SCIENCECHRONICLES

Okanagan-Similikameen, BC. Credit: Flickr user James Wheeler via Creative Commons.

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Editor's Note

A confession: for the past few months, for the first time that I can recall, I made a concerted effort to avoid all political news. Given that I was a news junkie, that I live near DC, and that I am old-fashioned enough to still get newspaper delivered to the end of the driveway every morning, this proved something of a challenge. To fight the withdrawal I found myself reading more fiction and fewer blogs, watching little television save for the World Series and the Premier League. I never considered sitting out the election entirely, so I assumed my decision to basically lower the volume was of no particular importance. Perhaps that is incorrect.

Still, it was all liberating in a way, but guilt-inducing too. Was I becoming the dreaded "low information voter" we hear about? What I perceived as the mindlessness of many current political debates drove me away from the news, but wasn't my alleged solution simply expanding the problem?

So I began to wonder whether Election Day is not just about choosing among various candidates, or choosing to go to the polls at all, but about a more fundamental kind of choice.

Consider, for example, the range of choices of various kinds highlighted in this issue: big cities making big decisions about water projects that will have impacts over entire watersheds; local communities deciding whether to invest in natural infrastructure; and how to plan for sea level rise. All are complex issues, demanding a good deal of sophistication among elected officials and policy makers as well as an informed and engaged electorate.

The important choice thus really is not the one that comes along every two or four years, but rather one we face every day: do we engage on the kinds of questions raised here, or assume that experts of one stripe or another will take care of them for us? That is the kind of passivity that, frankly, I may have succumbed to in what I thought was a simple choice to tune out the media noise machine.

There is a deep and rich speciality within conservation science that focuses on how to make the most informed and effective choices among competing priorities amid limited or even shrinking resources. That remains an inescapable fact of day-today conservation practice, but the articles in this issue reinforce the idea that there are a whole range of choices that we must make as individuals and communities that are just as or perhaps even more important. Those require very different kinds of data, and very different kinds of communication. For me, it may be as simple as going back to reading the paper.

As ever, your comments are more than welcome. **SC**

Jonathan Adams (pangolin19@gmail.com) is a science writer and editor based in Maryland. Visit PangolinWords.com or follow him on Twitter.

The Mission(s) of *Science Chronicles*:

1. To bring you the latest and best thinking and debates in conservation and conservation science;
2. To keep you up to date on Conservancy science — announcements, publications, issues, arguments;
3. To have a bit of fun doing #1 and #2.

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Article

Beyond City Limits: Exploring Land Practices to Improve Urban Water

By Daniel Shemie, director of water funds, The Nature Conservancy

New York. Credit: Flickr user Greg Wass via Creative Commons.

While the rise of farm-to-table restaurants in the United States has increased awareness and celebration of local foods, most of us still take for granted the forest-to-faucet reality that much of our water is collected and filtered by forests before ever reaching a pipe. In fact, a recent poll indicates that 75 percent of Americans have no idea where their water comes from (TNC 2011).

It is little wonder that people around the world aren't demanding that cities and water utilities invest in the protection of water sources. If they did, the planet might look very different. While the world's 100 largest cities occupy less than 1 percent of land area globally, their source watersheds — the rivers, forests and other ecosystems from which they get their water —cover over 12 percent. That represents 1.7 billion hectares, an area of land roughly the size of Russia that collects, filters and transports water to nearly a billion people before reaching man-made infrastructure. This basic fact will need to become common knowledge before we can expect cities to invest in nature to secure their water supply.

The Nature Conservancy's Global Water and Central Science teams, in partnership with C40 Cities Climate Leadership Group and the International Water Association, have released a new report, Urban Water Blueprint: Mapping Conservation Solutions to the

Global Water Challenge, representing the first-ever, comprehensive view of the potential for conservation to deliver clean water to cities. The report, and accompanying on-line tool, details the state of water in 2,000 water sources serving over 500 large and medium-sized cities worldwide, or roughly a sixth of humanity. The report goes beyond analyzing water risk, however, to include science-based recommendations for how natural solutions can be integrated alongside traditional infrastructure to improve water quality.

Findings illustrated below suggest that the greatest potential to improve water quality for cities globally lies in improving the management of agricultural lands—which is increasingly important as cropland is projected to grow10 percent globally by 2030 and fertilizer use by a staggering 58 percent over the same time (FAO 2006).

Urban Water Blueprint: Mapping Conservation Solutions to the Global Water Challenge **represents the first-ever, comprehensive view of the potential for conservation to deliver clean water to cities.**

Population in the 100 largest cities that have surface sources with high, medium, or low levels of sediment. The full report also features trends for nutrient pollution.

The report reveals that 600 million city dwellers would see a material improvement in the quality of their water sources if agricultural best management practices were targeted to some 6.4 million hectares, or just 0.2 percent of the cropland area of watersheds.

Reaping the Benefits in Beijing

Near Beijing, the Paddy Land-to-Dry Land (PLDL) program pays farmers to convert their croplands from rice to corn. Rice paddies are constantly flooded and often

located on steep slopes, leading to significant fertilizer and sediment runoff. Corn, meanwhile, requires much less water, and fertilizer and sediment are more likely to stay in the soil. The additional water flows into the Miyun Reservoir — the main surface water source for Beijing (the city also relies heavily on groundwater).

The major challenge to PLDL program is that farmers earn roughly three times more growing rice. The government therefore compensates farmers to make up the difference, a subsidy that is crucial to the program. In the long term, there will need to be a mechanism for ecological compensation with a clear standard, funding source, and evaluation criteria. But for now, door-to-door surveys reveal that the compensation program has mostly improved peoples' livelihoods. Farmers are making more money and, because corn is less time-intensive to grow, they have more time to farm elsewhere or work other jobs.

The program costs about US $1,330 per hectare of farmland to implement, but it produces US $2,020 per hectare of benefits, calculated as the value of increased water yield and improved water quality (Zheng 2013). According to the Urban Water Blueprint, Beijing could also reduce sediment and nutrient loading by 10 percent in Miyun Reservoir by instituting better farming practices on around 19,000 hectares.

Investing in natural solutions such as forest protection, reforestation, stream bank restoration, forest fire management, and improved agricultural practices can measurably reduce sediment and nutrient pollutants that flow into drinking water sources.

Naturally Money Wise

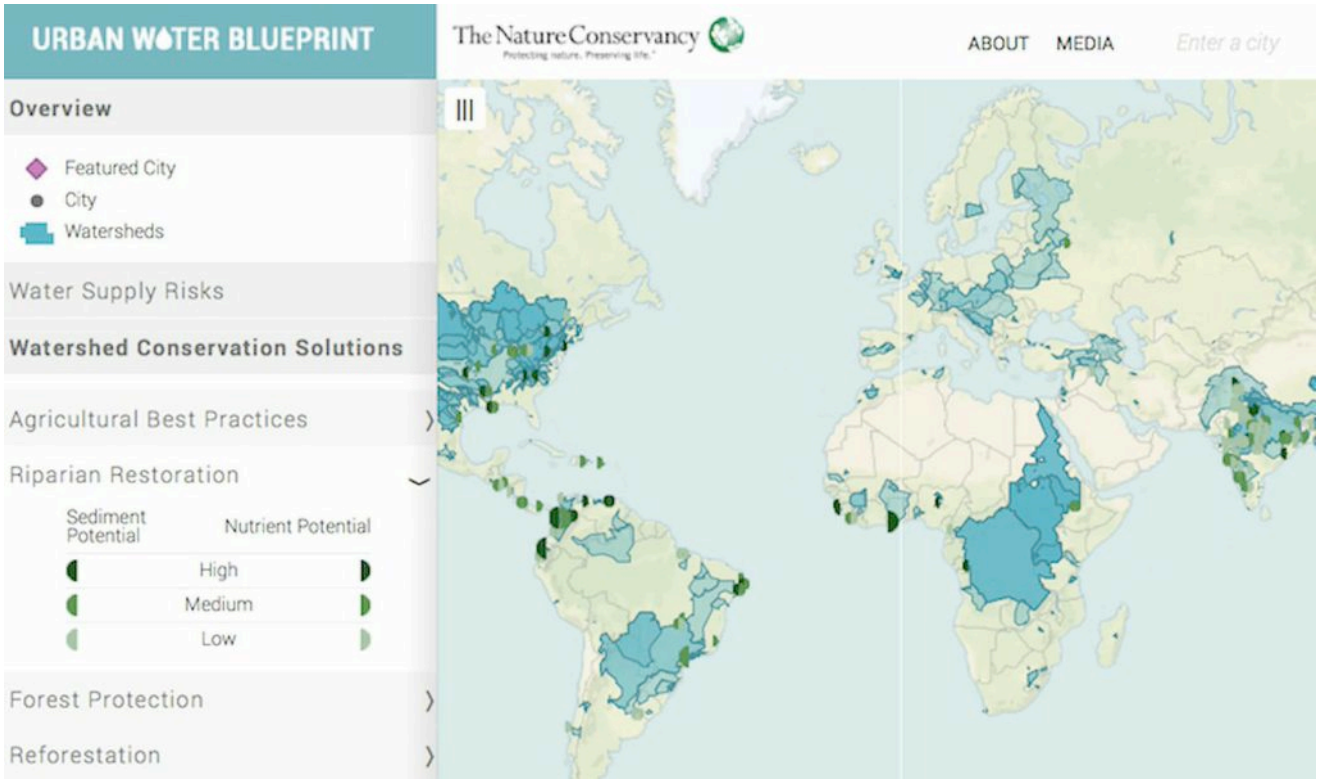
Each year, cities around the world spend US $90 billion to build infrastructure used to deliver and treat water. To meet the twin challenges of growing urban populations and climate variability, cities often transport clean water vast distances to their residents, while other cities invest in more complex technology to treat local water resources. But nature has an important role to play in water delivery and treatment, one that has gone largely untapped.

Although watersheds are vital to urban water supply, they typically receive little investment. In some cases, however, protecting water at its source can be cheaper and more efficient than treating it after it has already been polluted. Research has shown, for example, that increased forest cover can lead to lower operating and management costs for water treatment plants (Ernst 2004). New York City famously found that watershed protection can also help avoid capital costs. New York's more than US $1.5 billion investment in its watershed is sizable, but the value to the city extends far beyond avoided treatment costs and regulatory compliance (Alcott 2013).

But what other New York City stories are waiting to be told? The Urban Water Blueprint indicates for the first time that, out of all 534 cities analyzed, one in four would have a positive return on investment from investing in watershed conservation. Investing

in natural solutions such as forest protection, reforestation, stream bank restoration, forest fire management, and improved agricultural practices can measurably reduce sediment and nutrient pollutants that flow into drinking water sources. These solutions have the potential to improve water quality for more than 700 million people around the world.

For most cities, however, it is unlikely to be cost-effective for water utilities alone to pay the entire cost of watershed conservation. In these cases, cities should consider investing jointly with competing water users in a water fund — a process that establishes a financial mechanism to direct funds toward watershed conservation investments based on impartial science. Alternatively, cities should assess related values (co-benefits) of watershed conservation, such as recreation, economic development and biodiversity—many of which could be of equal or greater value to some cities.



The online portion of the Urban Water Blueprint enables visitors to manipulate data and find opportunities that exist for conservation solutions in the largest cities around the world. Visit nature.org/waterblueprint.

The Blueprint as a Planning Tool

The Urban Water Blueprint and accompanying interactive website can serve as a tool for decision makers in evaluating water quantity and quality risk across the world's largest cities, the steps cities have taken to overcome water stress, and the costs and benefits of incorporating natural solutions. The online tool was designed to be a truly engaging, interactive representation of the research and one that allows water providers

and consumers alike to zoom in on any of the 500+ cities. Each layer provides detail on the water challenges and conservation solutions for a city and each of its watersheds.

Building consistent demand among institutions and the public for source water protection interventions is critical to creating the space for the adoption of these solutions. **SC**

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Article

Human Decisions and Nature

By Shelia Walsh Reddy, sustainability scientist, The Nature Conservancy

Surfer's Point Park, Ventura, Ca. Credit: Flickr user wanderingnome via Creative Commons.

Last January, Science Chronicles argued that we need to get over our hang-ups with the idea of being "mainstream" and strive for being part of the status quo, the mass market, the mundane. After all, isn't success having nature conservation being a regular part of doing business, governing, and every-day lives?

In the same issue, I laid out a research challenge for myself: leverage behavioral sciences to understand why local decision makers invest in natural infrastructure. Here I am going to share what I've learned about mainstreaming natural infrastructure in coastal communities and propose some general lessons and future questions for conservation science.

Why Local Decision Makers Invest In Natural Infrastructure

Coastal hazard mitigation policy in the United States has historically focused on hardened, or gray, infrastructure. Recently, there is increased public interest and policy supporting the use of habitats, or natural infrastructure (NI), following decades of increasingly supportive ecological, engineering, and economic evidence. This trend

suggests that factors other than scientific evidence may be important for mainstreaming NI.

Local Community Decisions

To understand what factors affected specific decisions to use NI, we interviewed 16 people that were involved with three NI investments: Durant's Point Living Shoreline, NC; Ferry Point Park Living Shoreline, MD; and Surfer's Point Managed Retreat, CA.

Our decision analysis revealed that decisions to use NI were driven by innovators (citizens, local NGO staff, and/or state government resource managers). Innovators were influenced by seeing NI successes implemented by trusted experts. Innovators perceived NI benefits beyond protecting coastlines (e.g., maintaining coastal heritage and sense of place). Innovators also acted as local champions, getting others "comfortable" with NI and connecting benefits to local interests.

How do these three decisions reflect broader trends in local coastal hazard management and policy? How can policy help further the diffusion of innovation started in local communities and demonstration sites and transition NI from being an innovative, new technology to a standard practice?

How can policy help further the diffusion of innovation started in local communities and demonstration sites and transition natural infrastructure from being an innovative, new technology to a standard practice?

To find out, we got some big data: ten years of public meeting minutes from six coastal counties (one from each of our three study states). And, of course, we dug into the state registrars.

Local Coastal Hazard Management and State Policy

Over the last ten years, county governments have been discussing coastal hazards and coastal hazard management with increasing frequency, with discussions being more common in counties that are more vulnerable to coastal hazards (i.e., the Outer Banks of North Carolina). Consideration of natural infrastructure by county commissioners is extremely rare; however, there is evidence that in the last five years, county staff have recommended natural infrastructure as a preferred option.

In 2008, Maryland passed the Living Shoreline Protection Act that mainstreamed NI by making it the required option in places where scientific analysis suggested it would be effective, while in California and North Carolina natural infrastructure remains just a preferred option. This shift from NI as a preferred option to a required option helps avoid landowners from simply choosing the option that is easiest to permit (i.e., gray infrastructure). In Maryland, under the Living Shoreline Protection Act, the burden is on the applicant to show that NI is not suitable in order to get a permit for gray

infrastructure. A key to the success of this type of policy is having the scientific capacity in the state government to identify where NI is suitable and support implementation of NI.

What does it All Mean for Conservation Practice and Policy?

Communities may be at risk of making poor investment decisions that are not evidence-based and trusted experts have a responsibility to help communities avoid these decisions. This means that we need to continue to build the evidence-base that can help inform community decision and the most effective way to do that may be to the build the capacity of trusted experts such as engineers and government scientists. Our recent collaboration with CH2M Hill, the Coastal Defenses SNAP working group, and the Climate Risk Reduction Global Priority and the North American Risk Reduction and Resilience (NA RRR) Initiative's science strategies are already making important strides in these directions.

There is also an opportunity to leverage behavioral processes and policies to mainstream NI in places where there is scientific evidence that it would be effective. By identifying the decision processes at work in local communities, this study is helping to inform the tactics at the NA RRR demonstration sites. For example, it provided evidence for the importance of using visual aids to show success, identifying innovators, enabling local champions to help people get "comfortable," and connecting to local interests (e.g., sense of place). In addition, this study revealed an opportunity for NA RRR to use Maryland as a policy model and efforts are underway to identify additional states where new NI policies could be passed

One general lesson from this work is that we may be missing opportunities to influence decisions by focusing primarily on the ecological and economic evidence for nature's benefits.

General Lessons and Future Questions for the Science Human Decisions and Nature

One general lesson from this work is that we may be missing opportunities to influence decisions by focusing primarily on the ecological and economic evidence for nature's benefits. Other factors may be as or more important as scientific evidence. How and when these factors matter likely depends on whether the decision is being made by a community, a business, a fisherman, a volunteer, a consumer, or a conservation practitioner; and, whether, the decision relates to nature on your land or far off on public lands, coastal erosion that is creeping closer each day or the distant threat of a hundred-year storm.

At TNC and in the broader conservation science community, we are just beginning to uncover the relative roles of ecological information, economic signals, cognitive processes, social networks, and institutions in human decisions related to nature. Over the next two years my colleagues and I will be delving further into some of the most important conservation decisions to build a more general understanding of the role of human behavior in conservation. The results should provide new insights into how to use behavioral nudges, communications, and policies to mainstream conservation. **SC**

Article

Helping coastal communities make better choices

By Laura Geselbrach, senior marine scientist, and Doria Gordon, director of conservation, Florida Chapter, The Nature Conservancy

Apalachicola Bay. Credit: Florida Fish and Wildlife. via Creative Commons.

When we embarked on our research to better understand how sea level rise (SLR) might affect coastal ecosystems (see Geselbracht et al. 2014), none of us realized how the new information we would derive could be useful for so many aspects of adaptation planning.

We started our work with a relatively small amount of funding to model how SLR might affect coastal ecosystems in the Apalachicola Bay area of Florida's Gulf Coast. We employed the Sea Level Affecting Marshes Model (SLAMM) that was gaining steam as a relatively easy-to-use tool. From our first project site, we were able to extend our study to six other Gulf Coast Estuaries with additional funding: Corpus Christi Bay in Texas, Mobile Bay in Alabama, and Pensacola Bay, the Southern Big Bend Coast, Tampa Bay, and Charlotte Harbor in Florida.

Along the way, we conducted a hindcast of SLAMM to assess how well it tracked reality, as that was an unknown of model use when we began our investigations. We found out that SLAMM tracked the coastal ecosystem changes that were observed in the Waccasassa Bay area of Florida over a 27 year period quite well (Geselbracht et al 2011).

Across all the sites where we applied SLAMM, we found that the extent, spatial orientation, and relative composition of coastal wetland ecosystems and adjacent dry land will likely change substantially as sea level rises. Some coastal ecosystems are predicted to grow in extent, while others shrink.

The magnitude and type of the predicted changes will have wide ranging impacts to adjacent human communities and dependent species. For example, the changes predicted by SLAMM could leave adjacent human communities more exposed to wind and wave energy and the storm surge associated with tropical storms as coastal ecosystems such as beach and dune systems, forested wetlands and mangrove swamps lose spatial extent. These changes could have broad effects on the local economy by impacting property values, infrastructure, insurance costs, recreational opportunities, tourism, and fisheries, etc.

Implications for adaptation planning

The changes predicted by SLAMM could leave adjacent human communities more exposed to wind and wave energy and the storm surge associated with tropical storms as coastal ecosystems such as beach and dune systems, forested wetlands and mangrove swamps lose spatial extent.

SLAMM provides both spatial and quantitative outputs. This new information is helping the Florida Chapter identify priority coastal resilience project locations and actions. By providing information on which coastal ecosystems are most vulnerable to SLR and where they are most vulnerable, the SLAMM results have enabled us to pinpoint where human intervention could make the most most difference for ameliorating coastal ecosystem losses. Projects could include the installation of living shorelines or strategic restoration projects that reduces erosion and encourages sediment accumulation.

SLAMM also delivers information on the location of wetland advancement areas, areas that will become wetlands as sea level rises, and resilient wetland areas, areas that are likely to persist despite SLR, and enables us to identify areas that are particularly important for supporting future ecosystem health. If not already in a protected area, we can recommend that these areas be put into one and that any barriers to wetlands migration (such as roads or other infrastructure in the way) be addressed.

We are sharing what we have learned from SLAMM about increased human community vulnerability with local planners, elected officials, scientist,s and other community leaders so that they may make better decisions on what areas to protect or restore, where to shape growth and what infrastructure to improve. For example, people will have a tendency to harden shorelines as sea level rises. Modeling coastal system change with and without shoreline hardening shows that the former results in reductions in coastal wetland ecosystems over time. Associated with this reduction is a

loss of the services these ecosystems provide to human and natural communities, such as storm surge and wind energy protection as well as food, shelter, etc.

The SLAMM results have also improved our ability to hone outreach messages. For example, one-tenth the estuarine habitat will support fewer sportfish. Thus, protecting estuarine habitat protects the local economy, with benefits to sportfishers, guides, tackle business, boat rentals, etc. And a very compelling message in Florida: no beaches equals no tourists. Better messaging can yield more adaptation action.

The release of the SLAMM results is still fairly recent and it not yet clear how our partners in each of our study areas are changing the way they are addressing adaptation planning in light of the new information. In the Charlotte Harbor area, however, our partners have already begun supporting oyster reef restoration projects that not only return oyster reef habitat to the estuary, but also support coastal ecosystems vulnerable to SLR, especially those known to protect built areas such as mangrove ecosystems. The SLAMM results have provided natural resource managers with information on which species may be most impacted by SLR, allowing them to initiate planning to ameliorate some of the most severe impacts (e.g., a great reduction in tidal flats in some areas).

By providing information on which coastal ecosystems are most vulnerable to sea-level rise and where they are most vulnerable, the SLAMM results have enabled us to pinpoint where human intervention could make the most most difference for ameliorating coastal ecosystem losses.

Lessons to Share

The availability of high quality, high resolution input data influences modeling results. We were fortunate to have high quality land cover data and high resolution elevation data (LiDAR derived) for the majority of our study sites. The availability of some of the other SLAMM input parameters was more variable, either not available for the immediate area or decades old. Erosion, accretion and sedimentation rate data should be collected in every estuary to improve modeling capabilities for a better understanding of SLR impacts on coastal ecosystems, adjacent human communities and vulnerable species.

We also learned from our partners how to best frame the discussion of coastal wetland changes where anthropogenic SLR is not as accepted. While the modeling may be of one meter of SLR by 2100, some audiences will only accept the 2025 results of 25% of that increase. Even so, spatially explicit modeling helps to start the conversation that will result in many of the same adaptation results. SC

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Article

LANDFIRE Data

By Randy Swaty, , The Nature Conservancy

Sky Lakes Wilderness, Oregon. Credit: Michael McCullough via Creative Commons.

As TNC's LANDFIRE team reflects on our Program's 10th anniversary, we can't help but think of the many TNC scientists who have helped us as as we work to characterize vegetation and fuel conditions across the country. You have provided data, expertise, moral support and, most exciting to me, innovations and powerful research. I thought of this recently when I read a great paper that was brought to my attention by our chief scientist Peter Kareiva, and another one that was submitted by our TNC colleagues on the west coast, both discussed below.

As Peter noted in Cool Green Science, TNC environmental economist Timm Kroeger, and colleagues published a provocative and hopeful paper that examined the effectiveness of targeted reforestation efforts that may potentially reduce ozone levels. The findings, in the August 2014 Proceedings of the National Academy of Science, suggest that reforestation be considered as a strategy for ozone control; they also provide criteria for maximizing cost effectiveness. In addition to tackling an important issue, the authors were open about limitations, provided ample methods and presented a palatable win-win strategy. I also like the fact that LANDFIRE data contributed to the analysis, e.g. they used the LANDFIRE Biophysical Settings (BpS) data set to limit

potential sites for reforestation. The BpS data represents the vegetation that may have been dominant prior to major European settlement. By intersecting this data with USGS current vegetation data, the authors were able to identify areas that have the potential to be forested, but which are not currently being managed to do so. This is an appropriate and important use of LANDFIRE resources, in both concept and scale.

Longtime LANDFIRE users Ryan Haugo (TNC Senior Forest Ecologist based in Yakima, WA) and Chris Zanger (TNC Forest Analyst based in Bend, OR) and colleagues from TNC, Oregon State University, and the US Forest Service, identified forested areas of eastern Washington, eastern Oregon, and SW Oregon areas that are most in need of either active forest restoration or "aging" (i.e., performing no action so that trees can age). LANDFIRE provided the ecological models for their study. Coupled with USFS and OSU datasets representing current conditions, Haugo and colleagues were able to identify areas where the difference between baseline and current conditions are the greatest. Using LANDFIRE models, they determined appropriate actions that would close the gap between the two. The authors creatively combined datasets, mined models and adapted data in a way that presents a comprehensive view of vegetation conditions. That kind of research and scenario planning was impossible before the advent of large datasets such as those that LANDFIRE delivers.

A quick search of Google Scholar suggests that LANDFIRE products have been cited in roughly 1,000 peer-reviewed journal articles and technical reports over the last decade.

A quick search of Google Scholar suggests that LANDFIRE products have been cited in roughly 1,000 peer-reviewed journal articles and technical reports over the last decade. On our 10th birthday, the TNC-LANDFIRE team commends our federal partners and thanks our Conservancy colleagues for continuing to develop, fine-tune, and use this ground-breaking and important national product. With every application of LANDFIRE tools and data in "real world" settings, we support the Conservancy's mission and provide the foundation that land managers need to conserve and restore valuable and cherished landscapes. **SC**

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Drinking from the Fire Hose

A quick and entirely subjective monthly roundup of interesting articles, websites and other experiences collected by your editor. Send your suggestions for future roundups to pangolin19@gmail.com.

1. What do scientists really do?. Dan Kahan at Yale has shown that public acceptance of scientific finding has relatively little to do with scientific literacy or numeracy. But that does not necessarily mean that people understand what scientists actually do, or more importantly, how provisional much of science must be.

2. If Faulkner did it, so can you. Well, maybe not so much. But for science writers, few things are as annoying as scientists who are brilliant at both doing their science and explaining it. People like Stephen Pinker. Yet Pinker may have gone a bit too far in rewriting (while claiming not to) Strunk and White. Here he is in his own defense.

3. How did palm oil become such a problem?

4. In praise of pyrodiversity. Max Moritz calls for a more nuanced approach to wildfire, in a New Yorker feature and a review paper in Nature.

5. "The overall outlook for the Great Barrier Reef is poor and getting worse." So says the Great Barrier Reef Marine Park Authority. Coral cover dropped by half between 1985 and 2012, according to one study, while from a longer timescale things may be even worse. On the bright side, perhaps some of the damage is temporary: two cyclones (Hamish in 2009 and Yasi in 2011) hit the reef in a particular way, producing a combined battering expected just once every 600 years.

6. A to-do list for the world's parks. In honor of the World's Parks Congress, some leading thinkers, among them Bob Pressey and Hugh Possingham, share their priorities for making protected areas more effective.

7. According to new USGS data, water use in the US in 2010 was 13% less than 2005. Water withdrawals were lower in 2010 than at any time since 1970. Does this mean we have passed the point of "peak water," or do that national data mask crucial regional variations?

8. For those of you hoping for the fame and fortune that comes with a highly-cited scientific paper (I know you're out there), here is what you need to shoot for: the top 100 most-cited papers. To make the list you'll need about 12,000 citations. Watson and Crick's 1953 paper on the structure of DNA, by the way, don't come close, with only 5,245.

and finally,

9. You've seen the robot baby penguins (and yes, there is a paper on them, if you must). Now, you too can be a penguin researcher. **SC**

Announcements

There is still time: *Chronicles* Holiday Book Issue Needs You

Take one book, any topic; read. Write 250-300 words, distilling your opinions about said book. Send to pangolin19@gmail.com by December 12 for inclusion in the ever popular Holiday Book Issue of *Science Chronicles*. (Send me the titles you want to review first, so I can avoid duplicates.)

—Jonathan Adams **SC**

New Conservancy Publications

Conservancy-affiliated authors highlighted in bold.

Please send new citations and the PDF (when possible) to: science_pubs@tnc.org.

Some references also contain a link to the paper's abstract and a downloadable PDF of the paper. When open source or permitted by journal publisher, these PDFs are being stored on the Conservation Gateway, which also is keeping a running list of Conservancy authored science publications since 2009.

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