COASTAL INSTITUTE

COMMUNICATING SCIENCE

a primer with applications

Brandon J. C. Fuller

with a foreword by
Judith Swift

and thoughts from
Arnie Reisman
Sunshine Menezes
Nicole E. Rohr
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A publication of the Coastal Institute
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On the cover: Students investigate the rocky intertidal zone at Beavertail State Park in Rhode Island. **On the back:** Beavertail Lighthouse stands at the southernmost tip of Conanicut Island in Jamestown, RI.

About the Editor

Brandon J. C. Fuller is a coastal marine ecologist, writer, illustrator, and pianist. His research investigates human impacts on New England's intertidal invertebrates, and he is particularly interested in estuarine ecology that informs the development and revision of coastal management practices. He is an advocate for solutions to climate change and natural resource issues and for the communication of science to the general public. He holds a B.S. in marine biology and a M.E.S.M. in conservation biology from the University of Rhode Island.

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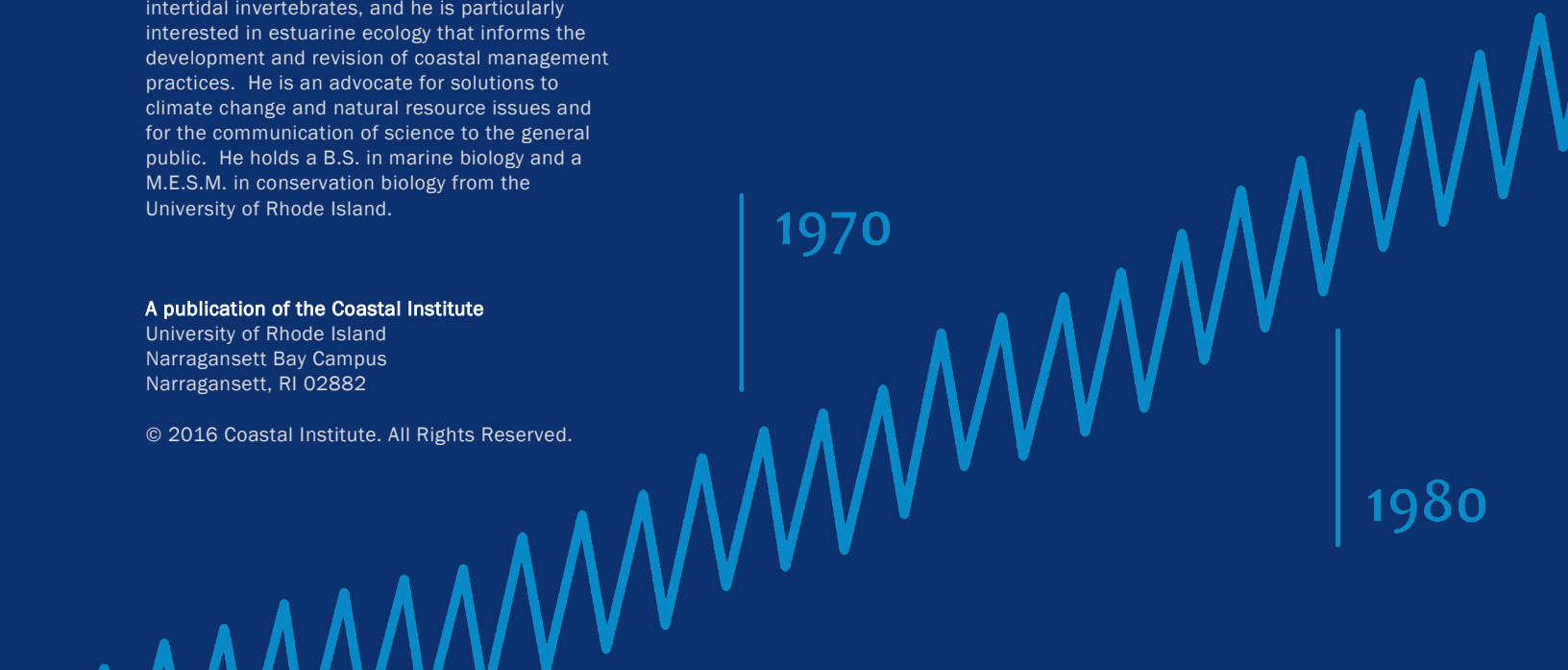


Foreword

BY JUDITH SWIFT

"We live in a society exquisitely dependent on science and technology, in which hardly anyone knows anything about science and technology."

— CARL SAGAN

LAMENTATIONS OVER THE failure of the general public to comprehend—let alone embrace—science are legion in the halls of academe, in science journals, and at conferences focused on all manner of science disciplines.

The public's failure to grasp science is largely viewed as a failure of our public school systems, particularly those in poverty pockets with inadequate resources; however, concerns grow about the ability of non-scientists of any social stripe to understand fundamentals as we experience exponential growth in the potential of computers, increasingly complex problems like climate change, and the burgeoning potential unlocked by the genome project. In truth, science literacy has never been owned by any single class. In the nineteenth century, Charles Babbage, who is credited with designing the first computer (aided by Ada Lovelace, the first computer programmer), complains that "scientific knowledge scarcely exists amongst the higher classes of society. The discussion in the Houses of Lords or of Commons, which arise on the occurrence of any subjects connected with science, sufficiently prove this fact . . . ." This observation is echoed two centuries later in op-eds bemoaning the inadequacies of many of our congressional leaders.

The despair over the scarcity of scientifically literate citizens is longstanding and unlikely to be resolved by yet another rigorous test or innovative pedagogy. But we do need to understand science. As Dr. Mae C. Jemison, an African-American physician and the first African-American woman in space notes:

"I've been very involved in science literacy because it's critically important in our world today. . . . As a public, we're asked to vote on issues, we're asked to accept explanations, we're asked to figure out what to do with our own health care, and you can't do that unless you have some level of science literacy. Science literacy isn't about figuring out how to solve equations like $E=mc^2$. Rather, it's about being able to read an article in the newspaper about the environment, about health care and figuring out how to vote on it. It's about being able to prepare nutritious meals. It's about being able to think your way through the day."

We need a public that understands the basic tenets of science enough to know when political factions are attempting to confuse them with bogus claims. Scare tactics work when the public is ignorant of basic scientific principles and the results can be alarming. The public must know enough not to be scammed by ads with actors posing as scientists denouncing peer-reviewed scientific consensus. Such gullibility will impact their future and that of generations to come.

Judith Swift serves as the director of the Coastal Institute at the University of Rhode Island. She has written/developed scripts for film and video which have aired on several PBS affiliates, and has constructed, authored, or co-authored over 40 productions based on historical events or science. She has directed Off- and Off-Off Broadway as well as tours for British theatre festivals and productions for New England-based companies. Through the Pew Charitable Trusts, she served as a consultant to numerous professional theatres on matters ranging from artistic development to management and strategic planning. She also regularly coaches political candidates, corporate officers, and civic officials regarding effective communication and presentation skills. Swift served as the vice provost for academic affairs at URI and has chaired several RI state commissions and committees. Her current teaching interests include sustainability and communication of science. She shares joint appointments as Professor of Communication Studies, Professor of Theatre, and Honors Program and Film Media Faculty.

The much-ballyhooed dangers of childhood vaccinations have halted advances in eradicating dangerous childhood diseases and endangered many more children as well as older populations. Special interest groups disavowing the consensus of 97% of climate scientists that climate change is a clear and present danger has potentially tragic consequences for our planet and all its inhabitants. The Pentagon is not a stronghold of liberalism, but has accepted scientific consensus on climate change. Military leaders are developing strategies to address anticipated mass migration from coastal areas as well as conflict over arable land and access to clean water. Regardless, many of our elected officials remain climate deniers by accepting arguments that climate scientists have refuted with solid evidence. Many of us are ill-prepared to evaluate these opposing views. How are we to bridge this gap?

Scientists often begin a discussion of their research by leading with any points of uncertainty. The purpose is twofold: 1) uncertainty is where new questions lie and often sets the direction of future research; and 2) scientists work in the world of peer review in which their colleagues rigorously attempt to replicate their findings in order to determine the legitimacy of the work. For those who see this uncertainty as the chink in the science armor and for those with a vested interest in discrediting findings, uncertainty is redefined as misguided and misleading information. Nothing could be further from the truth. The crux of the problem lies in the complexity of the scientist's message, which is steeped in the language and protocol of science—a language and methodology all too foreign to the general public. The result is too often a confused public—ripe for the charlatan's picking—and a frustrated scientist disheartened by the lack of science literacy.

This primer is intended as a guide for those who want to bridge that gap between the world of science and the public, which includes policymakers, regulating bodies, and travels straight up the leadership food chain to the highest levels of the executive, legislative and judicial branches of government. Better communication between scientists and the public will reveal, as Albert Einstein once observed, that "most people say that it is the intellect which makes a great scientist. They are wrong: it is character." We will grow to appreciate the legions of principled scientists working for our benefit if we hold up our end of the bargain and make an effort to listen. They, in turn, must make every effort to work with those skilled at translating science for public consumption. This primer is offered as a step in that direction.

Continue


SIDEWALK
CLOSED

Introduction

Facing: Repairs to the sea wall in Narragansett, RI, after the wall, sidewalk, and road were heavily damaged by Superstorm Sandy in October 2012.

SCIENCE HAS HIT a road block. For all the brilliant brains behind particle colliders and medical cures, fisheries declines and carbon fluctuations, remarkably few of them are attuned to delivering science in a meaningful way to those gazing up at—or, more recently, ignorantly away from—the ivory tower.

This all stems from a relatively simple problem: the very things that allow scientists to communicate so intricately between one another have made it nearly impossible for them to communicate otherwise. Scientists used to write extensive narratives, recounting their discoveries in beautiful language that rivaled a good novel. But as the need for more precise and discipline-specific terminology crept in, vivid prose gave way to highly technical manuscripts describing more and more things to fewer and fewer people, to the point where publications now convey enormous amounts of information to ever more exclusive circles.

Because of this disconnect, the public lacks a sincere interest in or understanding of how the natural world works. When it comes to the challenges facing our planet—natural resources, climate change, invasive species—this blindness is devastating. Part of the problem is the very nature of environmental studies. In museums and science centers, biology and the environment are often overshadowed by the physical sciences, which more readily lend themselves to hands-on activities which both teach and entertain. What kid doesn't like wave tanks, levitation, or driving a virtual rover on Mars? These setups engage children in topics such as fluid dynamics, electromagnetism, and robotics, whether they're aware of it or not. But it's more difficult to demonstrate biology in the same way, aside from dioramas, touch-tanks, or placing plastic organs into a manikin. Because biology and the environment involve living organisms—or their extinct relatives—visitors of most exhibits are left to merely read and observe.

Consequently, the public's understanding of the natural world consists of elementary concepts, like food webs and habitats, and whatever people have gathered from their own observations or outdoor activities. Despite being fundamental, the interconnectedness of the biological, physical, chemical, and geological aspects of the environment is more difficult to perceive, and so it is equally difficult for the public to imagine the consequences of human activity in one ecosystem on another.

On top of this, the environmental sciences often tangle with politics, the economy, and corporate activities. No one is up in arms about gravity, for example, because denial is not financially advantageous. But the accumulation of atmospheric carbon dioxide is cause for a raging debate because of its link to the auto and energy industries, which are in turn regulated by government authorities. To those who understand the issue, denying these warning signs is just as absurd as believing the next apple to let loose from a tree might go *up*.

Addressing the problem is at least two-fold: an educated voting population and educated elected officials. Few have risen to the task of explaining science effectively to those groups, and the result is a massive traffic jam on the road to public appreciation of science. If only we could clear the gridlock and silence the ineffective horn blowing, the road has much to offer: on-ramps from private and government support, scenic views of environmental legislation, and, on the horizon, that shining city on the hill—a scientifically literate electorate.

What follows is a collection of tools, examples, and commentary on how to begin making relevant science available and accessible to the public. We may not be able to clear the road immediately, but we could at least start directing traffic.

Explore ▶

Breaking the language barrier

"Most of the fundamental ideas of science are essentially simple, and may, as a rule, be expressed in a language comprehensible to everyone." ALBERT EINSTEIN

THE COMMUNICATION OF science—effective communication, in a public sphere—is incredibly important, but is unfortunately a skill that far too many scientists lack. Part of the problem is that scientific research doesn't spit out easily-digestible information, at least to those not immediately involved in the field. While technical jargon, complex graphs, and extremely precise language are important tools in accurately relaying science peer-to-peer, they make it nearly impossible for the average person to find real meaning in raw science.

Here's what needs to happen:

SCIENCE MUST BE ACCESSIBLE ON A FUNDAMENTALLY **HUMAN** LEVEL.

Explain how science works

Oftentimes science comes across poorly because people are generally unfamiliar with the basic process of science and how knowledge is acquired, and this makes them wary to believe or be interested in anything that results from it. Reminding people of what goes on 'behind the scenes' is important in demystifying the nature of science—and, in turn, the science of nature.

Tell a human-interest story

Basic human psychology tells us that people are most interested in things that affect them directly. We're a very self-absorbed species. This means that in order for science to be interesting and meaningful to a lay audience, it must have a social component and be accessible on a fundamentally human level. People will connect naturally to the plight of others; if that connection is mediated by a scientific subject matter, all the better.

Science doesn't have to be boring

Most science is actually pretty interesting if it's conveyed in an interesting way. Sometimes scientists get locked in the stuffy atmosphere of precision and technicality necessary in the lab, but as Alan Alda was able to draw out in his PBS show *Scientific American Frontiers*, most scientists do have a sense of humor about their work and what they've discovered. It is this excitement that needs to work its way into how those discoveries are explained to the public. In the performing arts, audiences are most receptive when they sense the enthusiasm of those performing; the same principle can be applied to science.

Watch your language!

Of course, explaining how science works or telling human-interest stories won't be any more effective if it's not communicated in a way an audience can understand. In other words, sometimes science is difficult to comprehend precisely because we make it so. Complicated principles and theories usually thought of as higher-education material can be taught to elementary school children if they're explained in the right way.

People can understand a lot if they're able to **relate it** to something with which they're **already familiar**.

Understand your audience

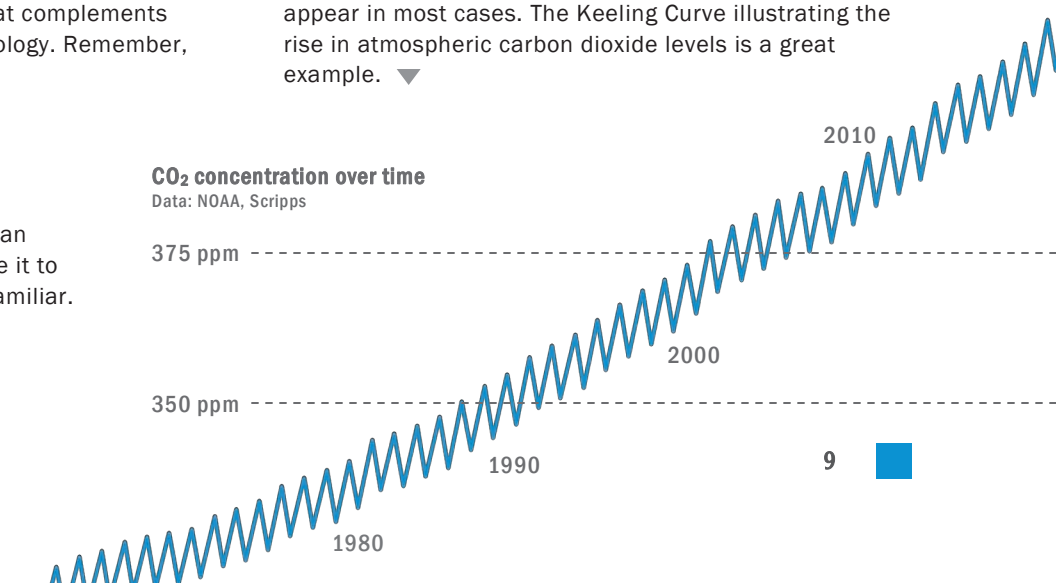
This is important for two reasons: 1) to determine the extent of information they need to know, and 2) to make sure their intelligence isn't insulted. Not *everything* needs to be dumbed down—there is an important difference between this and *accessibility*. Take articles in the New York Times Science Section for example: there's usually plenty of scientific lingo woven in, but the rest of the article is written in a way that complements the insertion of some authentic terminology. Remember, the ultimate goal is still to educate.

Make graphics simple

There's nothing the general public finds more off-putting than a graph with lots of symbols, boxes, and lines. Sometimes, an accompanying caption only makes things more confusing. In either case, the information is likely to be ignored. Graphs and pictures should tell a convincing story fast—a simple pair of axes with one obvious trend line is about as complicated as it needs to appear in most cases. The Keeling Curve illustrating the rise in atmospheric carbon dioxide levels is a great example.

Make connections

Explain things metaphorically. People can understand a lot if they're able to relate it to something with which they're already familiar.



They Blinded Me with Science

BY ARNIE REISMAN

WHY DO I get the feeling these days that yelling "Science!" in a crowded auditorium is tantamount to inciting a riot of either brickbats or boredom?

Why is there a disconnect among science and the American media, the American voter, and the American student?

How did science get sentenced and sequestered in an ivory tower—where the sun is never shining, where it's always dark and stormy, where lighting strikes, emanating from an angry God and from man-made technology run amuck?

We embrace Rod Serling, Ray Bradbury, Isaac Asimov, Ursula Le Guin, and venerate all the way back to Jules Verne. So why do we love science fiction but look askance at science fact? Because we really don't like reality?

Let's look at the stereotypes. We have always had the nerd scientist, once with pocket protector and slide rule and now with a bespectacled face up against a computer screen. We make fun of the nerd scientist, and so we have TV's popular sitcom "The Big Bang Theory." When we're not ridiculing, we're recoiling in horror. Just look at the science of medicine depicted in literature and film: Dr. Frankenstein, Dr. Jekyll, Dr. Moreau, Dr. Caligari, Dr. No, and of course, Nurse Ratched.

Mad science is then propelled into the ether by our elected officials, usually flapping from the right wing. They tell us rape victims can shut down their reproductive systems or the HPV vaccine provokes mental disabilities. They see the issue of global warming as a ruse to sell insurance. They see science as voodoo and pass it along as disinformation. But they also see science as a classic example of elitism, holier-than-thou -ism and too much education.

Thanks to the messengers who are allowed to take over our avenues of communication, science is alarming, suspect, costly, complex and downright highfalutin. There are just too many Chicken Littles running around telling us the sky is falling, the sea is rising, and whatever we're putting in our mouths we're going to regret.

So we have a fear of science for the usual reason that dominates how we live our lives—a fear of change. Scientists change the world and explain why and how the world changes. They and their work should be respected. How do we break the fear?

First, with apologies to Shakespeare, let's kill all the reporters. Well, maybe, let's first try to educate them.

There are three major hurdles within the media: 1) they think science is too complicated for mass consumption; 2) they think news and entertainment are one and the same; and 3) the choices offered by cable and the internet are so diverse, we have all become opinionated and stupid.

I know this for a fact because for many years I worked on that other side of the small screen, the side where decisions of what goes on TV are made. I watched the disintegration of attention spans brought on by the shrinking of reportage. When experts tried to get out their messages, news producers cried, "They're blinding us with science!" And they surmised if they put science on TV, the eyes of would-be viewers would glaze over.

Nearly three decades ago, the three major television networks changed ownership. Before this change, network news was seen as a loss leader, the crown jewel where prestige shines while the rest of the programming schedule makes the money. After this change, profit shined brighter than prestige. The word went out: news should make money. To bolster that idea, news must be entertaining. When news and entertainment combine, more harm than good is done to the American psyche. Information is shredded and reconstructed with flash, dash, and sequins. And it's now broadcast on thousands of little networks all over our communication spectrum. One man's media becomes another man's poison.

Up against all this stands the deflated scientist knocking at the gates. Do they have to wear glitter to be allowed in? Do they have to speak in short tongues to worship in the house of communication? Years ago I was asked by the Boston-Cambridge chapter of Physicians for Social Responsibility to help them get their word out. They felt mistreated by the media, which kept asking them to boil their message down to a sound bite. They complained that not everything could be explained in a matter of seconds. When they refused to play by the rules and spoke to reporters as if they were in a classroom, through the magic of TV editing the image of the mad scientist was reborn on the 10 o'clock News.

Clearly they and I were in a dilemma. And that dilemma still stands today. Besides getting their own network (now a possibility) and their own programs, scientists have no choice but to play the communication game. Be clear, concise, newsy yet entertaining. Be animated. Be excited. Be a cheer leader for your field. Encourage education with the thrill of discovery. That's how "Brain Games" became popular on the National Geographic channel. That's why Hayden Planetarium director Neil deGrasse Tyson and the Human Genome Project's Eric Lander became known quantities on PBS. That's why students flocked to Bill Nye the Science Guy. That's how Michael Jacobson of the Center for Science in the Public Interest mastered explaining the science of food.

WE HAVE ALL BECOME **OPINIONATED** AND **STUPID**.

The concept of communicating the value of science needs a wake up call. There is an urgent need to get the word out and get it out in the most unthreatening way. We are on the earth. We need to know about the earth if we intend to continue living on it. We need to know its moods, its ups and downs, its changes, its threats, its happiness, its distress. Scientists study the earth. They examine and monitor and diagnose all its aspects. In that regard, they are our experts, our trustees, our parents. It's time we listened to them with respect. It's time to understand that fact is more than a four-letter word and that the health of our future rests in the hands of our scientists. Now if we can just get their mouths to work properly.

Arnie Reisman has been an award-winning writer, producer, and performer for more than three decades, in commercial and public television, corporate video, theatre, and film. In 2009, with Ann Carol Grossman, he produced for PBS The Powder & The Glory, a 90-minute film focusing on the business rivalry and cultural influences of Helena Rubinstein and Elizabeth Arden. His national telecasts include Hollywood On Trial (Oscar-nominated documentary on the blacklist), The Other Side of the Moon (90-minute PBS special for 20th anniversary of the lunar landing) and PBS' AIDS Quarterly with Peter Jennings. Since the inception of the series in 1996, he has been a regular panelist on National Public Radio's Says You!, the weekly comedy quiz show now airing in more than 120 markets. He was also the former executive editor of the news weekly, Boston After Dark (now the Boston Phoenix), and is presently the vice president of the American Civil Liberties Union of Massachusetts.

Venues for science communication

"The media. It sounds like a convention of spiritualists." Sir TOM STOPPARD

LOTS OF SCIENCE tends to stay put in its own academic circle, but getting science out to the public is one of the most crucial steps in realizing and sharing the discoveries we've made. The media world offers many tools for sharing science, but understanding how to go about this task can be daunting.

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Local media relations

BY CHIP YOUNG

LOCAL NEWSPAPERS, RADIO and television stations, and news websites are all influential shapers of local opinion, and you—the scientist—want the information they give to the public to be accurate.

To do this, you should build a foundation by meeting with the editor of the local news outlet at the beginning of your initiative to tell them about what you are trying to do in the area and answer any questions they may have. This isn't necessarily to receive news coverage at that point, and you should make that clear. Instead, you want them fully informed about your goals, objectives, and process. This will allow them to cover future news stories with background information in hand, rather than coming in "cold."

In many cases, you will be dealing with complex issues. Tell the media that. Explain that you want them to understand it is quite normal to have questions. On a controversial project, they will be hearing many other voices, ranging from polished arguments to off-the-wall accusations. One thing that is very important—after you have briefed them and answered their questions—is to say, "If you hear anything different from what we've told you, please call us." The media don't want to be wrong, and you don't want them to be wrong either.

Chip Young is a communications specialist who has worked on environmental issues in Rhode Island and beyond for over 30 years. He currently is president of his own media/government/public relations firm, CY Communications, and is also a senior fellow for communications for the URI Coastal Institute. His previous work has included being the public relations director for Save The Bay, and involvement with the state's Ocean Special Area Management Plan to site wind turbines off the coast of Rhode Island. He is president of the board of directors of ecoRI News, and is a widely published journalist and opinion/commentary writer.

So what?

No matter what venue you use—whether it be print or web publications, television, or radio—science will not be inherently interesting to most people unless you tell them exactly how it affects them. *Put it in the kitchen*, you might say—make it something that they can relate to in their everyday lives. People are constantly inundated with information they don't have time to process as it is; if you don't answer the "So what?" question, you've only cluttered their mind further.

Broadcast Media

Radio is a fantastic form of communication, but it poses some unique challenges to you, the scientist: the audience can't see what you're talking about. This means even closer attention must be paid to the words you use, because they will be nearly one-hundred-percent responsible for conveying your message. You can't use charts or graphs, pictures or animations, or show videos to help explain what you are talking about—it all comes down to language.

Whether it's in the form of radio or other audio-only media, like podcasts or sound bites posted online, this means that all the imagery you would normally use in a print or video publication must be reduced to words and sounds. Language must be simple, yet vivid—think of some of the popular old-time radio shows which held audiences captivated without any need for visuals. Metaphors, too, are critical in allowing your audience to picture exactly what you mean, more so in radio than in print. And, if the work you do involves interesting sounds, as many fields in environmental science do, use them; they are an incredible way to create powerful, meaningful images in the listener's mind, and it's one of the things print media simply can't do.

Television, of course, has the added benefit of visuals—and not just static images afforded by print media. Animations are often useful to simplify complex processes through illustration, and can be engaging to watch. At the same time, it is important to keep the educational goals in mind, since animation can easily be overdone. If the science is not effectively communicated, it doesn't matter how flashy the visualizations are; they still fail their intended purpose.

If you're being interviewed for either radio or television, make sure the interviewer is prepared to ask you relevant, meaningful questions. Remember, you are the expert; meet with them in advance and provide some background information. You will help them form intelligent questions that you will be prepared to answer, and in the process you'll make both of you more comfortable. Good interviewers will be able to ask the right questions if they're educated about the topic, and this is the part where you can really help.


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JOURNALISTS WHO SPECIALIZE in coverage of science and the environment are fewer and farther between than they once were, or than they should be, in light of the growth rates of both scientific knowledge and scientific illiteracy.

Faced with an ever-growing list of environmental concerns coupled with abysmal comprehension of these issues among most Americans, it is critical that journalists know how to identify these stories, successfully pitch them to their supervisors, and report them accurately, clearly, and without oversimplification. In fact, this oversimplification is a major point of contention between scientists and journalists.

To cover these complex stories well, journalists need training in scientific research and methodology, time to build contacts across areas of expertise, and sufficient knowledge to discern hyperbole from authenticity. Metcalf Institute provides this training, but with the expanded use of general assignment reporters to cover complex science and environment stories, it's no wonder that many scientists express dismay, if not downright disdain, about the news media's coverage of these important topics.

Admittedly, this antipathy stems from many poor experiences on the part of the scientists, but it is ultimately a shortsighted approach that overlooks journalism's valuable role in society. It's high time that scientists recognize the news media as an ally for increasing public understanding of science, rather than as a confederacy of dunces who don't care if they get the story right.

Any scientist who has ever been interviewed by a reporter is likely to offer the same litany of complaints about the final story: 1) "I was misquoted!" 2) "The headline/story introduction was misleading!" 3) "The reporter totally missed the point!" 4) "I talked to the reporter for an hour but they didn't include a word I

said!" and that perennial favorite, 5) "I wish the reporter would have let me check the story before printing/broadcasting/posting it!"

Many researchers then extrapolate these points to mean that the reporter was lazy, ignorant, and/or unwilling to take the time to clarify the facts. In fact, these assumptions demonstrate how little most people understand about the norms and culture of the journalism profession.

"I was misquoted!"

This is probably the most common complaint about newspaper and online journalists, regardless of the story topic. When professionals from any field think they have been misquoted, they fear that the offending language will make them look uninformed in front of their peers. The hard truth, however, is that many of us make comments in the course of a conversation that we may not remember afterward. Any good reporter will engage the interviewee in a conversation, rather than a series of obvious questions, specifically to elicit more off-the-cuff remarks. The best way to avoid being misquoted is to identify your main points ahead of an interview and stick to them. Practice really does make perfect here: take advantage of every opportunity to tell people about your research, including why you do it, how you do it and what you hope to accomplish.

"The headline/story introduction was misleading!"

Yes, it likely was, and there is a very good reason for this. In most newsrooms, editors write headlines, not the person who actually reported the story. This situation often leads to confusing or completely inaccurate story summations, but it's not the fault of the reporter who covered the story. Editors are looking for titles that grab the reader's attention. If the headline accomplished this, it's a job well done. Many readers won't dive into an article titled, "Ocean Acidification May Affect Rates of Photosynthesis in Phytoplankton," but they are likely to be piqued by "Climate Change Threatens Marine Food Chain."

"The reporter totally missed the point!"

Once again, this often comes down to poor communication on the part of the researcher. To be sure that you are making clear and understandable points, summarize the most important ideas for yourself ahead of the interview, avoid using jargon and acronyms, use analogies that general audiences could easily relate to, and don't hesitate to ask if the reporter needs clarification during the interview. Remember: journalists are smart people, but they are not experts in your area of study.

"I talked to the reporter for an hour but they didn't include a word I said!"

Sometimes a reporter may need to talk to an expert just to better understand the topic they are covering. Feel free to ask a reporter if he wants to talk with you to provide some background for the story, or because he is looking for some quotes. He will likely want both, but just because you are not quoted, don't think that you haven't helped to improve the story. Consider this an important public service!

"I wish the reporter would have let me check the story before printing/broadcasting/posting it!"

Put this out of your mind right now. Hardly any reporters will ever allow you to preview their reporting before it is made public. They are professionals, covering the timely issues of the day—not students writing term papers. They are under no ethical or professional obligation to get a source's "approval" before running a story. This makes it all the more important to get your message straight ahead of an interview, and to speak in everyday terminology, avoiding acronyms. "Climate change is happening because of large-scale releases of carbon dioxide since the industrial revolution" is much more accessible than "anthropogenic climate change from an exponential increase in GHGs."

A first step toward becoming a more effective science communicator comes from having a more accurate understanding of how journalists do their work and the expectations that can reasonably be made of them. The second step is to practice explaining the importance and significance of research to different audiences. What are you waiting for?

Sunshine Menezes, Ph.D. works to foster broader public understanding of science and the environment through effective science communication as executive director of the Metcalf Institute for Marine & Environmental Reporting and associate director for communication in the Office of Marine Programs at the University of Rhode Island Graduate School of Oceanography. Prior to focusing her communication efforts on improving news coverage of the environment, she worked on federal environmental and energy policy as a Legislative Fellow in the Dean John Knauss National Sea Grant Marine Policy Fellowship class of 2003-2004 and later as the lead facilitator and author of an innovative urban coastal zone policy for Narragansett Bay at the URI Coastal Resources Center and Rhode Island Sea Grant. She currently serves on the Rhode Island Conservation Law Foundation Board and the Rhode Island Sea Grant Senior Advisory Council and is a Rhode Island Foundation Leadership Fellow. She received a B.S. in zoology from Michigan State University and a Ph.D. in biological oceanography from the URI Graduate School of Oceanography.

www.metcalfinstitute.org

Application to environmental sciences

"The choice to 'do nothing' in response to the mounting evidence is actually a choice to continue and even accelerate the reckless environmental destruction that is creating the catastrophe at hand." AL GORE

We don't have a lot of open spaces left. Below: site of the 1969 Woodstock Festival in Bethel, NY.

AS FAR AS the environmental sciences are concerned, there are really three main issues that must be communicated effectively: natural resources, climate change, and invasive species. These are issues that have profound impacts on humanity, ones that stand at the crossroads between the natural and social sciences. They are the ones that require the most attention when it comes to educating the public.

WE TAKE A LOT FROM OUR PLANET, AND WE DON'T GIVE A WHOLE LOT BACK.

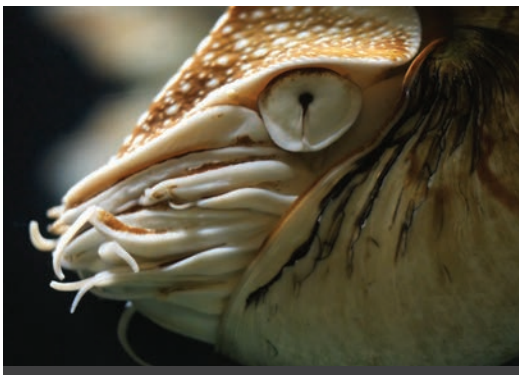
Let's start with natural resources

We take a lot from our planet, and we don't give a whole lot back. Because advances in technology have allowed our population to expand well beyond what would otherwise be our natural carrying capacity, we take much more than our fair share of the earth's resources, and we're upsetting the natural balance of ecosystems worldwide. Extensive research has been conducted in just about every natural resource sector imaginable to try and assess the damage we've caused.

To see how natural resources science can be effectively communicated to the public, **let's look at a case study.**

Here's the abstract from a paper published in the peer-reviewed journal *Fisheries Research* about overfishing in the Philippines (citations omitted):

> Baseline capture and mark-and-release studies of *Nautilus pompilius* conducted at Osprey Reef, Coral Sea, Australia reveal that this unexploited population is stable from a catch per unit effort (CPUE) basis over 12 years. In contrast, data from a detailed interview questionnaire of *N. pompilius* fishers and traders in Palawan, Philippines highlight a fishery that is unsustainable. The results from the Philippines show up to 80% declines in reported CPUE from 1980 to the present, fewer than three *Nautilus* generations, which can be attributed to fishing pressure. This is evidence for *N. pompilius* (and by ecological association, other *Nautilus* species) to be assessed as 'endangered' in the IUCN (International Union for Conservation of Nature) Red List. Questionnaire responses suggested there is no cultural or historical relevance of *Nautilus* fishing to local communities and the fishery only provides approximately 10–20 years of economic return before becoming non-viable. Identification of new *Nautilus* fishing sites and training of locals by buyers from distant depleted fishing areas illustrate how the value and demand for *Nautilus* shells generates fishing pressure.



Nautilus pompilius.

Original article:

Dunstan A, Alanis O, Marshall J. 2010. Nautilus pompilius fishing and population decline in the Philippines: A comparison with an unexploited Australian Nautilus population. Fish Res 106:239–247.

This kind of language, combined with charts, figures, and statistical analyses, continues for eight pages. It's not very public-friendly—nor is it intended to be; it is intended for fellow scientists. But the material presented here has serious implications. The challenge is to emphasize the relationship between this science and society in order to give lay audiences a reason to appreciate the research behind it.

After boiling down the technicalities necessary to prove their research, the information presented by Dunstan, Alanis, and Marshall is really pretty straightforward. In communicating this research effectively, there are **three main points** to be made:

1. *The nautilus is important to the people of Palawan;*
2. *The nautilus is endangered because of overfishing;*
3. *It's difficult to find common ground between fishing regulations and the livelihood of the Palawan community.*

The next pages show how a popular press article might approach telling this story.

Selling Seashells Comes with a Heavy Price

Hook the reader by introducing the aspect of human resources.

PUERTO PRINCESA CITY, Philippines—To the people of Palawan in the Philippines, feeding their children and sending them to school is based on one thing, and one thing only: selling seashells. But soon that may not be possible.

Introduce the nautilus.

These aren't just ordinary seashells. People might know the Nautilus as the submarine commanded by Jules Verne's Captain Nemo. But in the biological world, the nautilus is a slow-growing marine creature related to octopi and squid—complete with tentacles, well-developed eyes, and the characteristic jet-propulsion system they use to move about. But unlike their better-known cousins, the nautilus is packed into an elaborate, spiraled shell decorated with stripes and iridescent mother-of-pearl. Like the stripes on zebras, each nautilus's shell pattern is unique, allowing individual specimens to be recognized and cataloged akin to human fingerprinting.

Link the nautilus to the human resources aspect and set up a conflict (the primary issue).

Palawan fishermen began catching the nautilus in the 1970s, and have been selling the shells to local buyers ever since. The trade has even reached the international market, attracting buyers from the U.S., China, and parts of Europe. But a new study released by researchers from Australia's University of Queensland has environmentalists concerned about the fate of the nautilus in the region, and raises a red flag over the impact of nautilus fisheries around the world.

The 12-year study examined the stability of the Palawan nautilus fishery compared to unexploited populations in Australia's Coral Sea. While unfished areas continue to teem with nautilus, the Palawan fishery catch has declined as much as 95 percent, and other Philippines nautilus fisheries have crashed entirely. Researchers think the main reasons for the nautilus's vulnerability to fishing are its long life, low reproductive rate, and late age of sexual maturity, all of which contribute to the species' inability to keep pace with fishing demands.

The study also highlighted the region's lack of education about fishing exploitation. "They may lessen in numbers but they cannot . . . disappear because the sea is big," said one fisher who participated in the study's questionnaire, which was designed to gauge the economic and cultural relevance of nautilus fishing to the community.

Researchers say the biggest challenge is finding a way to protect and regulate nautilus fisheries without destroying the livelihood of the Palawan community. Collaborators are now looking toward sea turtle conservation programs, which have been largely successful, to see how those methods could be adapted to help the nautilus. Funding for education and cooperation with social scientists in developing an alternative livelihood for Palawan fishers may help bring the nautilus back, but nothing is certain yet.

Explain the primary issue, using the scientific study as merit.

Introduce a secondary issue, which helps explain the cause of the main issue.

Explain what can be or has been done about this issue and conclude appropriately.

Warming up to climate change

Climate change is one of the most pressing issues facing society today. Unfortunately, though, in an age where we should be focused on solving the problems climate change poses, we are still trying to convince many that climate change is actually occurring in the first place.

How do we do this? The science of climate change, and the journal articles that result, can be translated in the same manner as the natural resources case study described earlier. The basic elements of science communication apply, tailored to the needs of the climate change topic.

Correct misconceptions. A lot of people are reluctant to believe climate change is real because they're unaware of what's actually occurring. One of the biggest inaccuracies in the promotion of climate change awareness is the use of the phrase "global warming." This gives the impression that every location in the world is getting hotter and drier. *Climate change*, conversely, is exactly that—*changes* in the normal climate and weather around the globe, both hotter *and* colder, drier *and* wetter. A snow-capped Grand Canyon doesn't appear to be the product of something called "global warming," but if the concept of "climate change" is understood, it makes perfect sense.

Focus on actions over causes. Initially, this might seem to miss the whole point of talking about climate change. But we are in a position now where those who need to understand the cause of climate change do, and energy is better spent motivating those who don't to take action rather than to continue passive education without putting it into practice. The neutral-positive mindset (see sidebar) more or less eliminates concern over the cause of climate change, and instead focuses on what we can do to be better stewards of the earth—whether our actions are the root cause of climate change or not.

▲ Superstorm Sandy tore up the Eastern seaboard in 2012, reminding us that these types of weather events will only become more frequent with climate change. The sand in this damaged parking lot in Narragansett, RI, piled here after the storm, used to be on the town beach behind it.

Exercise a neutral-positive motive for action.

When weighing the consequences of taking action against climate change, consider the outcomes of not doing anything at all. It is better to err on the side of caution. Taking action against climate change has either positive or neutral results, while not taking action has either negative or neutral results.

If climate change is real, and we take action, the outcome is "positive":
The effects of climate change have been mitigated, and our society is more environmentally friendly.

If climate change isn't real, and we take action, the outcome is "neutral":
We are not harmed by being more energy efficient, for example, if climate change wasn't real.

If climate change is real, and we take no action, the outcome is "negative":
The effects of climate change become increasingly devastating.

If climate change isn't real, and we take no action, the outcome is "neutral":
This scenario is purely theoretical, since the negative effects of society on the environment extend well beyond climate change—the outcome is *not* neutral.

Bees are invaluable pollinators whose importance in maintaining the ecosystem around us is generally underappreciated. They are just one of literally countless types of organisms already affected by anthropogenic climate change.

Get real about it. People are barely concerned with how the earth will be affected by climate change next year, much less a decade from now; describing events that may come to pass by the end of the century expresses no urgency whatsoever to people who have trouble waiting two minutes for a friend to text back. The lack of foresight exhibited by society today is a very real fact that science communication must deal with. It is critical to show how climate change has *already* impacted individuals, and how it will continue to impact them within their lifetime—the more immediate, the better.

Grassroots is not the answer. Former Vice President Al Gore's film *An Inconvenient Truth* sparked controversy over whether climate change should become a political issue or remain in the hands of environmental activists and non-profits. As a nation, we have tried for the last 40 years to take action against climate change through grassroots efforts, convincing people that by throwing paper in a different receptacle than trash, or by replacing their incandescent bulbs with compact fluorescent and LED ones, they've done their share and climate change will go away. While these actions certainly contribute to the solution, the problem of climate change has not, will not, and never will be solved this way alone.

This means that, from a science communication standpoint, a major audience must be politicians; unfortunately, this can be an extremely difficult group to communicate to successfully. The far-reaching effects of crony capitalism and corporate interests, which have helped our nation neglect the natural world for decades, make it hard to get an environmental word in edge-wise.

THE **LACK OF FORESIGHT** EXHIBITED BY SOCIETY TODAY IS A VERY REAL FACT THAT SCIENCE COMMUNICATION MUST DEAL WITH.

Let's look at how to address environmental issues with politicians

Inspiring policy changes

BY NICOLE E. ROHR, PH.D.

POLICY-MAKERS ARE A discrete subset of the general public. These are elected officials at the state and federal levels who likely do not have a strong science background—though that is not always the case—but who write and enact laws that need to be informed by science and can have a strong impact on our natural environment. Many stakeholder groups have meetings with elected officials to request specific actions that relate to environmental issues and certain tactics may make your message more effective:

1

Have a single, clear "ask":
If you have requested a meeting with an elected official, then it is assumed that you would like to ask him or her to do something for your organization or interest group. Whether that is to support a specific bill or amendment, appear at your local event, or send a letter of support for a specific action, you should be clear on what you are requesting. It is often best to lead with your bottom line, then provide supporting reasons on why this would be a positive action for the elected you are meeting, and close with repeating the ask.

Thank you very much for taking the time to meet with us today, Senator Everyman, we appreciate your time. We are here in support of Senate Bill 646, the National Endowment for the Oceans Act. This legislation would create a permanent endowment to support baseline scientific research and observations of our oceans, coasts, and Great Lakes. We encourage you to vote "yes" when it comes to the U.S. Senate floor for a vote.

2

Don't get bogged down in the details:
You should be able to explain in two to three clear sentences that are not laden with dashes, semi-colons, acronyms, and scientific jargon what the action item includes and why it is important.

Congressman, our oceans and coasts are extremely valuable to our economy and our use of this resource depends on its health. Our oceans and coasts face myriad threats ranging from nutrient inputs to climate change, but most areas lack basic, long-term information on things like average sea surface temperature and extent of seagrass beds because sustainable funding streams have yet to be established. This bill would help remedy that problem by dedicating an endowment to these long-term research needs with the requirement that the federal funds are matched with non-federal dollars.

The United States Capitol.

2 CONTINUED

If the ask is more complicated than that, you should consider a clutter-free one-pager to reference in the meeting and to then leave behind that concisely summarizes the issue and lays out the major points in bulleted form. The ask should be clearly visible on the one-pager as well as contact information for the appropriate person who can succinctly answer any follow-up questions. Keep in mind that additional inquiries may come from a legislative assistant who has more in-depth knowledge on the issue and is charged with making a recommendation to the elected official. During the meeting, you want to ensure there is time for dialogue with the elected and they have the opportunity to ask questions or raise concerns.

There are many nuances to this bill, so we have also prepared a one-pager with more details that we will leave behind for you and your staff.

IT IS BEST TO **LEAD WITH YOUR BOTTOM LINE**, THEN PROVIDE SUPPORTING REASONS WHY IT WOULD BE A POSITIVE ACTION.

3

Connect the "ask" to the elected's constituents:
All elected officials want to serve the constituents who voted them into office by accurately representing their views. You should explain how your request will benefit the elected's constituents or support a widespread view they share. If you request the same action from multiple electeds, then this portion should be tailored to each individual.

As you know, sir, Rhode Island has been hit by a series of natural disasters including the 2010 floods, Superstorm Sandy, and sea level rise above the national average. Your constituents are very savvy and active on environmental issues and want to prepare for and recover from natural disasters in a smart and sustainable manner. However, it is hard to know what our maintenance and rebuilding goals should be when there is no baseline data for comparison. Also, there is very little monitoring after we do implement restoration activities and regulation to determine if these actions are effective enough to merit the investment. Our local economy relies heavily on our oceans and coasts and having a clear understanding of the changes we are seeing, the possibility of natural threats, and being able to assess our management actions is crucial for the economic and environmental health of The Ocean State.

4 + 5

Strength in numbers:
Are there other stakeholders or influential people who have the same ask as your group? If so, then consider scheduling meetings the same week or include representatives from many organizations in a single meeting to relay a standardized message. This shows that the request is a high priority for many people and will carry more weight.

Make sure to leave contact information and follow up:
You should leave behind a business card with your contact information with an offer to be of assistance if more information is required. You should always be gracious and thank the person for his/her time and follow up with a thank you note or email— either is appropriate. It is appropriate to reiterate your ask in the thank you note.

Thank you again for your time. My contact information is at the bottom of the one-pager. Please feel free to contact me with any questions or if you need additional information.

Continued

Sample thank you note:

June 16, 2014

Senator Jane Rhody
Hart Senate Office Building,
Room 530
Washington, D.C. 20510

Dear Senator Rhody:

Thank you for meeting with representatives of the Oceans Conservation Group to discuss your support for The National Endowment for the Oceans Act. We appreciate your time and commitment to this important bill.

As we discussed, this bill would help ensure funding for critical scientific research, long-term monitoring, and restoration of our oceans and coasts. Rhode Islanders would benefit greatly from the enactment of this legislation by guiding and providing a baseline for assessment of the management decisions we implement. We would welcome your strong support of this bill and a "yes" vote should it come to the Senate floor.

If you have any questions or need additional information, please do not hesitate to contact me at johndoe@anonymous.org or 401-555-1234.

Best wishes,
John Doe
Executive Director
Oceans Conservation Group

Other helpful tips:

- Remember that elected officials can have back-to-back commitments and something unforeseen may come up that results in your meeting to be cancelled or moved. Do not take it personally and make every attempt to be accommodating.

- Some elected officials have dedicated staff to advise them on policy issues. You may find yourself meeting with a legislative assistant instead of the elected. If this is the case, remember that the staff member will relay your meeting items to the elected so your message should not change. You are meeting with a trusted member of the staff so do not be put off by the failure of the elected to meet with you personally.

- If you have recently seen the elected at an event or he/she supported one of your previous asks, you can start your meeting by complimenting the event or thanking the elected for her support.

- Ask the elected what his thoughts are on your ask: does he/she have any concerns you can address?

- If the elected is supportive of your ask in the meeting, it may be helpful to ask him/her if there are other electeds you should be sure to schedule meetings with as well.

- Always be prepared to answer questions and alleviate common concerns. You should anticipate potential conversation topics related to your ask and be able to speak confidently at the meeting.

- If the elected asks you a question and you are unsure of the answer, it is perfectly acceptable to admit that you do not know. However, you should always offer to find out for them, make a note of it, and provide an answer to the appropriate person as soon as possible.

- Relax and enjoy the meeting. While we have suggested dialogue above, your meeting should be a conversation and may be less formal if you have a level of familiarity with the elected.

Perhaps most importantly, put your political preferences aside and give the elected the respect the office deserves. Again, politicians want to serve their constituents. Whether their interest is self-motivated or not is irrelevant to gaining their support.

Nicole E. Rohr, Ph.D. is the assistant director of the Coastal Institute at the University of Rhode Island. In this role, she works to promote long-term environmental monitoring, and to communicate ocean science and climate change to state and federal agencies, non-governmental organizations, and the general public. Prior to joining the Coastal Institute, Rohr was a NOAA Sea Grant Knauss Legislative Fellow in Washington, DC in the Office of Senator Roger Wicker (R-MS). She then moved over the Hill and across the aisle as a Legislative Assistant for Congressman Mike Thompson (D-CA-05). In both offices, Rohr handled ocean and coastal, environmental, energy, and agricultural issues. Rohr earned a Ph.D. in Biological Sciences from the University of Rhode Island, and was a National Science Foundation Integrated Graduate Education and Research trainee focused on interdisciplinary education in coastal and estuarine science. Originally from northwest Missouri, Rohr has a B.S. in Biological Sciences with Chemistry minor from Missouri State University.

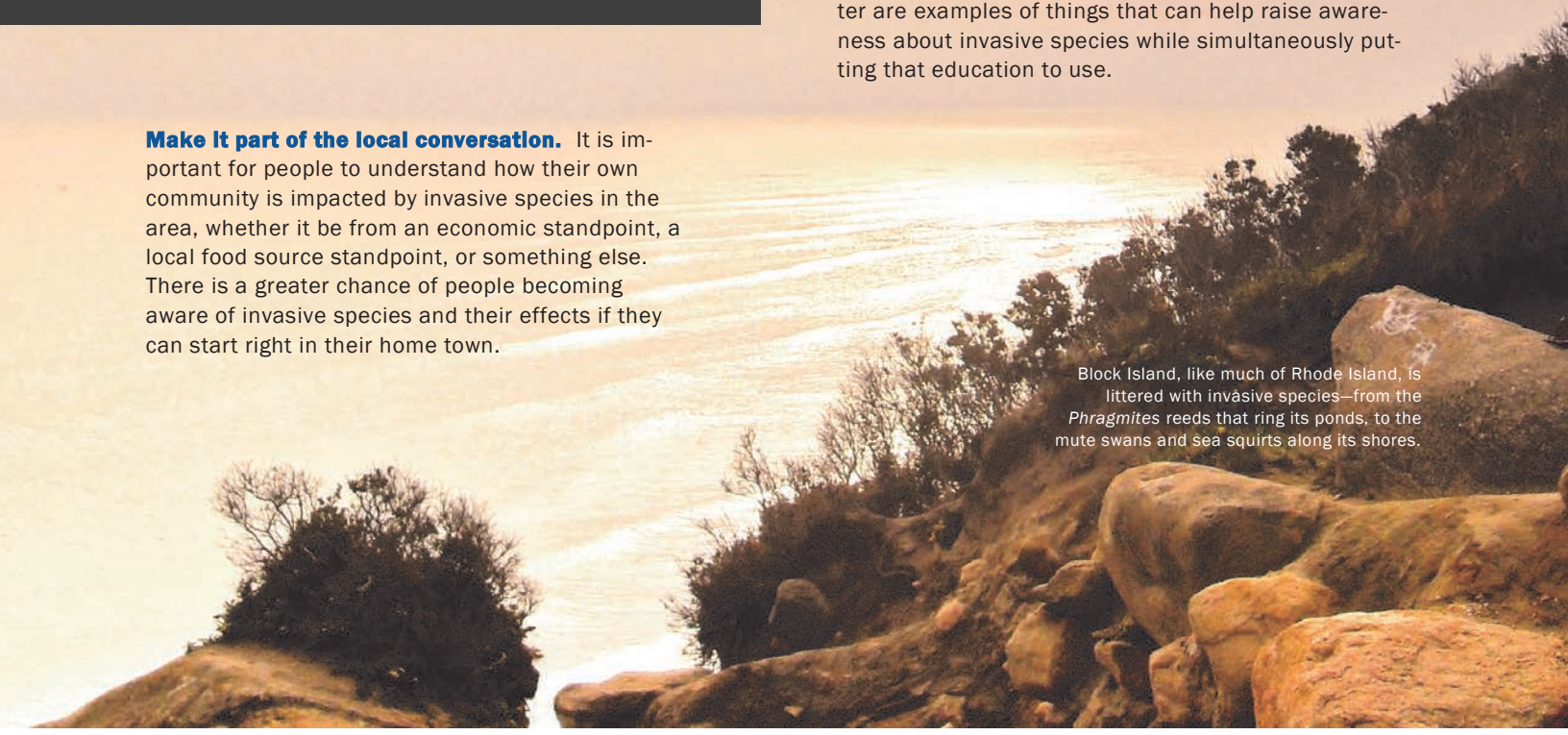
Invasive Species

The third and final category of pressing environmental issues (at least for our discussion here) is invasive species. Like natural resources and climate change, combating invasive species must involve natural and social sciences, policy, management, and public education in order to be effective. Many of the strategies used in communicating natural resource issues and climate change issues can be used in communicating about invasive species as well, but here are a couple specific tactics that are important to consider:

Show why it matters. Once again, we come back to the central pillar of science communication. There are plenty of human-interest stories to tell with invasive species, and this is the best way to garner public attention: invasive plants are eyesores, invasive insects decimate crops and forests, invasive fish displace commercially important stocks, invasive bivalves congest waterways, invasive crustaceans wreak havoc on shellfisheries, invasive snakes wipe out bird populations—the list goes on and on. All of this effects policy change, alteration of shipping practices, reevaluation of aqua- and agriculture methods, and sparks new management initiatives. The ways in which invasive species impact human activity should be painfully clear in any communication about them.

Get people involved. While a lot of invasive species management requires the actions of organizations and government agencies—and even Congress in some cases—there is a lot people can do on their own to combat local invasives and prevent their spread. Educating people about proper herbicide and insecticide use on their lawns and shrubs, or promoting better boating practices when moving vessels between bodies of water are examples of things that can help raise awareness about invasive species while simultaneously putting that education to use.

Make it part of the local conversation. It is important for people to understand how their own community is impacted by invasive species in the area, whether it be from an economic standpoint, a local food source standpoint, or something else. There is a greater chance of people becoming aware of invasive species and their effects if they can start right in their home town.



Block Island, like much of Rhode Island, is littered with invasive species—from the *Phragmites* reeds that ring its ponds, to the mute swans and sea squirts along its shores.

Spreading the word on invasives

BY DAVID W. GREGG, PH.D.

INVASIVE SPECIES ARE organisms moved outside of their natural range by human activity, living and reproducing to the detriment of native species or ecological communities. With modern transportation and global markets for everything, species are being introduced from one place to another at an unprecedented pace and invasive species are now said to be the largest threat to biodiversity after habitat loss.

Despite the urgency, effective communication about invasive species, as with many scientific subjects, can be challenging. Too often, correspondents resort to using one of two simplistic narrative mechanisms: a "scary" narrative, like a screenplay for the next Mars Attacks! movie, or a "geeky" narrative, like a Victorian treatise on invertebrate taxonomy. Neither approach is well-suited to the nuances and complexities inherent in all kinds of science and essential to more meaningful public participation in tough policy and management decisions. Scientists' failure to develop and effectively promulgate more diverse and versatile genres of communication about invasive species hinders the main messages on the subject: 1) that invasives are a serious problem; 2) that the consequences are economic and social, not just environmental; and 3) that we can reduce the harm if we allow ourselves to be guided by the science.

The nature of the invasives subject inherently favors these two counterproductive themes. First, invasive species is a chronological subject: for each species there is a time before its arrival and a time after, and there are trends in population and effects. It is easy for communication to simplify the invasion process into these two distinct time periods, neglecting the more gradual ecological transition that really takes place. This division is rhetorically easy and we sense it could be a good way to get attention—one might hope to galvanize action by telling a story about an intact, pristine ecosystem before the arrival of invasive Chinese mitten crab, for example, and the inexorable, increasingly detrimental, and irreversible changes that occurred after arrival. The public longs for an idealized past and fears the invader that destroys it, but in the process may overlook important context and lose the ability to prioritize among invaders or between invaders and some other environmental threat. Important subtlety and detail are lost.

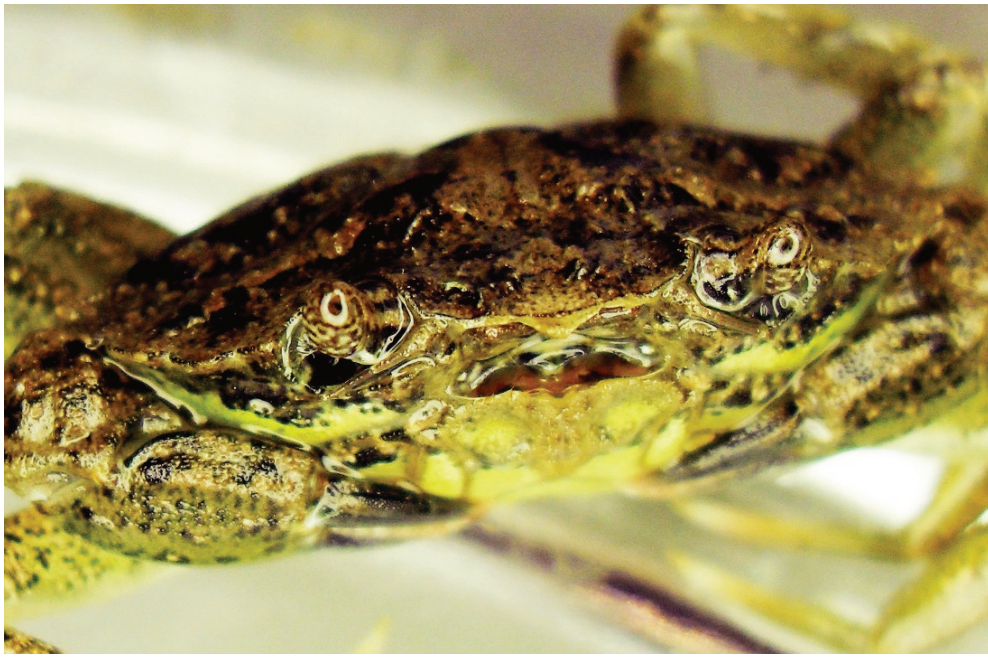
Overselling the effect of an invasive species can also diminish the impact of communication, especially for resource users who are observant but non-scientific. Such resource users may still enjoy their beach, boating, or fishing and not perceive much wrong with the present. People who are not as well informed about ecosystems and historic trends as scientists might understandably ask, "If green crabs, which I see all the time in the estuarine environment, are themselves an invasive species of long standing, isn't change a constant? Why make a fuss about another new kind of crab such as Asian shore crab?" These resource users should be considered a natural constituency for messages about invasives and could be enlisted to change policies or contribute to management, yet even they are a locus of confusion resulting from a poorly framed chronological narrative. Although the chronological structure is an attractive rhetorical device in invasives communication, contradictions created in the minds of resource users can weaken the effect of the message.

Secondly, communication about invasive species is also often hampered when the correspondent indulges in the "geeky" narrative style and makes the story unnecessarily technical, as it often happens when species identification is part of the story. For example, there are two species of

the invasive swallowwort plant in North America, and communication about each as invaders sometimes degenerates into the somewhat subtle botanical differences between them. In this case, it is more important to encourage surveillance volunteers to report any new swallowwort rather than identify the specific species, since both have similarly bad effects. In communicating effectively about invasive species, as about any subject, it is important to keep the audience and their circumstances in mind.

As with invasive species identification, invasive species control methods can also be highly technical, and are becoming even more so. Research is providing ever more specific prescriptions for effective, efficient control: a certain time of year to spray or pull, a certain way to pull, the latest herbicides or special herbicide mixes. While scientists who understand invasive ecology, chemistry, or environmental management often focus on communicating subtle distinctions, such communication to a non-technical audience may appear to be just a slew of contradictory recommendations. Though technical information can be important, audiences that could be supportive of invasive species management efforts can be confused and put off by needlessly technical communication.

Communication about invasive species is often either too simplified—to the point of inaccuracy—or too technical and detailed. These directions can disempower and disengage members of the public who might otherwise be strong advocates for invasive species management. Nor will such communication effectively raise the priority of the issue for policy makers. As with other important areas of scientific communication, poor invasives communication can give skeptics ammunition against the scientific consensus and derail important public action. Experience shows that communication built instead around the details of a case study chosen to illustrate a key point is more likely to increase the audience's real understanding. Carefully chosen case studies that touch the audience's experience and make specific emotional connections without being tritely horrific become "case stories," and are more likely to be remembered.



David W. Gregg, Ph.D. is executive director of the Rhode Island Natural History Survey. RINHS activities promote biodiversity and environmental science and provide technical assistance on the management of rare species and invasive species. Before coming to RINHS, Gregg had 14 years' experience in museums in project management and exhibition development and taught anthropology and museum studies at Brown University and Regis College. By training, Gregg is an archaeologist and has excavated in Britain, Italy, Rhode Island, and Alaska. He holds a Ph.D. in anthropology from Brown University. Gregg has collected insects as a hobby since his childhood on Cape Cod, Massachusetts. He lives in Wakefield, Rhode Island.

www.rinhs.org

The green crab, *Carcinus maenas*, which has prevailed on the east coast since the early 1800s, challenges our definition of an "invasive species"—should we still consider it one nearly 200 years later?

COASTAL INSTITUTE

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THE UNIVERSITY OF RHODE ISLAND