# SCIENCECHRONICLES


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## Evidence

## Editor's Note

This month we take stock of the progress thus toward evidence-based conservation from four unique perspectives. Andrew Pullin, from Bangor University in Wales, is Director of the Centre for Evidence-Based Conservation and is one of leading academic thinkers on the subject. Rob Richards, Director of Evidentiary, works in Australia to help conservation practitioners adopt an evidence-based approach to their work. Craig Leisher and Timm Kroeger, come at the subject from the perspectives of social science and economics. I hope these articles will prompt even more discussion.

In that spirit, a question: for whom is the evidence about the effectiveness of conservation interventions intended? Practitioners, researchers, funders, policy makers, media, average voters and consumers? All of the above? As several of the articles in this issue describe, evidence-based conservation draws much of its power from the experience in medicine, where demonstrating the effectiveness of particular treatments can transform the culture and the very way doctors work. But in medicine, it may be enough, or nearly so, to convince doctors themselves, and then corporate and government interests follow. Is that true of conservation as well? I would dearly like to believe it is, but I am not so sure. The evidence about a particular way of addressing a particular conservation threat may be overwhelming and may convince every practitioner on the ground, and it still may not be enough. Why? Because we cannot succeed without convincing huge numbers of people that the interventions are necessary in the first place, and in that regard evidence may not be as compelling as we hope.

***For whom is the evidence about the effectiveness of conservation interventions intended?***

Recent research about the utterly debunked and pernicious claim about a link between autism and vaccines shows how resistant people are to changing behavior when it is desperately relevant to the their lives and in the face of overwhelming scientific evidence. One study found that presenting the evidence about the safety of vaccines made some parents *less* likely to vaccinate their children.

Findings such as these are enough to make you weep, or chew the furniture, and they raise fundamental questions about the role of science in the public square. This is not an argument against evidence-based conservation, just the opposite. It is, however, an indication of the huge communication challenge we all must face. **SC**

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**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

## Leech Logic and Baselines

**By Craig Leisher, Senior Social Scientist, The Nature Conservancy**


**Above: 19th C. bloodletting business card. Credit: Flickr user John Lester via Creative Commons**

For more than 2,000 years, physicians used leeches to treat everything from hemorrhoids to headaches. Few questioned medical leeches efficacy because authorities such the Greek physician Galen (ad 129–c. 216) used leeches, and many people had seen the sick recover after a good "leeching." Doctors did not discover that medical leeches hurt rather than help most ailments until they developed what statistician Howard Wainer calls "a reverence of empiricism." (Wainer 2014).

How we know something is as important as what we know.

**When it comes to conserving the lands and waters on which all life depends, like a 19th century doctor, we look to anecdote and experience for answers because we lack reliable evidence.**

In conservation, we still rely primarily on "leech logic" for project design. From strengthening protected areas to payments for watershed services, we think we know what works, but we have no evidence. With Red Lists and global habitat prioritizations, we know empirically what we need to protect. But when it comes to conserving the lands and waters on which all life depends, like a 19th century doctor, we look to anecdote and experience for answers because we lack reliable evidence.

We are the first generation in human history to have the ability to use data to inform our decision-making. Rigorous data collection and measurement has revolutionized medicine and finance. But conservation is only just beginning to develop rigorous measurements of our work.

Exhibit A is the "Open Standards for the Practice of Conservation." The April 2013 Open Standards are testament to both how far conservation has come in the last decade

and how far it has yet to go. Twenty-five of the largest conservation organizations and funders supported Open Standards 3.0, and the Standards have become the accepted practice within the conservation community.

When developing a monitoring plan, the Open Standards call for methods that are "accurate, reliable, cost-effective, feasible and appropriate." To which I could add valid, targeted, and a half dozen other adjectives that all describe the ideal monitoring method but fail to prescribe which monitoring method should be used where. The Open Standards give a normative statement about what a monitoring method or tool ought to be. The tools themselves are missing.

I submit that, globally, the single most important tool for conservation monitoring is baseline data — i.e., data on carefully chosen indicators collected before a conservation action begins. Walk with me through the logic.

If we agree that conservation organizations alone are never going to save the lands and waters on which all life depends, and if we agree that our conservation work needs to demonstrate replicable approaches that can be adopted by others, then our monitoring needs to show in the most credible way possible whether a project met its objectives and how it did so. From medicine to education, the caliber of evidence it takes to put a replicable approach into the global marketplace of ideas is some form of experimental or quasi-experimental monitoring design (Shadish et al. 2002). It is the standard of proof without which conservation is just another arm-waver in the crowd. Within conservation, experimental design is rarely possible, but ecology has a useful quasi-experimental design: BACI or Before-After, Control-Impact (Underwood 1994). Economists call this species of study a Difference-in-Differences design (Abadie 2003). Regardless of what it is called, it requires a benchmark, a baseline.

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Baselines are a requirement for evidence-based conservation. Without a baseline, it is impossible to measure what changes over the life of a project. Without a baseline, one cannot verify results. Without a baseline, attribution of cause and effect is impossible.

In short, absent baselines, conservation will never develop rigorous evidence of results and will loose ground among key donors who demand evidence rather than anecdotes before investing.

Baseline data collection is not just about measuring results. A baseline can also help a project design team zero-in on priority actions. Baselines help define the eventual project evaluation because the methods used in the baseline are usually the same methods used in the endline evaluation. Get the baseline right, and a project's likelihood of success goes up, and the ability to measure the expected results is almost certain.

Our mission and our supporters deserve nothing less than a strong focus on evidence-based conservation, and the place to start is with baselines for every new project aimed at replication. For the conservation community to "stand alongside other competing interests and fight its case, justify its need for resources, and demonstrate its effectiveness," as Andrew Pullin advocates in the essay that follows, we need more baselines as a first step. **SC**

# Article

## Whither Evidence-based conservation?

**By Andrew Pullin, Director, Centre for Evidence-Based Conservation, Bangor, UK**

RSPB Reserve, Bedfordshire. Credit: Flickr user orangeaurochs via Creative Commons.

Over a decade after the first arguments and ambitions for evidence-based conservation (EBC) were published (Pullin & Knight 2001; Sutherland 2004) it might seem reasonable to ask what's happened since. The proposal that collecting together all the available evidence on the effectiveness of interventions might lead to better decision making and better use of limited resources was advanced as a basis for something of a revolution. Expectations were high; after all, such an 'effectiveness revolution' was already well underway in human healthcare and conservation might benefit from similar practices.

The proposal for EBC caused much academic discussion (Adams & Sandbrook 2013; Haddaway & Pullin 2013) and a lot of misunderstanding, but did it achieve any progress? A quick comparison of the approximately 6000 health-related systematic reviews collected in the Cochrane Collaboration Library since 1993 with the 60 so far accumulated in the Collaboration for Environmental Evidence (CEE) Library since 2004 suggests progress is slow. A previous article Science Chronicles described this progress as a 'failure to take off.' But this statistic is only one indicator and it ignores some major inequalities in the comparison and some other key developments toward EBC.

The comparison of CEE with Cochrane at first seems valid and is of course made by CEE itself in terms of its visions and goals, but the more specific comparison of rate of production of systematic reviews is not as valid when one considers the readiness of health research and the health community in 1993 compared to the conservation community in 2004. The former already had a large and rapidly increasing base of randomized controlled trials, a highly

professionalized workforce well-attuned to standards of conduct and practice, and the influence of a large and powerful pharmaceuticals industry with vested interest in demonstrating the effectiveness (or hiding the ineffectiveness) of their products. For multiple reasons the state of conservation research in 2004 was, and remains, far patchier in quality, and consequently had less potential for meaningful synthesis. The workforce was more diverse in skills and practice, and sometimes untrained in experimental methods or data to inform their actions. In short, in conservation we started from a much lower baseline than health. Nevertheless, other indicators are more positive.

Advances in how we organize the process of evidence gathering and synthesis have been significant. CEE gained charity status in 2008 and is currently preparing the fifth version of its guidelines on conducting systematic reviews of evidence for environmental management. It has four centers — Australia, South Africa, Sweden, and UK — as well as methodology and subject review groups. In 2012 CEE launched an open-access journal, Environmental Evidence to publish systematic reviews and associated papers. As its name suggests, CEE serves the entire environmental sector, not just conservation, and some areas of that sector have embraced EBP more readily than others.

CEE is an open collaboration and provides opportunities for individuals and organizations to get involved in evidence-based practice. Capacity building is an important goal and training is available in various forms if you want to commission or conduct systematic reviews. The UK Centre will soon launch a new Distance Learning Course. There is a CEE LinkedIn Discussion Group and you can even follow CEE on Twitter (@EnvEvidence) and receive updates as new reviews are published. CEE has thus created a framework for those wishing to become active and contribute to evidence-based conservation.

**Systematic reviews can be an important step in connecting primary research to policy and practice, including in the commercial sector.**

In Europe, the vocabulary of evidence-based practice has spread across the policy community. One can argue that this more a result of 'leakage' from other sectors (e.g. health and education) than bottom up from within the environmental sector, but a few examples may suffice. Within the UK, where the culture of EBP is relatively strong, the Department for Environment, Food and Rural Affairs (Defra) is currently working with CEE to harmonize guidelines for evidence synthesis across its areas of responsibility. Systematic Review is recognized as a gold standard methodology of evidence synthesis within Defra and the UK Government in general, and a number of reviews on environmental issues are underway (e.g. Palmer-Felgate et al. 2013). The European Commission is developing a Biodiversity Knowledge Network to address key questions through evidence synthesis based on systematic reviews. In Sweden, a major charity has funded a new centre for Evidence-Based Environmental Management specifically to commission systematic reviews of evidence on questions of concern to environmental management. The first few of these is now underway (e.g. Bernes et al. 2013). Both the community and the culture of evidence-based practice are growing steadily.

There is still a missing element in terms of incentive to undertake the skilled process of evidence synthesis. Most North American and European Universities have a group or center devoted to evidence synthesis within their Medical School, but few have an equivalent in environmental or ecology departments. Recognition for conducting systematic reviews in conservation and environmental management is still poor in academia, but there are signs of change. Research Councils and Government Funding Agencies are becoming more aware that systematic reviews are a means of realizing the potential of data that they have generated using tax payers money. Systematic reviews can be an important step in connecting primary research to policy and practice, including in the commercial sector.

The impact of EBP is not being seen everywhere, and probably least at the field practitioner level, but even here the principle that providing evidence will help make better decisions is gaining ground. Conservation Evidence is an initiative that provides access to reports of findings on the effectiveness of conservation interventions and is forming close links with conservation organizations that are both contributing case studies and benefitting from better access to evidence. Similar initiatives have been established in other countries, and hopefully these can be more integrated in the future to provide a common standard resource for communicating the effectiveness of many practical interventions. For example, the control of *Crassula helmsii* by inundation with seawater is an intervention reported as successful by the Royal Society for the Protection of Birds in one of their UK reserves and is now being applied in others (Charlton et al. 2010). If more reports of outcome are submitted this could eventually be the subject of a systematic review, or its relevance may remain at a local level, the evidence from one or two studies being sufficient for the scale of decision making.

**Evidence-based conservation is one of a suite of practices that can contribute to the professionalizatio n of conservation, to stand alongside other competing interests and make its case, justify its need for resources, and demonstrate its effectiveness.**

The perceived value of evidence-based practice may depend on the level of the decision being made and the risk of being seen to have made the wrong decision. The finding (by Archie Cochrane and others) that different hospitals were employing different interventions with differing levels of success in terms of health outcomes had multiple repercussions in the health sector. It alarmed policy makers and patients, but it also exposed doctors and consultants to scrutiny and called them to account for their decisions. This may never happen in the case of conservation practice. There is no expectation that organizations should be employing the same interventions to achieve the same outcomes. The understanding of the system and expectation of successful intervention are lower, and usually, the risk of being seen to be making the wrong decision is also low, although reporting failure remains something of a taboo.

Biodiversity conservation is currently under threat of being swamped by a global policy drive to view ecosystems primarily as providers of services for human wellbeing. My fear is that conservation, having risen up the political agenda, will once again

become a fringe activity, largely confined to the voluntary sector. Evidence-based conservation is one of a suite of practices that can contribute to the professionalization of conservation, not in the sense that excludes volunteers, but in situations where the conservation community needs to stand alongside other competing interests and make its case, justify its need for resources, and demonstrate its effectiveness. SC

**References**

Adams, W.M. and C. Sandbrook. 2013. Conservation, evidence and policy. Oryx, 47, 329–335.

Bernes, C. et al. 2013. What are the impacts of reindeer/caribou (*Rangifer tarandus* L.) on arctic and alpine vegetation? A systematic review protocol. Environmental Evidence 2:6.

Charlton, P.E., M. Gurney, and G. Lyons. 2010. Large-scale eradication of New Zealand pygmy weed *Crassula helmsii* from grazing marsh by inundation with seawater, Old Hall Marshes RSPB reserve, Essex, England. Conservation Evidence 7: 130-133.

Haddaway, N. and A.S. Pullin. 2013. Evidence-based conservation and evidence-informed policy: a response to Adams & Sandbrook. Oryx, 47, 336–338.

Palmer-Felgate, E. et al. 2013. How effective are reedbeds, ponds, restored and constructed wetlands at retaining nitrogen, phosphorus and suspended sediment from agricultural pollution in England? Environmental Evidence 2:1

Pullin, A.S. and T.M. Knight. 2001. Effectiveness in Conservation Practice: Pointers from Medicine and Public Health. Conservation Biology 15: 50-54.

Sutherland, W.J., A.S. Pullin, P.M. Dolman, and T.M. Knight. 2004. The need for evidence-based conservation. Trends in Ecology and Evolution 19: 305-308.

# Article

## Evidence-based Conservation: An Economic Perspective

**By Timm Kroeger, Senior Environmental Economist, The Nature Conservancy**

**Above: San Pedro Riparian NCA. Bob Wick, BLM California, via Flickr and Creative Commons.**

At its core, economics is about using scarce resources smartly to maximize the production of desired outcomes. Most human endeavors are constrained by available resources and their pursuit therefore has an economic dimension. Conservation is no exception. So what does it mean to be smart about pursuing conservation objectives? It means employing the strategies and tools that yield the biggest conservation gain for our budget — in other words, maximizing the conservation "return" on our investments.

Unfortunately, figuring out what those gains are for each of the various approaches we might deploy to promote a particular conservation outcome generally is not a trivial undertaking. This task could be aided if systematic reviews were available for many conservation interventions that would provide an evidence base to draw on (Pullin and Knight, 2001).

Yet, for many interventions, that evidence base currently is less than solid, especially interventions that aim to increase the provision of ecosystem services. Here, the challenge is to translate evidence on the effects of interventions on ecosystem functions into the resulting changes in ecosystem services that directly impact people's wellbeing (Ringold et al., 2013). For example, we know that riparian reforestation reduces nutrient

inputs into surface waters from pasture and agricultural lands. But by how much does reforestation of specific lands in the watershed increase the quality of recreational swimming or fishing at the locations those activities occur downstream? How much does it reduce water treatment costs for the downstream utility?

Conducting rigorous experimental or quasi-experimental assessments for each and every project would be prohibitively expensive and inefficient. After all, whatever resources we spend on predicting and documenting the conservation outcomes of interventions are no longer available for actually implementing those interventions and producing those outcomes.

Effectiveness evaluation is itself subject to a return-on-investment calculus: We need to make sure that the additional resources invested in analysis generate "value of information" in the form of improved project design and resulting conservation outcomes that at least offsets the reduction in those outcomes caused by redirecting funds away from implementation and to evaluation. In short, the goal of conservation planning cannot be to identify for each project the "perfect" intervention.

**We need a nuanced approach: focus on projects that most require evidence and are characterized by high risk and high leverage potential, and only where there is a clear plan for incorporating the findings into future planning.**

Despite these challenges, there is an urgent need to build the evidence base for many types of conservation interventions. We need a nuanced approach: focus on projects that most require evidence (Montambault, 2012) and are characterized by high risk and high leverage potential, and only where there is a clear plan for incorporating the findings into future planning (Montambault and Groves, 2009).

But don't we already know that our interventions work?

For many interventions, the answer is yes. The question, however, is not so much whether something works, but rather how much or how well it works, and how much or well it would work at alternative sites. Only if we can answer these questions can we become smarter about selecting our intervention portfolio and improving intervention designs. To return to the riparian example, reforestation reduces sediment loads from a parcel of land, but we need to know how much it does so on parcels with specific characteristics (i.e., land cover/use, slope, soil type and climate), and how those impacts travel downstream to the locations at which we care about sediment (say, fish spawning grounds, reservoirs, or municipal water intakes).

Crucially, the size of the conservation return on our investment depends on what would happen without the conservation action. Reforestation of the riparian zone of a property currently in pasture will reduce stream sediment loads. But we cannot automatically assume that our effect on sediment loads is the difference between current loads and loads produced with a restored riparian forest in place. Reforestation might occur anyway for any number of reasons, or pasture might be converted to row crops or some other cover. Correctly identifying the impact of an intervention on target outcomes thus requires accounting for changes in the other factors affecting those outcomes.

Such "counterfactual thinking" is critical for credible project evaluation and for building the evidence base for conservation and environmental policy in general (Ferraro, 2009). Constructing quality counterfactuals is not easy nor always possible. But neither is it rocket science. Failing to account for the counterfactual — "the world without the project"— can lead to large biases in assessments of intervention effectiveness (Blackman, 2013).

The ability to demonstrate and quantify the effectiveness of conservation interventions will be crucial for mobilizing large-scale investments in natural infrastructure solutions. While those investments seek to increase particular ecosystem services flows rather than conservation per se, they nevertheless can yield substantial conservation benefits. However, mobilizing those investments in many cases will require demonstrating a solid "business case" by showing that conservation produces desired gains in priority ecosystem services at lower cost than alternative solutions.

**The ability to demonstrate and quantify the effectiveness of conservation interventions will be crucial for mobilizing large-scale investments in natural infrastructure solutions.**

Take water funds, for example. Investors contributing to existing water funds in many cases appear to be motivated by a variety of reasons other than a clear expectation of net financial gain. Many of those reasons — advancing environmental science and management; benefiting local communities and ecosystems; applying the precautionary principle — are laudable, and there will be other cases where these reasons provide a sufficient incentive for some investment by some private or public entities.

Yet, it seems reasonable to assume that vastly larger investments in watershed conservation in many more watersheds, not 10 or 20, but 1,000 or 2,000, might be unlocked if one could demonstrate that their returns would exceed those of alternative, conventional solutions. Such demonstration requires evidence based on credible analysis similar in rigor to that demanded for conventional solutions. It also requires application of an appropriate analytical framework that guides the design of efficiently targeted monitoring, construction of counterfactual scenarios, and use of modeling and appropriate ecosystem services metrics (Higgins et al., 2013). In short, to have a chance

at unlocking those sorely-needed new funding streams for conservation, we need to move from intuition, anecdotes and qualitative assessments to quantitative proof of effectiveness. We need to identify where investment in creating an evidence base would yield the highest returns of target ecosystem services, and then start building that base. Water funds have begun doing this, and so have a number of other high-profile strategies.

None of this is easy. Yet it is necessary, worthwhile, and urgent. The massive projected infrastructure spending on climate change adaptation (Parry et al., 2009) will go entirely towards grey infrastructure in the absence of proof of the competitiveness of natural alternatives. And grey infrastructure is sunk-cost and long-lived — once it is in the ground, no amount of proof of the superior performance of natural alternatives will un-build it. **SC**

**References**

Blackman, A. 2013. Evaluating forest conservation policies in developing countries using remote sensing data: An introduction and practical guide. Forest Policy and Economics 34:1-16.

Ferraro, P.J. 2009. Counterfactual thinking and impact evaluation in environmental policy. New Directions for Evaluation 122:75–84.

Higgins, J., A. Zimmerling, A. Vogl, T. Kroeger, L. Bremer, P. Petry, C. Leisher, J. Nelson and H. Tallis. 2013. A Primer for Monitoring Water Funds. Arlington: The Nature Conservancy.
Honey-Rosés, J., K. Baylis and M.I. Ramírez. 2011. A spatially−explicit estimate of avoided forest loss. Conservation Biology 25(5):1032-1043.

Montambault, J. 2012. Conservation's smoking gun: Who bears the cost of making us 'evidence-based'? Science Chronicles September 2012.

Montambault, J. and C. Groves. 2009. Improving conservation practice by investing in monitoring strategy effectiveness. Conservation Measures Working Paper No. 2

Parry, M., J. Lowe and C. Hanson. 2009. Overshoot, adapt and recover. Nature 458:1102-1103.

Pullin, A.S. and T.M. Knight. 2001. Effectiveness in conservation practice: pointers from medicine and public health. Conservation Biology 15:50–54.

Ringold, P.L., J. Boyd, D. Landers and M. Weber. 2013. What data should we collect? A framework for identifying indicators of ecosystem contributions to human well-being. Frontiers in Ecology and Environment 11(2):98–105.

# Viewpoint

## The adoption of evidence based practice – an Australian perspective

**By Rob Richards, Director, Evidentiary, Melbourne, Australia.**

Kakadu, Australia. Credit: Flickr user 12 Green Giraffes via Creative Commons

"Are you telling me that I am not using real evidence to make my decision when I am an expert with 20 years of experience in this area?" A question such as this is often the subtext to an opening conversation about the merits of evidence-based decision making among many environmental practitioners. As the Director of a company that helps policy makers and practitioners adopt evidence based approaches, I have learned that the way we introduce practitioners to evidence based practice may be the difference between them adopting it for the long term adoption and just dismissing it as another passing fad.

The potential benefits to the use of scientific information to support decision making are apparent, but there are numerous barriers, such as lack of access to scientific literature (Pullin and Knight, 2005). The first hurdle, however, may be the fact that experienced practitioners often see little need to use or even consider other sources of evidence in the decision making process. It is also easy to forget that the notion of evidence based practice in the environmental sector is relatively new. A

novice in the area may find the concepts, approaches, and language of evidence-based approaches foreign and initially challenging. A common supposition is that the term 'evidence' has simply been adopted as a substitute for more familiar terms like 'knowledge' or 'information', in order to add credibility and legitimacy to a concept.

While it has been useful to draw on the successes of evidence based practice in the health sector in the early phases of engagement with practitioners, it has been even more useful to elucidate the differences. One of the earliest Australian studies of the potential transfer of evidence-based approaches from the medical to the environmental sectors (Fazey et al.2004) identified some fundamental differences. These included the nature and quantity of available evidence and the nature of questions of concern to environmental management.

I would add that most environmental organizations struggle to identify and prioritize questions that warrant investment in generating new evidence. Most practitioners, however, understand that evidence can ameliorate risk in decision making, and that investing is worthwhile even in a time of decreasing budgets and increasing demands.

**The first hurdle may be the fact that experienced practitioners often see little need to use or even consider other sources of evidence in the decision making process.**

Questions of effectiveness that are best answered by quantitative methods such as meta-analysis resulting in a single statistic can be of limited value to practitioners. It is the contextual variables, or 'effect modifiers,' that are most critical in influencing the size and direction of the outcome. Practitioners are concerned with how an intervention or threat works, and understanding what influences the outcome so that the evidence can be applied to their particular context. As a result, we have found that practitioners respond well to the use systematic reviews where evidence is structured around a simple cause and effect network diagram (Gough et al., 2012) that provides not just evidence to substantiate the cause and effect relationship, but evidence of the effect modifiers as well.

The role of systematic review is essential to evidence-based practice. The benefits, still largely unproven in the environmental sector, will undoubtedly change the way we work, just as we have seen in medicine. Our challenge is to integrate the findings of systematic review into policy and practitioner decision making. We need to embrace systematic review as a key component of the adaptive management cycle, not as a decision end point.

Our greatest initial challenge is a cultural change. We must accept that there is a wealth of evidence beyond our own personal or organizational experiences that can provide us the confidence we need for more sound environmental decision making.

Current Australian environmental funding and auditing arrangements often reward the collection of evidence more than the application of evidence in demonstrating adaptive management. This perhaps reflects the immaturity of the understanding of environmental evidence based decision making in Australia and the need for new practices. The lead role that organizations such as the Collaboration for Environmental Evidence are playing in advocating and setting international standards for the collection and synthesis of environmental evidence is critical to inspiring cultural change of environmental practice. Our role is to advocate, integrate, and pollinate the role and findings of systematic review onto the practitioner's desk and apply it in the construction of a decision-making framework. **SC**

**References**

Fazey, I., J.G. Salisbury, D.B. Lindenmayer, J. Maindonald, and R. Douglas. 2004. Can methods applied in medicine be used to summarize and disseminate conservation research? Environmental Conservation 3: 190–198.

Gough, D., S..Oliver, and J. Thomas. 2012. An introduction to systematic reviews. Sage Publications.

Pullin, A.S., and T.M. Knight. 2005. Assessing Conservation Management's Evidence Base: a Survey of Management-Plan Compilers in the United Kingdom and Australia. Conservation Biology 19:1989–1996.

Regan, H.M., M. Colyvan, and M.A. Burgman. 2002. A taxonomy and treatment of uncertainty for ecology and conservation biology. Ecological Applications 12:618–628.

# Article
# So you want to visualize data

By Dan Majka and Tara Schnaible, The Nature Conservancy


Image credit: Lauren Manning via Flickr via and the Creative Commons.

Data visualization is one of the best tools in the science communicator's toolkit for understanding and probing a problem. From elegant and functional static journal figures, to the interactive graphics The New York Times uses expertly to tell stories, to visualizations such as the worldwide wind and ocean currents map that are so beautiful they border on art, it is difficult to know where to start. How are these visualizations created, and how can we communicate our data more effectively using the same techniques?

Unfortunately, 500 words are not enough to teach anyone how to create an effective visualization. And while a picture is worth a thousand words, and surely visualization is worth ten thousand, that is still not enough to say anything too useful. Like any other endeavor that requires a mix of analytical and creative thinking, the best way to get started is to 1) get inspired, and learn how to distinguish between good and bad visualizations, 2) learn conceptually what makes a good visualization, and 3) practice, practice, practice.

### Getting inspired

To create your own visualizations, it is helpful to train your eyes to recognize examples of what works well and what works poorly. A great collection of bad graphics can be found at WTFViz, a blog dedicated to visualizations that make no sense. Junk Charts is another good source, and is particularly useful because it breaks down why certain graphics do not communicate effectively.

More exciting are good visualizations: those that communicate in a clear and intuitive fashion, providing "visual representations of abstract data to amplify

cognition" (Card et al. 1999). For my money, the best visualization team on the planet is the NYT graphics department, a team of ~30 individuals who use a wide range of visual storytelling techniques. I recommend checking out the NYT Graphics twitter account, yearly graphic wrap-ups from 2013 and 2012, and Andy Kirk's article on 10 things you can learn from NYT's data visualizations, for starters.

Another great source of inspiration is VisualLoop's visualization round-ups, a collection of the best published graphics in any given week. The great thing about VisualLoop is that they break down their posts into thematic categories such as digital cartography, interactive graphics, visual journalism, and vintage infodesign. Another must-read is the DashingD3 newsletter, a great weekly email wrap-up of inspiring visualizations, technical tutorials, and blog articles. Finally, check out HelpMeViz, a site that allows you to submit a graphic and get helpful advice from the pros on how to improve it.

**Learning what makes a visualization good**

Seeing the great work of others is inspiring, but it is useful to step back to learn the basic principles on how to create effective graphics. If you can't sketch out an idea for a graphic on the back of a napkin, chances are slim you'll be able to effectively visualize the idea using a computer.

**The purpose of information visualization is not to make pictures, but to help us think. – Stephen Few, *Now You See It***

While Edward Tufte's is often the first name thrown around when people talk about information design, his ideas are often too abstract to apply directly, and he too frequently passes off opinion as fact. Better to start with Stephen Few's books *Show Me the Numbers*, *Now You See It*, and *Information Dashboard Design*. Few provides specific, tangible advice for designing graphs and tables that can be applied with simple tools such as Excel to make more effective figures for publications and reports.

Moving to more complex visualizations, Isabel Meirelles created one of the better resources integrating both theory and a wealth of examples in her book *Design for Information*. Finally, if you geek out on the cognitive theory behind what makes an effective visualization, and want to better understand how the brain processes graphics, there is no finer book than Colin Ware's *Information Visualization: Perception for Design* (2012).

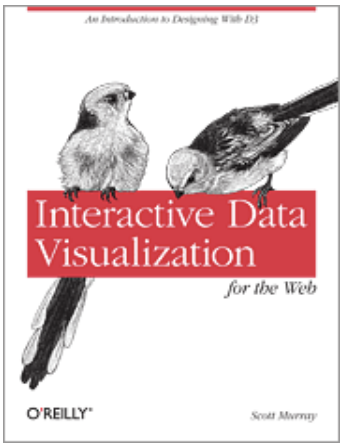
**Learning the tools**

After getting inspired by others' work and reading a bit to understand what makes a good visualization, you're probably excited to create your own. So, you sit down to your computer, turn it on, and…uh…what now?

There are a bafflingly large number of tools for visualizing data, ranging from simple tools like Excel, more advanced commercial tools like Tableau, and dozens of open source code libraries. For simple graphs, the combo of Excel + ideas gleaned from

Stephen Few can go a long way. If we're interested in creating interactive graphics, however, we can look to the tools professional data journalists such as those at the New York Times and Washington Post use. The good news is that just a handful of tools power a majority of interactive graphics these days; the bad news is that to learn them, you have to learn a bit of coding.

A good fraction of the interactive graphics created by the Times, Post, and other journalism outfits are now powered by the D3js library. D3 (data driven documents) is a JavaScript library that gives you the tools to efficiently create visualizations from scratch. If you can dream a visualization up, there's probably way to make it happen with D3. Bostock provides a huge number of examples that let you examine his code to understand how things work. An accessible introduction to D3 is Scott Murray's book *Interactive Data Visualization for the Web*, which can be read for free online.




A couple other options are also worth mentioning. Plotly creates high-quality visualizations from Excel or CSV files, and also provides an interface for creating graphs from languages such as R and Python. Highcharts is a JavaScript charting library that is a little easier to use than D3, but also much less powerful. Bokeh is a D3-inspired library for Python for creating interactive graphics, and ggplot2 is probably the best graphics package for R, and can also be used through a web-based interface.

**"We don't use templates for our visualizations, just like we don't use madlibs for our articles." – Amanda Cox, NYT Graphics Desk**

Finally, let's talk maps. Mapbox, and their free tool for designing interactive maps, Tilemill, provide a way to create customized basemaps that work at multiple scales (like a customized Google Maps), as well as a JavaScript library for interacting with maps. CartoDB allows for easy map visualizations using large data sets, and Leaflet is a wildly popular, easy-to-use JavaScript library for creating simple web maps. If you're used to developing web maps using Esri's tools, they created a plugin for Leaflet that makes it easy to combine Esri's maps with Leaflet.

### Continuing the conversation

To share resources, tips, favorite graphics, and provide a space where staff can ask for suggestions on how to improve graphics, we've created a new Data Visualization community on Connect for TNC employees. We encourage you to join. Let's learn together! SC

### References

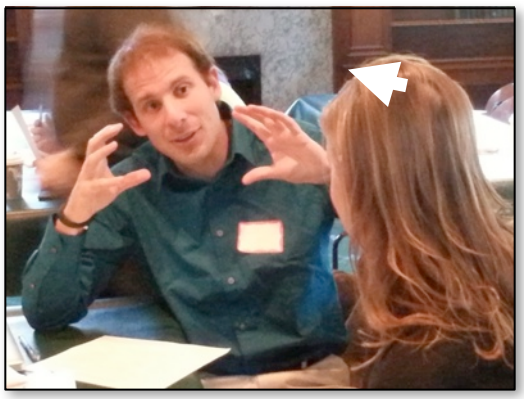
Cart, S.K., J. Mackilay, and B. Schneiderman (Eds). 1999. Information visualization: using vision to think. San Francisco, CA. Morgan Kaufmann.

# The Nature Conservancy's Science Impact Project

*Supporting innovation, leadership, and communication for conservation success.*

The Science Impact Project (SIP) is now recruiting Conservancy scientists to join its third cohort, beginning in June, 2014. SIP is one of the premier communications and thought leadership training programs in applied conservation science today. Find out more about the program and details on how to apply below:

**What is SIP?** Conservation leadership in today's world means not only delivering on-the-ground results, but also being a visible, articulate *thought leader* — innovative, interdisciplinary, and able to communicate effectively with a variety of audiences. And the Nature Conservancy increasingly demands leaders of this caliber to implement and drive its Global Challenges/Global Solutions Framework.



SIP — now recruiting in its third year — draws together exceptional talent from the Conservancy's global science staff to cultivate superior leadership and communications skills. Through a series of targeted trainings and mentoring, SIP helps TNC scientists develop paradigm-shifting ideas on how to best meet today's greatest conservation challenges — and gives them the tools and strategies to help put them into action.

**"I've never experienced such a supportive environment; SIP stimulates and celebrates creativity, encouraging me to push my limits." —Stephanie Wear, SIP 2012**

Candidates for the program propose a novel and significant project to complete over 2 ½ years. Selected participants commit to attending semi-annual meetings where they will pursue advanced communication and leadership training, challenge and support each other, and be mentored by senior leadership in science and science communications. As part of developing their professional persona, SIP participants will also take on a team project — leading to a group publication that advances the conservation conversation in a significant way and contributes to the evolution of the Conservancy's strategy and profile.

*For Cohort 3, applications from U.S. based female scientists as well as scientists based outside the United States are especially encouraged.*

**About the training:** SIP is much more than a series of training opportunities. The program offers a curriculum that builds from basic messaging and presentation skills, through special communications topics, to collaboration, leadership and organizational effectiveness. With the same group of scientists at each workshop, participants come to trust and rely on each other to offer fresh ideas, new perspective, and supportive and thoughtful critique. In addition to in-house expertise, the science communication staff draws on trainers with specialized experience in messaging, presentation skills, performance, data visualization, media effectiveness, emotional intelligence, leadership, and the science of science communication.

**About the projects:** The *group project* will be selected jointly at the first meeting, based on the strengths and skills of the group with input from the Central Science team.

*Individual projects* are proposed as part of the application process and must be approved by the candidate's supervisor. The ideal individual project incorporates three considerations. It should be a manifestation of the candidate's individual expertise and ambition; it should aim to shift conservation practice or advance the scientific conversation in a globally or regionally significant way; and it should be coherent with the goals of the candidate's operating unit. The candidate's supervisor should participate in selecting and refining the project.

The individual project represents a major focus of the program. Participants will develop and carry out an implementation and dissemination plan for projects and related products, which will provide a focus for all program activities.

Previous projects have included:

- Developing and implementing a new approach to cell phone based surveys for social data in Africa
- An analysis of the interplay between land-sharing and land sparing in tropical forests
- A book, grounded in a family trip down the Mekong River, integrating themes of river conservation, children and nature, and evolving cultures
- Developing a strategy for restoring financial stability to Australia's reserve system
- Analysis of enabling conditions for effective management in data poor fisheries
- An investigation of the factors contributing to awareness and selection of green infrastructure solutions

**Application deadline is April 4, with selection completed by May 1. Applicants must secure support for their candidacy and their project from their supervisor. The first group meeting is scheduled for June 2-6, 2014.**

For questions or additional information, contact Marty Downs, Associate Director, Science Communications.

To apply, please submit the following documents to sip@tnc.org no later than April 4, 2014: Items 1-3 should be submitted as a single pdf, using the e-mail subject line: SIP3 Application: <firstname lastname>. The candidate's supervisor should submit item 4 directly to sip@tnc.org, using the subject line: SIP3 Letter of Support: <candidate's firstname candidate's lastname> from <supervisor's firstname supervisor's lastname>.

- Letter of interest, including candidate's background in conservation, recent accomplishments, and goals for the program
- A brief (<1500 word) project description, including a 200 word abstract
- A current résumé
- A letter of support from candidate's supervisor, submitted directly to sip@tnc.org SC

# 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)** The little things that run, or save, the world. The changes in ocean chemistry we are now seeing resemble those that occurred when underwater volcanoes melted frozen methane deposits 55 million years ago. But those changes took place over 1,000 years, while we are now accumulating the same amount of about $CO_2$ in the upper ocean in one-tenth that amount of time. Then, acidic waters eventually turned over and dissolved long-dead plankton on the sea floor, releasing calcium carbonate the acted as an antacid. Now, we may not have the benefit of that braking mechanism.

***2)*** Karl Marx, ecological sociologist. Ideology aside, this, from 1867, is prescient: "[Man] sets in motion the natural forces, which belong to his own body, his arms, legs, head and hands, in order to appropriate the materials of nature in a form adapted to his own needs. Through this movement he acts upon external nature and changes it, and in this way he simultaneously changes his own nature."

***3)*** Some good news for a change from the Capitol: for the first time since 2009, both houses of Congress passed a wilderness bill. That used to be an annual occurrence, every year since the Wilderness Act was passed in 1964, regardless of who was in power, but now its newsworthy. Such are the times we live in. Meanwhile, at the White House, new counselor John Podesta is pushing President Obama to adopt more aggressive environmental policies this year.

***4)*** Frankly, I am not sure if this is encouraging or depressing. The depressing part is that efforts to create a standard language for ecology have been going nowhere for a long time, and this might be just another in the impressive line of failures. Still, these authors bring a new sensibility to the effort, bred in part by a background in storytelling and performance.

***5)*** Can trophy hunting be a conservation strategy in Africa? This is hardly a new debate, so it is hard to believe that the hunter Corey Knowlton was unaware of the visceral reaction many people would have to the idea of shooting a black rhino in Namibia as a means of furthering conservation efforts there. But the debate is playing out in new ways; among other things, the hactivist group Anonymous crashed the websites of both the Dallas Safari Club, that is sponsoring the hunt, and the Government of Namibia.

***6)*** Western water woes are not news, but this article sums up the issues in the context of the current water crisis in California.

***7)*** On the other hand, too much rain brings other problems. In Wales, recent record storms have unburied the remains of a 6,000 year-old forest. **SC**

## Announcements

## Peer Review Help Desk

For the past three years, the TNC Science Peer Review Help Desk has provided peer review to 33 different documents or products. From manuscripts being prepared for publication in peer-reviewed journals, to reports that had been written by a consultant, to an Excel tool, we have matched up TNC staff with expert reviewers to help them identify opportunities for improvement. Originally we served as an intermediary between the reviewers and authors to allow for anonymous review. But we found that authors often had questions for their reviewers, and few reviewers chose to remain anonymous. As a result, in 2014 we will be shifting the role of the help desk to directly connecting authors with potential reviewers.

The process for obtaining review will remain similar. Email jon_fisher@tnc.org whatever you want reviewed (from a half-baked outline to a polished manuscript), along with details of the kind of reviewers you need (e.g. tallgrass prairie ecologists, business planning experts, South American spatial planners, etc.). We will search for people who meet your criteria, and email you back with a list of potential reviewers (and some documents to help explain the process) within a week. From there, you can directly email them to ask for their help. Hopefully simplifying the process in this way will allow us to facilitate more peer review. If you have any questions or comments, please contact jon_fisher@tnc.org **SC**

## *Chronicles* Summer Book Issue Needs You

It's almost spring, so it must be time to plan your summer reading. If you would like to help your fellow bibliophiles, here is what you do: read one or more books, any topic, fiction, non-fiction, memoir, even something about vampires if you must, then write 250-300 words, distilling your opinions about said book. Send to pangolin19@gmail.com by Memorial Day for inclusion in the ever popular Summer 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: pkareiva@tnc.org and rlalasz@tnc.org. Please include "Chronicles Citation" in your subject line so we don't miss it.**

**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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Blandon, A. and **P.S.E. zu Ermgassen**. 2014. Quantitative estimate of commercial fish enhancement by seagrass habitat in souther Australia. Estuarine, Coastal and Shelf Science 141:1-8.

Collinge, S.K. C. Ray, and **J.T. Marty**. 2013. A Long-Term Comparison of Hydrology and Plant Community Composition in Constructed Versus Naturally Occurring Vernal Pools. Restoration Ecology 21:704-712.

**Fitzsimons, J., M. Heiner, B. McKenney, K. Sochi,** and **J. Kiesecker.** 2014. Development by Design in Western Australia: Overcoming offset obstacles. Land 3: 167-187.

Gillespie, N., A. Unthank. L. Campbell, P. Anderson,R. Gubernick,; M. Weinhold, D. Cenderelli, B. Austin, D. McKinley, S. Wells, J. Rowan, C. Orvis, M. Hudy, **A. Bowden**, A. Singler, E.Fretz, and **J. Levine**. 2014. Flood Effects on Road-Stream Crossing Infrastructure: Economic and Ecological Benefits of Stream Simulation Designs. Fisheries 39:62-76.

**Kroeger, T**. 2013. The quest for the "optimal" payment for environmental services program: Ambition meets reality, with useful lessons. Forest Policy and Economics 37: 65-74

Baruch-Mordo, S, J.S. Evans, J.P. Severson, D.E. Naugle, J.D. Maestas, **J.M. Kiesecker,** M.J. Falkowski, C.A. Hagen, and K.P. Reese. 2013. Saving sage-grouse from the trees: A proactive solution to reducing a key threat to a candidate species. Biological Conservation 167: 233-241

**Reemts, C. M**. 2013. "Allometric Equations for Ashe Juniper (Juniperus ashei) of Small Diameter." The Southwestern Naturalist 58: 359-363.

Saenz, S., T. Walschburger, J.C. González, J. León, B. McKenney, and **J. Kiesecker**. 2013. Development by Design in Colombia: Making Mitigation Decisions Consistent with Conservation Outcomes. PLoS ONE 8(12): e81831. doi:10.1371/journal.pone.0081831

Saenz, S., T. Walschburger, J.C. González, J. León, B. McKenney, and **J. Kiesecker**. 2013. A Framework for Implementing and Valuing Biodiversity Offsets in Colombia: A Landscape Scale Perspective. Sustainability 5: 4961-4987.

**Special Section in Coastal Management**
Over the last 5 years, the AP Marine Program (now Indo-Pacific Division) has been engaged in supporting the CTI-CFF through the US-CTI Support Program and the Coral Triangle Support Partnership (CTSP). One outcome was a Special Theme issue of the Coastal Management Journal to summarize all aspects of the development of the CT MPA System Framework and Action Plan.

The Theme Issue: Establishing a Region-wide System of Marine Protected Areas in the Coral Triangle focuses on describing progress towards achieving MPA commitments under the CTI-CFF, through a partnership of lead national agencies of the CT6 and implementation partners (non-government organizations, multi and bilateral aid agencies, and scientists) and elaborates the issues that need to be addressed and research questions that need to be answered to move the CTMPAS forward. The papers include an introduction to the Coral Triangle and six papers. TNC affiliated papers are below.

**White, A. T.**, Aliño, Porfirio M.,Cros, A.,Fatan, N. A., **Green, A. L**.,Teoh, S. J.,Laroya, L.,Peterson, N.,Tan, S.,Tighe, S.,Venegas-Li, R.,Walton, A, and **Wen, W**. 2014. Marine Protected Areas in the Coral Triangle: Progress, Issues, and Options. Coastal Management 42: 87-106.

Walton, A.,**White, A T**., Tighe, S., Aliño, P. M., Laroya, L., Dermawan, A., Kasasiah, A., Hamid, S.A.,Vave-Karamui, A., Genia, V.,De Jesus Martins, L., and **Green, A. L.** 2014. Establishing a Functional Region-Wide Coral Triangle Marine Protected Area System. Coastal Management 42: 107-127.

**Cros, A.**,Venegas-Li, R., Teoh, S.J., **Peterson, N**., **Wen, W.**, and Fata A. 2014 Spatial Data Quality Control for the Coral Triangle Atlas. Coastal Management 42: 128-142

**Green, A. L**., Fernandes, L., Almany, G., Abesamis, R.,McLeod, E., Aliño, P. M., **White, A.T., Salm, R**., Tanzer, J.,and Pressey, R.L. 2014. Designing Marine Reserves for Fisheries Management, Biodiversity Conservation, and Climate Change Adaptation. Coastal Management 42: 143-159

Weeks, R., Aliño, P.M.,Atkinson, S.,Beldia, P, Binson, A., Campos, W.L., Djohani, R., **Green, A.L**.,Hamilton, R., Horigue, V, Jumin, R.,Kalim, K., Kasasiah, A., **Kereseka, J**.,Klein, C., Laroya, L., Magupin, S., **Masike, B**., Mohan, C., and Da Silva Pinto, R.M. 2014. Developing Marine Protected Area Networks in the Coral Triangle: Good Practices for Expanding the Coral Triangle Marine Protected Area System. Coastal Management 42:183-205

**SC**