SCIENCECHRONICLES

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Image: Singapore's futuristic Garden by the Bay. Credit: Flickr user williamcho and a Creative Commons license.

The Future Is Now

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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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Craig Groves
Genetic Engineers and Conservation Biologists: Scenes From a First Date

By Craig Groves, director, Conservation Methods and Learning

Image: Woolly mammoth sculpture. Image credit: Flickr user anitakhart via a Creative Commons license.

Sipping coffee one morning in early April, my eyes quickly darted to an article in my city newspaper by our local hunting columnist entitled "De-extinction coming to Montana." I didn't even need to read the column to know what was coming. Having just read the cover story in the April issue of *National Geographic* on bringing back extinct species, our columnist — who has spent years fretting over a conservation initiative to restore bison to the grasslands of eastern Montana — now found good reason to fear that the reintroduction of woolly mammoths and other extinct species was headed our way.

Fast forward a week later and I was in Cambridge, England, along with Conservancy Chief Scientist Peter Kareiva, at an international conference organized by the Wildlife Conservation Society on the topic of synthetic biology and how it may influence the future of nature and conservation.

You may already be asking yourself, just what is synthetic biology? In a recent paper in *PLOS Biology*, Kent Redford and colleagues, borrowing from the Presidential Commission for the Study of Bioethical Issues, defined it as "a scientific discipline that relies on chemically synthesized DNA, along with standardized and automatable processes, to address human needs by the creation of organisms with novel or enhanced characteristics or traits." The Cambridge meeting brought together over 80 synthetic biologists and conservation scientists to learn about each other's disciplines and explore how we could work together. (It may be easier to think of synthetic biologists as genetic

engineers, as they definitely approach their discipline from an engineering perspective.) From the perspective of a conservation organization like The Nature Conservancy, the meeting was really a first, significant opportunity to better understand how synthetic biology could contribute to the practice of conservation. As for those wooly mammoths, their return to Montana is neither technically or politically feasible for at least decades. And de-extinction? It is but one high-profile tip of the iceberg of the vast and rapidly growing field of synthetic biology.

As the framing paper for the Cambridge conference explained, synthetic biology is already influencing our daily lives (think GMOs) and may well be transformative across six sectors: bio-energy, agriculture and food production, environmental protection and remediation, consumer products, chemical production, and human health. The revenue from GMOs alone in the U.S. is already valued at over 2% of GDP.

The Cambridge gathering explored both the promises and pitfalls of synthetic biology. For example, former TNC scientist and now chief scientist for WWF-US Jon Hoekstra noted that about 24% of the world's land remains up for grabs in terms of its use, much of that land is degraded, and synthetic biology techniques show real promise in helping restore these lands. Stanford marine biologist Steve Palumbi reported on innovative research he leads in American Samoa to identify and protect coral reef species that have genetically evolved to tolerate warm waters, findings that could help the Conservancy and other conservation organizations confront the challenge of warming oceans and coral bleaching. Jay Keasling, a professor of chemical engineering at UC Berkeley and one of the foremost authorities in synthetic biology, reported on his lab's successful efforts to synthesize the anti-malarial drug artemisinin, research that has been supported by the Bill and Melinda Gates Foundation in their global efforts to eradicate malaria.

Despite the promise of synthetic biology, there are no shortage of legitimate concerns ranging from gene leakage into the environment, to a weak regulatory environment, bio-terror, and indirect negative impacts on biodiversity (such as through "green grabbing" or the appropriation of lands for synthetic fuel purposes). As Redford et al.'s *PLOS* paper points out, there seems to be very little middle ground — "utopias and dystopias seem to be the only scenarios possible" is a widely quoted sentiment of synthetic biology. These worries were often evident at the Cambridge conference, even if a bit one-sided. As conference organizer Redford joked: "Conservation biologists get more pessimistic when they drink, but synthetic biologists get more optimistic."

"As Redford et al.'s *PLOS* paper points out, there seems to be very little middle ground — "utopias and dystopias seem to be the only scenarios possible" is a widely quoted sentiment of synthetic biology."

Redford and his colleagues have identified five key issues related to the confluence of synthetic biology and conservation that need to be seriously considered by all of us involved in nature conservation:

- *Extinction may not be forever*. We are on the verge of re-creating extinct species like the passenger pigeon, yet doing so should give us pause to consider a number of scientific, conservation, political, and philosophical issues.

- *Synthetic life evolves*. As it evolves, it raises serious questions for science and conservation such as how these new organisms will interact with existing species

and whether the conservation community will consider ecosystems that contain these new species as enhanced or degraded.

- *Our working definition of "natural" is no longer fit for purpose*. The impacts of climate change are already forcing us to re-think what is "natural" as species shift their ranges into previously unoccupied habitats and novel ecosystems are created. The introduction of synthetic species raises the very same issues.

- *Nature's services can be synthesized*. As the Conservancy advances its efforts to incorporate ecosystem services into our conservation practice, how will we think about organisms that are created specifically to generate some of these services such as pollution control or carbon sequestration?

- *Synthetic life delivers private benefits*. Synthetic biology is already producing products that are netting large corporations enormous profits with negative impacts at times for small producers' livelihoods and for conservation land use. There are clearly risks, benefits, gains, and losses on both the private and public side at stake. How will the Conservancy's growing corporate relations efforts best navigate these murky waters?

For those who may be interested in learning more about synthetic biology and its role in conservation, there are many useful papers to read or blogs, podcasts, and TED talks to investigate. A good starting point would be to read the framing paper for the Cambridge conference — "How will synthetic biology and conservation shape the future of nature?" — along with the *PLOS Biology* paper previously referenced. You can also check out Ed Yong's excellent blog on the topic for *National Geographic*, an intriguing two-part podcast with Kent Redford posted by the staff of *Scientific American* Stewart Brand's (of *Whole Earth Catalog* fame) enthralling TED talk on the "dawn of de-extinction," and a fascinating recent forum on de-extinction hosted by the National Geographic Society entitled *TEDxDeExtinction*.

"The impacts of climate change are already forcing us to re-think what is "natural" as species shift their ranges into previously unoccupied habitats and novel ecosystems are created. The introduction of synthetic species raises the very same issues."

In a rousing after-dinner talk at the Cambridge conference, Harvard social psychologist and best-selling author Daniel Gilbert reminded us that one of the most fascinating elements of the human condition is our ability to imagine the future, followed by several sobering accounts of how lousy we are at predicting our own futures.

Regardless of what we may think about synthetic biology, there is at least one future we don't have to imagine and that we can predict fairly reliably — synthetic biology is going to significantly influence our lives and our conservation work in the years ahead. Whether it will be a force for nature or not will hinge in part on how we in the conservation community engage with our bio-engineering colleagues. **SC**

References

Redford, K.H, W. Adams, and G. Mace. 2013. Synthetic biology and conservation of nature: wicked problems and wicked solutions. *PLOS Biology* 11:e10011530.

Article
Like Zombies, Invaders Come in Multiples

By Sara Kuebbing, University of Tennessee, Knoxville

Image: Zombie parade. Image credit: Flickr user Eric.Parker via a Creative Commons license.

I *always* used to get in trouble for talking in school. No matter the subject, no matter the classmate next to me, I always received stern looks and grumbles from my teachers. I always felt that this was unfair. There were many *other* chatterboxes in the classroom — I just seemed to be one who always got caught.

Maybe it is this deep-rooted sensitivity that has led me to my current research interests. I study biological invasions, specifically terrestrial plant invasions, and their impacts on native communities and ecosystems. Yet, I feel strongly that the current research paradigm of my field is focused too narrowly on understanding the impact of a single invasive plant across a landscape. Just like how my teacher ignored the other chatterboxes in the classroom, our scientific inquiry may be missing the impacts of other invaders within our ecosystem "classrooms."

If we want to know more about the impacts of bush honeysuckle (*Lonicera spp.*) or purple loosestrife (*Lythrum salicaria*) there are many published studies showing the negative population, community and ecosystem impacts of these individual invasive plants. In reality though, if you stroll through a forest or a wetland, you will come across more than just these individual species.

For example, in eastern Tennessee, where I currently live, the mixed hardwood deciduous forests are home to a few shrubby woody invaders. While I'm well aware of

the published literature that tells me about the influence of bush honeysuckle on native pollinator networks or the decline of native plants in association with stands of Chinese privet (*Ligustrum sinense*), there is no research to explain the impacts when these two shrubs are growing side-by-side. Furthermore, these forests may also showcase woody vine invaders like Japanese honeysuckle (*Lonicera japonica*) or Asiatic bittersweet (*Celastrus orbiculatus*), herbaceous understory invaders such as English ivy (*Hedera helix*) and garlic mustard (*Alliaria petiolata*), or even canopy species like princess tree (*Paulownia tomentosa*) and mimosa (*Albizia julibrissin*).

Increase in Invaders Leads to New Ecosystems

I am not the first to note that we are seeing an increase in invader richness in many habitats. In 2003, Sue Milton wrote in the *South African Journal of Science* about the concept of "emerging ecosystems." She defined these as never-before-seen ecosystems that arose on highly disturbed tracts of land cleared of vegetation and then left to re-vegetate under new conditions. In 2006, Richard Hobbs and colleagues expanded this concept and introduced the term "novel ecosystems" to describe any landscape that contained novel combinations or abundances of species that had never occurred together before. While emerging ecosystems deal with anthropogenic land disturbance and novel ecosystems more broadly with anthropogenic climate change, both these concepts touch upon the issue of invasion. Underlying both is the implication that new communities, composed of odd mixes of native and invasive species, are becoming more frequent and must be addressed by research.

Academia has been thinking about these mixtures of invaders, but until now (to my knowledge) there are only sparse records of efforts to quantify how common it is to find multiple invaders within a habitat. However, thanks to all of you who have entered conservation projects and CAP plans into the Conservancy's ConPro database, we now have quantifiable data to support the hypothesis that it is more common to come across a site invaded by multiple invasive species than one invaded by only a single invasive species.

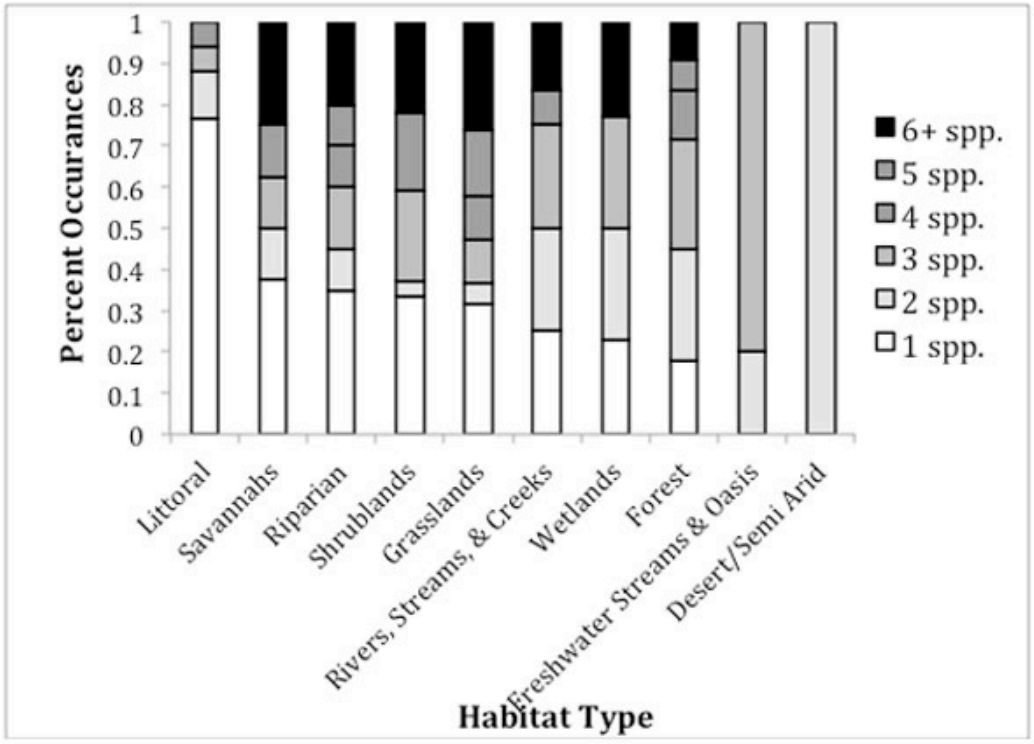
"While emerging ecosystems deal with anthropogenic land disturbance and novel ecosystems more broadly with anthropogenic climate change, both these concepts touch upon the issue of invasion."

With the help of ConPro database managers, I conducted a search through the database and extracted all entries that listed invasive plant species as a "threat." Starting with over 4,500 entries that had Invasive Species as a threat — by far, the most commonly listed threat according to the Conservancy's Jon Fisher — I culled this list to 1,700 entries that met the following two criteria: (1) only "threats" concerning invasive, exotic, terrestrial plant species and (2) "conservation targets" limited to those with specified habitat-based targets (i.e. plant species assemblages or ecological systems). I further refined this list to contain only those entries that specified which invasive plant species were of concern. To increase my sampling size, I emailed all the ConPro public project managers to ask for more details when invasive plants were listed as threats to conservation targets. This surveying brought my dataset up to 311 entries for which I could identify the habitat-type and specific plant invader(s) of concern.

From these data, I've found that an overwhelming 69% (N = 214) of those entries were typically concerned with more than one plant invader within a habitat. This pattern contrasts with current research activity, which focuses primarily on effects of single species. Looking within those entries only concerned with single-species invaders we see that 47% (N = 42) were grasses. The graminoids giant reed (*Phragmites australis*) (N = 12) and cheatgrass (*Bromus tectorum*) (N=12) were especially likely to be cited as solo-invaders.

Parsing the data by habitat type also proved to show interesting patterns (figure 1). Some broad habitat types, like forests and wetlands, have multiple species of concern (> 80% of the entries). Conversely, littoral and savannah communities (grass-dominated) were much more likely to report only a single problematic invader. The results of this analysis have been recently published in *Biological Conservation*.

Figure1: Number of invader species by habitat type.



"Although I can now observationally and quantitatively support the hypothesis that invaders congregate, I would argue that the current invasion biology research paradigm still does not take this phenomenon into account."

How Do Multiple Invaders Interact?

Although I can now observationally and quantitatively support the hypothesis that invaders congregate, I would argue that the current invasion biology research paradigm still does not take this phenomenon into account. It seems, with cases like eastern Tennessee's forests (and, I imagine, many, many other habitats around the world) that research needs to shift its focus from single-invader impact studies and begin to assess how multiple invaders may have non-additive or differential effects.

There are few studies that have looked at the impacts of co-occurring invaders, but those that have provide very interesting results. For example, Peter Kourtev, Joan

Ehrenfeld and colleagues have shown in a series of studies that two common invaders in New Jersey's forests, Japanese stilt grass (*Microstegium vimineum*) and Japanese barberry (*Berberis thunbergii*) have structurally and functionally different microbial communities and increases in invasive earthworm abundances than native blueberries (*Vaccinium* spp.). These plant-induced soil differences (which were confirmed through greenhouse studies) led to increased rates of soil nitrogen cycling. While different mechanisms are associated with this increased rate of nitrogen cycling with each exotic (barberry produces ample nitrogen-rich leaf litter that decomposes quickly; stilt-grass has shallow roots that loosely bind soil particles causing higher N mineralization), both seem to capitalize on the increased rates more quickly than does the native blueberry. This could explain the co-dominance of the two invaders and a potential mechanism for native plant exclusion.

While some invaders might create positive feedbacks, some multiple invaders might be more likely to compete with one another. Travis Belote and Jake Weltzin studied competition between two common eastern Tennessee invaders, Japanese honeysuckle (*Lonicera japonica*) and Japanese stilt-grass (*Microstegium vimineum*), and found that in forest understories, these two species compete for space and light. They showed, through a series of manipulative experiments, that the fast-growing annual grass will typically outcompete and exclude the perennial woody vine unless enough "support hosts" (i.e. climbing branches) exist to allow the vine to overtop the grasses' canopy.

The paucity of studies like those I mention above show that we have little understanding of when invaders will interact positively, negatively or neutrally with one another. Will invasive plants facilitate one another, leading to a daunting "invasion meltdown" scenario in which the number and impact of invaders accelerate as more are added to the system? Will multiple, co-occurring invasive plants compete more with one another than with natives, introducing some sort of natural "biological control" as the number of invaders within a community increases? Understanding these interactions among plant invaders is critical for conservation planning techniques that intend to prioritize and plan for invasive management.

"Will invasive plants facilitate one another, leading to a daunting "invasion meltdown" scenario in which the number and impact of invaders accelerate as more are added to the system?"

There is a lot of noise in any given ecosystem and yet we tend to focus only on individual noisemakers. With the excellent data provided by TNC and the ConPro database, we can now say with more confidence (and in my case, some personal satisfaction) that it is time for us to stop ignoring those other "chatterboxes" in our ecosystem classrooms. **SC**

Sara Kuebbing *is a doctoral candidate at the University of Tennessee, Knoxville. Her dissertation research focuses on the impacts and implications of co-occurring invasive plant species. Prior to entering graduate school, Sara was the program coordinator for the Vermont Chapter of The Nature Conservancy's "Wise On Weeds!" invasive plant outreach program. Sara also holds a B.S. in Wildlife Conservation from the University of Delaware.*

Eddie Game
Prediction in Conservation

By Eddie Game, conservation planning specialist, The Nature Conservancy

Image: Swans refracted in crystal ball. Credit: Flickr user Lee Jordan via a Creative Commons license.

"It's tough to make predictions, especially about the future." — Yogi Berra

The term *prediction* tends to evoke slightly pejorative notions of psychics or prophetic statements from TV pundits.

It shouldn't. Prediction is a routine part of applied science. In fact, I would go so far as to suggest that prediction is the principle task of a conservation scientist.

The logic is simple. The task of conservation scientists is to improve our work. We do this by using our knowledge to help guide our choice of actions. This guidance requires prediction about what actions will deliver the best outcomes.

Even if not thought of in these terms, all of the research in conservation dedicated to understanding how social-ecological systems function is ultimately about predicting the consequences — positive and negative — of different actions.

Think about it. The science supporting our work is all about prediction. What will happen to water quality if we establish a water fund? What will happen if we don't? What damage will storm surges do? What will be saved by establishing this easement? What emissions will be avoided by this fire regime? How much money will this generate?

Predictions are what make our science useful. What project director or senior manager doesn't want to know the predicted outcome from the options they're considering?

I often find conservation scientists slightly surprised to realize just how much of their work is about making predictions. Consider a CAP workshop; all of the time spent identifying key ecological attributes, assessing viability, ranking threats, considering feasibility, building results chains, is ultimately working towards predicting the impact an action is going to have on a target. Anytime we make a decision to work in one place over another, we do so because we predict that it will advance our objectives more effectively. Even our monitoring work is ultimately about prediction; either revising and improving our own predictions or influencing the predictions of funders about what will be achieved in the future.

Yogi Berra was right — prediction is difficult. This is especially true in the complex socio-ecological systems that conservation works in. The task of making good predictions is made all the more challenging when we don't recognise that this is what we are doing.

Wait, Does This Require a Lot of (gulp) Math?

There are many different approaches to prediction but all essentially involve models. At one end of the spectrum you have formal mathematical models and at the other end you have implicit mental models. Formal models employ mathematical expressions (*functions*) that translate an amount of one thing (an action) to amount of another thing (something we care about). For example, a couple of weeks ago I saw Nels Johnson present a model that translated potential shale gas development patterns into an impact on biodiversity.

You don't have to be a mathematician to develop predictive models, you can collaborate with modellers. By far the most useful predictive models I've seen in conservation have been collaborations between empirical field ecologists and modellers. E.O. Wilson recently made a plea in the *Wall Street Journal* that math wasn't a necessary skill for great science, only the ability to collaborate with mathematicians in order to codify field insights, concepts and intuition into models (but see Jeremy Fox pushing back on this on his *Dynamic Ecology* blog).

"I often find conservation scientists slightly surprised to realize just how much of their work is about making predictions."

Predictions don't have to be based on formal models, they can also be sourced from expert judgment. Expert-based predictions can be particularly useful in highly complex situations. This is because we can sometimes have a good feel for what an outcome is likely to be, even if we don't fully understand the mechanism behind it. Many sports people are good at predicting the trajectory of a falling ball (think tennis, football, or baseball) without necessarily being able to describe how gravity functions. Even the U.S. military, who have access to some of the best mathematical modellers, rely heavily on subjective prediction in complex situations.

Predictions can also be based on a combination of expert judgement and data. Bayesian methods are particularly useful in this regard. For example, imagine we are considering entering into a voluntary agreement around some environmental practice

with a big mining corporation and want to predict the likely result. We might start by making a prediction of what could happen if the mining company does everything it says it will. However, it would be important not to neglect information we have on the *base rate* (the expectation in the absence of case-specific knowledge). In this case we might know that the mining company has been penalised for infringing a number of state environmental regulations each year for the past 10 years. Our prediction of success should consider this record. We are probably all guilty of believing that our case is different — but history suggests it is not, and that it would be unwise to assume so.

Recognize Your Role in Making Predictions

There is almost no faster way to learn about any system than by making predictions. Predictions force us to be clear about our knowledge. Conservation scientists are frequently asked to construct a theory of change to articulate our expectation of how change happens in a system. It is important that we take this a step further and make explicit predictions about change in the things we care about. For example, what is the predicted change in forest health as a result of an action like fostering community leadership?

I'm not pretending this is easy, but if you can't at least make a start at this prediction, then it seems reasonable to ask what confidence anyone should have in outcomes being achieved. Because of our vulnerability to hindsight bias (where outcomes seem obvious and inevitable after they've occurred) it is critical that we make predictions explicit if we are to learn from them.

We only get better at predictions through making them and receiving feedback on our accuracy. The reason why sports people are good at predicting the fall of a ball is that they have made similar predictions many times over and received feedback on the accuracy of these predictions. Testing the accuracy of conservation outcomes is a little more difficult than ball fall because things often happen slowly, but this doesn't mean we shouldn't be doing it. It is in our best interest to get better at predictions and also to know who amongst us is best at making predictions.

"Because of our vulnerability to hindsight bias (where outcomes seem obvious and inevitable after they've occurred) it is critical that we make predictions explicit if we are to learn from them."

It might seem a little counter intuitive to emphasize prediction in the complex and dynamic systems in which we work, but it is important to remember that predictions don't have to be precise to be accurate. They can be expressed as ranges or probabilities, or even scenarios with specific assumptions attached to them (for example, if we continue to fish coral reef herbivores at this rate and climate change proceeds at this rate...).

Prediction is where science meets, and influences, our conservation decisions. It is this task above others that should excite scientists because this is where their knowledge and expertise is most important. I strongly believe that our work will be far more effective if all our scientists recognise their role as making predictions, and make these predictions more explicit. **SC**

Jonathan Higgins
Can We Play to Win? Clarifying Our Whole-Systems Work to Explicitly Be About Multiple Scales

By Jonathan Higgins, senior aquatic ecologist, The Nature Conservancy

Image: Chess in the Budapest baths, Hungary. Image credit: Flckr user Eole via a Creative Commons license.

In a chess match, one player new to the game proudly displays the numerous pieces he has acquired — many pawns, two rooks and a bishop. The other player captures only two pieces, a bishop and the king, and has won. The lesson? It is not how many pieces you capture, but whether you have been successful in taking down the main object through a strategic approach.

What does this have to do with conservation? For many decades, TNC has been working at the site scale, for the most part on sites in isolation of each other and in absence of a larger context. We've been counting the pieces we work on and adding them up, thinking that will mean success at a larger scale — instead of looking for a way to actually win the game at the larger scale. Now we're embarking on a whole system conservation approach… and we're all tangled up in knots about how to do it.

One of the issues is the confusion, and discrepancies, about what it means to do whole system conservation. Some of this confusion comes from different perspectives on what the "whole system" conservation approach is. One perspective is that whole system conservation is about defining ***the*** scale that we have to ***work at*** — such as a large eco-geography like a river basin or a large forest block — and then applying conservation planning approaches that we have employed for sites at a larger scale, while adding some nuances learned in recent decades and throwing in people because they are

important to us now. In moving to this one larger scale, there have been suggestions that we are also changing what we care about and what we measure to be consistent with that one scale. (For instance, maybe we shouldn't care about individual species because we are working at larger scales, and instead we should focus solely on ecosystem processes.)

Another perspective — one that I think is better — is that whole-system conservation is best conceived of and implemented through defining the ecological, social and economic patterns, processes and issues critical at *multiple scales*, and defining appropriate targets, objectives, strategies and measures that are appropriate for each of those scales. Multiple-scale approaches to whole-system conservation can be organized into a hierarchy of eco-geography systems to address processes and threats to specific scales (e.g. whole river basin, sub-basins, and sites). But what makes this approach even more flexible is that the system can also be defined by the political, structural or economic systems that manage the ecological systems as well. Examples of such systems include infrastructure managed by the Army Corps of Engineers; uses that transcends a river basin boundary (such as water resource management of the Colorado River basin, which moves water out of the basin to Los Angeles); policies established at the state, provincial or federal levels; or global corporate supply chains.

Larger-scale system work should benefit smaller scales — since smaller-scale patterns and processes are generally affected and constrained by larger-scale processes. The patterns and processes that are determined at the larger scale cannot be addressed at the site scale. This is the central concept of ecological hierarchy theory. This multiple-scale perspective also considers the need to work at individual sites, since there are processes and threats that operate at the individual scale that need to be addressed at larger scales.

"Scaling-Up" Does Not Equal Whole-System Conservation

Why do these subtle differences matter? Because TNC needs to break out of the old mold of thinking everything we do amounts to scaling-up the approaches of site-based conservation.

"Why do these subtle differences matter? Because TNC needs to break out of the old mold of thinking everything we do amounts to scaling-up the approaches of site-based conservation."

Multiple-scale approaches are critical to achieving conservation, and our thinking needs to evolve to include strategies at different scales to accomplish what is necessary. This is not a one-or-the-other choice. Work at larger scales is done to address issues that cannot be done at smaller scales, and this work should generally provide benefits to sites. And site-based work continues, when necessary, even if it does not "leverage up" as part of larger-scale strategies.

But why shouldn't all sites "leverage-up" to larger scale strategies? While sites *can* contribute to part of a leveraged strategy, most sites are not "leveraging up." Some sites are critical components of a functioning system (e.g., critical spawning habitats for a species, or migratory corridors). These sites are necessary components of whole-system conservation. Some sites are just providing site-scale benefits to a system, adding more of a good thing, while also increasing viability and resilience to the system (e.g. more

natural forest). Some may say that is contributing to larger-scale success. Yes, but it is not "leveraging up"; and that is OK too.

There is capacity in global, regional and many state and country programs to work on large-scale strategies. However, when a global program is working at a different scale than a state or country program, there is often a lack of clarity as to how the work of the global program will benefit the state or country program and their sites, and there is a call to "align the efforts." What does alignment mean? It does not mean that all programs work on the same scale or threats. It means that they work on different scales and on different strategies to contribute to whole-system conservation. This approach is going to require alternative incentives and management approaches, and I hope we are making progress in figuring those out.

How System-Scale Conservation Should Work

The Laurentian Great Lakes basin has been declared a whole-system conservation project. The Great Lakes Project has defined aquatic invasive species as a whole system issue and they have generated a strategy — one that will impact the entire system — a "system-scale" strategy. This makes sense. Addressing invasions requires a collaborative effort across all states and provinces in order to keep them out, and manage them if they get in. Invasive species threaten many if not all freshwater priority sites in the Great Lakes, and a given site or state cannot by itself keep invasive species out of the basin.

In addition, each Great Lake has a distinct biological composition as well as distinct large-scale physical patterns and processes. Each lake is planned for and managed as a distinct system by government agencies within the broader system of 5 lakes. All of the lakes have a natural annual and inter-annual lake level fluctuation. These fluctuations are critical for maintaining shoreline wetlands, as terrestrial plants move lake-ward during low-water, and retreat inland during high-water. This is analogous to how fire keeps oak trees from taking over prairies. There is a dam on the St. Lawrence River, the outlet to Lake Ontario, which has resulted in a flattening of the lake level fluctuations. TNC staff worked with partners and the dam operators, and defined an operational approach to reinstate lake level fluctuations.

"Many of our priority systems are also impacted by global issues, such as infrastructure development and food production being funded by international development banks or being advanced by global corporations."

This is a strategy applied at the scale of an individual lake, (or a sub-system strategy, if you are thinking of the entire Laurentian Great Lakes, but who cares about definitions — it is the multiple scale that matters) that will benefit the entire shoreline of Lake Ontario and all of the priority shoreline wetlands that TNC and others care about as well. It could not have been addressed by a single site, or a single state alone. But many of the wetlands have other threats that need to be addressed at the site-scale, and work to address these threats at that scale should continue.

Here's an example of another scale that matters. Many of our priority systems are also impacted by global issues, such as infrastructure development and food production being funded by international development banks or being advanced by global corporations. The drivers of these issues are generally not constrained by a given eco-geography. For example, global corporations have supply chains all over the world. They affect land use and water supplies worldwide. Many corporations are now

becoming concerned about future ecosystem conditions, climate change and long-term resource availability. Many are changing their approaches to take into account the benefits that well-maintained natural systems provide for supply chain sustainability. Working with corporations and industry organizations to evaluate and change standards and practices can lead to benefits to numerous eco-geographies around the world, including many we identify as priorities. This is yet another scale we need to work at in order to be successful at whole system conservation. Global corporate behaviors affect local conditions. Think locally, act globally.

Make a Greater Impact

Multi-scale conservation can move the needle at small, intermediate and large-scales, provide benefits to people and nature *within and beyond* our site-specific, ecoregional, and whole system priorities, while making progress towards our whole system goals, and those for the sites that we and many of our long-term donors and partners care about. Sometimes identifying a strategy to address a site or system-wide issue leads us to address a source of impact to many other systems as well — we need to think beyond individual sites and systems to get it right in many cases. That is also what we are trying to achieve through many global strategies that focus on issues and opportunities beyond individual whole systems.

Multi-scale conservation seems to me to be an appealing approach to partners and society, and critical to conserving what we care about as well as changing the world. It is not changing what we care about or necessarily what we have been working on for years, but it includes contexts and strategies that many in our organization still do not understand or embrace. It is providing approaches at scales to make the differences necessary to be successful at conservation. It is the difference between being a global organization and an organization that works on numerous sites in many places around the world. **SC**

"It [multi-scale conservation] is the difference between being a global organization and an organization that works on numerous sites in many places around the world."

Article
Empowering Citizen Scientists Through Mapping Invasive Species

By Jennifer Dean, invasive species biologist at NY Natural Heritage Program; Steve Buttrick, director of conservation science and planning for The Nature Conservancy in Oregon; Sharon Plumb, membership and outreach coordinator at the Vermont Land Trust

Image: Middle school students collect data about an infestation of the invasive common reed (*Phragmites australis subsp. australis*) to enter into iMapInvasives for New York. Image credit: Bryan Banks.

High school students are no strangers to technology, especially at Tech Valley High near Albany, NY, where STEM subjects are the focus. A few weeks into the new school year, students rummage through their desks to pull out laptops for their biotechnology class. Today they are entering invasive species locations into the New York *i*MapInvasives website. Their class had conducted a survey for oriental bittersweet at a nearby state park, and now using coordinates they collected and the online maps, they watch as their points appear on the same map being used by conservation professionals across the state.

In 2008, the Natural Heritage Programs of New York and Florida partnered with the TNC Global Invasive Species Team to develop an online invasive species database. Natural resource managers, TNC and beyond, wanted to stay current with what others were doing to control invasive species, and whether these techniques were effective. The goal was to create a shared, standardized data management tool for land managers, many of whom were lamenting the loss of version support and upgrades for WIMS (Weed Information Management System). By creating a cloud-based system that was

platform-independent, programs could keep current with constantly evolving technology. The result was *i*MapInvasives, an on-line database and mapping system that allows land managers to track monitoring and treatment efforts across projects and organizations in real-time, while also serving as an early detection alert tool.

Creating a Shared Database for Land Managers

*i*Mapinvasives was first launched to the public in New York in 2010, and has since become available in several other states and one province (OR, FL, VT, AZ, VA, NH, PA, and SK). In New York, the state had recognized the need for one all-inclusive, GIS-based system for invasive species data, and tasked the NY Natural Heritage Program (which was a partnership between TNC and NYS Department of Environmental Conservation at the time) with developing a state-wide solution. Since then, the system has been introduced to local, state, and federal partners as a way to manage invasive species data on a shared platform. Oregon, for example, has aggregated over 269 thousand observations, including all records from the Forest Service, Bureau of Land Management, state agencies and NGOs. The ability to track infestations across organizations has helped reduce some of the political and geographical challenges to making strategic decisions about invasive species.

As more organizations connect through a shared database, the system becomes more powerful. When a new population of *Hydrilla verticillata*, an aggressive aquatic weed, was discovered 150 miles from any known infestation in NY, regional entities decided to evaluate the infestation quickly, knowing that if determined to be a management candidate, time could not be wasted. A task force of partners consisting of the US Fish and Wildlife Service, Army Corp of Engineers, three state agencies, and the local Western NY Partnership for Regional Invasive Species Management, first needed to delineate the infestation. As each partner investigated target areas over the next weeks, they recorded survey locations and *Hydrilla* findings in *i*MapInvasives as a way to quickly communicate updates. Partners could immediately see which areas had been surveyed and where they still needed to look.

"The ability to track infestations across organizations has helped reduce some of the political and geographical challenges to making strategic decisions about invasive species."

In the upper Willamette Valley of Oregon, seven organizations with overlapping jurisdictions were independently mapping new invasions of Japanese knotweed across a 2.2 million acre area. They have now uploaded all of their locational data into *i*MapInvasives and created the Upper Willamette Knotweed Partnership. For the first time they have a big picture view of the status of knotweed across this landscape and now jointly identify and treat priority infestations and direct early detection monitoring.

Citizen Scientists: The Power Behind the System

While *i*MapInvasives was designed around the needs of natural resource managers, much of the power behind the database comes from contributions by the public. Citizen scientists — whether amateur naturalists, educators and students, or concerned neighbors that are somehow being affected by invasive species — take data-

entry training and become part of the essential army of "eyes-on-the-ground." Early detection is our best defense against new invaders becoming established. In NY, half of the 1,000-plus account holders use *i*MapInvasives as citizen scientists, and in Oregon, TNC has created a large team of Weed Warriors trained to identify and report priority invasives. Their reports and photos are added to the state map and await verification, which then triggers email alerts depending on the species or location. Reports of high priority or regulated species are automatically sent to state officials to aid in larger efforts.

Engaging citizen scientists in mapping invasive species goes beyond new data points: it promotes awareness of the impact of invasive species on the well-being of people and the places they love. In Vermont, volunteers in Hinesburg partnered with TNC staff to map invasives on a beloved conserved property. The information was then used to create a weed plan. Since then, there have been several work days to remove honeysuckle, celandine, buckthorn and barberry. This citizen-based inventory helped people who use the property for hiking and birding see it through a new lens — the hard work it takes to keep it ecologically healthy.

Using technology to map and report invasive species draws in new audiences, especially youth. *i*MapInvasives has been used as an educational tool for schools, 4-H, and summer camps. A field trip to a local preserve becomes an adventure when kids are equipped with a GPS unit or smartphone, the knowledge of how to identify a few select invasive species, and the feeling that your class is collecting real data to help protect a special place. And in urban settings, this special place may be the neighborhood around your school.

As a way to engage youth in New York City, the NY Natural Heritage Program teamed up with Leaders in Environmental Action for the Future (LEAF) to train high school teachers and create lesson plans with the goal of getting students outside to appreciate their urban nature. One lesson taps into the expertise of the Healthy Urban Tree Initiative of the Forest Health Program (TNC) to focus on surveying street trees for signs of Asian longhorned beetle and using *i*MapInvasives to report their findings. Students gain an appreciation for the trees around them while contributing to a larger effort to protect urban trees.

"A field trip to a local preserve becomes an adventure when kids are equipped with a GPS unit or smartphone, the knowledge of how to identify a few select invasive species, and the feeling that your class is collecting real data to help protect a special place."

Last summer, NY *i*MapInvasives received a report for Asian longhorned beetle in the Catskills, but the photo provided by the attentive land owner showed a native beetle commonly confused with the infamous invader. Even though it was a false alarm, success is felt when a citizen is aware enough to report a sighting. *i*MapInvasives gives us a tool to connect the efforts of conservation professionals and citizen scientists. The outcomes are awareness, engagement, and hopefully, detection of invaders before they become established. **SC**

Those interested in learning more about iMapInvasives should visit iMapInvasives.org.

Bob Lalasz
Why and How Conservation Needs to Tackle Human Well-Being: A Q&A with Heather Tallis

By Bob Lalasz, director of science communications, The Nature Conservancy

Image: Goba women on the banks of the Zambezi River in the Chiawa Game Management Area, near Lower Zambezi National Park. Image credit: Brian Richter/ TNC.

Can conservation make a decisive and systematic contribution to solving social problems and improving the lives of people — especially the world's poor?

Finding out is Heather Tallis's job: As a new lead scientist at The Nature Conservancy in charge of the Conservancy's new Human Dimensions Program, it's her task to bring "people metrics" to assess the impact of the Conservancy's work on the ground on people. She's also charged with integrating innovative economics and social science into the organization's field work in a way that builds conservation methods and tools that can benefit everyone.

The challenges are many — among them, getting those metrics right (something conservation has struggled to do); designing conservation from the ground up to impact people positively; and helping policymakers and other decision-makers to recognize the value of conservation for answering many of the big questions facing the planet.

I sat down with Tallis to talk about where she and the Human Dimension Program will begin addressing those challenges:

First, what is the Human Dimensions Program, anyway? Is it a new global priority, or something else?

HT: The Human Dimensions Program (let's call it HDP for short) is not a new global priority. It will sit in Central Science as a cross-cutting program that will aim to intersect with the Conservancy's Global Priorities. One of the first ways we'll do that is by helping to develop the much talked about "people metrics" for assessing the impact of the Conservancy's work on the ground. Overall, HDP will build off of existing economics and social science work in the Conservancy, and innovate in both fields to help solve field problems. At the same time, we'll use these field experiences to build methods and tools that can spread across the organization.

You're not a social scientist. So why are you the right person to lead HDP, much of which is about topics that fall under social science?

HT: A lot of the hard questions the Conservancy and conservation in general needs to grapple with now involve people, but they aren't purely social science or economics questions.

For example, we don't just care about the unemployment rate, we care about whether or not conservation programs are protecting species *and* creating jobs. The Conservancy is not going to go out and work solely on securing food supplies, but we are going to figure out how to help produce more food with less environmental impact. These are issues at the interface of natural and social science. It can still take serious translation for these fields to connect well. The Conservancy is largely an organization of natural scientists, so it makes sense to start where you are. I come from the same kind of background as most of our scientists, but I've spent the last decade working with social scientists and economists — so I understand the path they'll have to go down to be able to engage these new fields in their work.

"The Conservancy is not going to go out and work solely on securing food supplies, but we are going to figure out how to help produce more food with less environmental impact."

Why does conservation need an initiative to attack human well-being head-on?

HT: Well, I like the way the folks from the Stockholm Resilience Center say it: "There are no natural systems without people, nor social systems without nature." This is our reality, especially as the Conservancy moves to thinking about and managing whole systems.

But this is obviously not the way most people see the world, so our personal decisions, our political ideas and our management process are out of synch with this reality. The next 20-30 years will see dramatic change in the face of the planet — and what lives on it or doesn't — as society decides how to double food production, build

hundreds of billions of dollars worth of infrastructure and create more megacities. Conservation needs to be in those decisions. And we won't get past the door unless we know and can describe what nature has to do with major social problems, and how nature can contribute to human well-being solutions.

Conservation orgs have talked for years about how they're going to be relevant to people. What do we have to do to get people measures right?

HT: We have to focus right at the intersection of people and nature. This is not easy.

Natural scientists have done a decent job of figuring out how we measure what's going on with the environment. And governments, development groups and companies have decent ways of measuring what's going on with the economy and people. But none of this tells us explicitly how the two are connected. We can watch GDP, the unemployment rate, child malnutrition, and infectious disease rates go up and down, and with these metrics alone, we have no idea if they are changing because of government programs, changes in markets or change in the environment.

So these broadly used and accepted metrics are a good starting point, but we need new metrics that tell us what nature contributes to different components of human life. If we want to know the impact of a new marine protected area on local nutrition, we can't just measure individual nutritional health in the region. We need to measure the amount of nutrition provided by fish, relative to other sources. Some of these metrics are worked out; many are not. And the biggest challenge will be designing monitoring programs for these new metrics that are practical and cost-effective.

We also have to get people *strategies* right. There's a lot of talk about how we measure the impact of conservation on people, without a strong parallel conversation about how we *design* conservation to help people.

"We also have to get people strategies right. There's a lot of talk about how we measure the impact of conservation on people, without a strong parallel conversation about how we design conservation to help people."

Some of the good examples we have now of how conservation helps people are projects with two independent goals and strategies. For example, a conservation program restores natural habitat and also builds a health clinic. There's the idea that people have to have their basic needs met before they can think about nature conservation. Sometimes this is true, but in some cases, the two can go hand-in-hand.

For example, many rural communities in developing countries rely heavily on disappearing native plants for medicinal treatments. Conservation can develop a project that restores native plants *and* fosters local governance in support of access for local communities to use these plants medicinally. This could directly benefit nature and give people an opportunity to *directly* preserve culture and be healthy.

This is not a novel idea, but it's also not a widely employed one. Water funds are a good example of moving in this direction. I'd like to see the Conservancy go more

towards creating and supporting strategies that shine a light on and cultivate these real, valuable connections between people and nature. And honestly, if we design our work this way, it will make it a heck of a lot easier to know what to measure and to say whether or not we are succeeding.

What are you going to tackle first? What are the paradigms and approaches that are priorities for you to bring to conservation off the bat?

HT: Certainly metrics that highlight nature's contribution to people will be at the top of the list. It's also time to have a standard approach for mapping ecosystem service priority areas. This kind of mapping is relevant to bringing ecosystem services into Development by Design and the mitigation hierarchy, land and ocean planning, protected area design and many other lines of conservation work.

Another important concept I'd like to see taken up broadly in TNC is the idea of servicesheds. These help us map in space where different benefits originate, and which people are receiving them. We've started developing ways to use servicesheds to keep track of who will lose benefits from proposed infrastructure development, and how to site mitigation so offsets don't create inequities.

Servicesheds can also help in targeting restoration investments to provide the greatest returns in biodiversity and multiple human benefits. We can see how many people will be affected by putting habitat back in different places, and we can say whether those people are particularly vulnerable, or hold especially high values for the services that will be restored. The approach helps us deal with distributional issues that often go unaccounted for in conservation work.

I also see a need to bring some rigorous thinking about tradeoff analyses to TNC's work so we can identify more clearly up front what kinds of conservation projects are likely to provide high returns for people and nature, and which may cause tradeoffs.

Editor's note: An edited version of this interview appeared on the Conservancy's blog, Cool Green Science.

"Another important concept I'd like to see taken up broadly in TNC is the idea of servicesheds. These help us map in space where different benefits originate, and which people are receiving them."

15 Seconds of Fame
Anne Bradley

When 33-year Conservancy veteran Phil Tabas says someone has "led one of the best field trips that I've ever been on in TNC," you know it must mean something. Tabas emailed me with this glowing recommendation after a recent trip into the Jemez Mountains with New Mexico forest conservation program director Anne Bradley.

Image: New Mexico forest conservation program director Anne Bradley.

WHAT I DO: Forests are typically federal lands, so I collaborate a lot with federal agencies and academic groups. I participate in the Southwest fire science consortium, which organizes fire ecology conferences, produces videos, working papers, webinars and field trips. Our goal is to get the science out to managers as fast as possible, faster and more efficiently than if people are just putting all their work into journals, and to develop more partnerships between scientists and practitioners.

FORESTS: What I know is what's in front of me, and I'm here to tell you that there is no forest in North America that is not under threat. We can't assume they're ok just because of federal protection. Changes are happening quickly and we need all our creative energies and attention focused on addressing climate change and other human impacts. The Southwest is a place that is warming and drying quickly. We're teetering on the edge of whether we can have trees or not. The science suggests that forests are more sensitive than we thought, and we wouldn't have known that until we started futzing around with climate change.

FAVORITE PLACE: I love Tsankawi, (pronounced TSAN-ka-wee) an independent unit of Bandelier National Monument. You hike up an ancient trail along a mesa, and get an up-close look at a large Pueblo village ruin, at cavates (natural caves enhanced by

ancient Pueblo Indian people) and petroglyphs to a panoramic view of the Jemez Mountains, up and down the Rio Grande Valley and into the Rockies on the Colorado border. This is *my* landscape. It's so important to me. I grew up in these mountains. I was raised in Los Alamos, which lies on the eastern mesas that skirt the range. I left to pursue education and career elsewhere in the West, but when I joined the Conservancy in 2004 I came back to Santa Fe. These mountains inspired my career.

ISLANDS IN THE SKY: The Jemez Mountains are "sky islands" — they rise up steeply and have unique features for such a dry area. These mountains are famous among vulcanologists; some of the first modeling of how volcanoes blew up and formed calderas was done here. And they're famous archeologically — humans have been living here for 11,000+ years and their cultural evidence is scattered pretty much everywhere. The Pueblo Indian and Spanish cultures are alive here still.

A lot of scientists want to work here. We have so much historic information — tons of tree ring research has been done here. We probably know as much about forest disturbance dynamics here as any place in the world. Up until a decade ago, we were looking at this historic info to guide us. Now we have the overlay of climate change. What can we tell managers about this moving target? What are the processes we want to prioritize? Is there a "graceful" transition we can facilitate to a new norm?

SONGBIRD: I sing in a chorale. Santa Fe is a great arts community — there's lots of musicians, composers, etc. I wish I could sound like someone interesting, like Susan Tedeschi. But I'm a soprano, most suited to composers like Handel. When I used to work in Montana in bear country, I'd sing while out hiking to let the bears know I was around.

READING: I'm working my way through *1493* by Charles Mann. We keep talking about the Anthropocene, but you read this book and remember that even in the 1400s people were hauling things across continents, bringing in new stuff — people have been influencing nature for a long time. It is hard to be hopeful sometimes, but this book reminds me of nature's resilience.

FUTURE OF CONSERVATION: The whole concept of conservation is a social construct. We preserve what we value as people. I'm glad the Conservancy is talking about people more; it makes sense to me. I work with people who've lived on the land for generations. New Mexico wouldn't be such a rich place without those deep roots.

The concept of wilderness, fighting for places untrammeled — when you have climate change, is that a relevant concept anymore? The problems right now are really at a scale that overwhelms all our administrative boundaries. We really need to be good at collaborative science and integrating the social piece to have a prayer of creating a useful response to the current challenges. I am so grateful for the cadre of really capable scientists that I work with right now. We have very talented, creative science partners who are dedicated, practical and a lot of fun to boot! I find it enormously valuable to have such incredible colleagues, at TNC and with our partners. **SC**

Interview by Darci Palmquist. Know someone we should feature in this column? Please email her with comments or suggestions.

Blog Reel

Voices from the Conservancy's science blog, *Cool Green Science*. Interested in contributing? Contact Matt Miller.

"Environmental problems are big, but resources for conservation are tiny — so conservation groups are constantly prioritizing what they do and recommend so as to allocate those resources better. So why isn't conservation making more of a dent?"

— **Bob Lalasz** in *Quick Study: Six Common Mistakes in Conservation*

Image: Don't get too close and keep an airhorn handy: aggressive Tibetan blue bears often greet visitors by charging. Eddie Game/TNC

"Holy s---. These airhorns just saved our lives."

— **Eddie Game** in *Expedition to Northern Tibet: The Land of Charging Blue Bears*

"Dig deeper into the scientific research about organic foods and you'll find the jury is still out; in other words, it's not time to give up on organics yet."

— **Rebecca Benner** in *What Does the Science Really Say about Organics?*

"But we also need to ask, what can MPAs do for us? Can MPAs help shore up all the ecosystem services on which billions of lives depend?"

— **Darci Palmquist** in *New Study: Marine Protection Goals Are on Target, But Still Not*

"The shad were passing the dam. They were breeding. And thriving."

— **Matt Miller** in *Results: Great News for Shad*

Science Short
Consumption, Competitiveness and Conformity

Dasgupta, P.S., P.R. Ehrlich. 2013. Pervasive externalities at the population, consumption, and environment nexus. *Science* 2013 Apr 19;340(6130):324-8 doi: 10.1126/science.1224664.

I give a lot of public talks about the future of conservation and always do my best to paint an optimistic vision. Inevitably, someone in the audience raises their hand and says, isn't the real problem consumption and aren't we doomed to an environmental collapse because of our patterns of ever-expanding consumption? I always admit consumption is a big issue, emphasizing it is not that we consume, but what we consume, and I warn about that preaching about consumption can be a turn-off. But I have not been able to frame a really strong answer.

In a recent article, Partha Dasgupta and Paul Ehrlich give me the seeds of a stronger argument. They emphasize that two of the strongest universal human traits are competitiveness and conformity. We conform because we strive to find ways to relate to one another — after all we are a tribal species. And competitive consumption has been noted in almost all societies — rich and poor. It is just that as wealth accumulates, the global impact of competitive consumption also grows. All true. But those same traits can also provide the momentum for change and improvement. Just think of the students at Simon Fraser University in Vancouver, Canada, who chided Chinese couples to not serve shark fin soup at their weddings (a traditional symbol of prosperity) with the poster campaign that labeled shark fin soup as "so 80's."

In their first years, these students got pledges from 38 couples, which amounts to 4,300 bowls of soup not served and between 200 and 400 sharks saved in one city in one year. I remain convinced that preaching some sort of monastic non-consumptive return to a paleolithic lifestyle just makes conservationists look totally out of touch. But whereas competitiveness and conformity are seen by Ehrlich and Dasgupta at the nexus of the consumption-environment meltdown, I see these very human traits as a potential force of change. Conformity and competitiveness can be forces for green consumption if we can get the "cool kids" to tout their green habits as an indication of hipness and attractiveness. **SC**

— **Peter Kareiva,** chief scientist, The Nature Conservancy

Science Short
No Surprise: Protected Areas Work

Ferraro, P. et al. 2013. More strictly protected areas are not necessarily more protective: evidence from Bolivia, Costa Rica, Indonesia, and Thailand. *Environ. Res. Lett*. 8 025011 doi:10.1088/1748-9326/8/2/025011.

Do protected areas that are more strictly protected (IUCN category I-IV) have less deforestation than less strictly protected areas (IUCN category V-VI)?

The short answer is yes but not always.

This might sound like another we-just-proved-the-world-is-round analysis, but this study is authored by some of the more rigorous thinkers in conservation. It sets a new standard for accuracy and precision in estimating avoided deforestation from protected area status.

The authors use a quasi-experimental design to create national-level counterfactuals of what would have been the deforestation rate with no protection or if the protected area category were less strict. They estimate that there's 2% to 21% less deforestation depending on the country because of protected area status. (REDDers take note of these national-level counterfactuals for deforestation…)

They find that in Bolivia, Indonesia and Thailand a more strict protection level equals less deforestation. In Costa Rica, however, the location of the protected areas matters more than the level of protection, with protected areas located in more remote areas less likely to be deforested regardless of the protection level.

The takeaway point is that more strictly protected areas do a better job of stopping deforestation than less strictly protected areas in 3 of the 4 countries studied. So yes the world is round, but it has some anomalies. **SC**

— **Craig Leisher**, senior social scientist, The Nature Conservancy

Science Short
How Smart Is That Doggy in the Window?

Taylor A.H., B. Knaebe, R.D. Gray. 2012. An end to insight? New Caledonian crows can spontaneously solve problems without planning their actions. Proc Biol Sci. 2012 Dec 22;279(1749):4977-81. doi: 10.1098/rspb.2012.1998. Epub 2012 Oct 24.

Not anthropomorphizing animals can be really hard. I've never met a dog owner who could watch their dog furiously wag its tail upon returning home without thinking "my dog is happy." It's certainly a reasonable working hypothesis in the absence of other information, but these preconceived notions make interpreting animal behavior difficult (read "The Pig Who Sang to the Moon" for an example of interpreting animal behavior by assuming they are very similar to us without checking the data).

A similar problem is how to interpret the ability of certain animals to pass or fail cognitive tests. A classic interpretation of how animals carry out difficult tasks is that they can experience insight that lets them plan out how to solve these problems (for a great example, see this video of a crow using a sequence of three tools to get a treat).

Now a new study lays out the case that at least crows likely rely on perceptual feedback rather than insight. If they are unable to see a piece of food they are trying to pull towards themselves, it prevents them from persisting until they get the food.

It's hard to watch the video above without thinking that the crow is planning ahead, but this study is a reminder for us to check our assumptions and to keep refining our science until our hypothesis fits all of the data better than any of the alternatives. **SC**

— **Jon Fisher**, spatial scientist, The Nature Conservancy

Spotlight
Science and GIS Resources Available from the North America Region Science Team

Submitted by Joe Fargione, science director for the North America region

The North America Region has a small science team and we're working on some things that may be of interest to you. This is a brief overview, with additional information and resources available on our CONNECT page and the other embedded links throughout this article.

Our team is designed to 1) provide science and GIS support to NA Region priorities; 2) manage key data; 3) provide compelling data delivery; 4) conduct horizon scanning and other cutting-edge science; 5) promote science and science communication within the NA Region. While providing science and GIS support for regional priorities comprises and funds the bulk of our work, we are also able to provide a variety of resources for use throughout the region, listed below. Our small size limits the amount of direct service that we can provide to operating units, but we are always looking to increase the added value that we can bring to the region. Suggestions and questions are welcome, and can be addressed to Joe Fargione.

Resources

Data You Can Use:

1. **ParcelPoint.** We manage the ParcelPoint dataset, which contains legal boundaries and landowners for 85% of the counties in the United States. New data are added quarterly. This dataset is useful for many facets of TNC's work, such as the identification of landowners in priority areas and generating parcel boundaries for documenting our protection work. Our license allows access by unlimited users to the GIS data for internal use, and the dataset currently has about 200 users.

2. **Ventyx Energy Data**. We manage the Ventyx energy dataset, which contains 128 existing and proposed energy infrastructure layers, including transmission lines, power plants (including renewables), wind turbine locations, ethanol plants, and natural gas pipelines. Our license allows access by unlimited users to the GIS data for internal use and the dataset currently has about 60 users.

3. **TNC Lands.** In collaboration with Dan Mahoney in Central Division's Legal Dept, we manage TNC Lands. This dataset shows TNC ownership and other legal interests and is shared externally with the Protected Areas Dataset of the U.S. and the National Conservation Easement Database. We are currently updating the dataset and associated web map tool, which will also be available via maps.tnc.org when complete.

4. **Ecoregional Assessments**. We manage TNC's ecoregional spatial data, both in the U.S. and globally. The U.S. geodatabase includes all of the conservation targets associated with each portfolio site and the global geodatabase includes only priority area boundaries (but not associated targets). We are currently updating the global dataset and associated web map tool,

which will also be available via maps.tnc.org when complete. We are also currently working on a roll-up of our freshwater priority areas for the United States.

Services for Science Staff:

1. **Science Spotlight.** We host a quarterly webinar in which TNC scientists present exciting science happening within the region. Want the spotlight to shine on you? We are now accepting proposals for future topics and presentations. Visit the Science Spotlight website to learn more about how to become involved and get up-to-date information about current, past and future webinars (including links to relevant resources and recordings of old webinars).

2. **Writing Workshops.** In collaboration with Central Science, we host an annual writing workshop each winter, to support a culture of producing high-impact science publications by staff throughout our region. Each workshop can accommodate about a dozen participants. Look in *Science Chronicles* this fall for a request for applications to participate.

3. **Map Gallery.** We maintain a gallery of maps relevant to regional priorities and whole systems. Let Dan Majka know if there is a map that you would like to see added to the library.

4. **Map Requests.** We field map requests from within the region via our online map request form. We only have capacity to field map requests that come with funding.

Additional Resources:

1. **Avian conservation.** Dave Mehlman provides internal consulting on all things bird-related, such as the North American Wetlands Conservation Act (NAWCA) and TNC proposals for NAWCA funding. He is also our in-house expert on the Migratory Bird Treaty Act (MBTA), Bald and Golden Eagle Protection Act (BGEPA), and Endangered Species Act as it pertains to listed and candidate birds. Dave is the Conservancy's liaison to the North American Bird Conservation Initiative and helps produce the annual "State of the Birds Report." He has worked extensively on Department of Interior's Landscape Conservation Cooperatives efforts and the interaction of birds and energy development, particularly wind energy.

2. **Connectivity tools**. Brad McRae maintains Circuitscape and Linkage Mapper, a suite of tools to identify wildlife habitat corridors (including corridors that follow climatic gradients to facilitate range shifts in response to climate change), pinch points most at risk from development, and opportunities for restoration. Dan Majka maintains guidance for wildlife corridor design and other resources on his Corridor Design website.

3. **Web mapping and tools**. We have developed regional web tools, such as the Landscape Assessment Tool for wind energy siting. We have also provided development support custom requests, such as a Development by Design project viewer. Inquiries about collaborations on future projects should be addressed to Joe Fargione.

4. **Cutting-edge science.** We have conducted high-impact research related to connectivity analyses; the ecological impacts of biofuels; wind and wildlife; energy sprawl; and floodplain ecosystem services, among others topics. A complete list of relevant publications is available on our CONNECT publications page. **SC**

Announcements

The Future of Nature: Events May 13 & June 10

This Boston-based speaker series, produced by TNC in partnership with WBUR, explores the future of food, energy (May 13) and water (June 10). For tickets and more information, visit the website or contact Sean Fitzpatrick. **SC**

June 4 at 2PM ET: Southern Blue Ridge Analysis Webinar

By Megan Sutton

The much anticipated Southern Blue Ridge Analysis of Matrix Forests and Core & Interior Forest Delineation are complete. This new data can help inform the important conservation work that you are doing.

The "Analysis of Matrix Forests" report is currently available with all of its supporting documents, including an 8-minute video explaining the analysis in layman's terms, the final shapefile that can be downloaded for mapping purposes, as well as other materials. The Core & Interior Forest Delineation Report will soon be uploaded, along with its supporting materials, to this webpage as well.

If you would like to participate in this webinar, please contact Jennifer Lamb to register. **SC**

June 27 at 2PM ET: NA Region Science Spotlight Webinar

By Brad McRae

The North America Region is hosting a webinar series to highlight some of the most exciting new TNC science happening in the U.S., Canada and Caribbean.

Building on our March coastal resilience webinar, the June 27 installment will focus on planning for terrestrial adaptation and resilience at the landscape scale. Mark Anderson and Steve Buttrick will talk about broad-scale work to identify sites resilient to climate change in the southeastern U.S. and Pacific Northwest, and Thomas Minney will talk about how this work is being applied to on-the-ground conservation planning. Register and get the call-in info here.

Know of science projects going on in our region that your colleagues should hear about? Please send your suggestions to Brad McRae and visit our site to learn about upcoming webinars. **SC**

October 29-31: Course in Climate-Smart Conservation at NCTC

Submitted by Craig Groves

This pilot course is designed to demystify climate adaptation for application to on-the-ground conservation. Conservation practitioners and natural resource managers will learn to become savvy consumers of climate information, tools and models. Seating is limited – register through DOI Learn. The course takes place at the USFWS National Conservation Training Center. **SC**

Access to Scientific Journals

By Jon Fisher

Recently we have received a lot of questions about TNC's access to scientific journals. For now, here is the process we recommend that you follow when searching for journal articles. Please note that by the end of the fiscal year we expect to have a new way to access the journals (other than via Conserve Online).

1. Search for your article in Google Scholar. There may be a free PDF version available, and regardless it will tell you what journal your article is in. You may also wish to try searching on Free Full PDF, which lists 80 million open access journal articles (some of which are not indexed by Google Scholar).

2. Look for the journal on the following CONNECT list (use Ctrl + F to search within the list) and click on the journal name if it is present. If it is not on the list, TNC does not have access to the journal so you may wish to look for it at a local library.

3. If your journal IS on the CONNECT list but the link does not work, note the source (e.g. JSTOR, ESA, etc.) and access the article via Conserve Online by clicking on the appropriate source and searching for the journal by name. If this happens, please also email Jon Fisher.

For questions or suggestions about the journals TNC has access to, please contact Lynne Eder. For technical problems accessing journals, please contact Kyle Burford. **SC**

Submit Your 250-Word Book Review by May 24

Read any good books lately? Send in a 250-word review and we'll publish it in our upcoming summer reading issue. Any genre – fiction, non-fiction, textbook, children's literature, self-help, etc. If you enjoyed it, someone else might, too. Submit your review by May 24 (deadline extended!) to Darci Palmquist. **SC**

Correction

Sally Palmer's article "Mind Your Bias: Shattering the Glass Ceiling and Cinderella's Slippers" in the April issue of *Science Chronicles* mis-identified the president of Princeton University as "Helen Tilghman." Her name is actually Shirley Tilghman. **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/or 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.

Ban, N.C., N.J. Bax, K.M. Gjerde, R. Devillers, D.C. Dunn, P.K. Dunstan, A.J. Hobday, S.M. Maxwell, D.M. Kaplan, R.L. Pressey, J.A. Ardron, **E.T. Game**, and P.N. Halpin. 2013. Systematic conservation planning: a better recipe for managing the high seas for biodiversity conservation and sustainable use. *Conservation Letters* doi: 10.1111/conl.12010.

Emery, S.M., and **P.J. Doran**. 2013. Presence and management of the invasive plant *Gypsophila paniculata* (baby's breath) on sand dunes alters arthropod abundance and community structure. *Biological Conservation*, 161:174-181.

Figgis, P., **J. Fitzsimons** and J. Irving (eds). 2012. *Innovation for 21st Century Conservation*. Australian Committee for IUCN, Sydney.

Fitzsimons, J. and **M. Looker**. 2012. Innovative approaches to land acquisition and conservation management: the case of Fish River Station, Northern Territory. In: Figgis, P., J. Fitzsimons and J. Irving (eds). *Innovation for 21st Century Conservation*, pp. 78-85. Australian Committee for IUCN, Sydney.

Fitzsimons, J., I. Pulsford, and G. Wescott. 2013. Lessons from large-scale conservation networks in Australia. *Parks* 19.1, 115-125.

Friedrich, T., A. Timmermann, A. Abe-Ouchi, N.R. Bates, M.O. Chikamoto, M.J. Church, J.E. Dore, D.K. Gledhill, M. Gonzales-Davila, M. Heinemann, T. Ilyina, J.H. Jungclaus, **E. Mcleod**, A. Mouchet, and J.M. Santana-Casiano. 2012: Detecting regional anthropogenic trends in ocean acidification against natural variability. *Nature Climate Change*, 2, 167-171.

Game, E.T., P. Kareiva, and H.P. Possingham. 2013. Six common mistakes in conservation priority setting. *Conservation Biology* DOI: 10.1111/cobi.12051.

Gleason, M., E.M. Feller, M. Merrifield, S. Copps, R. Fujita, **M. Bell**, S. Rienecke and **C. Cook**. 2013. A transactional and collaborative aproach to reducing effects of bottom trawling. *Conservation Biology* doi: 10.1111/cobi.12041

Januchowski-Hartley, S.R., P.B. McIntyre, M. Diebel, **P.J. Doran**, D. Infante, C. Joseph, and J.D. Allan. 2013. Restoring aquatic ecosystem connectivity requires expanding inventories of both dams and road crossings. *Frontiers in Ecology and the Environment* (e-view) http://dx.doi.org/10.1890/120168.

Mcleod, E., **A. Green**, **E. Game**, K. Anthony, J. Cinner, S.F. Heron, J. Kleypas, C.E. Lovelock, J.M. Pandolfi, R.L. Pressey, **R. Salm**, **S. Schill**, and C. Woodroffe. 2012. Integrating climate and ocean change vulnerability into conservation planning. *Coastal Management* 40: 651-672.

Mcleod, E. 2013. Marine protected areas: Static boundaries in a changing world. In: Levin S.A. (ed.) *Encyclopedia of Biodiversity*, second edition, volume 5, pp. 94-104. Waltham, MA: Academic Press.

McLeod, E., and K.R.N. Anthony. 2012. Ocean acidification—Management. In: Fogel, D., Fredericks, S., and Spellerberg, I. (eds.). *The Encyclopedia of Sustainability: Vol. 6. Measurements, Indicators, and Research Methods for Sustainability*. Great Barrington, MA: Berkshire Publishing.

Rau, G.H., **E. Mcleod**, and O. Hoegh-Guldberg. 2012. Ocean conservation in a high CO2 world: the need to evaluate new approaches. *Nature Climate Change* 2: 720-724.

Shanley, C.S., G.P. Kofinas, and S. Pyare. 2013. Balancing the conservation of wildlife habitat with subsistence hunting access: A geospatial-scenario planning framework. *Landscape and Urban Planning* 115: 10-17.

Smith, J.A.M. *In press*. The role of *Phragmites australis* in mediating inland salt marsh migration in a mid-Atlantic estuary. *PLOS One.*