Why iSWOOP? ... There has always been a slight disconnect between current research and interpreters. Because of that, visitors' understanding of science may suffer from misinformation or complete lack of information. The more that visitors understand the significance of the science, the more they will value the park and the resources it protects. —National Park Service Interpreter

Resources for Interpreters

Acknowledgments

iSWOOP Project leaders, Louise Allen, Nickolay Hristov, and Martha Merson are grateful to the many interpreters, scientists and resource managers who have made park-based research a lively, interactive part of park visitors' experiences. We are thankful for our advisors' input as well as for the assistance from many Park Service staff, and for support from The National Science Foundation.

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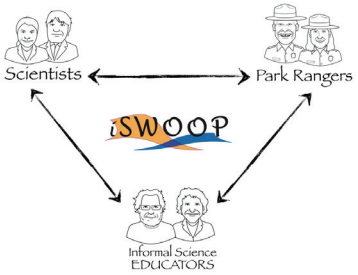
For more information about the project, visit www.iSWOOPparks.com or www.terc.edu/iswoop

Table of Contents

Welcoming You

Welcome to iSWOOP, a unique collaboration of rangers, educators, and scientists to advance the public's engagement with park-based science. iSWOOP, Interpreters and Scientists Working on Our Parks, seeks to increase the public's science literacy, awareness, engagement, and enthusiasm for parks as our nation's outdoor laboratories. Collaborations among i--Interpreters, S--Scientists, and informal education researchers working on our parks reveal stories and arresting visualizations to capture interest and promote conversations. iSWOOP encourages interpreters to create audience-centered experiences with invitations to visitors to consider researchers' questions and obstacles to research, to learn about new methods, and consider the relevance of research.



Resources designed to make communicating park-based science your default.

iSWOOP's success hinges on interpreters, other staff, and volunteers communicating with the public. In this packet, we support you in:

- Seeking out untold science stories with potential to engage visitors
- Eliciting stories to inspire and relate scientific research to visitors
- Integrating techniques for using visualizations as hooks, illustrations, AND jumping off points for observation, prediction, and speculation
- Kindling visitors' interest in cutting-edge science on protected lands
- Being confident in presenting current park-based science in ways that will interest multi-age family visitors using interpretive techniques that are audience-centered and interactive.

iSWOOP focused on bats and wildlife researchers originally, but can feature any scientist or resource.

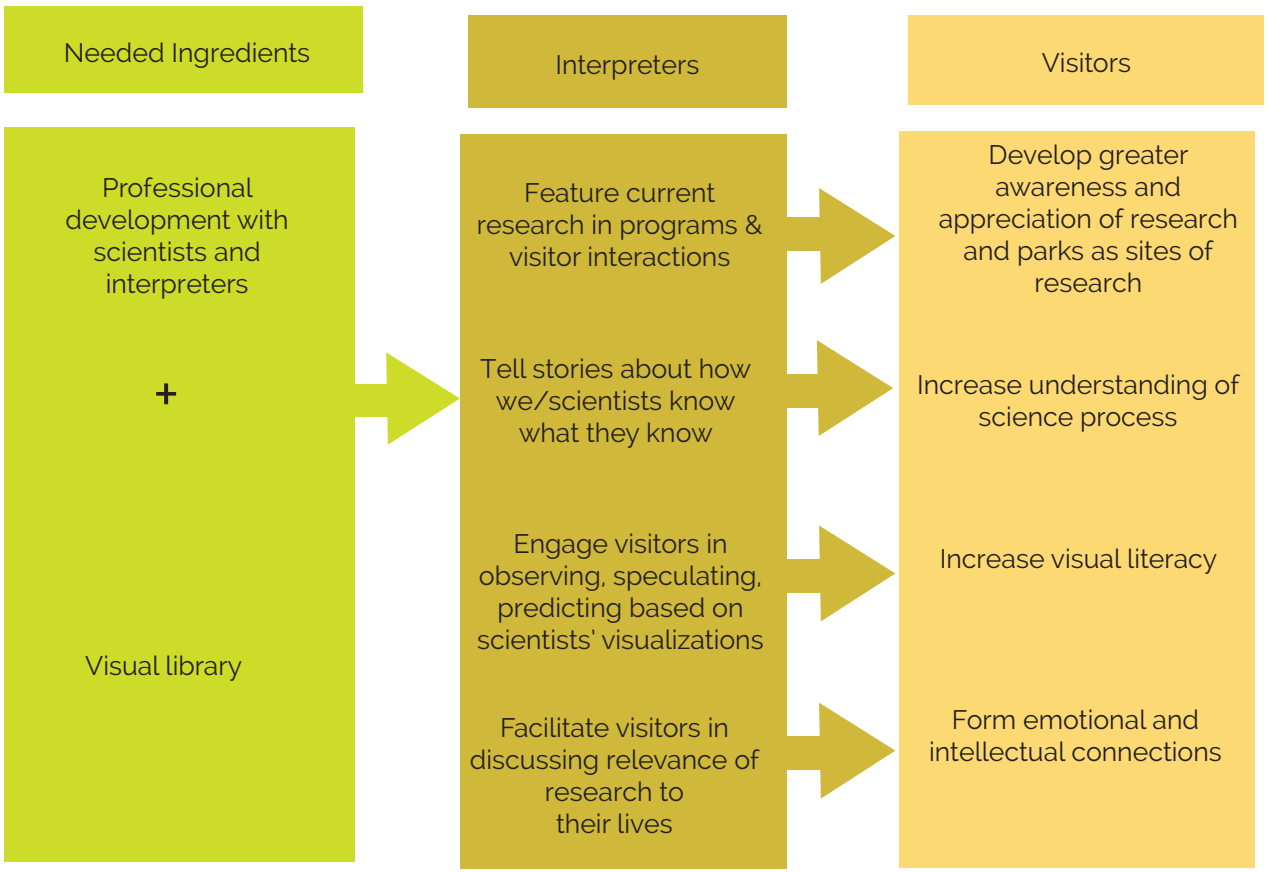
Introduction to iSWOOP Project Goals and Model

As mentioned, iSWOOP stands for *Interpreters and Scientists Working On Our Parks.* The National Science Foundation and the National Park Service both include public education in their mission statements. In a nutshell, this project is meant to advance STEM (science, technology, engineering, and math) learning among national park visitors. iSWOOP brings together educators, scientists, and National Park Service (NPS) interpreters to create a model that brings visitors into the loop on the science research underway on park lands. **iSWOOP programs and informal interactions led by interpretive rangers give visitors an opportunity to see aspects of the park that are not usually visible.** iSWOOP:

- Showcases science happening in national parks
- Makes prominent dramatic stories as well as the daunting challenges scientists face
- Capitalizes on visitors' interests
- Increases visitors' science literacy by showing how scientists know what they know
- Increases visitors' visual literacy

Scientists, interpreters, and park leaders have all reflected on the value of iSWOOP and made recommendations on its implementation to best achieve its goals. The project's evaluation reports are available on http://www.terc.edu/iswoop along with short videos that lay out the need for the project and its goals,

What iSWOOP Is: Program Components and Expected Outcomes



What iSWOOP Is and Is NOT

Parks get at science in many ways, through signs, newspaper articles, social media posts, talks and walks, and even apps that help visitors identify species or contribute data to a study. How does iSWOOP distinguish itself from the science-based interpretation currently happening in parks? Below are some of the ways we see iSWOOP as different.

Check http://www.terc.edu/iswoop/_resources-for-parks-getting-started-with-iswoop/ for examples of iSWOOP-influenced stationed interpretation, roves, talks, hikes, and evening programs.

iSWOOP Is ...	iSWOOP Is Not ...
Personal and interactive: an approach to personal interpretation that makes science in parks an interactive and visible part of the public's park experience	Primarily using waysides, social media, exhibits, or print media to showcase park-based science
Audience-centered, two-way conversations that allow time for visitors to engage with each others' ideas	Information out
A way to talk about science as a process that starts from questions, involves revision, and has the potential to matter to all of us	A way to remind visitors that science is largely a collection of facts about how the world works
Science in parks is inherently interesting and full of good stories--both first person from interpreters' experiences and about the researchers and what they are studying	Facts strung together and offered in an engaging way
Technology and innovative methods that are key to understanding how we know what we know	Facts shared without attention to who figured it out and how
Images that are sequenced to reveal something about the resource, but also as a starting point for inquiry and discussions of relevance	Images primarily shown to illustrate a place
Programs, formal and informal, that invite visitors to predict, observe, and speculate	A replacement for the strategies and know-how interpreters possess already
Comfortable with silence and reflection	Pre-scripted and pre-determined
Possible because interpreters and scientists spend time together in the field and in the classroom	Minimal or limited direct contact between interpreters and scientists, such as a 1 hour bag-lunch or a field work encounter without follow up

Findings from iSWOOP Parks

iSWOOP first offered professional development at Carlsbad Caverns in 2014. iSWOOP then led professional development online and in person at four more parks. Many interpreters were part of an evaluation that gathered feedback about iSWOOP workshops and the impact on their interactions with visitors. Based on surveys interpreters completed after using iSWOOP approaches and resources multiple times, we found:

iSWOOP increased access to park-based research. More than 75% (n=39) said contact with featured scientists was valuable or very valuable.

> *My own personal science literacy has been drastically improved.*

50% reported that they often facilitated visitor discussions of the relevance of park-based research.

iSWOOP encouraged conversation. The techniques that were used often or very often by a majority of interpreters (n = 38) included sharing stories about specific researchers and their methods; using scientists' research questions, data collection strategies, and findings to explore how we know what we know; and showing visualizations related to scientists' questions and findings.

Interpreters commented on visitor engagement.

> *Oftentimes the default for our programs is to do all the talking. This helped me step back from that.*
>
> *I've realized that I should let the visitor define the parameters of the interaction more, especially in family settings. When I hear a question, instead of immediately swooping in to answer, let the adults in the group respond first, and let them invite me to participate. This has been richly rewarding …*

Interpreters increased visitors' engagement with park-based research. Interpreters reported on 82 programs (during just over a year). They reported:

- 84% of programs visitors and/or they talked about the questions that drive research.
- 74% of the programs they discussed how scientists know what they know.
- 22 instances of visitors making specific predictions. Those clustered around impact of climate change on food availability, forest health, and species survival.

Visualizations enabled visitors and interpreters to talk about patterns related to precipitation and colony size (of bats and amphibians).

The idea that researchers are working at national parks was new and impressive.

> *Most of [the visitors] thought that seeing scientist's work presented this way was different. It was ... an opportunity to see things they weren't expecting to.*

For more findings, see "To Be More Inquisitve in the NaturalWorld" and "iSWOOP Implementation in National Parks: Perspectives from Park Leaders, Interpretaters, Visitors, and Scientists," at http://www.terc.edu/iswoop

iSWOOP gives me a chance to get into researchers' lives and to see their stories.

— Acadia Ranger

Accomplishments

5 Parks

12 Featured scientists & their stories

105 Workshop hours

Hi-intensity engagement from BIPOC partners

50,000+ visitor interactions

iSWOOP and Foundational Competencies for 21st Century Interpretation

iSWOOP recommends approaches that dovetail with central ideas of 21st century interpretation. iSWOOP is not an add-on or replacement, but rather an amplification of certain key ideas.

Evolving Interpretive Theory & Relevant and Essential Ideas

- Uses park-based (or park-relevant) research to provoke emotional and intellectual engagement with resource meanings and relevance
- In active and engaging ways, uses scientists' research questions and findings to explore how we know what we know, as well as other relevant and essential ideas and/or values
- Asks questions which help audiences consider both personal relevance and broader needs of society

Knowledge of Audience and Community & Using Multiple Engagement Strategies

- Actively engages participants and solicits open expression of their unique perspective
- Invites audience to express observations, speculations, and predictions
- Balances the amount of "broadcast" and "listening" time intentionally to facilitate visitor engagement and expression of knowledge
- Continuously adapts and employs different modes of communication in response to evolving audience input, reaction, and self-expression
- Responds to audience input in intentional ways, allowing experience to evolve based on audience motivation
- Encourages audience members to build on each others' ideas and perspectives.

Knowledge of On-Site Resources, Research and Current Context

- Incorporates current scholarship, giving the research a frame or context related to the meanings of the resource and engages visitors in learning about science research;
- Shares details or broad purpose of the scientific research being conducted at the park, including research questions, methods, findings, future research agendas
- Positions self and audience as learners and stakeholders in research, its questions, challenges, innovations and applications;
- Incorporates scientists' instrumentation and visualizations into programs;
- Explains and fields questions to help visitors make sense of scientists' visualizations;
- Integrates cultural history into conversations about scientific studies, considering the messages explicitly or implicitly conveyed about science, its historical uses and abuses;
- Expresses a personal and organizational willingness to learn, grow and change.

The Mather Center for Interpretive Development intends to update these annually.

Project Viewpoints on Science and Technology

STEM Literacy

Most people think science is the accumulated set of facts about how our world works. iSWOOP emphasizes other aspects of science. Which idea has the most appeal or resonance for you? When you encounter visitors, can you form new connections by framing park-based science studies with one of these ideas?

1) Science is about questions, the next question. We are realistic about what we don't know.

In *Ignorance: How It Drives Science* Firestein (2013) began by saying: "So every fact really that we get just spawns ten new questions. And those are the things that ought to be interesting to us, not the facts… This makes science more accessible to all of us because we can all understand the questions…".

Try asking scientists about their questions. Firestein speaks with scientists (as part of a seminar on ignorance), he asks: "What will happen if you don't know this, if you never get to know it? What will happen when you do? Then where will you go? …" He noted: All they ever think about all day long is what they don't know. That's what a scientist's job is ..."

Tim Watkins (NPS) says, "In formal science education, students are almost never asked "What do you wonder about?" When I've asked them, they're grateful and startled. Interpreters can ask visitors: "What do you wonder about?" In sharing their current and past "I wonder" questions, we frame science in a way that nurtures curiosity; that can spark long-term interest and engagement in science.

What if ...? questions free up the imagination.

2) Science and technology are intimately connected.

Curiosity about how things work and the determination to overcome obstacles that stand between us and finding out leads to invention, to using technology to answer *What if...?* questions. What if you could see the past? What if you could see into dark places? What might you invent to help you?

What if ...? questions tend to free up the imagination because they allow you to "see things as other than they currently are" (Berger, 2014, p. 114). They allow you to shift reality, if only briefly.

According to Berger, "… In today's increasingly dynamic environment, we're all being challenged (or soon will be) to quickly adapt to using new and unfamiliar tools … using ever-changing technology, without clear instructions, and with the clock ticking. All of which require people to be not only better questioners, but better experimenters" (p.121).

3) Research is about constant revision and refinement. Over time the story is going to change.

As Firestein (2013) said, "I think we have an over-emphasis now on the idea of fact and data and science…Scientists themselves don't care that much about facts. I mean, … we work had to get facts, but we all know they're the most unreliable thing about the whole operation. The next generation of scientists with the next generation of tools is going to revise the facts. That's what science does; it revises. Revisions in science are victories …"

4) One key component of science literacy is "how we know what we know."

Ask yourself this question: "Does the Earth go around the Sun, or does the Sun go around the Earth?" Chances are that you answered that the Earth orbits the Sun. Now ask yourself: "How do we know?" Chances are, you know the because you've been told so. Knowing something to be true only because authorities say so is a dangerous position to be in, and one that shortchanges democracy. Scientific knowledge is inherently democratic because it derives from observation and reason, which anyone can do, not from kings, popes, or other authorities. Being ignorant about "how we know what we know" regarding climate change, vaccines, GMOs, stem cell technologies, or a dozen other scientific phenomena that affect our lives may influence our choices and decisions in ways that run counter to our own interests. In his book *Fool Me Twice: Fighting the Assault on Science in America*, Shawn Otto makes a strong case for science literacy as critically important in a democracy. He asks provocatively: "In a world dominated by science that requires extensive education to practice or even fully grasp, can democracy still prosper … ?"

If we who know science don't communicate how we know about our world, then somebody else will fill the void. Ideologues and others interested in controlling political power or making a profit may distort ideas, imply bias in research, or intentionally misinform the public. Ultimately, knowledge is power and to remain scientifically illiterate in a science-dominated age is to cede power. Park interpreters and allies are especially well-positioned to foster scientific literacy – that includes an understanding of how scientists know things.

5) So what? Science matters especially when we the public, individuals, and NPS act on it.

Park interpreters can take advantage of the fact that parks are visited by people of all backgrounds and beliefs. Through emotionally and intellectually rich, place-based experiences, interpreters can introduce visitors to the science that is informing park management. Park interpreters can introduce or weave in complex issues related to land management and changing conditions. And by drawing on the parks' long history of story-telling, they can convey the excitement of scientific inquiry, discovery, and relevance.

Opportunities to engage benefit visitors in their lifelong learning. Educational research shows that people have greater motivation to engage and learn if the subject matter is directly relevant to their lives and interests and/or if the learning process is interactive—one in which the learner affects the learning process, content, and/or outcomes of the experience (Falk, 2001).

With thanks to Tim Watkins for his contributions

Identifying Scientists

To talk about park-based research credibly, of course you need stories to tell and a grasp on the science. The pool you draw from can include four types of scientists, but first ...

Determine the protocol. At some parks supervisors have guidelines or preferences for who and how to contact scientists. Clarify if the guidelines apply to all four types of scientists (see below). For outside researchers, you might ask the person who approves permits if they have a sense of which scientists would welcome contact. Consider whether to contact scientists or resource managers who are:

1) Currently and actively conducting research in the park, but employed elsewhere
2) Currently and actively conducting research in the park, employed by NPS
3) Currently and actively conducting research in the park, though not work at the park on a daily basis, however, is employed by NPS or a Dept of Interior agency)
4) Knowledgeable on topics with relevance to the park, but do not have park study sites.

Bob Brodman, Indiana Dunes' scientist, is Type #1.

Jacquelyn Gill, Acadia's featured scientist, is Type #4.

Make the request. On page 14, we summarize the research that has led us to recommend certain points you can emphasize and on page 12 we included a draft email. Scientists can always say no or just not respond, so iSWOOP's general stance is that it doesn't hurt to ask. Make it clear that you:

1) will not take too much time

2) are committed to giving the public accurate information

3) want to inspire others to do science

If this becomes a division-wide project, consult the *Getting Started* Guide (available on http://www.terc.edu/iswoop). We walk through the process Jean Lafitte NHPP used, opening the opportunity to all their active scientists by issuing a request for proposals. A sample RFP is in the appendix of *Getting Started with iSWOOP*.

Establish criteria. Brainstorm and prioritize. Suggested criteria:

- Research interests are close to visitors' interests
- You sense a story, e.g., the research is suspenseful, the tech itself is innovative ways or has a development story
- The researcher could expand the idea of who a scientist is, e.g. is female, is from an underserved community, brings art to their science
- Is interested in participating with no funds or within the budget available, that is willing to:
  a) Donate images or generate new ones
  b) Participate in meetings, will lead field-work with authentic tasks
  c) Be responsive (e.g., via email and phone) and fun to work with.

Selecting a Scientist: Reflections from Indiana Dunes N.P. (INDU)

At INDU staff from interpretation and resource management considered a few options, such as featuring bat research. Because the majority of people don't encounter bats and the monitoring project underway was simple, they dismissed that study and looked for a more complex story.

Wendy Smith remembered: "One project leaped out when we consulted the NPS Research Permit and Reporting System (RPRS)—'Amphibian Response to Climate Change.' The selection team was excited about improving our ability to interpret climate changes. We thought that people might relate in positive ways to amphibians, and might take action to slow climate change if they understood negative impacts on amphibians. Dr. Brodman's data are analyzed in association with satellite data from USGS. We thought some people would be interested in the use of the satellite technology.

The fit seemed promising, especially when we factored in how passionate Dr. Brodman is about helping people understand his work,"

Wendy Smith, Education Coordinator
Great Lakes Research and Education Center

Tips for Finding Cool Science

Look for intriguing research updates on websites and in newsletters from non-profits like Audubon, Sierra Club, and the National Park Foundation. The National Science Foundation, *Park Science*, and *The George Wright Forum*.

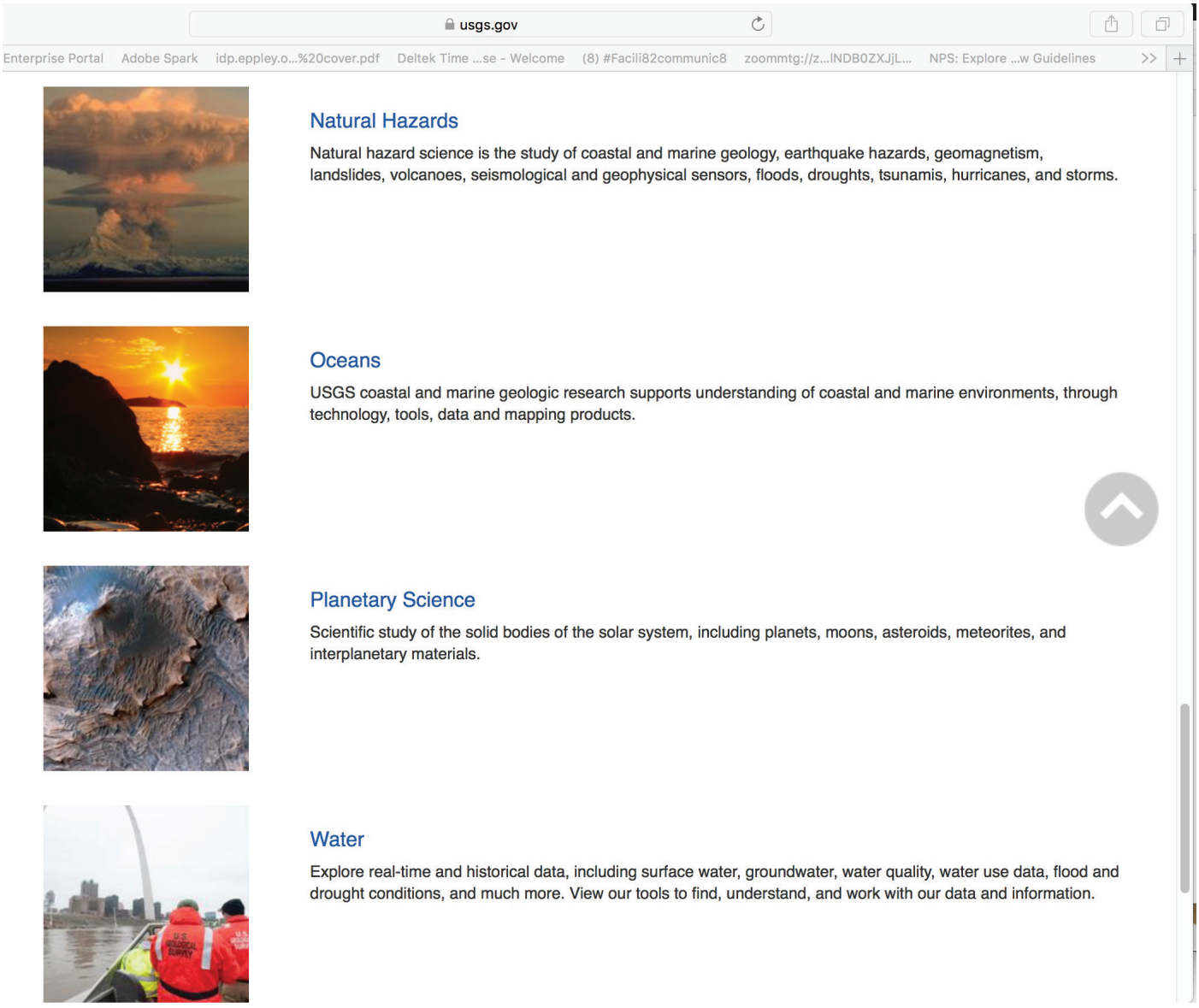
Check out nearby university websites, search articles about researchers.

Look on government sites like USGS and NOAA for cool images, reports, and gifs.

Check out National Park Service sites like a Research Learning Center in your region or the Inventory and Monitoring regional site covering similar habitat and geography to find briefs on a variety of topics.

Consult irma.nps.gov to search a specific park or a specific discipline (such as reptiles).

Search informalscience.org. Use the "project" filter and type in a topic, e.g., rivers or trees.



Check-in: Reading Science Studies

Take notes on park-based or park-relevant studies. To identify a scientist or a particular study, check annual reports on irma.nps.gov, university press releases, and newsletters from organizations like Audubon and the Sierra Club, as well as *Park Science*, and other journals.

Questions

Key Words

Critical Points

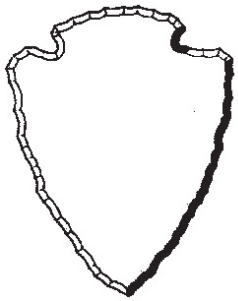
Methods

Figures

Story possibilities

Implications

Contacting Researchers: Sample Email



Greetings from [park],

I read about your research/heard about your research from …

In my work, I talk with visitors about the natural and cultural resources of the park. I try to inspire people to come back to the park to solve all the questions that we have about our natural world.

I'd like to talk about your research in my programs and interactions with park visitors. Of course I want to make sure that I represent the science accurately and tell the story of the research in a way that is meaningful and memorable to park visitors. Thus I am writing with a few requests

> Could we schedule 20-30 minutes for me to hear how you got started on this line of research and what the main struggles have been?
>
> Do you have a powerpoint or blog or other resources I could review in addition to more technical reports?
>
> Do you have plans to do research in the park in the coming months? If so, I would love the opportunity to shadow or assist.

Thanks so much for considering this request.

For subsequent communications

The iSWOOP project, Interpreters and Scientists Working on Our Parks, with support from the National Science Foundation, has been encouraging and facilitating these kinds of partnerships. You can read more about the project at http://www.terc.edu/iswoop

Any visual media that interpreters like me can use with the public helps bring science to life (e.g., slides from labwork, video clips, thermal images, still images of instruments, sequences of images that show new students your workflow, graphs, tables, or charts or visualizations based on them for ease in communicating with others about your findings, etc.). When we talk, perhaps we can exchange ideas about images that might capture the public's attention and further their appreciation of park-relevant science. You might already have photos or slides based on published work that would be cool for the public to see. I hope to talk with you about ideas soon.

Points to make

1 you will inspire others

2 this is a time-limited request; you need a few hours or less

3 you will give visibility to the research

The Point. The iSWOOP project aims to forge connections between scientists and park interpreters to make science an interactive part of visitors' experience. In spite of a willing workforce of interpretive rangers and a range of relevant science, too often opportunities to engage the public in learning about and discussing park-based science are missed. We wanted to understand scientists' opinions better in order to shape the structure and invitations to collaborate on outreach and education.

Our Hunches. We had two hypotheses that we can report on. iSWOOP staff sent email invitations to complete an online survey to 2,189 investigators who had submitted an annual report to the NPS Research and Permitting Reporting System (www.irma.nps.gov) on permitted research conducted in 2016. We report on 365 survey responses which we analyzed using latent class analysis, exploratory analysis, and descriptive statistics.

Prior experience with education and outreach collaborations is mixed, leading to the need to tread carefully with new requests for collaboration. On the contrary, prior experience is positive for 88% of respondents.

The most desirable outcome for scientists of collaboration with NPS is the opportunity for thousands to hear about their research. Not so. We found that inspiring others is the most highly rated response in terms of potential outcomes of outreach.

Researchers' Preferences. Park-based scientific researchers:
✓Are more likely to consider giving informal talks (60%) compared to formal talks (47%). Contributing to a teacher workshop, consulting on an exhibit, and setting up a citizen science project were among the top three preferred formats for about 30% of respondents. These options were more popular than participating in online chats (selected by 8%).

✓ Give high importance to being able to prepare for and control what happens (Item 3).

✓ Were more likely to rate taking on a new challenge as highly important—if they held fewer than three permits. (Item 3)

✓ Rated reaching thousands of people or even advancing their own research as less important than inspiring others and influencing policy (Item 5).

✓ Indicated that funds for such things as travel limit their outreach efforts (Item 4).

✓ Rated lack of clarity about the process for initiating outreach as somewhat limiting their outreach activities.

if true, there's potential to influence policy

and you have respect for the work and want to be accurate

Researchers' Styles. We identified three different profiles that corresponded to researchers' approaches to outreach planning:

Class 1 (Proactive and Positive), includes 31% of the researchers surveyed. They reported budgeting seriously for outreach. They seriously planned outreach while designing their research plan. An offer of assistance of more than a few hours to explore funding, design a new program, or increase the visibility of the research will likely be met with enthusiasm.

Class 2 (Neutral), is 12% of the researchers being surveyed. They budget not at all or minimally for outreach. They say that they plan not at all or minimally for outreach even once findings are in. On all items they tended to select "somewhat important" (the neutral category) rather than "highly important". Many members of this group labeled their prior experience with park outreach as mixed. None or a few hours might be acceptable for collaborating.

Class 3 (Potential Allies), more than half (58%) of the researchers surveyed are in the third group. Like the first group, they say it is highly important to them to inspire others to do science as well as to influence management or policy, and rate their most recent experience leading or contributing to an educational experience as positive. This group hovered in the middle space between seriously and not at all budgeting and planning for outreach. Potential Allies preferred just a couple hours of assistance with collaborative outreach projects. They were most likely to want to spend a few hours exploring funding, designing a new program, or increasing the visibility of the research. For several, increasing the visibility of the outreach could spark interest in collaborating for more than a few hours.

So what does it mean for initiating contact with a scientific researcher?

More than half the researchers are potential allies who on their own might not plan or initiate outreach, however, they appeared willing to spend a few hours collaborating. Based on this sample, in initial contact with the researcher, the request should be something the researchers can prepare for and control and require a minimal time commitment (no more than a few hours). Outreach activities that are likely to be attractive to researchers will:

✓ inspire others to do science

✓ influence policy, and

✓ are designed to give visibility to the research

Most survey respondents thought that inspiring others was highly important.

Interpreters reaching out to scientists could ask colleagues to find out if the scientist has prior experience giving talks at the park or otherwise collaborating with interpretive or education rangers. If so, these are likely positive experiences that can be built on. Among park-based researchers, interpreters may meet some who decline to give their time to talks or teacher workshops. Among this group, you might find interest in collaborations that advance science, such as a citizen science project.

Questions for Scientists

Peer-reviewed articles leave out juicy, human stories. Elicit them in a conversation or interview with a scientist.

Why isn't it easy to find out? Challenges & impetus for the study

Credit: Percy

Why is it challenging to answer the research questions?

Where did the idea for this study come from? Did you have guidance or previous experience?

How'd you do it? Overcoming challenges

What was it like to work in the field?

What challenges did you encounter? Did you ever have to change your plans significantly? Can you describe how you felt and how you overcame challenges you encountered?

What is something you always have with you? Why?

Relationship questions

What kinds of people do you work with? What muppets (or cartoon characters) do they remind you of? What are their roles and expertise? Who is good at this work in your experience?

Who influenced your path in life? How did you get here today?

Did the research affect your personal life? How so?

Do you see your researching aiding the work being done by others? How so?

Building a Story: Tips from Experts

Break down the parts.

Make sure you can answer: What happens in this story? Who's in it? What do they do? What happens to them? What do they want? What's in their way? How do they succeed, or why do they fail?

Breaking down how stories work can help you recognize opportunities for narrative. When you hear a story, note:

- *who the story is about, what you learn about him/her, how the characters talk*
- *where the story begins, where the story changes, where the story ends*
- *three instances of description, how the teller invites listeners to imagine the smells or sights.*

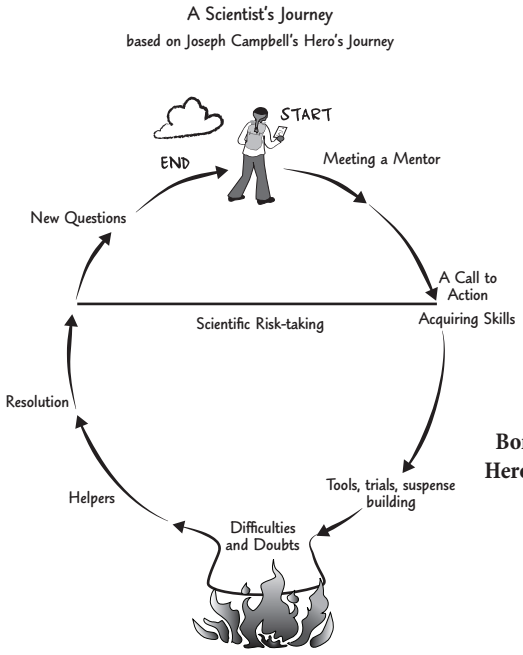
Adapted from **http://niemanstoryboard.org/stories/how-to-tell-a-story-the-moth/**

Take Advice from ***This American Life*** on how they evaluate pitches.

http://www.thisamericanlife.org/about/submissions

Use the Classic Approach:

The Hero's Journey



Bond-Upson, D. "Joseph Campbell's Hero's Journey" AwesomeStories.com.

Add elements that increase the drama and suspense

1) Pursuit 2) Rescue 3) Escape 4) Revenge	5) Rivalry 6) Underdog Succeeds 7) Temptation 8) Love	9) Forbidden Love 10) Sacrifice 11) Discovery 12) Wretched Excess

Found on **http://womeninwetlands.blogspot.com/2013/08/presentation-myths-tell-good-story.html**, from *20 Master Plots and How to Build Them* by Ronald Tobias, published by Writer's Digest Books (2012).

Check in: Finding the Science Story for an iSWOOP Interaction

1) Elements of a good iSWOOP story:

2) Purpose of using a scientist's story in iSWOOP programming:

3) Logistical considerations when preparing to reach out to scientists:

Story Frames: What's Not Dull?

Travel—science goes to remote places

Travel through time

Journeys literal and metaphorical

Mysteries

Gizmos/Technology

4) Challenges to integrating and presenting scientists' stories and potential solutions:

5) What about this? The storytelling tips below come from The Moth. Do they seem compatible with your ideas? With iSWOOP project ideas about integrating stories in science communication?

- A story should answer: Who does the audience need to meet and care about? What do they do? What happens to them? What do they want? What's in their way? How do they succeed, or why do they fail?
- When you are eliciting a scientist's story and crafting it to tell, include:
  - ✓ something a bit unexpected about the scientists and the people or places who figure in the story
  - ✓ how the characters talk
  - ✓ a point where the story changes, where the story ends
  - ✓ three instances of description, where listeners are invitied to imagine the smells or sights.
- As an example, during an interaction about coring would you tell parts of Tasting the Ice Age? https://vimeo.com/325286493

Adapted from **http://niemanstoryboard.org/stories/how-to-tell-a-story-the-moth/**

6) Which of these elements might give your science story traction? How so?

1) Pursuit 2) Rescue 3) Escape	4) Rivalry 5) Underdog 6) Temptation 7) Love	8) Sacrifice 9) Discovery 10) Other

Found on http://womeninwetlands.blogspot.com/2013/08/presentation-myths-tell-good-story.html, from *20 Master Plots and How to Build Them* (Tobias, 2012).

Defining Visual Literacy

iSWOOP defines visual literacy as the ability to interpret, use, appreciate, and create visual media to advance thinking, decision making, communication and learning. If you don't like this definition, read around. There are others.

Designing a Visual Library

iSWOOP has developed an approach to visually assisted interpretation that keeps the interpreter in the mix. In articles (see http://www.terc.edu/iswoop and listed on the For More on These Topics, p. 31), we have written about the design principles we see as relevant for communicating science to park visitors

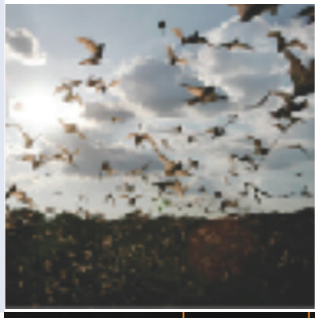
Purpose-driven Use of Visualizations

The dominant use of visual media in science communication is to illustrate or explain to the audience what they don't know. This is the deficit model and usually such imagery feels like a science textbook. Think about images for three purposes: a hook to spark curiosity and grab attention; a catalyst for observing, predicting, speculating, and discussing; and as illustrations of something hard to grasp or see (because it is too large or too small, out of season, or out of sight). Go for images that strike you as art as much as science to expand the audience for park science.

Getting Started

Start with 10 or 12 images. Reflect on how conversations between interpreters and visitors unfold. Add to the library as needed. Suggestions for getting started and examples for what to include follow.

Create a Visual Library—Types of Images

TYPE	PURPOSE	EXAMPLE	MEDIA
High-resolution images of the resource	Make aspects of the resource visible; inspire stewardship	Bottomland hardwood forest	
High-resolution images of the research instrument	Visual reference for scientists' tools; illustrate an innovation	Low-tech artificial nest boxes	
Visual of the researcher in action	Illustrate the science process; put a human face to scientific research	Field assistant removing a bird from the net	
Visual of human interaction with the resource	Model how to handle the resource; get across scale	A migratory songbird whose weight is equal to a car key	
Visual that documents the focus of study	Illustrate what was investigated	Emergence of 1,000s of bats from roost	
Video or audio of the phenomenon	Help viewers imagine themselves in the scene	Group dynamics in a dense flight formation	
Image that precedes a graph or visualization	Show the progress of data analysis; what the instruments pick up that is then analyzed	Anyalysis of bat emergence with computer vision	
Graphs, spectographs, or visualization	Show the data and other results of the research activity; illustrate evidence	Each colorful trail shows the trajectory of a bat	
Tutorial visual that demonstrates the technology	Scaffold understanding by showing technology in use with familiar objects	Thermal image of candle and icepack	
Juxtaposition of any kind	Highlight characteristics	Thermal image shows heat and cold sources	

Fostering Visual Literacy iSWOOP programs can offer a safe space for visitors to apply their visual literacy skills, an essential 21st century skill that cuts across disciplines. A democracy needs critical consumers of visual media, yet students tend to exhibit less comfort and skill with interpreting and discussing visual information than they do with textual information (Hattwig, Bussert, Medaille & Burgess, 2012). College faculty find students have trouble coordinating visuals with other information and making effective arguments with visuals (Green, 2006). iSWOOP can encourage:

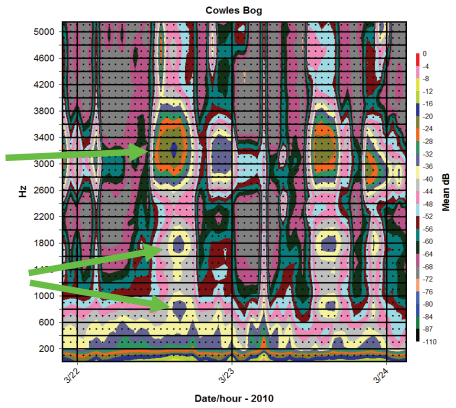
Interpretation of visualizations, which is the practice of making sense of visual information like lines, shape, color and interpreting these to understand relationships like change over time. Presented as a puzzle, visitors can look at individual points and trends. They can look for patterns and a story.

Applying a critical lens. Rather than taking visualizations at face value, one can pose questions about the production of an image: Who took captured the image? How was it processed? Where was it cropped and what was left out? (See Jarman et al, 2012).

Becoming inquisitive. Prompts can stimulate an imaginative response that explores multiple perspectives. What would [someone different from you in age, background or profession] want to know?

Suggestions

- ✓ Install digital media on a tablet or make prints. Start testing with small groups of staff or visitors. Listen for the questions, silence, comments, prompts, and images that spark reactions and conversations about relevance.
- ✓ Identify gaps in the story and see if there is a way to fill them in (e.g., There is nothing on taking measurements in the field. Will anyone be doing field work again soon?)
- ✓ Create or show less complex versions of graphs to scaffold understanding. Use this approach especially if a feature or concept is counter-intuitive, for example, if red doesn't denote the hottest spot.
- ✓ Seek out images that juxtapose literal with symbolic representations. Imagine comparing video of actual movement with a graph of the speed of movement. Researchers (Nemirovsky, Wright, Rubin, Barstow) have all found such scaffolding helps learners understand change over time and scale, which are invaluable.
- ✓ Request or design less complex versions of graphs, to scaffold understanding. For example, if a graph shows multiple species over multiple years with multiple environmental factors, ask about creating graphs with one species. Building toward complexity helps visitors stay engaged and follow along. Use this approach especially if a feature or concept is counter-intuitive, i.e., color-coding is used to relay information about wind strength or depth rather than temperature or if red doesn't denote the hottest spot.



Spectrographs help scientists analyze sound, but they are daunting for novices.

Finding Images

Hints

- Check research briefs from a Research Learning Center like this one https://www.nps.gov/rlc/crown/resourcebriefs.htm
- Ask resource managers for imagery like aerial photos, maps of habitats, types of rock, or plant ranges. Before-and-after pictures (of restoration, flooding, or fire) generate observations and conversation.
- Find a poster (ask resource managers about past conferences)
- If you've identified a scientist, check their Twitter or Instagram accounts to see if they have images (e.g. of lab or field work). If the person is an academic, check the university website for press releases with relevant imagery. You could email the scientist directly. Consider specifying that you are looking for slides from a talk for public audiences or students, vs. a conference presentation targeted to colleagues.
- Images from government agencies like NOAA and USFWS and the Library of Congress are in the public domain as are images or artwork by federal employees. The exception is NASA; they have strict guidelines. Any image that is credited to the National Park Service with no copyright symbol is in the public domain. Multimedia media with a copyright symbol or credited to any other entity other than the NPS must not be presumed to be public domain. Contact the host park or program to ascertain who owns the material.
- Search for Creative Commons images.

Resources

NPS Here are some links to nps.gov resources, as well as others, that feature images with the "rights" information.
NPS.GOV Multimedia Search - multimedia search of nps.gov entire website network

NPGallery Digital Asset Management System - comprehensive library of NPS images, video, audio, maps, etc.

NPS.gov Instagram, flickr, and facebook, also https://www.instagram.com/usinterior/?hl=en

https://www.flickr.com/photos/usnationalarchives/sets/ (National Archives on flickr)

https://www.usgs.gov/products/multimedia-gallery/overview

https://www.loc.gov/free-to-use (Library of Congress)

https://www.flickr.com/photos/britishlibrary/albums (images from the British Library for all to use, remix, repurpose)

https://www.nypl.org/research/collections/digital-collections/public-domain (NY Public Library)

https://pixabay.com

https://unsplash.com/

https://library.noaa.gov/Collections (NOAA)

Last week, the National Park Service's History Collection officially released over 4,600 images from the NPS Wildlife Division photo archive. Dating ffrom the late 1920s to the early 1950s, these fantastic images can be accessed by all, free of charge, through the Park Service's public NPGallery. Images can be searched by species or subject, keyword,

Tips for Examining Visualizations with Others

Note these questions are designed to open conversation with multiple right answers possible.
(Collected by Rosebery and Warren at the Chèche Konnen Center at TERC)

With any visual you can ask:

Credit: Percy

a) What are you struck by? What do you notice or see?

b) Does this image or text connect with, resonate with, remind you of anything you've experienced before—something visual or written or some other type of experience?

c) Is there a story here? What mood or emotion, tone or attitude comes through?

d) What are you wondering about? What puzzles you about it? What questions does it raise for you?

e) Imagine you are in the image (as the infant bat, for example). Narrate your experience from that point of view. Does it bring up anything new for you in how you understand that world?

f) Although scientists tend to act as if science is always objective, every visualization presents just part of the story, reflecting conscious choices about what to show and what not to show. How might this image be a partial story?

Notes on Images

Note the purpose you foresee for at least 3 images you've selected and collected. Do you have a hook or illustration of a concept or a jumping off point for discussion? What can visitors do based on the visual experience you have to offer? Observe or predict or speculate? Make notes below.

Record a quick sketch or description

Record a quick sketch or description

Record a quick sketch or description

Check-In: Purposes for Images

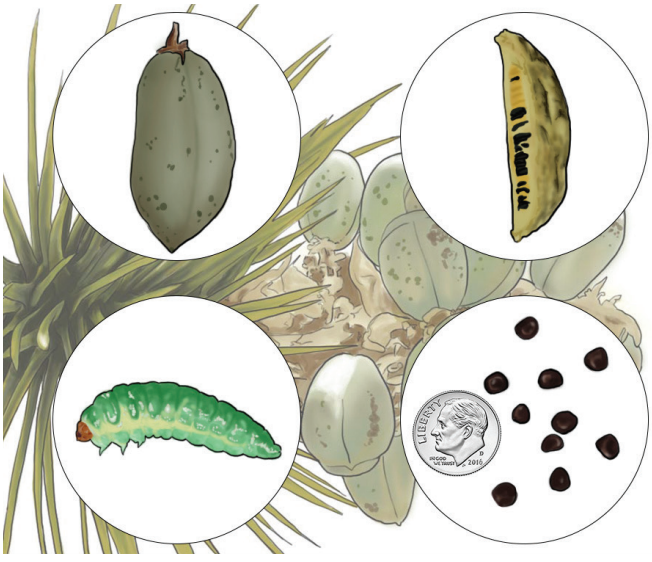
1) A visual library is a collection of ...

2) iSWOOP emphasizes using visualizations for the purposes of ...

3) Some principles for adapting or creating a visual are ...

4) What about this? Are these views and your views the same or different from iSWOOP's design principles?

- A visual library helps tell the story of how we know what we know with images of instruments and people using them.
- A scientist at work in the field can be a good addition to a visual library (unless the scientist is doing something you don't want visitors to do).
- To prepare a graph as a jumping off point for discussion, remove the title.
- Avoid illustrations that remind visitors of a science textbook.
- Go for scientific imagery that is also art.
- Use the resource unless your focus is too large, too small, out of season, or otherwise out of view.
- A provocative question is: "What do you imagine is outside this frame?"
- If visitors are the ones to observe and point, they will remember more.



Visitor Interaction: Prompting Conversations about Scientists' Studies

iSWOOP programs should have many chances for visitors to examine visual data closely, to form their own ideas, and to talk through those ideas with their companions.

Besides Tips for Looking at Visualizations with Others, we recommend thinking about what visitors can touch and do during any interaction (formal or informal). Artifacts, models, a chance to make their own, a hand lens, an invitation to act out the action, all contribute to memorable STEM learning.

Beyond that, iSWOOP encourages thoughtful use of questions. All questions aren't equal. Pay attention to the types of questions you pose. How do you use the responses to move the narrative or to go deeper? You might want to keep track of questions that you'd like to try and which questions work for you.

Types of questions

Closed questions invite a short focused answer. They can keep an audience engaged, but questions with a right or wrong answer can have a chilling effect. Someone who worries about looking stupid might not answer or might disengage if their first answer isn't right.

Rhetorical questions don't require an answer, and are sometimes humorous.

> **Example:** Who wants to eat insects for dinner?
>
> Professionals from priests to camp counselors use rhetorical questions to keep their audience with them. Even when an answer isn't expected or required, our brains are programmed to think through a response, thus keeping us more engaged with the speaker.

Leading questions set a direction. They can establish common ground.

> **Example:** What traces do trees leave of their existence?
>
> **Example:** What problems do scientists run into when they start counting bats?

Open questions invite a longer response with more potential for creativity and information to be shared in the answer. They tend to require deeper thought, analysis, and/or sharing of an opinion.

Specific types of open (process) questions

Affective questions elicit expressions of attitude, values, or feelings

Example: What are your thoughts about removing invasive grasses]?

Often these questions may start with or contain phrases such as:

- How do you feel about _____ ?
- How important is _____ to you?

Divergent questions allow visitors to explore different avenues. Divergent questions often require people to analyze, synthesize and then project or predict different outcomes. A divergent question can serve as an overarching question that frames an experience.

Example: Since we have seen plant communities change in the past 100 years, what else might we expect? What else do you wish we knew?

Divergent questions can lead to a variety of answers or scenarios, so...

- Correctness may be contextual, arrived at through logic, conjecture, intuition, or imagination. A wide range of answers could be considered correct.
- Frequently the intention is to stimulate imaginative thought in a playful space

Evaluative questions – usually require emotional judgment and time to form an answer.

Example: What are the similarities and differences between this and that?

Example: How would you apply what you've heard to changing the way people see xyz?

More details/explanation about evaluative questions:

- In attempting to answer evaluative questions, people may be combining multiple logical and/or affective thinking process, or comparative frameworks.
- Often an answer is analyzed at multiple levels and from different perspectives before the respondent arrives at newly synthesized information or conclusions.

Techniques for Inviting Active Participation

There are so many options for welcoming participants' voices. These are a few we know are compatible with park-based science.

Science is about questions, about investigating the next question.

Research is constant revision and refinement. Over time the story is going to change.

One key component of science literacy is "how we know what we know."

Science is for "We the People" to use.

Makes Sense to Me

Post four statements. Ask participants to stand next to the one that resonates for them. Ask participants to volunteer their opinions and experience that led them to choose that particular statement. Then ask for volunteers to share with the group.

Word Whip

Let participants know you'd like to hear one word (or phrase) that represents their feeling [at the moment, going forward, about some part of the experience you just led]. They can pass if they want. If they start speaking sentences and paragraphs, you will cut them off. Acknowledge this is a limited an imperfect representation, but one that can be a start of a new conversation. Let participants know of any other rules. For example, they can't repeat an already used word. Choose a volunteer to start. Listen closely. Summarize the range of words you heard. Thank everyone for their contribution.

For more resources and ideas, see: http://idp.eppley.org/Interp-Toolkit

Take a Stand
(also called Vote with Your Feet)

The purpose of this exercise is to craft statements that elicit opinions. Draft a statement which lends itself to multiple perspectives and no wrong answers. Test out questions with peers or family ahead of time.

1) Tell the participants that you will read a statement and ask them to take a stand along the continuum at a point that best matches their opinion. On social media, you might ask for a rating 1-10, with 1 being strongly disagree and 10 being strongly agree. . For example:

Bats are more like birds than they are like humans.

Set appropriate ground rules. In person, before asking for volunteers to speak about their positions, remind everyone of the following:

- We need to "share the air".
- As the facilitator, I might interrupt someone to allow for multiple perspectives. It's not a reflection on the value of your opinion.

2) After everyone has taken a position, explain that you will ask volunteers for the reasons they chose their positions. In a face-to-face workshop, if participants hear something that affects their opinion, they may move to a new spot.

3) Begin by calling on someone within the largest cluster. Move on to other points on the spectrum. Ask if anyone who took roughly the same position has additional thoughts to add. Traditionally, the facilitator does not express his or her own view. With the addition of new information, the facilitator can ask if that leads anyone to change position.

Adopt questions like these depending on the venue:

How did you choose your position?

Do most people you know agree with you?

Describe a time when you felt differently.

Who saw it a different way?

Make a Plan to Feature Park-Based Research

What aspect(s) of the scientist's research will you focus on?

What's the hook? What's the revelation or conclusion?

What puzzle or mystery will keep the audience interested?

What additional research might you need to do?

What images will you use? Are there others you would you like?

What prompts will you use to invite the audience to observe, predict, speculate, and interact? At what point?

What prompts will you use to invite participants to discuss relevance? At what point?

Is there a natural place to pose one or more of these prompts?

Did you pick up something new?

Did you pick up on new ways to think about the park?

What was your favorite part or What was most interesting?

Complete the statement: *Research in parks matters to me because…*

Techniques and Tips for Using a Tablet-based Visual Library

These ideas are a compilation based on comments from iSWOOP interpreters in 2014.

Beforehand

- Check the battery.
- Make a mini-presentation so you have handy the images or videos you know you want to show in the sequence that makes sense to you.
- Practice starting and pausing videos. Imagine holding the iPad to show others the screen.
- Plan different ways you can mention and give credit to participating researchers.
- Read up. At Carlsbad Caverns, several interpreters had to field questions about bat houses. Questions about rain barrels or invasives may come up. Be ready to involve others in the audience in brainstorming.
- Plan questions to get the visitors involved in thinking like: Why might scientists pick a bog or lake to core instead of this field? In places where you've lived have you experienced major landscape changes? What were some of the causes or factors? Vary your questions, posing some to consider and some to answer. Choose those that invite a personal truth rather than forensic truth (with a right or wrong answer). For example: What do you see as some advantages or disadvantages of a cooler climate (personal) vs. how high were sea levels a thousand years ago (forensic)?
- Plan some questions to find out whether the visitor has knowledge of geology or paleontology as a hobby or has worked with cores. Use their expertise and prior knowledge to add to your repertoire. Listen for a story you can share with others.

Locations for an iSWOOP Conversation

- Approach people in areas where the light works in your favor.
- Approach people waiting around, e.g., for a tour, program, or transportation.
- Start conversations where there is a space to talk; keep the main path clear.
- Avoid upstaging the landscape. Rather than asking, "Want to see something cool?" assume they already are. Ask instead: "Want to see the park from a different perspective?" or "Want to see how researchers are looking at the landscape?"

Initiating the Conversation

- **Make a connection, then use visualizations in response to visitors' questions.**

  One interpreter said: I will say hello and ask them how they are doing and if they are enjoying their day… This invites them to talk to me. I will then ask them if they have any questions. … If they have questions, I will use the iPad.

- **Start with a question about visitors' personal experience or a hypothetical experience.**

  Ask things like *Have you ever dug into the bottom of a lake?* or *What would you say if I offered you a handful of mud from 11,000 years ago?*

- **Start with an offer to show some images.**

  Anyone interested in what plant-eating critters might have found for dinner here 10,000 years ago? If you have a few minutes I can show you...

Sustaining or Expanding the Conversation

- **Use open-ended questions to keep conversation going.**

  After showing a visual or telling a vignette, ask people what they noticed or how it felt to see the landscape from this other perspective instead of their own eyes.Asking why they think things are happening tends to generate questions.

  Ask, *So what?*, *Why do you think it's important? Who else in your life might be interested in this? Would you like to take a picture of anything to remember this?*

- **Build science literacy, and increase STEM learning**

  Explain the process of collecting and analyzing core samples.

- **Work in references to the researchers.**

  Acknowledge the source of the visual library. For example, you might say:

  I have some videos I can show you. A researcher named Jacquelyn Gill has shared what she is investigating so we can answer some questions, not all of them. iSWOOP is a project funded by the National Science Foundation to make sure that they public knows about the cool science going on in national parks.

- **Be mindful of visitors' attention spans.**

  Leaving visitors curious with an ongoing interest is more important than telling them everything you know. Make connections to resources they might enjoy online. Recommend programs or other opportunities at the park.

After the Fact

Make a list. Keep track of visitors' questions. Share them with other iSWOOP project participants and tell us how you answered them. Share the questions that you couldn't answer as well, so we can brainstorm together.

For More on These Topics

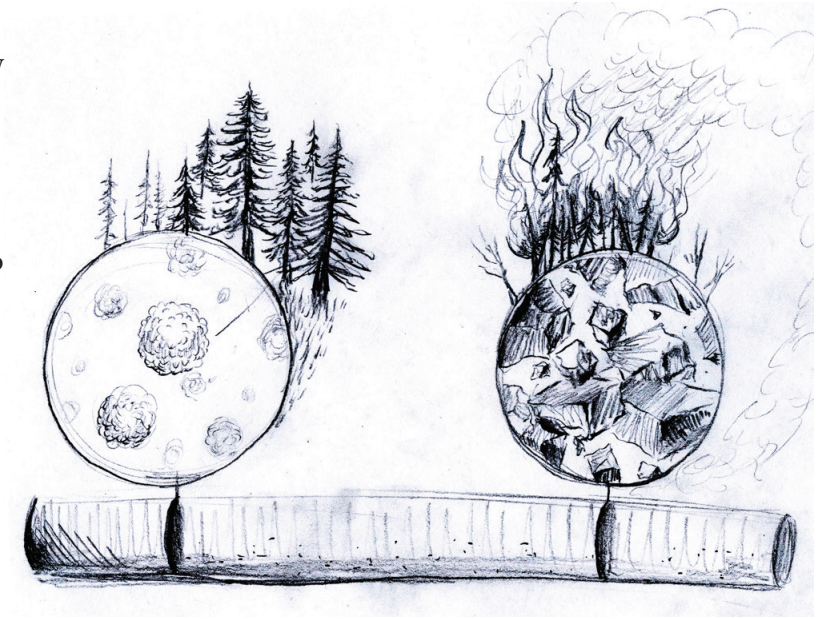
STEM Learning

Firestein, S. 2012. *Ignorance: How it drives science.* New York, NY: Oxford University Press.

Stories: Arouse and fulfill

Filmmaker and scientist Randy Olson reminds us to "arouse and fulfill". He has resources to offer:

- "And, But, Therefore" (ABT) approach to narrative, with a video about the ABT Dice: http://www.scienceneedsstory.com/2015/10/07/3-acquiring-narrative-intuition-painlessly-the-abt-dice/
- Narrative Index, including the difference between narrative and story: http://www.scienceneedsstory.com/blog/the-narrative-index/



Credit: Reading

Visitor Interaction

https://mylearning.nps.gov/wp-content/uploads/2020/01/Facilitated_Dialogue_Techniques-chart1.pdf

Visual Libraries for Interpretation

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Hristov, N. I., Strohecker, C., Allen, L.C., Merson, M. 2018. Designing for Broad Understanding. *Integrative and Comparative Biology 58* (1); 113-126.

Visual Literacy

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Hattwig, D. Bussert, K., Medaille, A., Burgess, J. 2012. Visual Literacy Standards in Higher Education: New Opportunities for Libraries and Student Learning. *Libraries and the Academy, 13*(1), pp. 61-89.

Jarman, R., B. McClune, E. Pyle & G. Braband (2012). The Critical Reading of the Images Associated with Science-Related News Reports: Establishing a knowledge, skills, and attitudes framework. *International Journal of Science Education, Part B: Communication and Public Engagement, 2*(2), 103-129, DOI: 10.1080/21548455.2011.559961