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Image: *Harmonia axyridis* (Asian lady beetle). Image credit: Furryscaly/Flickr

Invasives Special Issue 2 and Other Science Harvest Wonders

Editor's Note

By Bob Lalasz

It's sacrilege to contradict the King in his backyard — but that's just what last week's TNC All-Science meeting in Olive Branch, Mississippi did…and with all the flamboyance of one of late Elvis's Vegas extravaganzas.

Instead of "a little less conversation, a little more action," this All-Science meeting — the first in four years — made conversation the action. More than 100 presentations, panel discussions, interactive sessions, trainings, and poster sessions pushed 350 Conservancy scientists (plus invitees from TNC's policy, marketing, legal, philanthropy and conservation teams as well as partner NGOs) to debate the present state of conservation and chart how science can shape its future. The result was pure science culture — contentious but collegial, exhiliratingly geeky, and often unflinchingly honest.

TNC Chief Scientist Peter Kareiva began the meeting by emphasizing three themes: change, impact and natural history. To the surprise of some, he saluted natural history as having a universal appeal that the Conservancy should capitalize on.

"Alas, no fried peanut butter and banana sandwiches at the TNC All-Science meeting. But had Elvis been a scientist, he'd have loved it."

Bob Lalasz

"I am a biodiversity guy, in the full richness of it," he said. "As we communicate biodiversity, it leaves people cold. But species, nature — the richness, the stories, the science — they grab you."

But Kareiva also stressed that, in a time when conservation is competing with so many other social priorities for time, money and attention, conservation science must focus on being relentlessly inventive and problem-solving.

"We've moved way beyond recipes and menus for conservation," Kareiva said. "We're asking you to figure it out and solve problems in

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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.

Editor & Submissions Bob Lalasz

Mr. October Peter Kareiva

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your own way. It's no longer good enough just to do good work — you have to gauge your impact."

And the place for a scientist to have conservation impact is TNC, he added.

"TNC is the place you go as a scientist if you're impatient and you want your science turned into action," said Kareiva. "Look at how fast Development by Design is being ramped up. Look at Jon Hoekstra's paper on the state of grasslands worldwide — within two years after that paper was published, we opened offices in Africa, Mongolia and Argentina. No other institution, no other NGO gives you that opportunity."

Some other highlights:

- **The opening plenary session**, with Breakthrough Institute co-directors Michael Shellenberger and Ted Nordhaus joining Sanjayan, Natural Capital Project managing director Mary Ruckelshaus and *Rambunctious Garden* author Emma Marris to discuss how conservation can make peace with human economic progress and still protect enough nature to ensure prosperity. Line of the session goes to Shellenberger: "The developed world telling the developing world that it can't pursue modernity because it will collapse the planet is the single biggest failed political line in the last two centuries." Runner-up goes to Marris: "Where is TNC's propaganda and sci ops division? How are you going to change the aesthetic preferences of the Chinese public to include consideration of nature?"
- **Mark Tercek's plenary address** the following morning, in which TNC's president and CEO challenged science to continue fueling the innovation culture that has defined the Conservancy from its beginning 60 years ago.
- **Cornell herpetologist Harry Greene's bravura dinner talk** about nature, the sublime, the paternal instincts of frogs and people's love/hate relationship with snakes (turns out, it's evolution). Greene was so good, he prompted Kareiva to blurt out: "I love natural history!"
- The **closing plenary session on the new ecological stewardship**, led by University of Montana professor Dave Naugle's presentation on sagebrush and sage grouse strategies and closed by TNC prairie ecologist Chris Helzer's recommendations for how TNC stewardship and science can get back on the same page.
- **Supin Wongbusarakum's social science in conservation pane**l, with experts from TNC, CI and WWF presenting on tools and lessons for integrating social science into conservation planning and practice.
- A discussion led by Karen Poiani on **forming a Women's Network at TNC**.
- A panel discussion on **how TNC can communicate boldly while staying true to science**, which ended with the question: "When you as a TNC scientist write or speak, are you speaking for TNC?"
- **Tips on better presentation design** in the awesome Conservation by DESIGN session from TNC's Dan Majka and Tara Schnaible.
- **More than 150 tweets** to the conference hashtag #TNCallsci.
- The **excursions to Graceland** (who knew Elvis had a racquetball court?) **and Beale Street**.

There *was* controversy: Many field scientists weren't happy about their presentations being relegated to a 5-6:30 PM slot on one day. Others thought the conference could have done a better job mapping out the route and connections between the old Conservancy and the new. But most were grateful for the chance to come together after too long apart — and moved by the diversity and depth of the Conservancy's science knowledge and pursuits on display.

"What impressed me most was the amazing range of people and topics," said Conservancy social scientist Craig Leisher. "I had conversations on the Spanish names for kingfishers, freshwater clams in the Mississippi watershed, PLoS One review eccentricities, electric cars, microeconomics and conservation, household survey controls, and MSC-certified Patagonian Toothfish — all in one day!"

Alas, no fried peanut butter and banana sandwiches. But had Elvis been a scientist, he'd have loved it. **SC**

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Q&A
Into the *Rambunctious Garden*: A Chat with Emma Marris

(Interview by Bob Lalasz, director of science communications, The Nature Conservancy)

Image: New York City's High Line Park. Image credit: Image credit: notladj/Flickr. through a Creative Commons license.

What's more ecologically valuable — national parks, or median strips and vacant lots? Could dreaded invasive species actually be more beneficial than native ones? Are environmentalists clinging to a timeless notion of nature that science has thoroughly discredited? Is the best way to change conservation's reigning paradigms simply to wait for conservation's old guard to die?

Emma Marris asks these and other icon-busting questions her new book *Rambunctious Garden* — potentially the most optimistic and controversial work about the future of nature to appear in years. Marris, a former correspondent for *Nature* magazine, takes big issue with enviro doom-and-gloomers and last-great-places conservationists, arguing in *Rambunctious Garden* that pristine wildness has been a myth for at least 13,000 years and that we live on a thoroughly domesticated planet whose nature it's up to us to manage…and even improve upon. It sounded so heretical that I had to call her up and ask her to explain. (What follows is an extended excerpt of our Q&A; read the full interview on grist.org.)

Q: *The title of your book —* Rambunctious Garden *— encapsulates your vision for nature as a garden that humans firmly control, consciously making decisions about which kind of nature goes where. You know that's going to raise the hackles of a lot of environmentalists, don't you? It has connotations of playing God and engineering nature solely for our benefit.*

EMMA MARRIS: Yes. I decided to go for it and be provocative, because the title is meant to describe what the Earth is and can be. Because the planet already is a garden, and we're kidding ourselves if we don't admit the depth of human influence over nature. We're in charge about where plants and animals are, either intentionally or unintentionally. It's our space that we're landscaping now.

Q: *A big theme in the book is that nature is everywhere — not just some spectacular landscape, but in your backyard, the sliver of median strip you drive by every day, and in vacant lots and industrial waterways, and that nature as background to our everyday lives is the sense of nature that conservationists should be cultivating in the public. But doesn't that argument really reemphasize the marginality of nature, a nature that's weedy and degraded and that no one will really fight for?*

MARRIS: When you use the phrase "marginal" to describe this kind of nature, that's a tip-off as to where you're coming from. Because nature isn't marginal. Dirt is underneath everything — the built landscape floats like islands on the sea of nature. Some of that nature pokes through in skinny bits, but when you connect those together, there's a lot of nature.

"Big national parks have an impressive amount of acreage, but if you look at doing conservation in all these little spaces, the combined acreage of those could kick the ass of acreage of the big parks. It's just a huge playing field that we can do conservation on."

And just because I want people to get out and get excited about the vines growing in the alley doesn't mean that we shouldn't also get excited about going to national parks, or that conservation should swerve away from having big interconnected pieces of undeveloped nature for some species. What I'm really proposing is a shift in our value system. What we value and don't value can change. "Weedy" is an interesting cultural concept — in reality, weeds are successful plants. We should celebrate them, because they're the plants we don't have to worry about it. They're gong to be fine. They're the resilient part of nature.

Q: *But is there enough of that kind of nature around to make a difference, both for biodiversity and for ecological function?*

MARRIS: My argument comes down to acreage. Big national parks have an impressive amount of acreage, but if you look at doing conservation in all these little spaces, the combined acreage of those could kick the ass of the acreage of the big parks. It's just a huge playing field that we can do conservation on. It's practically everything. Getting a certain amount of conservation value out of farm management, for instance — that would be a huge victory globally.

Q: *You write a lot about conservation in Europe versus how it's practiced in America. Is Europe ahead of America in understanding this?*

MARRIS: Yeah, absolutely, and not necessarily because they're massively enlightened. It's because they don't have the Grand Canyon to distract them. They don't have the grand wildernesses to take over their mental space, so they've been able to see the beauty and complexity of nature in these much smaller canvases. And they're constantly fiddling with their conservation efforts. Management of nature is just second nature to them. They have to work really hard not to manage things, whereas we have to sort of grit our teeth to admit to ourselves that we do have to manage things.

Q: *You have this fascinating chapter on the Oostvaardersplassen, a nature reserve outside of Amsterdam in which an entire landscape has been designed by an ecologist to run as it did 10,000 years ago, created to look as if nothing had ever changed (except there are no predators). And except, of course, that it's one of the most intensely managed places you could possibly find outside of agriculture. How do you feel about re-wilding projects like this? Are the valuable? Are they curiosities? What are they saying to us?*

MARRIS: I love that place. I mean, here you are, in one of the tidiest, densest, most organized countries in the world, and then you go through these gates, and all of a sudden, you're in the savannah, with huge herds of animals running around. It's fascinating and just unbelievable.

"Conservationists should get on board with assisted migration...Who is going to move the little squiggly guys that aren't as glamorous or aren't commercially valuable? If conservationists find the whole thing too distasteful because it's meddling with nature, then they might as well stand back and watch those squiggly guys turn to charcoal."

And if part of what we value about nature is that sense of awe that it can give us, I was awed by that place. They've also had a lot of success attracting animals that have showed up voluntarily and responded well to the habitat. So I think that if that keeps happening, then the Oostvaardersplassen is an argument that re-wilding projects are not just curiosities but can be really valuable conservation tools.

Q: *Back to the garden idea: You're advancing a radical idea in this book — that people can make more nature or better nature than we have now. That cuts directly against the usual pessimistic paradigm of environmentalism — as advanced by Bill McKibben and others — which assumes that there is a set amount of nature, that nature left alone is the ideal, and all we can do is defend it against the ravages of rampant development. How did you come to this idea?*

MARRIS: Partly because I was never classically trained as either an ecologist or an environmentalist. So I came to the ecology and conservation beat at *Nature* as an outsider, and while I sort of casually held a number of the sort of common beliefs about what is wilderness and what counts as nature, I wasn't really wedded to them culturally. So it was easier for me to see where some of the more traditional ideas of conservation and environmentalism are starting to come apart at the seams a little bit, the more we learn about paleoecology and the dynamic nature of ecosystems and how nature has always been changing. And this thinking has been popping up at ecology conferences over the last few years. I also had a childhood where I spent a lot of time in really crappy ecosystems and had a ball — in badly maintained city parks and third-growth forests — and it just never occurred to me that I wasn't in nature.

Q: *In the book, you talk about a number of bêtes noire for conservation — including assisted migration of species in the face of climate change to other geographies where they might have a chance of surviving. That's still a really controversial topic with conservationists.*

MARRIS: Conservationists should get on board with assisted migration, because industry is going to lead the way. What is industry going to move? Timber species, crop species. They might, if they're clever, move the wild ancestors of crop species, so that we'll still have good pools of them to play with, and they might move horticultural species. But who is going to move everything else? Who is going to move the little squiggly guys that aren't as glamorous or aren't commercially valuable? If conservationists find the whole thing too distasteful because it's meddling with nature, then they might as well stand back and watch those squiggly guys turn to charcoal.

Q: *Conservation doesn't come off really well in your book — it seems dogmatic, nostalgic, sometimes even anti-scientific, and not ready to take up the challenge of the economic and cultural forces that seem to be arrayed against it. In your view, how can conservation catch up?*

MARRIS: First, I hope I don't come across as really beating up on conservationists, because I admire them very much, and I feel that what they're trying to do is a really important thing.

"You can't just care about nature and not care about humanity. So an ideal mix would be a conservation movement that was also strong on human rights and human development, with a mix of priorities that was decided on in a very fair, democratic way."

One priority I think conservation has to focus on more is genetics. I've very fond of using a genetic lens — genes are the raw material of what we have to work with for the future, so it seems a smart move to throw out as few genes as possible.

But I do think that keeping conservation and environmentalism separate from other progressive movements like human rights and global human development has made environmentalism just another special interest fighting for its place, almost in competition with some of these other positive movements. That's got to change. You can't just care about nature and not care about humanity. So an ideal mix would be a conservation movement that was also strong on human rights and human development, with a mix of priorities that was decided on in a very fair, democratic way.

I also think that there will be change toward the directions I outline in the book — whether the conservation field wants them or not — just on the basis of generational turnover of its scientists. There's that old chestnut about there are no revolutions in science, you just wait for the old guard to die, and I think there's probably a bit of truth to that in this case, too. **SC**

Viewpoint
Making Science Count: Getting Smart About How to Have an Impact

By Peter Kareiva, chief scientist, The Nature Conservancy

Image credit: spettacolopuro/ Flickr

Discuss this article on the Conservation Gateway.

The hardest thing to do as a scientist is to actually make a difference.

By comparison, publishing is easy, provoking is easy, being rigorous is easy, criticizing is easy, telling managers they have should have used return on investment is easy, preaching the value of measures is easy, contributing to a CAP is easy, and so on. But trying to use your science to change how things get done or even what gets done — that can be a huge challenge.

And yet, in the end, it is our responsibility as scientists to do everything we can do to meet that challenge. No one will do it for us. And it is folly to wait for an invitation to do it.

Hard on the heels of last week's "ALL SCIENCE" meeting, which assembled hundreds of scientists from around The Conservancy and other NGOs, I'd like to

instigate a conversation about what we as scientists at the Conservancy need to do to have a greater impact on and be more useful for both TNC and conservation as a whole. To start that conversation, I offer below my responses to some typical complaints I hear from Conservancy scientists:

"'They'" made these decisions about where to _____ , and they did not do any return on investment or scientific analyses."

Yes, I have seen high-level decisions or projects go forward for which I questioned the scientific justification. But it has always been *my* fault for not speaking up early enough, for not giving practical advice, for not understanding in advance how decisions were being made and what were the constraints, or for lacking patience and follow-up. In my 10 years at TNC, I have never spoken out on behalf of a scientific point and been ignored. If science is not adequately informing the Conservancy's decisions, it is *our* fault as TNC scientists for not investing our time and thinking into knowing what the decision process really is (as opposed to some academic ideal) and identifying where we can insert science in a practical way. It does no good to complain after the fact.

"Marketing is making certain claims that put at risk our science-based credibility."

Of course marketing is making us uncomfortable with their claims — it is their job to tell our story in a compelling way. It is our job to give them credible numbers and data that help them do this. For example, it takes extra scientific work to express the impacts of our projects in terms of benefits to people. That is extra work we need to start doing. I guarantee our marketers will use that data if we give it to them.

"They were not really interested in what I had to say, and spent all their time on their Blackberry or doing e-mail."

If an audience is inattentive, it is *always* the speaker's fault. Too often we scientists fail to be concise, crisp, clear and practical. We dive into details, caveat our remarks to death, meander around our points, and do not highlight the ONE THING to pay attention to. Randy Olson's book *Don't Be Such a Scientist* is a good primer on how to improve your communication skills.

"If science is not adequately informing a decision at the Conservancy, it is our fault as TNC scientists for not investing our time and thinking into knowing what the decision process really is...and identifying where we can insert science in a practical way."

"We are a biodiversity organization — other organizations can worry about people and poverty."

Get over it. Read the scientific literature and see for yourself how the field of conservation has changed and is changing. Conservation has been a focus for science for over 100 years, but biodiversity has been the centerpiece of conservation for only 20 of those years. And now the science of conservation is turning to pay more attention to working landscapes, ecosystem services and impacts on people. As a science-driven organization, we need to keep up with the science instead of clinging to ideology.

"Our External Affairs group is releasing policy statements without any good science."

External affairs and policy teams wherever I have worked are always on the lookout for science. The problem is that scientists too often write papers and deliver information

THEY think are important to policy, as opposed to asking policy experts what type of science would REALLY be most useful. If you want to see more science behind our policy work, work more closely with government relations or external affairs (at state, national and international levels) and give them what they need, rather than what interests you personally.

The bottom line: We need to gauge everything we do as scientists at the Conservancy in terms of impact. Resources are scant, the problems are large, and our time is limited — which means we must always ask ourselves what impact we intend to make with whatever scientific endeavor we engage in, and exactly how that impact will be achieved. Monitoring invasive weeds on a small reserve for 20 years may not be the best use of our science talent — unless we have a plan for taking what we learn to a broader audience and an audience that can by virtue of being better informed actually change something. And that burden of understanding how change works falls on us as well.

What do you think? Send me an email or a letter to *Chronicles* and let us know. **SC**

Article

Bringing Efficient and Effective Ecosystem Markets to Scale: Challenges & Solutions

By Sheila Walsh, ecosystem services analyst, The Nature Conservancy

Above: Fresh market of Kota Bharu, Malaysia. Image credti: paularps/Flickr.

Discuss this article on the Conservation Gateway.

Ecosystem markets often are touted as an efficient and effective way to solve environmental problems. As interest in market solutions grows both within the Conservancy and in the private and public sector, it is critical to know when markets deliver better environmental results at a lower cost than alternative approaches — and how to scale them up when they do.

In Part I of this piece, I outline some of the general challenges and issues around creating efficient and effective ecosystem markets — including transaction costs, property rights, competition, and verifiable outcomes — and how those challenges and issues vary by the type of market strategy. Some regulatory markets have largely overcome these challenges and resulted in arguably the greatest environmental success story of the last two decades: significant reductions of SO2 emissions and acid rain. Excitement from the success of regulatory markets has turned attention to direct (e.g.

voluntary) markets and payments for ecosystem services (PES). Although the Conservancy pioneered market-based conservation strategies by buying land (long before the term PES existed), we should consider the new and remaining challenges for market-based strategies that target individual or bundled ecosystem services using regulatory markets, direct markets or PES.

The Market Solution and the Problem of Transaction Costs

Ecosystems generate important benefits to society in the form of public goods, such as clean drinking water, clean air, climate regulation or areas for recreation. Ecosystems also benefit people by acting as sinks for pollution or providing food and fiber for harvest. Use of ecosystems as pollution sinks or for food and fiber production services, however, limits the ability of society to enjoy other services from these ecosystems, and vice versa.

The Coase Theorem suggests that the problem of how to allocate ecosystem services to different desirable uses can be solved efficiently through markets. Regardless of whether the polluter has the right to pollute or an individual has the right to consume clean water, says the theorem, multiple parties should be able to come to a mutually beneficial solution through bargaining, *if there are no transaction costs*. In reality, the transaction costs associated with establishing agreed-upon resource-use levels among multiple parties are usually very high for individuals relative to the benefits they get from those resources, which leads to economically inefficient resource use that reduces the total benefits to society.

"In order for markets to form, they need well-established and complete property rights and a signal of scarcity. Ecosystem services that are public goods, such as clean air for breathing or genetic resources, do not fit these criteria."

Governments can help overcome these high transaction costs to individuals by representing the collective "willingness to pay" for ecosystem services. For example, the U.S. Conservation Reserve Program pays farmers to not grow crops in order to increase water filtration services or biodiversity, which benefit the public. Similarly, by purchasing land for conservation, the Conservancy and other land trusts represent their members' demand for the services the land provides. In contrast, regulatory (i.e., established via regulation) markets, such as emissions markets or fisheries catch shares, force large resource users to carry the burden of transaction costs rather than individuals, who would face especially large costs to organize.

The Problem of Market Formation for Public Goods

In order for markets to form, they need well-established and complete property rights and a signal of scarcity. Ecosystem services that are public goods, such as clean air for breathing or genetic resources, do not fit these criteria. Property rights cannot easily be established for clean air because people cannot be excluded from enjoying it and because one person breathing clean air does not effectively limit another person's ability to do so. In contrast, in the case of common-pool resources (such as pelagic fish stocks outside of a country's 200-mile exclusive economic zone), use by one person *does* limit

other people's ability to use the resource. Yet the creation of property rights for this kind of resource is still extremely challenging.

Regulatory markets have gotten around these challenges by focusing on harm to these resources. By limiting the rights to extract or pollute, the government indirectly protects the rights of society to healthy fish populations or clean air, for example. Users then buy or sell their right to extract or pollute within the limit set by the government. In contrast to command-and-control regulations that prescribe specific actions for all regulated individuals, regulatory markets in many cases should be more cost-effective because individuals are free to find innovative solutions to achieve target levels of use or pollution through decentralized decision-making. For example, the SO2 emissions market, the largest regulatory market in the United States, is estimated to have resulted in $1 billion in reduced costs annually (Carlson et al. 2000).

Issues Around Creating Efficient and Effective Ecosystem Markets

The greater efficiency of ecosystem markets over command-and-control solutions depends on the markets being competitive as well as on enforcement of regulations.[1] A competitive market needs lots of buyers and sellers trading homogenous goods with low transaction costs, good information and no uncompensated effects on third parties. This combination of requirements sets a high bar. Markets for industrial air or atmospheric pollutants, however, may fit most of these requirements. For example, greenhouse gas emissions reductions in one place, theoretically, should offset emissions anywhere else in the world. Based on this principle, voluntary markets for forest carbon have already been created, and regulatory markets are emerging (e.g. in California). In contrast, nutrients in a river, wetlands, or habitats for endangered species are not equivalent from one place to the next. Many mitigation, offset or trading programs have addressed this problem by limiting the geographic area in which transactions may occur. For example, nutrient trading in the Chesapeake Bay may only occur within major tributaries (Branosky et al. 2011). Although this limitation makes it less likely that some tributaries would get most of the nutrient pollution, it also limits the number of buyers and sellers.

[1]There is some research that shows that compliance monitoring requirements and costs are higher for market-based approaches (measuring actual emissions over time vs. checking if the mandated filter is installed and in good condition) (e.g. Russell 2001).

However, even competitive markets may not be effective if they do not verifiably deliver ecosystem services. Most markets are not actually markets for the ecosystem services (or disservices) but markets for actions that should increase the service. Even with some actions that are directly linked to the ecosystem, such as wetland restoration, there is concern over whether these restoration efforts really result in the projected levels of ecosystem services.

Beyond Regulatory Markets: Direct Markets and Payment for Services

Despite some of these challenges, the success of regulatory markets has generated interest in direct markets for ecosystem services. Direct markets are where the user of the ecosystem service pays voluntarily rather the polluter paying to comply with

regulations. However, as noted above, forming direct markets for public and even common goods is problematic because of their attributes. Even when common goods show signs of scarcity, it's difficult to motivate users to pay because others can benefit from their action through free-riding.

Voluntary engagement in direct markets may result from philanthropic motivations, a sense of social responsibility, or a perceived opportunity to generate private value or minimize risk (especially in preparation for regulatory markets). The Conservancy and other non-profit organizations have made significant impacts through buying land and, increasingly, for-profit organizations are participating in voluntary carbon markets. Despite political uncertainty over regulatory markets for carbon, 2010 saw the largest volume of trading in voluntary carbon markets, with 29% of credits coming from REDD (Peters-Stanley 2011). However, participation may decline if regulations are never created; and philanthropy or social responsibility will likely not be sufficient to keep pace with the increasing magnitude and scale of environmental problems.

Payments for ecosystem services, which are not markets but agreements (usually between one or a few buyers and a few sellers), are prone to greater inefficiencies than markets but may still provide better solutions in certain situations. For instance, PES may not increase ecosystem services if payments are biased towards individuals who were least likely to clear forest on their land, for example, or if they increase resource degradation in other places by displacing effort or increasing resource prices. These issues are referred to as *additionality* and *leakage*, respectively. Recent careful evaluations of a PES scheme in Costa Rica to reduce deforestation and of the clean development mechanism in China showed these efforts resulted in far less additional conservation or reductions in greenhouse gases and other pollutants, respectively, than was expected (Zhang and Wang 2011; Pfaff et al. 2008). In fact the study in Costa Rica estimates that the PES scheme resulted in avoidance of only about 0.08% per year of deforestation, one-third of what might have been expected (Pfaff et al. 2008).

"PES may not increase ecosystem services if payments are biased towards individuals who were least likely to clear forest on their land, for example, or if they increase resource degradation in other places by displacing effort or increasing resource prices."

In addition to not always producing the expected results, PES may not be cost-effective. In contrast to environmental taxes that both reduce the undesired activity and generate revenue, publicly funded payments for ecosystem services may be less efficient because they tax desirable activities to pay for reductions in undesirable activities (Jaeger 2011). Yet, PES may be a more efficient solution when the harm occurs outside of the jurisdiction of the people that enjoy the ecosystem service. For example, a government may use PES for international environmental issues, while non-profit organizations or individuals may use PES to have influence without ownership. PES may also be more desirable when payments also decrease income inequality. For example, the Conservancy's Guandu Water Producer Project pays low-income landowners to maintain or restore forests with fees collected from water users in Rio de Jainero.

In order to bring efficient and effective ecosystem service markets to scale, the Conservancy needs to overcome or avoid the pitfalls and understand the limitations of markets or PES, use science and policy evaluation to improve market design and demonstrate opportunities to generate value, communicate this science to involve new actors and ecosystem services, and help build the policy and infrastructure to support markets. I'll outline how the Conservancy can and is addressing these challenges in Part II next month. **SC**

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Special Issue: Invasives
An Ounce of Prevention: Should TNC Do More About Invasives?

By Doria Gordon, director of conservation, The Nature Conservancy in Florida

Above: Calosoma sycophanta, imported into the United States in the early 1900s to control gypsy moths. Image credit: kqedquest/Flickr.

Once again, Mom was right: Avoiding an impact — whether you're running with scissors or importing species without discrimination — is less painful than dealing with the consequences. The Conservancy is playing a leading role in trying to incorporate risk assessment into government decisions about species introduction. But do we need to do more on an organizational level?

Certainly, the science is clear: Research is demonstrating that preventing the import of species likely to become harmful invaders is more cost-effective in both economic and ecological terms than controlling those species once they have become established and

identified as detrimental to human or natural systems (Leung et al 2002; Keller et al. 2007b).

The approach seems intuitive, particularly for intentional imports, if only we could identify (as Davis et al. 2011 caution) the high-priority species to prohibit. Risk assessment would allow exclusion of the small proportion of species that cause damage, while allowing commerce in valuable, non-invasive species (Keller & Lodge 2007). Unintentional imports of species are more difficult to prevent; in these cases, efforts generally focus on the pathway (shipping containers, seed contaminants, ballast water, etc.) rather than on the particular species (Lodge et al. 2006). In either case, pre-border prevention approaches are more effective than post-border inspection (Lodge et al. 2006).

For a century, the United States has incorporated prevention approaches into national regulatory policies to protect agricultural productivity. The U.S. Noxious Weed list contains roughly 100 species and some genera; the vast majority of those taxa are species that have never been recorded in the United States but are known to have such costly impacts to agricultural crops elsewhere that they have been prohibited for decades (Westbrooks 2002). Most other countries also regulate plant imports for potential impacts to agricultural productivity. Prohibited pests and pathogen lists are similarly dominated by taxa known to impact economically valuable species. Species that carry diseases that impact human health (such as Gambian pouch rats (monkey pox; CDC 2003)) or livestock (such as ticks on imported African lizards (heartwater; Burridge et al. 2000)) are also readily prohibited. Governments have long and rightly prioritized prevention of impacts to human health and livelihoods.

"Only recently have regulated species lists started to include representation of species damaging to *natural* areas....In the United States, if those species are already considered too widespread for effective control...or have high economic values or a strong lobby, they are unlikely to be listed regardless of the current or potential damage incurred."

Only recently have regulated species lists started to include representation of species damaging to *natural areas*. The difference in the latter group is that the species considered are generally already present and spreading in the new range. In the United States, if those species are already considered too widespread for effective control (even if only present in one region) or have high economic values or a strong lobby, they are unlikely to be listed regardless of the current or potential damage incurred. If you doubt that statement, research the current battle to place nine constrictor species in the pet trade — all of which are demonstrated to pose a risk of invasion in the United States (Reed & Rodda 2009) — on the U.S. Fish and Wildlife Service's Injurious Wildlife list in order to prohibit their import and interstate trade.

Countries such as Australia and New Zealand — which have unique flora and fauna and clear documentation of negative impacts by non-native invaders (e.g., Taylor 1984, Williams & West 2000) — use a more precautionary approach to potential invasives. These countries require the use of a predictive screening tool prior to import of any new species, be it plant, vertebrate or invertebrate (e.g., Bomford 2003, Roberts et al. 2010). If a species is predicted to have a high probability of becoming a harmful invader, the regulatory decision is made to restrict trade in that species. No assessment of potential

economic value, stakeholder interest or other political considerations factor into the decision.

So how should preventative decisions be made? *Precautionary listing* has traditionally been based on evidence of harmful impacts of the species in other countries. Any species parasitic on a cereal crop in one location, for example, is considered too risky to import into other countries where that crop is cultivated, unless the environment would not support the parasite. After seeing the impacts of zebra mussels or fire ants or hydrilla in the United States, countries without these species are likely to prohibit them. And, in fact, the best predictor of whether a species is invasive in a new range is whether it has already been documented as invasive elsewhere outside its native range (Panetta 1993, Mack 1996). However, precautionary listing is insufficient for species that have no or only a brief history of translocation. This caveat is critical: species translocation rates have substantially increased in recent years (Levine & D'Antonio 2003, Lodge et al. 2006), and many species do not exhibit their full invasive potential for over a century (Kowarik 1995, Simberloff SC Sept. 2011).

Luckily, the more precautionary approach of countries like Australia means that *predictive screening* or *risk assessment* tools are available for testing in new locations (e.g., Gordon et al. 2008), and efforts are under way to develop such tools for multiple taxa (e.g., Kohler & Lodge 2002, Keller et al. 2007a). The Nature Conservancy, while clearly investing in control efforts for the species identified to most significantly threaten our conservation targets on the ground, has been working for several years to incorporate into the relevant U.S. national laws requirements for risk assessment prior to introduction of novel species. The Global Invasive Species Team was working on laws in South America and other countries as well; I don't know if such efforts are still under way. However, different North America Conservation Region (NACR) operating units within the Conservancy have agreed to take the lead on different taxa. For example, the Conservancy's Florida program is leading incorporation of risk assessments with known accuracy into various federal regulations — for plants, into the USDA Plant Protection and Quarantine (PPQ) rules, and for animals, into the U.S. Fish and Wildlife Service Lacey Act. The NACR Forest Pest and Pathogen Team is leading efforts to reduce the probability of accidental introduction of species impacting forests, and the Conservancy's New York program is leading similar efforts to reduce the threat to aquatic systems through regulation of ballast water management.

"I have been contacted by agency staff from every continent about the plant screening tools I have been testing, and am heartened that — despite the academic interest in novel ecosystems — many geographies are trying to prevent the homogenization and simplification of their biota."

In my experience, many other countries are very interested in implementing the tools that we are developing, increasing the leverage of this work and reducing the probability that harmful invaders will be translocated to new regions. I have been contacted by agency staff from every continent about the plant screening tools I have been testing, and am heartened that — despite the academic interest in novel ecosystems — many geographies are trying to prevent the homogenization and simplification of their biota.

So, is TNC still working on invasive species issues? Yes, at multiple scales that range from high-leverage prevention approaches that are having national and international impact, to more regional and local efforts to develop partnerships that (1) detect and respond rapidly to unintended and unanticipated imports and (2) manage those high priority species that are already here and are actively threatening the success of our conservation objectives. Greater coordination of all these efforts (see Serbesoff-King in this issue) would increase both our effectiveness and efficiency. **SC**

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Discuss this article on the Conservation Gateway.

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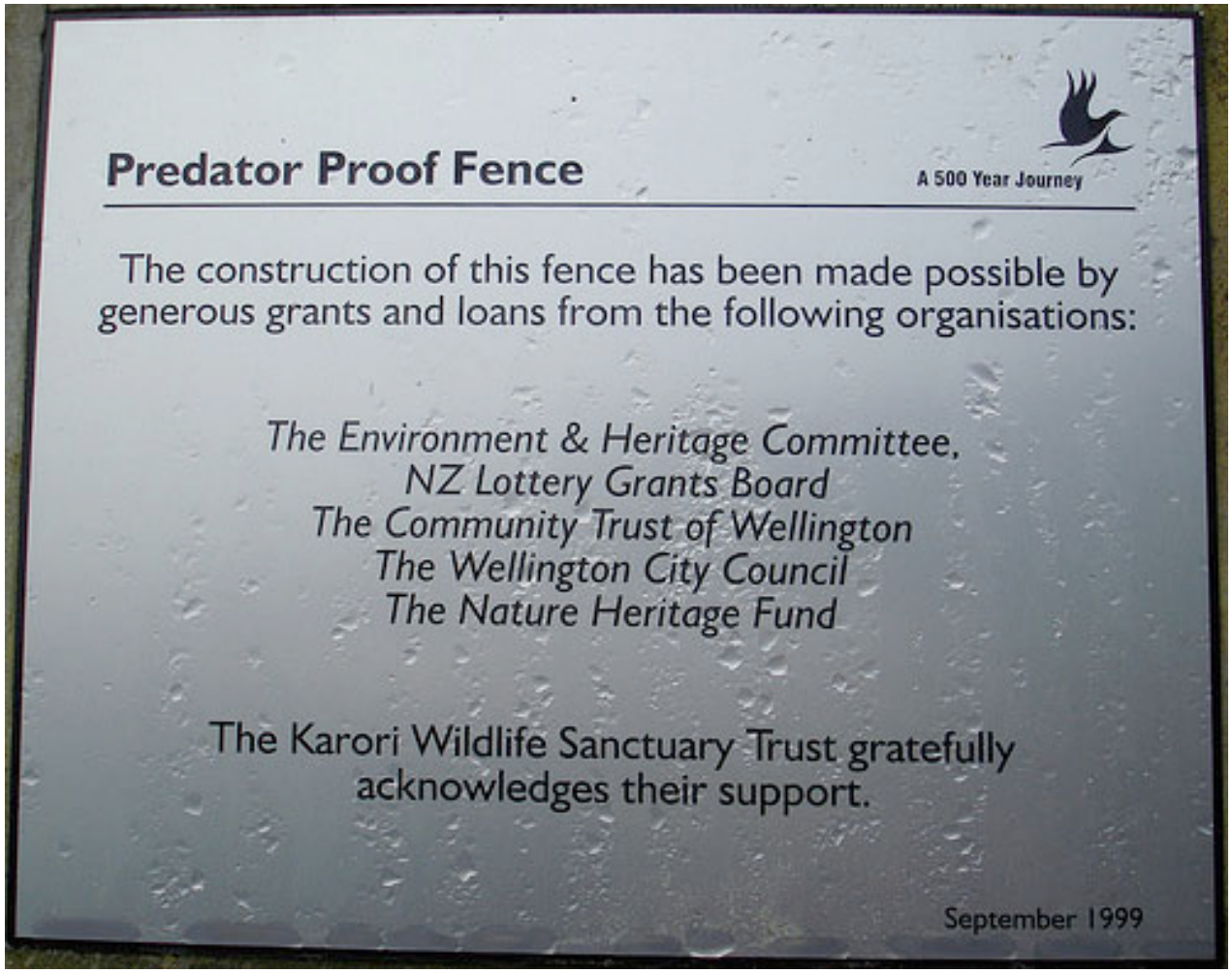
Special Issue: Invasives

The Cutting Edge of Invasive Species Control: Starting Small but Thinking Big

By Lindsay Chadderton, aquatic invasive species director, The Nature Conservancy's Great Lakes Program



Above: Predator-proof fence warning at Karori Sanctuary, Wellington, New Zealand. Image credit: Teacher Traveler/ Flickr.

Discuss this article on the Conservation Gateway.

In an age where the rate of new species invasions continues to increase and conservation resources have become scarcer, Davis et al. (2011) are correct that conservationists must continue to strive to refine and improve the way we manage pest species. That means we need to be clear about what we are trying to protect and what the key threatening processes are. There are well-established criteria and reasons for when and why we should engage in efforts to control or eradicate an invasive species (Bomford and O'Brien 1995, Owen 1998, Myer et al. 2000, Mack and Forster 2004, Panetta and Tsimmons 2004). There are also some pests and situations where the lack of resources or appropriate and effective control tools, monitoring methods or support from key decision-makers will require that we walk away or adapt.

But we need to be careful that, while acknowledging the criteria for engagement and the occasions when we do walk away or adapt, we are not infected by fatalism or a lack of vision (Simberloff 2002) regarding established invasive species — because we must control the impacts of these species to halt the ongoing decline in global biodiversity.

There are sound reasons for optimism that this task is possible. An increasing number of control and eradication success stories from around the globe (see, for example, Mack and Foster 2009) that are transforming how we think about plant, invertebrate and vertebrate pest management. The Nature Conservancy has an important role to play in disseminating these ideas and in ensuring development of invasive species control and eradication strategies at ecological meaningful scales.

Success Stories: Eradication on Islands, Freshwater Fish and More

Small to medium-sized islands have been particularly fertile locations for developing new techniques in invasive species control. Indeed, lessons learned from successful (and unsuccessful) eradication attempts have enabled techniques to be refined and applied to larger and larger islands, culminating in recent successes like the eradication of feral pigs from California's Santa Cruz Island (Ramsey et al. 2009). Successful island eradications have resulted in well-documented recoveries of numerous bird, reptile, plant and invertebrate species (Towns and Broome 2003). Skeptics are quick to point out that islands offer a unique set of conditions that can't necessarily be replicated on the mainland. However, success has not been limited to offshore islands. The eradication of African mosquito from Brazil, screwworm from the southern United States and Mexico, smallpox across the globe (Simberloff 2002) and barberry from five western European countries (Stakman 1923) are just a few examples of successful continental and regional scale eradication programs.

"We need to be careful that...we are not infected by fatalism or a lack of vision regarding established invasive species, because we must control the impacts of these species to halt the ongoing decline in global biodiversity."

Additionally, eradication methods for vertebrate pests developed on islands are now being refined and applied to successfully control the same species on mainland habitats in New Zealand and Australia. Predator-proof fences have been built to create "mainland islands," where introduced mammalian pests are then eradicated from within the fenced area, and missing native elements reintroduced. One of the earliest examples is the Karori Sanctuary, a 550-acre preserve in the heart of Wellington, New Zealand's capital city that has transformed public perception about these kinds of efforts, creating a demand that has been replicated around the country by local communities with public and private funding. The size of these initiatives varies, but some are starting to reach ecologically meaningful scales, such as the mountaintop preserve at Maungatautari, New Zealand that was the vision of a group of local farmers. This 8,400-acre preserve is enclosed by a 29-mile-long fence, which allowed both eradication of all major mammalian invasive species (e.g. rats, stoats, cats, brushtail possum, deer and goats) and successful reintroduction of various threatened species.

Where geographies, climate or the scale of the operation preclude fencing, management sites can be selected to take advantage of natural barriers to dispersal (e.g.

large rivers, glaciers, mountain ridges) that slow recolonization. Large-scale suppression is more cost-effective and sustainable in these situations, especially if source populations can be targeted (Robertson and Gemmell 2004). For example, in South Georgia (a British territory in the South Atlantic), rats are being systematically eradicated from large swaths of the island, on a scale that will eventually dwarf all previous individual eradication efforts (South Georgia ~1000 km2, previous largest ~110 km2) (Towns and Broome 2003, Robertson and Gemmell 2004). Glaciers are being used as natural fences that partition the island into smaller, more manageable treatment blocks. Genetic analyses show the glaciers to be effective barriers to rat dispersal (Robertson and Gemmell 2004). Fences were also used on Santa Cruz Island to break it into manageable treatment units. But large-scale, multi-species control programs are also being undertaken in valleys where natural features like large rivers or mountain ridges constrain or slow reinvasion, making it cost-effective to maintain long-term invasive species control programs provided these programs produce measurable benefits for target species such as threatened taxa (Cullen et al. 2005, Caruson 2006).

Success is not limited to terrestrial environments: the United States has led the world in development of freshwater fish eradication efforts. Successful removal of invasive fish like brown and rainbow trout from headwater streams to protect localized endemic fish and amphibians have been occurring for over 70 years (Finlayson et al. 2010). Fish are typically eradicated by multiple treatments using the fish piscicides rotenone or antimycin, and recolonization prevented by natural (waterfalls) or purpose-built fish barriers. These methods have been exported around the globe and used to restore populations of threatened fish (e.g., Lintermans 2000), and prevent establishment and spread of new introductions (e.g., Brazier and Britton 2006). Equally, the Great Lakes sea lamprey control program has successful reduced impacts to valued sports fisheries for the last 50 years and formed the model for a large-scale international effort to develop effective control tools for common carp in Australia and the United States (Bajer and Sorensen 2010).

"Eradication methods for vertebrate pests developed on islands are now being refined and applied to successfully control the same species on mainland habitats in New Zealand and Australia."

Eradication is the most cost-effective strategy for species that have been introduced, but it is not always possible, and maintenance control (sensu Myers et al. 2000, Simberloff 2002, 2009) is a standard approach used to safeguard and maintain conservation targets. However, whether the goal is control or eradication, successful operations share a common set of characteristics (Bomford and O'Brien 1995, Myers et al. 2000, Simberloff 2002, 2009, Mack and Forster 2009):

- An ability to access and target all individuals in a population;
- For plants, seed bank should be short-lived;
- A means to detect target species at low densities;
- Reinvasion is prevented;
- Clear lines of authority and an ability to compel action;
- Support from local communities and key decision-makers;
- Adequate resources for the life of the project (including sufficient duration to detect and remove propagules).

And eradication or control efforts must be underpinned by an understanding of the invasive species biology, particularly dispersal and home-range characteristics (Robertson and Gemmell 2004). It is important to critically evaluate control or eradication efforts against these criteria (Mack and Foster 2009, Owen 1998), as failed operations can usually be attributed to the failure to meet one or more of these conditions (Myers et al 2002).

While the scale of the invasive species problem can seem daunting, we should remember that globally we are often dealing with a common set of invasive species. By sharing resources and knowledge, we can stem the tide. Exciting new tools are becoming available, like a humane feral swine bait developed in Australia (Cowled et al. 2008), a species specific toxin for quagga and zebra mussels derived from locally occurring soil bacteria, or sensitive DNA detection methods (Ficetola et al. 2008, Jerde et al 2011) that will allow managers to go where few have dared to go before. The Conservancy's science and stewardship staff have an important role to play in ensuring that these tools are used to their fullest potential and do not fall victim to unwarranted fatalism (Simberloff 2009). **SC**

Acknowledgements

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Special Issue: Invasives

Recapturing a TNC Internal Forum for Invasives

By Kristina Serbesoff-King, invasive species program manager, The Nature Conservancy in Florida

Image credit: philipbouchard/Flickr.

Discuss this article on the Conservation Gateway.

I have been with the Conservancy for just over seven years, the entire time as the invasive species program manager for TNC's Florida program. During my tenure, I have been exposed to the Conservancy's national and international work more broadly through a fortunate series of opportunities including, but not limited to:

- Participating in and facilitating Eastern Invasives Learning Network meetings;
- Participating on an aquatic non-native species panel;
- Reviewing other TNC programs' invasive species strategic plans and having the Florida plan reviewed;
- Assisting with the development of a plan for the North Carolina program;
- Engaging in cross-program policy teams focused on invasive species;
- Being trained and training others in the Weed Information Management System;
- Starting and participating in the Caribbean-Florida Fire and Invasives Learning Network; and
- Meeting colleagues from many of our U.S. programs as well as Mexico, South America, the Caribbean and China.

I am extremely grateful for these opportunities. This exposure to other state and country programs has broadened my perspective of our work. It has solidified my knowledge of invasive species as a major threat to the mission of the Conservancy. It has made me a better scientist.

But in the past 2.5 years, since the dissolution of the Global Invasive Species Team (GIST), I have struggled to maintain these connections. I, along with others across the Conservancy, have attempted to step in and keep some high leverage work afloat (for examples, see Doria Gordon's article in this issue). I have represented the Conservancy on the U.S. National Invasive Species Advisory Committee for the past two years in order to maintain a conservation voice on that body (filling in the much-too-big shoes of our former colleague Catherine Hazelwood). To the common question from state and national colleagues of "does TNC do invasives anymore?" I respond: "Yes, but we have delegated it to our state and country programs." While I do believe that is true, I also believe that our individual program as well as our global work on invasives has suffered from lack of coordination (Lowenstein 2011).

Invasive species pose a threat to our conservation targets everywhere we work and will not go away. Conservancy staff will continue to face hard decisions about how, or if, to address this threat (Jordan 2011). Our past and current efforts on this issue mean that our partners will also continue to rely on our expertise and collaboration. It is important that we have our own house in order.

My intent here is not to lament the loss of GIST, but rather propose one idea for recapturing a communication network for invasive species issues within TNC. I am also open to other ideas; however, I feel that this is a critical step for the Conservancy and that addressing invasives is necessary for us to achieve effective conservation.[1]

I would like to propose the formation of a TNC Invasive Species Advisory Committee, along the following steps:

Establish a TNC internal committee

- One person designated as lead to coordinate communications and requests.
- Committee formed at WO level. All WO Group, Regions and Focal Area Directors and O.U. Directors need to know that this committee exists and that it should be used as an internal resource.
- Members of this committee can be appointed or self-designated committee members with representation across NACR and international staff. At a minimum, the committee needs to include Bill Toomey, our new NACR forest health director, as well as perhaps five representative staff.

Committee Role

- Coordinate peer review of state and country program invasive species efforts.

[1] For the Conservancy's purposes, a conservation area can be deemed to be under effective conservation when its biodiversity health score, threat status, and effective management status ratings are all acceptable. See Abstract Glossary of Science Terms (use in conjunction with Project Abstract Instructions.)

• Review TNC focal area and external affairs/policy efforts that need invasive species issues to be considered (e.g., energy, Farm Bill, climate change, restoration, emergency response in the Gulf of Mexico, changes in SOPs, etc.)

• Review internal and external Conservancy messaging that will discuss or reference invasive species (to ensure that as an organization we are not inadvertently undercutting our own science and stewardship efforts).

• Review requests for biological control releases on TNC preserves and submit committee-approved requests to the Conservancy's chief scientist.

Process

• TNC staff can submit requests to the committee as needed (i.e., the committee will not seek work, though committee members can submit requests).

• Committee can identify TNC staff not on committee to assist with reviews as subject matter warrants. The idea is for this committee to coordinate but not conduct all efforts.

• Committee will review biological control release requests within two weeks.

• Committee will maintain information on reviews and committee decisions in order to build an archive of information for staff and to inform future decisions. Ideally, this archive will be maintained in a location accessible to TNC staff.

• At least one committee member should join the TNC Stewardship listserv in order to provide feedback, if needed, and gain additional information on TNC work through the invasives discussions that occur in that forum.

IDEALLY: this committee will identify an avenue for communicating information on invasive species and strategies to address their impacts to all staff. We have many staff that have been hired in the last 3 years that are unaware of the resources that were lost with GIST (Jacquart 2011).

Thoughts? Other ideas? This proposal is selfishly motivated. As an example, I have been serving as TNC's voice on non-native animal import policy for the past 2.5 years. I would have liked to have had a mechanism for ensuring that all those TNC scientists and practitioners dealing with non-native wildlife threats were aware of that work. While I have reached out to many in our organization and to others in my field to provide assistance on this effort, I likely have missed engaging needed expertise from TNC's wildlife biologists. Equally important, I would gain going forward critical review of my work from a network of peers.

The loss of GIST significantly impacted my work. However, I know that the Conservancy continues to do crucial conservation and that many of us are faced with addressing the threat of invasive species as a part of our jobs. Recapturing an internal forum for invasives will benefit the Conservancy, starting with increasing our communication and our opportunity for peer review on this issue (for more on growing the Conservancy through sharing knowledge, I highly recommend reading the new "Knowledge Initiative Report"[2]). To further emphasize Frank Lowenstein's point

[2] **https://connect.tnc.org/teamsites/conservation/knowledgemanagement/Pages/Knowledge%20Management%20Home.aspx (look for "KI Recommendations Report – Final 09 09 11" in the documents section of the website)**

(Lowenstein 2011), this communication should not only be among operating units (lateral), but among staff who work at site, system and global scales (vertical). **SC**

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Special Issue: Invasives

To Control or Not to Control? An Invasive Plant Management Decision Analysis Tool

By Chris Zimmerman, conservation ecologist, The Nature Conservancy in New York

Above: Volunteers removing invasive Scott's Broom weeds from Mima Mounds Natural Area Preserve, Washington State. Image credit: WAstateDNR-Department of Nature Resources/Flickr.

A common theme in the articles on invasive species in the September 2011 issue of *Science Chronicles* is the need to prioritize scarce resources when deciding whether or not to manage invasive species. Despite lively differences of opinion, all contributors agreed that, to justify spending resources on control efforts, (1) the species must be causing serious economic or environmental harm or harm to human health, (2) the control efforts should have a high probability of success, and (3) the control efforts should give a good return on the investment. Control projects should also result in long-term maintenance or restoration of the viability/health/resilience of desired species, natural communities, and/or ecosystem processes, as was emphasized by TNC's Site Weed Management Plan Template in 1999.

In practice, it is often difficult to decide if all these criteria are met. A number of tools have been developed to prioritize invasive plant species for management at a site; however, these tools provide little assistance in determining if controlling an invasive *is or is not feasible and likely to succeed* when all factors in a given situation are considered. But we now have a tool to help us make the crucial decision to control or not to control.

Born out of an internal spirited debate on when to implement invasive plant control, a Nature Conservancy working group in New York completed the **Invasive Plant Management Decision Analysis Tool (IPMDAT)** in June 2011. The purpose of the IPMDAT is to assist conservation project managers in deciding if an invasive plant control project is warranted (i.e., that the non-native species causes significant impact or harm); feasible; has a high return on investment; and will lead to a successful conservation outcome. Using this tool makes our decisions on invasives control more transparent, understandable and fully documented. As a result, we expect to undertake fewer invasive control projects and spend our resources more strategically.

The IPMDAT is comprised of a strategy-selection decision tree (see Figure 1 at the end of this piece) and three control-strategy decision trees (eradication, containment/exclusion, and suppression) as well as associated worksheets and documentation. The strategy-selection tree is used to document the harm caused by an invasive plant species and to identify the appropriate control strategy based on the plant's abundance and distribution. Subsequent trees are used to determine whether control is feasible given the socio-political environment, biological attributes of the plant, effectiveness of control methods, risk of non-target impacts or unintended consequences, and available resources — including financial commitment. If the project is determined to be feasible, then the user is asked to weigh the costs and benefits of the control project. Lastly, a pre- and post-control monitoring plan is required for a control project to proceed.

The IPMDAT contains three potential control strategies: eradication, containment/exclusion, and suppression:

Eradication – goal is to eliminate all individuals and the seed bank from an area with the low likelihood of needing to address the species again for the next 10 years.

Containment/exclusion – a project which aims to prevent infestations of invasive species from spreading to uninfested areas.

Suppression – goal of project is to reduce an invasive plant population in size, abundance, and/or reproductive output below the threshold needed to maintain a species or ecological process.

Discuss this article on the Conservation Gateway.

It is emphasized that long-term containment/exclusion and suppression projects should be entered into with caution to be sure the benefits outweigh the costs; that internal support is in place (i.e. from a state program director of conservation programs or equivalent position); and that needed resources are available and secure.

The IPMDAT has four possible outcomes:

1) **Proceed with control** (project has conservation value and a high probability of success.

2) **Stop** – secure sustainable funding before proceeding.

3) **Stop** – control not feasible and/or not warranted.

4) **Peer-review required** – feasibility and/or conservation value is uncertain.

In New York State, we are currently using IPMDAT to evaluate new and current invasive plant control projects and training state agencies and organizations to use the tool. Additionally, we are sharing more details about the tool at the All-Science TNC Conference and other venues. Our hope is that other TNC programs and partners will see value in this tool and use it to evaluate their projects as well.

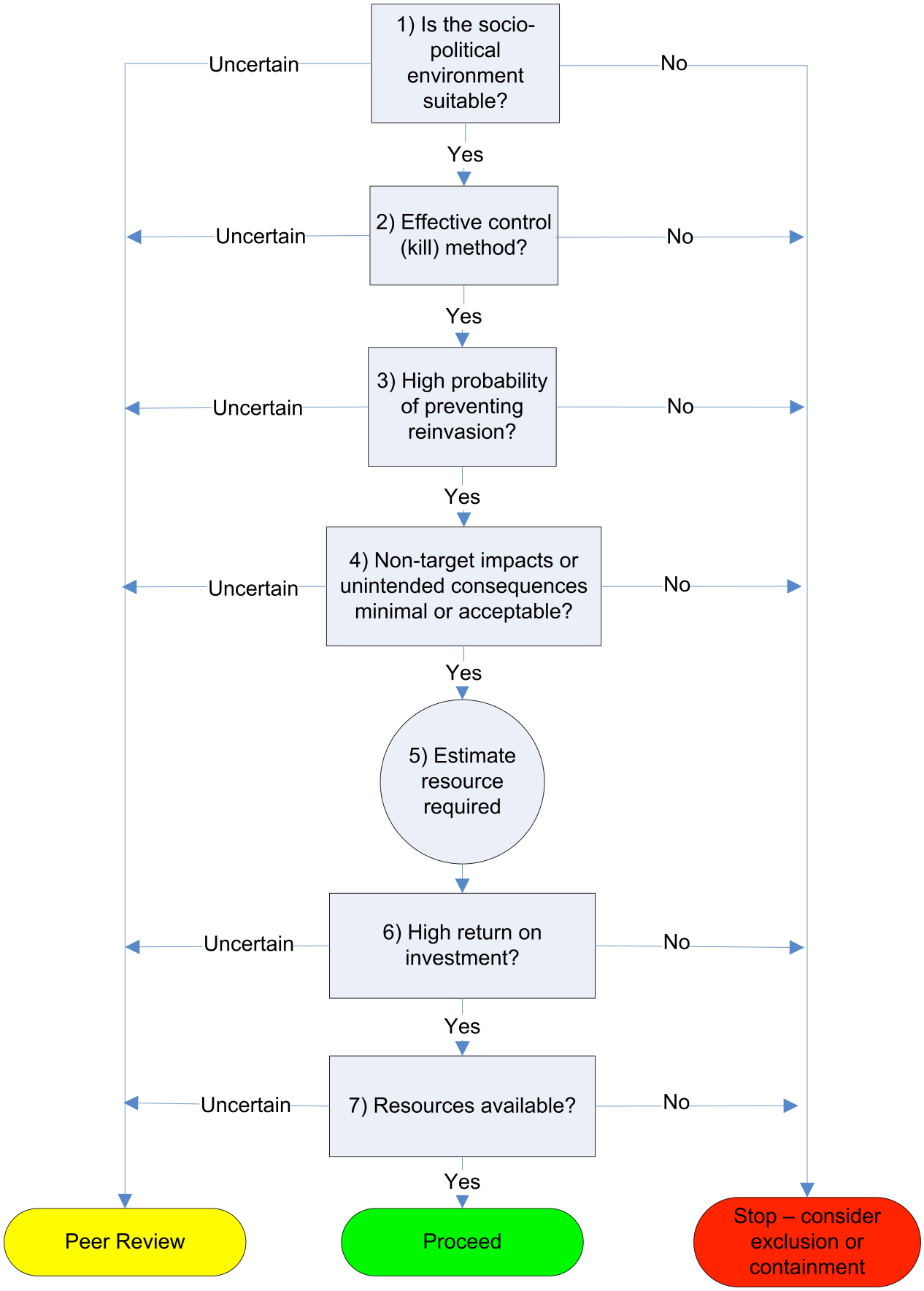
We view development of this tool as an iterative process. The tool will be updated as new information becomes available and as users provide input. We may also incorporate new quantitative approaches to evaluate the likelihood of success for different control strategies as well as to evaluate economic costs and benefits. With minimal modifications, the IPMDAT could also be used for forest pests, aquatic invaders and other non-plant invasive species. We envision that use of the IPMDAT now and in the future will lead to more effective and efficient use of resources as well as a high percentage of successful projects within the Conservancy. We envision even greater value if adopted across the entire organization, fostering better decisions and greater communication across political boundaries.

To review or use the IPMDAT go to:
http://conserveonline.org/library/an-invasive-plant-management-decision-analysis/view.html **SC**

Acknowledgements

I would like to thank Marilyn Jordan, Hilary Smith, Gregg Sargis, Troy Weldy and rest of the NYS Invasive Species Team for their hard work in developing the IPMDAT and contributions to this article.

Figure 1: IPMDAT Strategy-Selection Decision Tree



Science Shorts

See Your Uncertainty, Be Your Uncertainty

Spiegelhalter, D., M. Pearson, and I. Short. 2011. Visualizing uncertainty about the future. Science 333:1393-1400.

Beyond sticking a couple error bars on their data columns, most scientists are kerflummoxed when it comes to communicating uncertainty. It's not because our results are unequivocal. Scientists trying to communicate to non-technical audiences (and even scientists outside their discipline) run up against varying levels of "numeracy." It turns out that humans have innate problems processing odds and translating them into something meaningful.

Graphics to the rescue! The good news is that we can process much more complex concepts through thoughtful visualization, which means not only can you clearly represent pesky uncertainties, you can develop a suite of techniques to communicate nuanced results faster, better, cheaper. The authors dissect a series of science graphics ranging from historical classics to daily weather reports and distill their findings into an elegant list of 11 bullet points to guide modern scientists in the visual display of information — the best I've seen yet.

— **Jensen Montambault**, applied conservation scientist, The Nature Conservancy

Phosphorous: Too Much & Too Little

Elser, J., and E. Bennett. 2011. A broken biogeochemical cycle. Nature 478:29-31.

Our disruption of the world's climate system, hydrological cycles and nitrogen are well known. But equally troubling is our impact on the phosphorus. Phosphorus is essential to plant growth and hence a major component of fertilizer. It is in increasingly short supply, with peak phosphorus production (analogous to peak oil) predicted for 2030. Because of global phosphate scarcity, prices for it are high, making fertilizer too expensive for poorer nations. On the flip side, overuse of fertilizers has led to an excess of phosphorus in waterways, leading to algal blooms and coastal marine dead zones. Too much and too little. Here is a case where the conservation-friendly solution — which would embrace recycling phosphorous (e.g., urine separating latrines funded by the Gates Foundation) — could make fertilizer cheaper for poor nations and help save our freshwater and coastal marine systems. Elser and Bennett tell this story well, while discussing the conservation value of vegetarian diets and genetically engineered crops, as well as the riches being anticipated in Morocco as a result of their phosphate reserves. It is a truly bizarre situation that phosphorus is likely to be declared a "strategic material" in U.S. legislation so that attention can be given to securing access to this mineral, while phosphorous pollution degrades aquatic habitats around the world.

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

Does Fatherhood Make You 'Less of a Man'?

Gettler, L.T. et al. 2011. Longitudinal evidence that fatherhood decreases testosterone in human males. *PNAS* doi: 10.1073/pnas.1105403108.

Yes, I know this study is not about conservation — but some science is so damned interesting that it does not matter if it has nothing to do with conservation. Testosterone is THE male hormone — it promotes aggression, sexual appetite and accumulation of muscle mass. In a remarkable longitudinal study, Gettler and colleagues found that becoming a father (compared to similar-aged men who did not have children) caused an immediate decline in testosterone levels, and that the magnitude of this decline is proportional to the amount of time spent with your children. This makes evolutionary sense and is a very cool reminder that evolution and biology applies to us — we are a species just like all the rest of the biodiversity we strive to protect. Only 5% of all mammals provide paternal care, and our closest living relatives (chimpanzees) provide minimal paternal care. But we are special when it comes to nurturing our offspring — indeed one thing that sets us apart as a species is the remarkable degree of paternal care we provide. This distinction poses a biological quandary, however, since caring for our children (provisioning, holding, caring) is at odds with the behaviors elicited by high testosterone levels. Thus the pieces all fit together in an evolutionary sense — we have high testosterone prior to fathering children, but then as we care for our children, our male hormone levels decline. I have to say though, the longitudinal study did not proceed for a sufficiently long time. As the father of a teenage son, with whom I battle on the basketball courts as often as possible (and "battle" is the right word) — I am convinced that, if you are the father of a teenage son, your testosterone likely increases to equip you for this later parent-offspring conflict. **SC**

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

The Coda Files
Doug Shaw

Think being or hosting a Coda Global Fellow is mysterious and unattainable? Think again! The Coda Global Fellows program enables staff to apply their talents beyond their regular job to forward the Conservancy's global priorities. Coda Fellows can be anyone. They can be anywhere. They could even be...you. So take a step with us into...The Coda Files.

Doug Shaw thought he was taking a break from management to go back to his freshwater ecology roots, but his stint as a Coda Global Fellow, developing a cutting-edge large-scale measures framework for the Colorado River Program (CRP) was full of surprises.

"We thought it would be important to have freshwater skills, but this ended up being much less important than senior management skills to help people decide what to measure and what not to measure," Doug says.

His host, Taylor Hawes, couldn't agree more: "We needed someone like Doug who could really think outside the box and be a big picture person and also understand what these plans meant for implementation."

In 2010-2011, Doug and the CRP conducted in-person workshops and virtual exchanges to hammer out a measures framework for this river basin that encompasses six U.S. states and part of Mexico. Mike Roberts continues the CRP's measures work where Doug left off.

This exchange of expertise advanced Conservancy science by discovering:

- Sites and the state programs need to understand how they fit into the whole system work, but the basin-wide program also needs its own measures for its effectiveness;

Coda Fellow: Doug Shaw

Day Job: Assistant state director, The Nature Conservancy in Minnesota, South Dakota and North Dakota (current): director of conservation, The Nature Conservancy in Florida (at time of fellowship)

Assignment: Colorado River Program, June 2010-May 2011

Task: Develop basin-wide measures framework

Take-Home Lesson: "Finding the data needed to develop measures relevant at a scale of seven states and 250,000 square miles can be very challenging, even in such high profile and well-studied basins as the Colorado. We need to put as much thought and energy into strategies for developing meaningful data sets at that scale as into our conservation strategies themselves."

- Measures terminology varies wildly and terms should be boiled down to very simple words;
- Measures developments should be iterative, flexible and definitely non-linear.

Check out Doug and Mike's presentation at the April 2010 Freshwater Conference, their preliminary report and Mike and Taylor's Measures Brownbag WebEx on Tuesday, November 1st at 1:00pm ET/10:00am PT! **SC**

— **Jensen Montambault**, applied conservation scientist, Central Science, The Nature Conservancy

Have burning science needs? Want to share your skills with a global priority? Contact Jolie Sibert, Director of the Coda Global Fellows program!

Announcements

TNC Maps and Data Get a New Look! (You Betcha Asymptote That Deserves an Exclamation Point!)

By Jon Fisher, data management specialist, The Nature Conservancy

If you like maps, you owe it to yourself to check out the newly redesigned Conservation Maps and Data page. In addition to being able to view or download TNC's "core conservation data" (our portfolio, conservation projects, and TNC lands) you can see interactive web maps from all over the world. If you would like to list your map on the site, or learn how to create your own, please contact core_data@tnc.org. Many thanks to Dan Majka, who volunteered his time to redesign the site in the spirit of One Conservancy!

Science Peer Review Help Desk & Quantitative Support

By Jon Fisher, data management specialist, The Nature Conservancy

Most of us working in science can sometimes use input from our peers, but find it a pain to chase people down to get their review. The good news is that there's a service to do it for you: the TNC Science Peer Review Help Desk! So far we've provided review for 24 submissions across TNC. Plus, we have a new volunteer (a physics Ph.D. student) willing to provide direct support for people who want assistance with the quantitative aspect of papers they're working on.

* Have a paper you are working on that you want reviewed with no writing workshop in sight?
* Need help with the statistics or analysis of your data?
* Need feedback on a monitoring plan or protocol?
* Have a cool new science method or tool you want to use but need a sounding board?
* Been asked to write up the science for your programs business plan and want feedback?

If you answered "yes" to any of the above questions or find yourself in a similar situation to those described, then send your work to the Science Peer Review Help Desk. The help desk is designed for any and all science at TNC. Your submission can be "half baked" — i.e. just beginning — or nearly done. No matter the stage, you will receive thoughtful feedback from a set of peer reviewers.

Some examples of potential submissions:

* Monitoring plans
* Science that will inform a business plan
* New science methodologies
* Social science methods or approaches
* Draft funding proposals
* Draft papers to be submitted for peer-review
* Potentially high impact science analyses with policy implications

How does it work?

1. Send your submission to the help desk manager (Jon Fisher) at tncsciencehelpdesk@gmail.com, and specify what kind of review you're looking for (and/or what kind of quantitative support you need)
2. Jon will send your submission to 2-3 expert reviewers within TNC (and/or put you in touch with the new volunteer)
3. Reviewers will have up to 3 weeks to provide a review
4. Jon will then send all reviews back to you
5. Reviewers have the option to remain anonymous
6. For large file size submissions please use Accellion or another file transfer service. **SC**

Yes, Virginia, There Really Will Be Another Holiday Book Issue of *Chronicles*

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

Like the magazine, it's Real Simple: The holiday book issue of *Science Chronicles* is the most read, most talked-about, most passed-around-at-the-flash-mob-happening issue of the year. And *you* can be part of the magic.

Here's how: Email me over the next month and let me know which titles you'd like to review. (Anything goes...fiction, non-fiction, right down to the new book on Rin Tin Tin.) Then write 200-250 words on each book and send those pieces to me by Monday, 28 November.

Your review won't just be a pretext for people you barely know to come up and compliment your writing style. It also might just appear on Cool Green Science, the blog of The Nature Conservancy, for thousands more to rely on. Talk about holiday giving! So get your nose in a book, Rudolph, and then start typing. **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.

Ban, N.C., V. M. Adams, G. R. Almany, S. Ban, J.E. Cinner, L.J. McCook, M. Mills, R.L. Pressey, and **A. White.** 2011. Designing, implementing and managing marine protected areas: Emerging trends and opportunities for coral reef nations. Journal of Experimental Marine Biology and Ecology. doi:10.1016/j.jembe.2011.07.023.

Carroll, C., **B.H. McRae**, and A. Brookes. 2011. Use of linkage mapping and centrality analysis across habitat gradients to conserve connectivity of gray wolf populations in western North America. Conservation Biology DOI: 10.1111/j.1523-1739.2011.01753.x

Golet G.H., J. Hunt, and D. Koenig. 2011. Decline and recovery of small mammals after flooding: Implications for pest management and floodplain community dynamics. River Research and Applications. DOI: 10.1002/rra.1588.

Haugo, R.D., C.B. Halpern, and J.D. Bakker. 2011. Landscape context and long-term tree influences shape the dynamics of forest-meadow ecotones in mountain ecosystems. Ecosphere 2:art91. http://www.esajournals.org/doi/abs/10.1890/ES11-00110.1

Hedgcock, C., and **D. Turner**. 2011. Documenting diversity: The Madrean Archipelago Biodiversity Assessment (MABA). Journal of Biocommunication 37(1):E3-6.

Hess, S., S.N. Larsen, and **C. Leisher**. 2011. TNC Raja Ampat marine protect area perception monitoring trend analysis. The Nature Conservancy/Asia-Pacific Conservation Region Marine Program.