Connecting Communities and Nature through Science

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Speaking about science to an Audubon audience is an honor for many reasons. It is an honor because Audubon is one of the most influential conservation organizations in the country. It is an honor because Audubon is known for its science, especially its citizen science. It is an honor, most of all, because Audubon is deservedly respected for its science. Among advocacy groups this is a rare accolade and you should be proud of the scientific work you do and proud of the scientific work that you support.

It is also a pleasure to be in Florida. Pinellas County Commissioner Barbara Sheen Todd, a member of the NCSE Board of Directors, urges me to visit more often and I am delighted to comply.

My thesis tonight is that science can do more than help us understand the connections between communities and nature. Science, at its best, can help communities have the kinds of connections with nature that they desire when at their best.

First, a warning. When I was a graduate student at the University of Southern California, there was a warning from H.L. Menkin hung prominently in the lab where I worked. It read: “For every complex problem, there is a solution that is simple, neat, and wrong.” I do not intend to offer any simple, quick, or easy solutions tonight. Still, I hope that you will find my remarks helpful.

‘Connecting Communities and Nature’ is a wonderful phrase – it is a pity that it is actually needed. Surely human communities are always connected with nature. Hold your breath a little, go without water for a few hours, and you will get a quick reminder. Yet many feel - many believe themselves to be - separate and disconnected from nature. Perhaps it is because of how we live. Perhaps it is why some view the environment as a ‘special interest.’ The environment makes ‘life, liberty and the pursuit of happiness’ possible – that is no ‘special interest.’

So, let me begin with this declaration. Communities <u>are</u> connected with Nature. They always have been. They always will be. It is a marriage for better or for worse. Divorce is not an option. And, whether it is a marriage for better or a marriage for worse is up to us. If we seek better relations between human communities with nature, science can help.

Science is not truth with a capital T - it is a quest for truth without the presumption of achieving it. When people bandy about the word truth, I am always reminded of the prayer attributed to Sir Thomas More: “Lord help me find the truth and protect me from those who have found it.”

The great nineteen century biologist Thomas Huxley observed that “Science is simply common sense at its best. That is, rigidly accurate in observation, and merciless to fallacy in logic.” That is as good a definition as I know.

Science is not a silver bullet – not a be all and end all – and, most certainly, not a substitute for human values. Einstein once observed that “science can only ascertain what is, but not what should be, and outside of its domain value judgments of all kind remain necessary.”

Science cannot say why we should value and protect:

- Sandhill Cranes, or
- Florida Scrub Jays, or
- West Indian Manatees, or
- Leatherback Turtles, or
- Humpback Whales, or
- American Crocodiles, or
- Florida Panthers, or
- Grey Bats, or even
- the majestic Everglades.

Ultimately, the cranes, jays, bats, panthers, and the even the Everglades are worth preserving because of what you believe in your hearts and souls. They are worth preserving because they are worth preserving.

Science is not a substitute for values and values are not fundamentally rooted in science.

I think Einstein's phrase is incomplete. Science can do more than merely "ascertain what is." Science can also help us to achieve "what should be."

I suspect that achieving "what should be" might be an accurate description of the motivation of the many fine scientists who work for Audubon.

Let me illustrate the difference between the "what should be" or values part of this and the part that science can address with an example.

Ten years ago, at the Earth Summit in Rio de Janeiro, sustainable forestry was adopted as a goal for the nations of the world. That, in Einstein's phrase, is a "what should be."

In 1994, many northern hemisphere nations joined the Montreal Process on Temperate and Boreal Forests. They defined nine criteria for sustainable forests. Eight criteria are things that we desire to sustain in forests, like biological diversity, ecosystem health, and socio-economic benefits. The ninth criterion defines what society should have in place to make sustainable forestry happen: a legal, institutional and economic framework for achieving sustainable forests. Thus the criteria are simply a more detailed statement of "what should be" and not really scientific.

Underneath the nine criteria are 67 indicators -- measures of different aspects of the criteria. For example, the biodiversity criterion has indicators such as the area of a particular type of forest, the number of forest dependent species, and so forth. It is here that science comes in.

Criteria and indicators of sustainable forestry have been embraced in various certification systems. A method, if you will, of telling consumers whether a decision that they are about to make – like buying wood – does or does not conflict with society's desire for sustainable forests.

Home Depot and Ikea, the two largest buyers of wood products in the world, and several other large consumers, have indicated that they would like all their suppliers to be certified. This decision by large corporations has given a huge boost to the effort to achieve sustainable forests. It has moved it from a purely values-based decision by forest managers to an economic necessity.

But do the certification systems make scientific sense? Do the indicators really measure the key aspects of sustainablity in forestry ecosystems? If they do not, they are destined to fail.

Two years ago, the National Council for Science and the Environment was approached by a group of foundations who were concerned about that very question. Was this a case of *The Emperor's New Clothes* where an embarrassing absence of science would shame the entire certification effort? The challenge is this: if there are scientific weaknesses today, how can they be rectified as quickly as possible?

Science can tell us many things about forests, like:

- how forests function,
- how different logging practices impact forestry ecosystems, or
- how indicators of ecosystem function can tell whether forestry practices are sustainable.

Science can also help us understand how our desires for forest products and services can be reconciled with our desire to sustain biodiversity and the other important aspects of our forests.

This distinction between science "ascertaining what is" and science helping us achieve "what should be" on the one hand, and, on the other hand, the values of deciding "what should be" is at the heart of the National Council for Science and the Environment. Our vision is of a society where citizens and environmental decision-makers receive accurate, understandable, and integrated science-based information. We seek a society where people understand the risks, uncertainties, and potential consequences of environmental decisions – including the avoidance of action.

But we do not seek to say "what should be." The purpose for standing back from the decision about "what should be" is to allow those who differ strongly to find in science common ground and solutions that all can live with. Science can be a vehicle for partnerships. And, as has been noted in the conference, partnerships are key to solving really big problems. Advancing this role for science is our niche.

But let me be clear that there is great need for leadership in deciding "what should be." It is often said that leadership must come from the top and we must look to Washington or, for many Floridians, to Tallahassee. I disagree. There is the joke that a politician is someone who looks for a crowd marching down the street and then rushes out to walk at their head. There is much truth in that.

This nation, we are taught, is governed 'by the people, for the people.' After ten years in Washington, time spent inside and outside of the corridors of power, I still believe this is true. Although it is easy to be cynical and disillusioned by the flaws, the failings, and the failures, I would remind you of an observation made by Winston Churchill. He noted that "democracy is the worst form of government except all those other forms that have been tried from time to time."

And so, we the people must lead. Leadership on "what should be" falls to the people -- it falls to you. Washington looks to you. Tallahassee looks to you. Our children look to you. Generations yet unborn may never know your names but they will be grateful for your efforts. So, lead.

Let me turn now to science and say a little about the kind of science I feel can most effectively illuminate the connections between communities and nature. Let me say a little about how science can bring together those who disagree at the outset to find solutions that they can agree on at the end.

We all know that the really difficult environmental decisions are the ones where the connections between human communities and nature come into conflict with our environmental desires and goals.

We also know that the most pressing decisions are the ones that are irreversible and deal with things like the loss of biodiversity or the irreparable alteration of unique ecosystems like the Everglades.

How can science, at its best, help communities have the kinds of connections with nature that they desire when at their best?

The critical first step in science is to ask the right questions. If there is one common trait among scientists who make great discoveries and garner such plaudits as Nobel prizes and other awards, it is the ability to ask the right questions. With that ability, modest scientific talent accomplishes much. Without it, great scientific talent toils long with little result.

Scientists, left alone, will often ask questions and define research of no relevance to societal decisions, or lead to solutions that do not come in time to be helpful. Closing the barn door after the horse has bolted. A great solution to coral bleaching or to the water flow challenges of the Everglades in one hundred years will be too late.

As an aside, I will make two predictions about a century from now. First, the Everglades will still be facing challenges. Second, the Audubon Society will be still be confronting those challenges and fighting for the preservation of the Everglades.

Non-scientists left alone will often ask the questions that cannot be answered scientifically like asking science to say "what should be," or asking science to justify their values or to guarantee a specific policy outcome.

So, how to ask the right questions? Partnerships. By working together. Remember what I said about allowing those who differ strongly to find in science common ground and solutions that all can live with. Let me illustrate this point by returning to the sustainable forestry example.

When the National Council was asked to look at the science of sustainable forestry, we first focused on a part of the issue that we felt we could handle and have impact on - biodiversity on large managed forests in the United States. In order to define the questions that we should answer, we created a panel for the stakeholders: the National Commission on Science for Sustainable Forestry.

Half the Commission is composed of researchers with expertise in various aspects of forestry and biodiversity and, importantly, social sciences. The other half of the Commission is composed of decision-makers and decision-shapers – Defenders of Wildlife and International Paper Corporation, the U.S. Forest Service and the Chief Forester of the State of Oregon.

Working together they asked unique questions:

- How do we scientifically survey the lessons learned in the field by practicing, dirt-under-the-fingernails foresters?

- How do we assess impacts of non-timber forest products, like mushrooms, holly and ginseng, on biodiversity?

- How do we evaluate the requirements for systems that support science-based decision-making?

These are the sort of questions that arise from a very constructive interchange between researchers and policy makers and shapers.

These stakeholders were vested with real authority. They not only asked the questions, they set the agenda and they set the priorities.

The researchers ensure that the science is of the highest quality. The policy people ensure that the science is relevant.

This year we began to fund those activities with awards totaling $1.3 million for the first nine projects.

Bringing the stakeholders to the table in a constructive manner is not easy.

- It is hard.
- It is time consuming.
- It is prone to failure.
- It requires respect for those you strongly disagree with.
- It requires openness and honesty when you would rather hold your cards close to your chest.
- It requires compromise.

And when science is involved, it requires the rarest form of courage that I know of: the courage to admit when we are wrong and change our point of view. Do not underestimate how rare this form of courage is. Few inside or outside of the policy and scientific communities have it. The world would be a far better place if more of us had this rarest form of courage more often.

Traditionally, science has produced its best results by cutting narrowly but deeply into an unknown phenomenon within a scientific discipline. We focus on one aspect, one interaction, eliminating everything else. There are many good reasons for this purely reductionist, disciplinary approach to science. The most important one is that it works in many, many situations.

But traditional approaches are weak when confronted with complex environment problems – especially those that connect human communities with nature.

There is an old one-liner in physics: “first approximate the horse by a sphere,” i.e., simplify, simplify, simplify. Every freshman in physics learns that the ‘two-body problem’ is exactly solvable mathematically and the ‘three-body problem’ is not. The human world is a six billion body problem and Florida’s human communities are 16 million and growing – and they are very complicated bodies too – and that is before we connect them to nature.

When seeking to understand a complex environmental issue like the Everglades, the traditional approach is also to do lots and lots and lots of independent and separate studies. Agricultural studies separate from ecological studies, hydrological studies separate from species studies. It is rather like a host of people creating a pointillist painting. Then along comes somebody who looks at a group of points and begins to discern a larger picture. They notice new feedbacks and interrelationships and develop models.

Of course it rarely looks like a beautiful pointillist painting by Georges Seurat. More often, it appears like those pictures that you have seen in the mall that look like nothing until you unfocus your eyes and look deep below the surface until suddenly an image begins to form.

A scientific synthesis is often a mathematical model, which includes a lot of assumptions where scientific understanding is lacking. Places in that painting, if you will, where the points have not been painted. The reason for these gaps – and it is a real weakness with the traditional approach – is that the science gets funded in a shotgun manner. There is funding for many areas of agronomy but not many areas of ecology. There is lots of funding for studies of roads, dams, and canals but not much for demography and human behavior. So gaps occur. Interrelationships get missed.

Still, such traditional approaches can, if we are lucky, lead to solutions. And I am not going to suggest that purely reductionist and disciplinary science stop. It remains, and will always remain, in my opinion, absolutely essential.

But, I do suggest that science at its best can be far more effective in addressing environmental issues. Environmental research at its best is comprehensive and integrated and yields solutions. Science at its best gives society a bigger bang for its buck.

Environmental research at its best includes all scientific areas relevant to the questions defined by the stakeholders.

Environmental research at its best is designed from the outset like a jigsaw puzzle so that the pieces fit together –- ecology, hydrology, entomology, chemistry, biology, geography, toxicology, engineering, agronomy, ornithology, botany and -- and let me particularly emphasize this -- the social sciences including economics, anthropology, urban planning, demography and many other areas. One cannot hope to understand the connections between human communities and nature without social sciences. They are essential to helping society achieve "what should be."

But, it is not enough to merely bring these different sciences to bear separately on the issue. They must be integrated –- scientists coming together to share understanding and insights from different areas.

Environmental research at its best cuts across and connects the understanding and insights from different areas.

Environmental research at its best recognizes and addresses the gaps between areas of understanding.

Environmental research at its best recognizes that the best end results are solutions to real world problems and have environmental and social aspects to them.

Through such comprehensive and integrated efforts, environmental research at its best is more likely to provide solutions within the time that can be useful to society.

Back to those sustainable forestry projects. The Stakeholder Commission focused on outcomes and impacts and developed a prioritized set of projects that collectively will impact forestry management on the ground.

The projects that answer the questions that they raised are crosscutting and will be carried out by interdisciplinary teams. For example:

- The survey of practices will be carried out by eleven multidisciplinary scientists working in the field with foresters.

- The assessment of non-timber products and their impacts will be carried out by the Institute for Culture and Ecology in Oregon.

- A project connecting forest biodiversity to hydrologic and aquatic ecosystems – something that you will be discussing at length over the coming days – is being carried out by an innovating group known as Interdisciplinary Solutions for Environmental Sustainability.

The lead investigators of the projects funded by the Commission are also coming together so that they understand how the pieces fit together.

But there is more. There is genuine synergy in such integration. The aquatic research informs the indicators research; both are informed by the management practices research.

All current and future projects will be stewarded by the Commission, which will fuse the pieces together and reveal the big picture – the complete jig saw puzzle, if you will. The big picture will reveal solutions greater than those found in the parts.

This meeting itself is an interesting example too. You seek to be comprehensive, you seek to integrate, and you are going to see synergy. The synergies that occur serendipitously in the hallways and around the dinner tables will be particularly important.

Funders of environmental science must recognize this integrated approach and act appropriately by explicitly funding multidisciplinary and interdisciplinary efforts for sustained periods of time.

My rule of thumb is that it takes two years for scientists from different backgrounds to really understand each other and learn how to work together. But when they do great things happen.

Winston Churchill made a delightful observation about Great Britain and America being two nations divided by a common tongue. Scientists are very often divided by a common tongue.

The approach to science for the environment that I describe is catching a wave at this time. The phrase 'sustainability science' has been coined to describe it. Many prominent scientists from many fields are traveling the world expounding on the need for it, and many are listening.

Sustainability science is not simple, quick or easy, it is complicated, time consuming, and hard, very, very hard. Yet, if we are to find solutions that reconcile society's many goals, this kind of science is indispensable.

Some support for this kind of crosscutting research is occurring. The National Science Foundation launched its Biocomplexity Initiative three years ago and it is growing fast and being received well. $58 million will be given in Biocomplexity grants this year. It is still a drop in the bucket compared to what is needed, and less than 8% of funding for traditional approaches to environmental sciences at NSF, but the Biocomplexity Initiative is supporting very important work.

Let me note one illustrative Biocomplexity project that I think you will relate to.

University of Hawai`i researcher David Duffy, working with scientists from the U.S. Geological Survey, the Smithsonian and Princeton University, was awarded a five-year $4.1 million dollar grant to study malaria in Hawai`i's native birds.

Malaria has already contributed to the extinction of at least 10 species in Hawai`i and poses a threat to another 22.

Most research on avian malaria has been reductionist, breaking the problem into small parts, studying them intensely and then identifying the key links in the disease cycle. The traditional method has not been successful for human malaria, which remains a major health problem. Similarly, avian malaria resists reduction because of its apparent complexity. Duffy's team will analyze how a number of factors interact in the spreading of this destructive disease and integrate.

Duffy and colleagues are examining how the interplay of human activities, the biology of the mosquito, and the disease interact with the ecology and evolution of endemic birds that survived in Hawai`i before humans and their pests arrived.

This is the kind of crosscutting, holistic work that will lead to solutions, not just knowledge.

Efforts are underway at many federal agencies like NOAA, USGS, EPA, the Forest Service, and elsewhere to cut across traditional boundaries. They still have a long way to go.

Philanthropic enterprises like the David and Lucile Packard Foundation, Doris Duke Charitable Trusts, Surdna Foundation and National Forest Foundation are pitching in too and are funders of the Sustainable Forestry initiative that I have described as well as other efforts.

Environmental groups like Conservation International, WWF and yes, the wonderful Audubon Society are also playing their part.

Let us not forget why. Issues like the Everglades galvanize us and compel us to adopt such integrated efforts.

Yet, asking the right questions, followed by comprehensive and integrated research, is not enough. Just producing the right knowledge is not sufficient. Knowledge must be turned into tools and solutions and communicated.

The Sustainable Forestry Commission did not just fund research. The Commission also funded synthesis and assessment of scientific knowledge, tool development, and communication.

I think that the French man-of-letters Georges Bernanos got it right when he declared, “A thought which does not result in an action is nothing much, and an action which does not proceed from a thought is nothing at all.” Science which does not lead to decision does not serve society. A society that acts without consideration of science will ultimately fail to achieve its goals.

Communicating science-based information is not easy. Science always has limitations and uncertainties. Science is complicated and needs careful communication if non-scientists are to be able to understand it. Yet communication is crucial. I can only say again and again, communicate, communicate, communicate. And when you have finished, communicate some more.

There is much that we can do though our schools to build communities that are more scientifically and environmentally literate.

A new generation of programs that cut across boundaries is appearing. From Yale to the University of California there are innovative programs. Let me cite one of your own who I have come to respect highly: Richard Gragg and his Environmental Science Institute at Florida A&M University.

These efforts are training a new generation of scientists and scholars who will connect communities with nature in ways that we cannot conceive of today. Without abdicating any responsibility from our generation we must also commit ourselves to providing future generations with the skills and tools to do better than we can do.

To help this movement along, NCSE recently launched the Council of Environmental Deans and Directors to support the kinds of successful crosscutting environmental programs that will educate and train the next generation.

Informal education through zoos, museums and NGOs like Audubon are also essential in this area. I am delighted to see that non-advocacy environmental education is a high priority for Audubon of Florida. Theme parks like Disney’s Animal Kingdom, where we find ourselves tonight, can educate and communicate in ways that no one else can. Those of you who like me have small children will not underestimate this. I now agree with the observation made to me before my first child was born that all babies should come with shares of Disney stock.

I will take this opportunity to mention NCSE’s own National Library for the Environment at NCSEonline.org, which reaches two million people a year on a shoestring. So if there are any philanthropists here, see me afterwards.

Communication of science-based information also addresses the ‘Twain effect’ The Twain effect is rooted in the statement by Mark Twain that he was not worried by the things that we don’t know, but by “the things that we know that just ain’t so.”

Let me illustrate the Twain effect with one personal technology example that connects to Governor Bush's remarks at lunch on offshore oil exploration and the need to address energy efficiency. Most American believe that fuel-efficient, ultra-low emissions, electric hybrid vehicles are slow, small and expensive. You have to plug them in at night. They don’t accelerate well. They take years to save more in fuel costs than the extra that they cost. They are for rich, altruistic liberals. Well as the owner of a new electric hybrid, purchased for purely economic and selfish reasons, I can assure you that all of those myths about electric hybrids are untrue. They just ain’t so!

The approach to science for the environment that I am advocating here works. There are success stories.

The CFC and stratospheric ozone is a global success story. Sherry Rowland and Mario Molina, the two chemists who first recognized and understood the connection between CFC use in human communities and the protective ozone in the stratosphere spoke at an NCSE conference in late 2000. Their phenomenal lecture is on our web site. I am honored to say that Richard Benedick, the U.S. ambassador who was a principle architect of the successful Montreal Protocol to eliminate stratospheric ozone depleting chemicals is President of the NCSE Board.

Acid rain is another success, albeit with progress still to come. Acid rain has abated in the United States thanks to a combination of ecology, chemistry, engineering and environmental economics applied to emissions trading. Sulphur emissions are down significantly. Acid deposition is down modestly but continues to decline. The impact of acid rain, like many environmental wounds, is still with us and will take time to heal.

These are real science-based successes. The outcomes were not quick, simple, nor easy - not home runs when first at bat - but successes nevertheless.

And let us hope that one day soon, the Everglades of Florida will be added to the list of successes. If they are not, our descendants will not forgive us and history will judge us harshly.

Eight weeks ago, I, along with over twenty thousand others, was at the World Summit on Sustainable Development, which occurred in Johannesburg.

I was there to share the results of an NCSE conference on ‘Sustainable Communities: Science and Solutions.’ I only wish I had time to talk about that too – but time runs short.

The day before I left, I was bumped from my hotel near the main Summit and put into a bed and breakfast in the outskirts of the city. As a result I was exposed to many sights off the beaten track such as squatter camps that did not exist a few months before and would not likely exist a few months hence (though some do become permanent).

These squatter camps constituted several hundred to several thousand people living in long rows of shacks, maybe ten to fifteen feet square made of corrugated metal or plywood or other materials. The government had moved quickly to install a few very basic communal amenities -- water and toilets -- but very little else. Coming in and out of the camps were people carrying everything imaginable; there were no cars.

My hosts, gracious and good people, assured me that these camps were not the ‘real’ South Africa. Yet, they most assuredly were real and part of a very dynamic nation of 40 million people called South Africa.

Inside the Summit, science was acknowledged as an essential part of sustainable development. But, the question remains with me: what is the relevance of science, of environmental conservation, to the billions of humans living in extreme poverty? People for whom the surroundings in which we find ourselves tonight are at best dreams – and fanciful dreams at that.

Science is important to them and can reach down into their lives, into their communities, into their connections with nature in significant ways.

Let me illustrate with one example. Dengue fever is the most important mosquito-borne viral disease affecting humans; its global distribution is comparable to that of malaria. Globally, more than 2.5 billion people are at risk in over 100 countries. Each year there are tens of millions of cases of dengue fever with approximately 500,000 cases of dengue hemorrhagic fever – a fatal version of the disease.

No dengue vaccine is available. Recall that efforts to control mosquitoes have given us such well-known problems as wetlands loss and DDT.

Now let us to turn to the scientific study of copepods. Copepods are tiny aquatic crustaceans. They are found almost everywhere where water is available and they constitute the biggest source of protein in the oceans. The study of predatory freshwater copepods led to the discovery that they could be placed in water barrels and wells to feed on mosquito larva. It is a delicacy to the copepods. They don't need it, but they will go for it first. Copepods can be drunk and have no harmfully impact on humans. And, very importantly, there are no known negative ecological side effects.

Now, the story is rather more complicated than this, but copepods have be been successfully used to remove mosquito larva in human water supplies. Dengue fever has nearly disappeared in Laos and Vietnam. Human communities connected to nature without harming either.

Let me end now by looking to the future. There are great challenges ahead. We have accomplished much in the past thirty years. But let's not kid ourselves: greater challenges lie ahead. The science that you are discussing here cannot say what should be, but it can help us achieve what should be.

With your leadership, your dedication, science can connect communities with nature and bequeath to future generations as much as possible. They may not thank us, they may not even remember us – but no matter. Let us recall two pieces of advice from the British statesman Edmund Burke: "All that is necessary for evil to succeed is that good men do nothing;"
and, "Nobody made a greater mistake than he who did nothing because he could do only a little."

And so, I wish you success this weekend. And I wish you courage. Courage to stand up for what is right in the face of opposition and indifference. Courage to seek aid in science. And should science require you to change a cherished position now and then, I wish you that rarest form of courage.

Thank you very much for listening.