explaining their work and the role of phosphorus in terms that were easy to understand.

Cook, Hale, and Iwaniec are collaborators with other scientists on a project examining natural and human-mediated phosphorus flows and storage in Phoenix metropolitan area. Fertilizer for agriculture and urban landscaping, as well as human foods, represents the largest flux of P to the city. Although export of P is high, reuse of wastewater recycles many nutrients back to the urban landscape and aides in preventing downstream environmental degradation.

Sahertian, having a story telling nature, processed much of what she learned: that phosphorus is mined, that it is used in fertilizer, that we eat it and expel it and finally that it can actually be recycled and if not, it can have devastating effects on downstream ecosystems. She asked, “How can we show this process in a graphic way, without having to use too much text?” They discussed together abstract painterly ways of illustrating the levels of P, a flipbook idea and even a flash animation. When Sahertian actually sat down to work on this project though, some of these ideas seemed too vague or too complex to form the narrative. Working with collage as a medium, Patricia decided that it worked.

Doing some research into the history of phosphorus Sahertian found some old fertilizer brochures and articles about phosphorus printed in the New York Times that dated back to the 1800s. In addition, she incorporated some retro wallpaper and advertising images from the 1950s and 60s into the collages. One item, a vintage Premium King Korn Stamp ties them all together. “Sifting through my collection of ephemera, I thought the King Korn stamp was very effective in conveying, not only the image of agriculture, but the exchange of money and the reciprocation of the gifts you get back when you ‘cash’ them in. Somehow that symbolized, for me, the whole recycling process,” she said.

**About the Artist:**

Patricia Sahertian was raised right on the border of Brooklyn and Queens, the daughter of Irish and Greek immigrants. Influenced by her visits to the Metropolitan Museum of Art, the New York Public Library and the 1964 World’s Fair, she developed a love of visual art at an early age. She has studied painting, printmaking, ceramics and sculpture.

Her fascination with found objects, old letters and late 19th century history is evident in her current work, as is her extensive experience in graphic and multi-media design and film.

Sahertian considers herself a storyteller in picture form and is focused on developing her narrative style. She also reads coffee grounds. ⚫
Phosphorus is an essential and often limiting nutrient in ecosystems throughout the world. Growing demand for corn, soybeans, and other mega crops has drastically increased the amount of phosphorus being released into agricultural systems. Runoff from these crops can transport artificially high amounts of phosphorus into systems downstream. The ecological consequences of these increases are still unclear, but new evidence is emerging that increasing the availability of nutrients into ecosystems may increase the risk of disease in humans and wildlife.

(Catas)Trophic Cascade illustrates the wide reaching and often unforeseen consequences of artificially increasing the availability of phosphorus in the environment. Research has demonstrated that dumping phosphorus into aquatic systems will often result in algal blooms. As a result, populations of snails that feed on the algae grow, but they do not grow alone. The snails carry a parasite, which attaches itself to the developing legs of tadpoles, leading to mutations and deformities of the frogs’ legs. Having fewer, extra, or malformed legs may make the frogs easier for predators, such as snakes and birds, to catch. After eating the frogs, the predators effectively transport the parasite to other places, and the cycle continues anew.

This “cascading” effect, from phosphorus to algae to snails to mutant frogs, is a stark and powerful demonstration of the subtle and unpredictable ways in which human activities can alter ecosystems. Through the use of phosphorus based fertilizers we are changing the transmission dynamics of an infectious disease and in turn altering natural food chains. Although the overall effects of these changes are still unclear, they have the potential to be devastating to animal populations already at great risk, such as amphibians.

We hope our work will help viewers recognize that human activities can upset the balance of ecosystems in profound and often unpredictable ways, and enable them to think about the often over looked interconnections between our resource use and the environment.

About the Artist:
Lisa Corine von Koch received her BFA in Painting and Drawing from the University of Utah, and her MFA in Painting and Drawing from Arizona State University. Her practice has expanded to include sculpture, performance and installation in the interest of incorporating ecological practices into art making.

“My work deals with the intersection of nature and culture. As an artist and an environmentalist, I must constantly negotiate a compromise between content and material use. I am interested in exploring this tension in order to determine where boundaries are, to seek material histories, and to discover new solutions for each work.”
Joshua White
*Got Bones? Got Ca? Got P?*
Cyanotype, 20” x 40”, 2011.

**Joshua White**

*Got Bones? Got Ca? Got P?*

**Scientific Collaborator:**
Genevieve Metson, M.S. student, School of Sustainability,
Arizona State University

**Description of Artwork:**
Phosphorus is an essential element for life, and is a major component of bones. However, when we think of bones we most often think of the element calcium, not phosphorus. This piece is a play on the Got Milk? Commercials, where we think of the calcium in milk is important for healthy bones. Here we add the question Got phosphorus? Perhaps on the scale of one bone, one person, we do. But global mineral phosphorus reserves, the main source of phosphorus for fertilizer in agricultural production, are being depleted. And as a society we must ask ourselves where phosphorus for food production, and ultimately our nourishment and the growth of our bones, will come from. How can we find sustainable ways to recycle and manage P resources for the future?

The left-hand image represents the question Got Bones? Yes. The middle image represents the question Got Calcium? Yes. The right-hand image represents the question Got Phosphorus? We don’t know. The glass with milk in the middle representing calcium is full, but the glass on the right with phosphorus is much lower, representing phosphorus depletion. In addition to the content of the pictures, they are cyanotypes. This process results in an image made with iron, which is an element that binds strongly to phosphorus. This finish also represents how global phosphorus availability is decreasing by invoking the chemical bonding of phosphate and iron, making phosphorus unavailable.

**About the Artist:**
Joshua White received a BFA in Photography from Northern Kentucky University. His work has been exhibited regionally in Ohio and Kentucky, as well as in California and Arizona. As a graduate student at ASU majoring in photography, his work focuses on memory, and the way photographs function within that context. The photographs he creates are not clean, straightforward images that point and say, “Look here;” rather they act as catalysts, as stand-ins for what it feels like to remember.
Juri Yamashita
*Phosphorus infused into the food cycle of leafcutter ants*

**Scientific Collaborator:**
Rebecca Clark, Ph.D. student, School of Life Sciences, Arizona State University

**Description of Artwork:**
After meeting with Rebecca, who works with leafcutter ants, I became interested in the possibilities of naturally produced refuse that could be used as fertilizer. The addition of Phosphorous represents the research Rebecca is working on. The integration of these Phosphorous-infused leaves into the food cycle of leafcutter ants represents the ideal codependent relationship the fungus has with these ants. By placing the Phosphorous element in a realistic setting I wanted to inspire the use of working with natural relationships that have evolved over many years to create a food cycle that has worked well and extends the use of Phosphorous many more times than our Phosphorous-infused fertilizers that are used once and run off to waste and destruction. Hopefully we can come up with a way to use Phosphorous over and over again with the help of ants and fungus who have figured out a way to cycle and recycle their resources.

**About the Artist:**
Juri Yamashita: Considering myself a lifelong student of many things, I draw ideas from my experiences. In order to have a variety of experiences, I look for ways to expand my ideas about art. This opportunity to meet with Rebecca and explore the work she does with these fascinating leafcutter ants showed me an environment I had never thought about before. The possibilities of using art to explore our use of Phosphorous was exciting and I look forward to using inspiration from science again in the future. Hopefully some of the art expressed will spur ideas that might help with the issue of Sustainable Phosphorous.
Randy Zucker

*The latest poop about P*

**Scientific Collaborator:**
Dan Childers, Professor, School of Sustainability, Arizona State University

**Description of Artwork:**
Our “Toilet Seat Art” piece addresses phosphorus sustainability and food security from the context of the human phosphorus cycle. We use decoupage techniques and mixed media to connect scientific information with related photographic and design elements using a "canvas" that represents the circular nature of the human phosphorus cycle while also being a well-known (and practical) part of that cycle (i.e., human waste). A scientific review of the human phosphorus cycle as it relates to phosphorus sustainability challenges, which will be published in the February issue of Bioscience (Childers et al. 2011), forms the scientific framework for our piece. We use actual copy from this manuscript as a “text as art” background in our decoupage. Layered over this background, several key figures from the manuscript as well as excerpts and key phrases from the text are featured as images, as are photographs depicting the key points. Our presentation of the material and images is organized into four “chapters” (or sides of the seat): (Side 1 - top of lid) Background on the importance of phosphorus and where it comes from (i.e. the mining of mineral phosphorus); (Side 2 - inside of lid) The importance of phosphorus to our food production and the inefficiencies of its use by the “Agri-Industrial Complex;” (Side 3 - top of seat) The problems with [what is now] a very “leaky” and wasteful human phosphorus cycle, and; (Side 4 - bottom of seat) Sustainable solutions to the phosphorus challenge which include low impact food production and recycling, to name just two. A faint wash of yellow provides a unifying visual effect and represents pure elemental phosphorus (which is yellow in color) as well as phosphorus-rich animal excreations. Our piece is both decorative and fully functional—we demonstrate the latter through our installation. Notably, our installation base (the toilet) is recycled (from Stardust Industries in Mesa; a local business that specializes in recycling building materials and supplies). The “toilet paper” roll (a familiar accompaniment to our piece and necessary addition to our installation) features labels from different fertilizer bags, symbolic of this link between geologic phosphorus and our production of food (and the associated waste of phosphorus in its production and consumption).

**About the Artist:**
Randy Zucker is a self-taught “Outsider” artist currently working and showing in Phoenix Arizona. She is best known for her “Digital Transformation” Images and Decoupage Toilet Seats. She is co-manager of the MonOrchid Artist Collective, Past Treasurer of Artlink Phoenix, and represents her collective to the Roosevelt Row Merchant Association. Randy is currently spear-heading a year-long Community Art Project which will, through a blog and personal contact, involve the public in the conception and creation of a piece of Public Art made from pennies donated by art aficionados of all shapes, sizes, and backgrounds.
Randy Zucker; *The latest poop about P*; decoupage, 18” x 14” (seat), 2010.