Welcome, Wilkommen, Bienvenido, Fáilte, Karibu, Selamat Datang, or as my folks used to say, Howdy, y’all
I’m honored to be allowed to speak with you. I come from the environmental systems research institute, just down the hill, where I’ve run their conservation support program for almost 30 years. Our institute helped to create GIS, or geographic information systems, back in the seventies and we are one of the sponsors of this great conference.

As part of our sponsorship I asked if I could give a presentation about building communities of practice within ecological informatics, but the only opening you had was in this session on art. Yikes! Well, we’re all ecologists, so we’re used to odd things being interconnected, like art, technology and conservation. In fact, these slides are from SCGIS, an international society I started long ago, who really do connect all those things together and more.

Also, since this is my first time telling this, I’ve laid it out like a 3-act play, with a pledge, the turn, and the prestige.

The Pledge is my promise to you: I’ll show you how Naturalists, using your skills, your passion and a few modern advances in geography, can lead the human race forward to great victory in the protection of planet earth. More simply, I’ll show you how GIS is awesome, it makes cool stuff and does useful work, even outdoors, even for naturalists.

In the Turn, I’ll look back on the intertwined history of conservation, art and technology.

I’ll end with the Prestige, where I’ll show you how the promise can be met.
Back to the pledge. Seriously, I do believe that naturalists are among the most important people on the planet right now, because Natural History is the human practice best able to support life against a changing environment.

Much more than a profession, it is the oldest and most fundamental of all human survival arts: the art of careful observation, reflection and collection.

It’s also an act of stewardship and love, a fundamental practice of reverence that gave humanity a sense of belonging on this planet and belonging to one another.

The conscious practice of careful observation of nature places weight and value upon millions of years of natural selection, that rewarded those who were closely attuned to their changing environment, and removed those who weren’t.
But as important as you are, you suffered a severe blow after WWII when the postwar explosion in hard sciences and the space race meant that many natural history & geography degree programs started a decades-long decline, just as humans entered a new era of extinction and harm. I believe the 2 are deeply connected.
In spite of this long decline, a new renaissance in conservation began in the seventies during the environmental movement, as new programs in natural history began to appear around the west in National Parks and “alternative” universities like Prescott and UC Santa Cruz.

Dr. Ken Norris was one of the founders of the UC Reserves System and the modern field course. He also created a new Natural History Major at UC Santa Cruz in the early seventies, which I was lucky enough to complete.

Dr. Norris’ concept of a naturalist was someone rigorously trained to observe, study and understand like an ecologist, but to also teach, inspire and advocate like a conservationist, in an outdoor workplace, in the wild. I am proud of my degree in natural history and excited about this new statewide naturalists group.

It gives me new hope that the long decline is over, and I express that hope from what used to be a pretty odd point of view.
The reason I say I have a weird point of view is because I live in a schizophrenic conflict between a love of the wild outdoors and a love of technology & science fiction. It’s is a problem that has consumed me all my life. 

Like many naturalists I grew up in an outdoorsy family and spent my childhood backpacking across the Sierras. I was also a typical space-race, science geek, child of the sixties, sitting in dark rooms reading sci-fi & building ham radios, and making rockets and robots whose only notable effects were grass fires & terrified neighbors. Bear in mind that this was ten years before Star Wars made science fiction mainstream. In the sixties we were still nerds and misfits.

As an adult, though, about the only thing I was any good at was small computers, starting in the early seventies when they were just toys for hobbyists. I wasn’t a very good naturalist, and my fellow students thought my obsession with computers was highly suspect. I wanted to help them understand computers but I was also a terrible explainer. In fact the only award I ever got from those colleagues was when I was voted “Most likely to save the planet using dump trucks”, a reference to an awful analogy I’d tried once in explaining computer data structures to them.

Even so, as computers gained dominance I watched in horror as my own mental disorder became a social phenomenon, making it harder and harder to get people outside to experience nature firsthand. How can you reach people whose attention is constantly focused on an unending variety of little computer screens? I can’t even call my teenage daughters on their cell phones anymore, I have to send them a text or a twitter instead!
Maps were what saved me. In the case of the backcountry & the jungle, quite literally. But even though computer advances forced me into late-night green-lit rooms to create them, the fundamental user experience of a map is still an outdoor one.

More than any other kind of information, maps are democratic, in the same way as the scientific method: they compel you to step outside and see for yourself if what the map is trying to tell you is true. That basic experience, I believe, is an important moment when change can begin, the fundamental changes we need as a society if conservation is to succeed.

My core belief today is that GIS allows conservationists to create new kinds of maps and images, and thereby achieve new understandings and new strategies, telling new stories with a reach and a power unlike anything they’ve done before.

Now, Let’s turn back to look at a few of the great images that have changed human behavior & conservation in the past
Back when Natural History was a dominant force but conservation was just beginning, Moran's paintings and Jackson’s photographs were instrumental in the creation of Yellowstone National Park in 1872.
In current times, even as Natural History declined, the skills of the naturalist remain important to great nature photographers.

Ansel Adams would often spend a week observing a landscape and the patterns of light and dark within it before taking a single photograph. Have you ever seen someone with an iPhone studying the landscape for days or hours before taking a photo? I mean, really!

Frans Lanting would wait for days in cold water waiting for the perfect confluence of animal behavior and light.

When I hung out with the National Geographic in Botswana, I learned an important lesson, you never go where animals are, you go to where they are going to be. This requires the skill of the naturalist as much as the photographer.

This connection was so strong that many great photographers also became passionate leaders in conservation, such as Ansel Adams’ long history leading the Sierra Club, and Galen Rowell’s lifetime of work with wildlife and mountain conservation groups.
William Smith’s meticulous 1815 geological map of England is credited with helping start the field of Geology, as described in the new book “The Map that Changed the World”.

So what was it, specifically, about these maps and images that permitted them to change humanity and alter it’s future? Is there something intrinsic in the visual experience that just grabs your soul and won’t let go? Or is the impact deeper, drawing upon something else about that image, such as knowing that you are seeing beneath the surface of your home’s landscape in a way that was never possible before. Does the story, or the science underneath the image, also matter?

For my next example, Let’s look at what Galen Rowell has called the “most influential environmental photograph ever taken”
“Earthrise” from 1968 is often credited with inspiring the environmental movement.

Technically speaking it isn’t great, the Apollo spacecraft had just been turned around and astronaut Bill Anders was scrambling to get a quick photo. But this was a key moment in America’s great effort, “to put a man on the moon and bring him safely back to earth”.

Just look at all the dangers and firsts!

What makes this image so memorable is the knowledge that 3 humans on the farthest and most dangerous journey ever, looked back in time to see the first view of earth rising above another world.

So many people, myself included, thereby understood with visceral impact how small, rare and alone our precious green and blue home was. This image still haunts me with as much power as when I first saw it in 1968.
The idea that it’s the combination of images and stories that creates impact isn’t rocket science, no pun intended, it’s why National Geographic remains one of the oldest and most revered publications in America.

Great Images change society when they do one of 4 things:

1- They show something **new and unknown**, like Moran did for Yellowstone

2- They show something **familiar in a new way**, like Earthrise. Or new map projections that try to show the **sizes** of northern & southern hemishpere nations **more fairly compared to each other**. You’re all trained observers, right? So how many noticed that this map projection is also South-to-North as well?

3- They show **new science** or new information, like Smith’s geological map.

4- Finally, they show something **complicated in a simple way**

This was one of the **first public service** announcements about climate change, released in 2008, right after Al Gore’s book. **Global warming was hotly controversial** then, with powerful opposition and denial taking advantage of the complexity of climate science. **Environmental Defense Fund needed a way to show the pending risk**, and came up with this short public service ad of man walking in front of an oncoming freight train. The man is saying that even if climate change is real it’s effects won’t appear for at least 35 years, so why does he need to worry about it?
He then walks off to one side, revealing a small child now standing still, directly in the path of the onrushing train. **As the father of 2** incredible daughters I still struggle to hold back the tears whenever I see this image.
That's the power of a great environmental photo or map, that combination of knowing what's going on and seeing it in an image so viscerally you are never the same person again. Doing this well requires a deeper view of how people work and learn,

**FIRST:** You have to be able to get the science & the story right, know the data, how to picture it, how to analyze it, and know the right questions to ask & the right statements to make. You have to ring true to your viewer, or better yet motivate them to go out and prove it for themselves.

**NEXT:** You have to know where you are going with your map, what’s the plan of action? It’s not about what you want to say, it’s about what you need for others to hear so they can understand & experience that “eureka” moment. That takes a good knowledge of human nature and good skills in Teaching & explaining science to others.
Getting the science right has been a tall order for natural history. For centuries, it’s been a descriptive science, capturing ever more detailed narratives of what naturalists observe & specimens they find, in growing collections requiring ever more time and labor to manage. This is similar to Physics in the classical era, when they found they couldn’t describe planet motions accurately enough to predict where they would be. In 1687 Newton’s invention of the Calculus revolutionized the field by providing a precise mathematical language and methods that solved the problem.

Naturalists aren’t so lucky, we’re faced with the problem that nature is infinite in it’s variety and relationships. Statistics, a mathematics specific to the problem of measuring & describing systems of infinite variety, helped in the early 1900’s. So did the theory of Natural Selection, but we still lacked a unifying analytical framework able to bring simplicity and prediction to that growing chaos of biological measurements & statistics. We still didn’t have our Calculus.

About a decade before, though, the seeds of that revolution had already been planted, which brings me to my third act, the Prestige. I’ll show you why I believe that GIS is the Calculus of Natural History and Landscape Ecology, and that by learning about it and beginning to make use of it’s resources and data, Naturalists can achieve the combination of vision and skill needed to be leaders in the earth’s environmental movement, or as it should be called, the “Natural History Movement”? 
In the early sixties, a young English geographer and former RAF pilot, Roger Tomlinson, was given the problem of trying to predict the best location for a forest plantation in Kenya. He conceived of manually overlaying many different kinds of landscape data such as topography, geology, water and climate, in order to calculate place-based analyses across many different overlay combinations.

He then figured out how to use a computer to do the same thing more quickly and precisely and went on to create the Canada Geographic Information System, the first GIS in the world. Tomlinson’s ideas helped inspire Jack and Laura Dangermond to start a new nonprofit geographic research institute in Redlands in 1969. After a decade working with planners, managers and governments they finally released the first commercially available GIS software in the early 1980’s.

Since then, Esri and GIS have grown and thrived through the 5 great tectonic shifts in the computer revolution: the mainframe, personal computers, database systems, the internet & mobile devices.

GIS today is so much a part of how hundreds of thousands of scientists and professionals work that we don’t even call it software anymore. GIS for us is a universal ecosystem of thousands of interrelated and interacting tools and apps.

GIS also now includes a set of apps and templates called “Storymaps” for telling conservation stories to the public. Storymaps were created by some of world’s top minds in journalism and cartography, including no less than the chief cartographer of the National Geographic Society.

These kinds of resources and many more are why we now think of GIS more in terms of how humanity thinks about the earth and how to best support them to make smart decisions about our future.
This is our vision for how a geographic sensibility combined with strong information facilitates a more rational way of thinking about and existing on our planet. We believe most human activity in the world can be thought of as 6 connected steps,

- visualizing the problem,
- collaborative study and understanding,
- planning, designing and teaching appropriate solutions.

We think this is a way forward to a more rational and thoughtful world and we have created wide-ranging and widely-available resources to support and assist this process, with Storymaps helping at every stage.

**OMAPDA:** Observe, Map, Analyze, Plan, Decide, Act
Doing this right requires lots and lots of quality data, based on careful observation, rigorous scientific standards, and diligent management.

The Living Atlas is a major backbone of current mapmaking and GIS work. It includes some of the highest resolution imagery available for the entire planet.

There are thousands of these maps, millions of subscribers, making 10 billion maps a month, and sharing them over our open data platform to the tune of 15 million free downloads so far.
A new project related to the living atlas effort is to try to create the nations first multi-scale, richly-attributed, high-resolution map of our ecological communities. It is based on a relatively new ecological standard called the “International Vegetation Classification System”. It combines national maps of ecological systems from many agencies, with precise state level mapping being done in California by CNPS, Cal Fish & Wildlife & The National Park Service.
Another part of GIS is Apps. Apps for us are just like those you use on a smartphone, **hundreds of little packages of tools, data & best practices** specific to a single task, like field surveying, photo survey, citizen science events, or designing a park.

These Apps, decision workflows, collaboration tools and dozens of other work environments live and grow in this geographic information ecosystem, so much so that we refer to it as a **platform, a place to work on, think about and find solutions** for society's and earth’s problems.

Every app we put out is simple doorway onto this platform. So are all of our free online training courses. My job at esri is to make all those doorways free of charge for folks in the nonprofit and conservation communities.

What has all this meant? Like Natural History, Geography was also in a long postwar decline. GIS helped to connect Geography to the computer revolution and sparked a new & fast growing discipline of “Geographic Information Sciences”.

Can Natural History benefit from what helped Geography revitalize? We’ve seen how GIS is a landscape-based analytical & collaboration platform for many tasks. If it was combined with the disciplined field observational skills and passionate advocacy of the naturalist could it spark a new discipline called “Natural History Information Science?”
I think such a Science would encompass 3 fundamental patterns in how humans work with conservation and it’s information, including how observations are made, how data is managed, and how decisions, planning and action are carried out: Those patterns are Species, Land and People.

Work that is species-based is probably the most familiar, Life history studies, Taxonomy, Populations. Birdwatchers & Botanists are species-based, so are most Natural History Museums. Conservation focusses on the survival needs for each taxa.

Work that is land-based looks at landscapes and their origins, changes & management. Species are involved but only from an ecological point of view. Reserve design, Marine, Aquatic and Terrestrial Ecology, Conservation Planning, Parks management and Vegetation mapping are all examples of Land-based work.
Work that is people-based includes everything I might need to do with human beings – citizens & students, societies & institutions. This is an important distinction because all landscapes are human-modified in some way, so this Science needs to include the role and effects of humans. The Human pattern also includes the all-important task of collaborating with indigenous communities, whose traditions model sustainable landscape relationships in ways all conservationists need to understand.

The Human pattern also provides the context & methods for work in the critical planning, education & advocacy fields needed to achieve conservation goals. Citizen Science as a social effort is a good example of this, so are best practices in collaborative conservation planning, such as the “Greenprint” process used by the Trust for Public Land. Greenprint draws on the best practices in motivational theory to appeal to the positive human aspirations for community and independence, by putting local people in charge of the planning process right at the very beginning. Such plans have been far more persistent and successful than in the past. It also shows you no conservation plan can succeed on science or technology alone, you also have to have thoughtful citizens who have the good sense to know when to put the tools down and just talk, teach, make friends and build communities.

As the cultural anthropologist Margaret Mead said “Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it’s the only thing that ever has.” For me, that community of citizens, who give me the greatest hope for the future, is naturalists.

That’s why the final part of my story is about what happened in 1989 when I tried to build a new society devoted to supporting naturalists with GIS.
The Society for Conservation GIS is now an international organization of several hundred ecologists, indigenous people and activists who have been gathering annually for the past 20 years, sharing ideas and support, teaching and mentoring, and creating chapters all over the world. We even have our own artistic style for depicting our connection to humanity’s wild roots. After several joint conferences, we’ve gotten something of a reputation for being more passionate & more inclusive than many of our colleague organizations.

I was lucky enough to know Dr Michael Soule when I was first building SCGIS, and I got him out to be one of our first plenary speakers. He advised me to never let the bureaucracy get ahead of the passion and the belief, and always put the spirit of the organization in the center of everything you do & every decision you make.

I hope I’ve been able to communicate some of that spirit to you today, and express my own hope in the importance and power of what we might do together.
Thank you

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Useful URLs:
SCGIS: www.scgis.org
esri conservation program: www.conservationgis.org (PDF of this talk is on the main page)
esri nonprofit program: www.esri.com/nonprofit
Norris Center for Natural History: norriscenter.ucsc.edu/
Intro to ArcGIS online: https://learn.arcgis.com/en/projects/get-started-with-arcgis-online/
International Association for Landscape Ecology: http://www.landscape-ecology.org/
National Ecological Basemap Project, example webmap: http://arcg.is/2bPKx5s
Santa Monica iNaturalist Citizen Science Study: http://arcg.is/2bPJae9
Scgis Linkedin Page: https://www.linkedin.com/groups/60013/profile
“GIS for Conservationists” blog on Geonet: https://geonet.esri.com/groups/conservationtech/blog/2016/05/17/gis-for-conservationists
Scgis Free Listserver https://www.scgis.org/content/discussions/listserv-faq
Q & A / Useful URLs:

SCGIS:  www.scgis.org
esri conservation program: www.conservationgis.org  (PDF of this talk is at center of main page)
esri nonprofit program: www.esri.com/nonprofit
Norris Center for Natural History: Norriscenter.ucsc.edu/
Intro to ArcGIS online: https://learn.arcgis.com/en/projects/get-started-with-arcgis-online/
International Association for Landscape Ecology: http://www.landscape-ecology.org/
National Ecological Basemap Project, example webmap: http://arcg.is/2bPKx5s
ESA talk on national ecological basemap:
Santa Monica iNaturalist Citizen Science Study: http://arcg.is/2bPJae9
Scgis Conference Proceedings & Scholar Profiles: http://www.conservationgis.org/scgis
then pick 2016, 2015 or 2014
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