SCIENCECHRONICLES


Great Bear Rainforest, B.C. Credit: Flickr user **604*250** via Creative Commons.

Knowledge

Editor's Note

A long time ago, I thought I wanted to be a philosopher. This may come as little surprise to many of you, but it did not last long, less than a semester. The sad truth of the matter became clear when my philosophy professor bluntly informed me that a minimum of common sense would do away with the ideas I was attempted to foist upon him. The class was in existentialism and I was not aware, and am still less than clear, whether existentialism, despite its myriad attractions, and common sense ever truly overlapped. So it was probably fitting that my career in philosophy went nowhere.

Despite the lingering disappointment, I am still interested in one of the key questions raised in that classroom: how do we know what we know? But perhaps more urgently, should the "how" part of the question concern us as a practical matter, or is it better to just accumulate more knowledge, more information, that will help solve pressing problems as quickly as we can?

This, it turns out, is far from just an academic question. What we know clearly matters. How we know may matter just as much.

This month's lead article, by Eleanor Sterling and colleagues from the American Museum of Natural History and the Heiltsuk First Nation, addresses this question head on. Their experience in the Great Bear Rainforest of British Columbia demonstrates how traditional knowledge can be a critical complement to our Western, scientific mode of understanding the ecosystems in which we work. Their study should also force us to consider more carefully something we readily acknowledge in theory but often lose sight of in the tumult of deadlines and deliverables: just as science can never eliminate all uncertainty, scientists themselves can never, despite all their best intentions, eliminate all biases. Turning not just to other sources of information but to entirely different ways of knowing can help fill the gaps and balance the scales.

The other articles in this issue highlight different aspects of the knowledge question. Science will play a central role in solving problems like food security, air pollution, and elephant conservation, but that role may not be as straightforward as it seems. In each case, science will benefit enormously from the change in perspective that comes from seeing the world through the eyes of a farmer or an engineer or even an elephant. Epistemology may not be something we have time to explore, but we can only improve conservation by understanding that our way of knowing is far from the only way and is far from complete. As ever, your comments are more than welcome. **SC**

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Article

The Benefits of Drawing on Multiple Knowledge Systems for Conservation Decision Making

By Eleanor Sterling[1], Georgina Cullman[1], William Housty[2], Jess Housty[2], and Christopher Filardi[1]

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Tribal Elder's Hall, New Bella Bella, B.C. Credit: Flickr user A. Davey via Creative Commons.

Stretching over 20 million hectares, the Great Bear Rainforest in what is now British Columbia represents a quarter of the world's unlogged coastal temperate rainforest (Price et al. 2009). Land-use planning in the Great Bear Rainforest is led jointly by the Province of British Columbia and First Nations across 22 traditional territories and encompasses an ecosystem-based approach that reflects the traditional laws, customs, and values of First Nations peoples while embracing appropriate western science techniques.

Heiltsuk, the largest First Nation of the Great Bear Rainforest, have for thousands of years managed a traditional territory of over 4 million hectares of vibrant marine, freshwater, and forest ecosystems. Because of their prominence in Heiltsuk material and spiritual cultural traditions, grizzly bear and salmon are a priority focus for contemporary management in this area (Housty et al. 2014). Coastwatch, the research arm of the Heiltsuk non-profit Qqs Project Society, spearheaded a grizzly bear monitoring project in collaboration with a network of partners from the Heiltsuk Integrated Resource Management Department (HIRMD), conservation organizations (including the American Museum of Natural History's Center for Biodiversity and Conservation and The Nature Conservancy), university researchers, and fellow First Nations.

As a private non-profit organization, Coastwatch was in a unique position to bring together these various partners to support HIRMD's grizzly bear management and broader stewardship within Heiltsuk Territory. Prior to this research effort, Heiltsuk had long recognized that grizzly bears used the Koeye watershed, an 18,000-hectare Heiltsuk protected area, but the Canadian provincial government's model for grizzly habitat (based mostly on vegetation features) had designated the Koeye as low-quality grizzly bear habitat.

Heiltsuk traditional law, or *Gvi'ilas*, guided the design of the bear monitoring project. Researchers collected bear DNA in 2006-2009 in the Koeye watershed using non-invasive scented barbed wire hair snares, due to cultural prohibitions on negatively affecting bears. Through DNA analysis, Coastwatch and its partners discovered that a major population concentration of bears – 57 individuals – used the Koeye watershed. Thanks to a broader-scale study by partner researchers, Coastwatch identified the source geography of many of the individual grizzlies found in the Koeye. This research complemented Heiltsuk traditional knowledge by yielding more precise estimates of the grizzly bear population in the area and by showing how the Koeye watershed served as an important resource for grizzly bears from a much larger geographic region.

Using techniques that spanned indigenous and western knowledge systems, the Heiltsuk and their partners were able to perceive otherwise invisible relationships among culturally significant areas, bear movement corridors, and areas of potential bear-human conflict.

The study showed a potential for human-bear conflict in Koeye, particularly during years of low resource availability, a finding that has important implications for Heiltsuk management of the Koeye. Using techniques that spanned indigenous and western knowledge systems, the Heiltsuk and their partners were able to perceive otherwise invisible relationships among culturally significant areas, bear movement corridors, and areas of potential bear-human conflict.

Prior to this study, for example, rapid increases in trophy hunting for bears was thought not to affect the Koeye bear populations and bears that were hunted outside of the Great Bear Rainforest were thought not to come into the Koeye region. Coastwatch's work found that hunted bears do in fact come into the region and that in their search for salmon they frequently cross the site of an important, generations-old source for medicinal plants. This posed significant risk to plant-gatherers and children who were brought to the site to learn collection techniques.

This case presents many lessons for conservation practice, but here we would like to focus on the benefits of drawing on the "multiple evidence base" – i.e., knowledge from different viewpoints on changing conditions, trajectories, causal relationships, and interdependencies between people and nature relevant to the sustainable management of biodiversity and ecosystems (Tengö et al. 2014).

Heiltsuk cultural values drove the research and Heiltsuk community members undertook the data collection, so Heiltsuk governing bodies such as HIRMD were closely integrated into the research process and the research supported and strengthened Heiltsuk management. Without Heiltsuk direction, the Koeye may not have ever been chosen as a monitoring site.

Thanks to the research, the Heiltsuk have initiated a multi-First Nation bear management strategy. In addition, the Heiltsuk have gained a seat at the table with other interested parties in the region, along with the Canadian government, to steer future grizzly bear management.

Western science also was critical to the outcomes in this case. The DNA analysis in the Koeye, combined with the broader-scale companion study, enabled a spatial understanding of grizzly population dynamics that would not have been possible otherwise. Since the data created within western scientific knowledge system was a recognizable entity for Canadian provincial government agencies, and was created with and by the Heiltsuk and directly engaged their resource management arm, HIRMD, this co-generated knowledge catalyzed Heiltsuk management and empowerment.

Traditional knowledge is often the most complete, or only, source of knowledge available about the ecology and natural history of a place, and there is not enough time to develop the western scientific knowledge given the urgency of threats to biodiversity.

Traditional knowledge is often the most complete, or only, source of knowledge available about the ecology and natural history of a place, and there is not enough time to develop the western scientific knowledge given the urgency of threats to biodiversity. Yet until now, mainstream conservation organizations have tended to depend primarily on western scientific knowledge alone to frame problems and identify potential solutions. When conservation efforts have tried to incorporate other knowledge systems into decision-making, they have tended to use the tools and frameworks from western science to assess the validity of local and traditional knowledge. This one-way assimilation of knowledge is problematic for a variety of reasons, including the potential for rejecting important knowledge, setting up western science as the only "correct" answer, and alienating stakeholders from the decision-making process (Agrawal 1995, Nadasdy 1999, Nakashima & Roué 2002).

In addition, the extraction of parts of indigenous and local knowledge out of their original contexts – their "translation" to fit the structures of another knowledge system – has the potential to distort the meaning and value of that knowledge, as well as disempower the original knowledge holders (West 2005). As in the Great Bear Rainforest, however, conservation efforts have begun to use processes that recognize the complementarity between knowledge systems as a way to embrace other types of knowledge, practices, and strategies, including knowledge from practitioners (Reid et al. 2006).

These processes involve validating knowledge from within a particular system using standard criteria for that system, thus avoiding the potential for validation across systems with inappropriate metrics (Agrawal 1995, Berkes 2012, Nadasdy 1999).

Validation for local knowledge, for instance, may involve empirical or experiential validation, cultural or collective validation, and moral validation. Knowledge that passes these system-specific validation systems can then be synthesized across systems, using transparent processes and respect for ownership issues. The Great Bear case can attribute part of its success to the fact that the research did not aim to evaluate Heiltsuk traditional knowledge about grizzly aggregations in the Koeye with western science. Rather it aimed to support ongoing efforts by the Heiltsuk to manage their territory according to their laws.

In order to use the "multiple evidence base" to address a particular issue, decision makers can assess and discuss the synergies and incongruities between knowledge from different sources. This discussion can identify gaps in knowledge and the need for co-production of new knowledge. Co-production encompasses collaborative efforts to identify questions, collect and maintain complementary data, interpret the results, and define conclusions. The co-production of knowledge in this case provided benefits both in terms of improved knowledge about grizzly bear ecology crucial for management and in terms of strengthening and amplifying management institutions.

While there is great promise in calling upon the multiple evidence base for conservation action, this approach presents its own challenges.

While there is great promise in calling upon the multiple evidence base for conservation action, this approach presents its own challenges. Neither indigenous and local knowledge nor western scientific knowledge is uniform, as there are multiple sources of knowledge within the different systems and the knowledge itself is dynamic (Agrawal 1995, Folke 2012). Also, the cultural context for knowledge may preclude its easy translation across systems and decision-making when knowledges from within or between different systems contradict one another (Tengö et al. 2014). Ostrom (2011) identified frameworks that can help in addressing these challenges, and incongruities may be as informative as cross-system agreements. Potential knowledge discrepancies may relate to scale of observations and resolution of scale issues may show that a combination of knowledge approaches and methods will elucidate cross-scale interactions (Gagnon and Berteaux 2009). Better understanding of these interactions will illuminate the role of local responses to environmental changes in mediating or reinforcing global dynamics (Folke et al. 2011).

The Intergovernmental Panel on Biodiversity and Ecosystem Services, a developing analog to the Intergovernmental Platform for Climate Change, is particularly focused on identifying new tools and approaches for knowledge synthesis and methods for co-production of questions, data collection, and analysis. Case studies of effective knowledge synthesis such as the Heiltsuk grizzly bear project, identify patterns and eventually will help develop functioning mechanisms for exchange built on mutual respect for world views, knowledge systems, and approaches. Ultimately, this engagement of knowledge from diverse sources for decision making will support the applicability and sustainability of results. Given the fact that so many areas that are valued by conservationists for their exceptional and threatened biodiversity are also areas inhabited by indigenous and local communities, integrating across knowledge systems is just one of the many diverse strategies that as complex an endeavor as conservation should employ (Oviedo et al. 2000; Sterling et al. 2010). **SC**

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Article

Conservation and Global Food Security: The $115 Billion Role We Can Play

By Eddie Game, senior scientist, The Nature Conservancy

Allium pskemense B. Fedtsch, a wild perennial related to the common onion. Credit: Crop Wild Relatives Global Portal.

Conservationists love talking about the role we can play in food security. And with good reason – there is no more basic or universal need. Be it increased fish production in MPAs, water availability for household gardens, or grass cover during times of drought, conservation has a range of plausible ways to influence food security. But I often get the sense that when talking about food security we're grasping a little bit, trying to fill a role for which we are not a perfect fit. Well, there is a much overlooked role we can play, and one that conservation clearly possess the best tools and expertise to do the job: in situ conservation of crop wild relatives (CWRs).

A couple of years ago I was asked to help supervise a student who wanted to investigate how to prioritize conservation of CWRs. For those with as scant knowledge of CWRs as I had at the time, crop wild relatives are taxa that are closely related to domestic agricultural crops. Typically CWRs are varieties of the same species as the domestic crop but they may also include subspecies or even sometimes congeneric species. Although modern GM technology means that many species are potential gene donors for crop improvement, CWRs remain the taxa with the greatest potential to contribute beneficial traits to their related crops, such as resistance to disease or tolerance to abiotic stresses such as temperature or salinity.

To give a senses of just how important the genetic material from CWRs is, over the past 30 years, at least 60 CWRs have contributed more than 100 beneficial traits to 13 major crops such as wheat, rice, tomato, and potato (Hajjar and Hodgkin 2007) and even 15 years ago it was estimated that the global increase in crop yield as a results of crossing with CWRs represents a value of $115 billion per year (Pimentel et al. 1997). Many experts also see CWRs as one of the most promising avenues to address the challenges that climate change poses to global food security (Feuillet et al. 2008; Nevo and Chen 2010).

Just like many species that are the focus of conservation effort, there is anthropogenic pressure on CWRs in their native habitats (land conversion, degradation, overgrazing, competition from exotic species, etc.), threatening this global source of genetic diversity. Although plant resources can be safely conserved ex situ in seed banks, such as the one under the ice of Svalbard, Norway, in situ conservation is a critical compliment for at least two reasons. First, the genetic diversity across a species wild range can never hope to be captured entirely in ex situ collections and the traits that are most beneficial for future crop improvement are often adaptations to particular local environmental conditions (e.g., drought tolerance or salt tolerance). Second, *in situ* conservation allows populations to continue natural adaptation to changing conditions. Conserving CWRs in situ will ensure that their future value for crop improvement is maximized.

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Sustaining important species and their diversity in situ is what conservation does. It’s been our core business. It is perhaps a little surprising then that there has been such scant attention paid by conservation organizations to conserving CWRs, and that the subject is gravely under-represented in the main conservation literature. It is not as if it’s contested space – agricultural agencies generally have limited responsibility for wild species conservation.

It would, however, be grossly unfair to suggest that there is no awareness of this potential nexus between food security and classic conservation; reference to CWRs appears in the CBD’s Nagoya text, there is a CWR Specialist Group within the IUCN, and the FAO has a global initiative on CWR conservation. Like most taxa, developing countries contain the lion’s share of CWR diversity (which has disproportionately benefited developed nations so far), but are also where the pressures on remaining habitat are greatest and the resources for conservation most inadequate. One could easily make the case that developed nations have both a strong interest and responsibility to help poorer nations conserve CWRs.

Yes, a weedy-looking wild cowpea vine will struggle to compete with a black rhino on charisma, but have we asked the tens of millions of people in sub-Saharan Africa who depend on cowpea, which they value the conservation of more? The key, however, is that it doesn't have to be one or the other.

Existing protected areas and conservation projects are likely to contain a great many CWR resources and present an efficient option for the conservation. In the study I was involved in, we identified 182 existing protected areas across Africa likely to contain at least one important cowpea CWR (Moray et al. 2014).

I was recently with some donors in the Kimberley region of north-western Australia, and while I talked at length about the benefits of our work there for threatened and fauna and habitats, perhaps I should have made more of the fact that it's also a hotspot of diversity for wild soy bean relatives (González-Orozco et al. 2012). In many cases, I suspect it would not take much effort to incorporate CWRs into the management plans for existing conservation areas.

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At the level of a single conservation area, conserving CWRs is neither a guaranteed nor rapid pathway to food security for local communities. However, the challenges of feeding an increasing global population in a changing climate mean that if we're playing the long game, the potential impact of even a single CWR is staggering. If we are serious about conservation helping people, CWRs present a role for us in food security that is more important and better aligned than most of us realize. SC

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Article

Nature as a Problem Solver: Ozone

By Peter Kareiva, chief scientist, The Nature Conservancy

The Roy E. Larsen Sandyland Sanctuary in East Texas Credit: Lynn McBride.

Sustainability is big for big business. A recent McKinsey survey of 2,632 CEOs revealed that 36% see sustainability as one of their top three priorities, and 13% declared it their #1 priority. More than 50% of the Fortune 500 companies now issue sustainability reports. Meanwhile, almost every major environmental NGO now embraces corporate partnership as a means of making progress on their environmental agenda.

Yet these efforts are often criticized as greenwashing. New research also shows that, beyond reducing energy use and emissions, corporations themselves are not sure what it means to be environmentally sustainable or pro-conservation. The corporate world clearly has a new fondness for the environment, but how much of this effort is symbolic or image burnishing and how much is real? And why should companies care about habitats and conservation, anyway?

One reason companies are embracing conservation is the recognition that nature can help them solve problems at a price tag that makes good business sense. Marshes and near-shore reefs, for instance, are known to reduce storm surge and could help protect coastal facilities. Forests can help purify water and may take the place of in-plant treatment.

To this list of nature as problem solver, we can now add the role of forests in helping to mitigate air pollution as reported in a new paper by Nature Conservancy environmental economist Timm Kroeger and colleagues through the The Dow Chemical Company-Nature Conservancy collaboration published in the Proceedings of the National Academy of Sciences (PNAS). The paper suggests that large-scale peri-urban forest restoration can cost-effectively reduce ground-level ozone and ozone precursor levels and thereby should qualify for ozone precursor mitigation credits if a company pays for the restoration.

Adding Forests to the Engineering Solution for Reducing Ground-Level Ozone

In the United States alone, 46 areas with a total population of 123 million people currently (2013) are designated by the U.S. EPA as ozone nonattainment areas because their ambient ozone levels exceed the federal air quality standard for ozone. Nonattainment areas impose area-wide emission caps on ozone precursors coupled with

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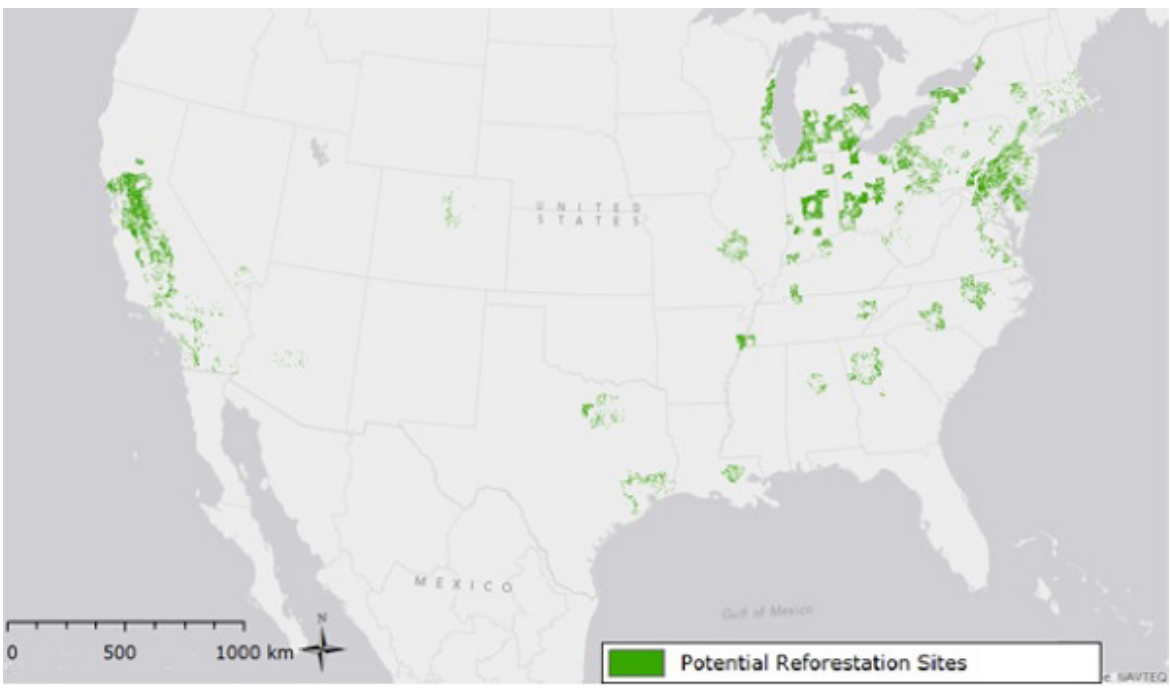

Locations with the potential to use reforestation for ozone abatement are shown in green. They have ozone levels that exceed federal standards, were once forested but are not currently, and have NOx-limited formation of ozone.

individual emission limits for major emitters. Those sources then implement emission controls — permanent or intermittent plant shutdowns, conversion to lower-emitting fossil fuels, production and combustion process changes and end-of-pipe controls — or purchase emission credits on local cap-and-trade markets.

While these conventional measures often have helped reduce ozone pollution, the problem of high ozone levels remains widespread. Furthermore, climate and land cover change threaten to counteract some of the historic gains in ozone control, leading to predictions of future increases in ozone levels for many areas of the world.

Kroeger and colleagues show that forests can be added to the engineering solutions in a significant way, and do so at a cost commensurate with conventional control approaches. And unlike the engineering solutions, forests bring numerous extra benefits as a bonus — they sequester carbon and help to mitigate climate change, they can cool air temperatures, they can help improve water quality and reduce flood risk, and they are habitats for wildlife and sites for recreation.

Innovative Ecosystem Science from the Dow-TNC Collaboration

The origin of this research is itself a story: the team of researchers comes from University of Florida, Department of Interior, Dow and the Conservancy. This article is the first of perhaps many peer-reviewed publications featuring research conducted as part of a collaboration between Dow and TNC.

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The work that resulted involved ecologists and economists from the conservation community identifying and jointly solving problems with engineers from Dow on how conservation gains could also make business sense for a Fortune 500 corporation.

The convergence of these science fields has yielded surprising questions and innovative results. Large-scale reforestation as a partial solution to ozone pollution was mentioned as a possibility in a 2004 EPA report, but not under any sort of serious consideration until Dow and TNC started having brainstorming sessions together to explore possible ways nature might be of business value. The entire field of ecosystem science has much to contribute to the business world — but making that contribution will require sometimes uncomfortable and difficult partnerships that cut across strikingly different cultures and languages.

Global Implications for Ozone Mitigation

The implications of this new research extend far beyond any NGO-business partnership. While Kroeger and colleagues did their analyses for ozone mitigation in the Houston area, the opportunity and need is truly global. Worldwide, ground-level ozone has been linked to 152,000 deaths annually. In the United States alone, an estimated 10 million cases of acute respiratory symptoms each year would be avoided if ground-level ozone concentrations could be reduced everywhere to less than 60 ppb.

And reforestation is a significant option in many of the areas with high ozone levels, as can be seen by mapping non built-up areas in the United States that used to have forests but have been cleared and in which ozone has exceeded 80 ppb (figure 2 from their paper). Forests around the world have been cleared at the expense of biodiversity — and, we now know, at the expense of clean air.

If the EPA would allow companies to receive credit for forest restoration as an ozone control measure, that move could be good for companies, for forests and for communities. A skeptical environmental purist might argue that allowing companies to use forest restoration to mitigate their polluting emissions is simply allowing them to pay-to-pollute. There is no question that air and water pollution warrant technical innovations that reduce the emissions from industrial processes. But the fact forests can also help should be viewed as a wonderful opportunity for nature.

We can imagine a dystopian world with no trees and no forests — just the concrete and steel edifices of human activity — suitably embellished with the latest in smokestack pollution controls. Or we can imagine a world that relies heavily on forests and floodplains, and coastal marshes mixed in with steel and concrete engineering solutions. There is no question which of these worlds offers the better life to people and nature. **SC**

Article
Should We Stop Counting Elephants?

By Jonathan Adams

Elephant at Madikwe Game Reserve, South Africa. © Andy Withers via Creative Commons

A new epidemic of elephant slaughter is sweeping across Central and East Africa — one of the worst outbreaks in decades. You may remember seeing similar headlines before, in the mid-1970s and again in the late 1980s. If so, you could be forgiven for dismissing the headlines as rather overwrought. But that would be a mistake. We are indeed in the midst of a crisis, just not the one you have been reading about.

In their rush to blame the plight of elephants on Chinese demand for ivory, Western journalists leave out the other factors that are equally or even more important, but far less dramatic. In the Daily Beast, Michael Tomasky blames "the despicable hunger of [China's] status-conscious middle class for baubles of worked ivory." In the New Yorker, Elizabeth Kolbert writes that "driving the slaughter is desire."

In reality, the elephant crisis we should be reading about is the loss of habitat — a trend that has been building, quietly and inexorably, for decades. That is the process, more than the killing of individual elephants or even whole herds and more than growing demand for ivory in China, that will doom Africa's elephants in the long term if it continues unchecked.

This article originally appeared on thebreakthrough.org

Over the past several decades, nearly one-third of elephant range in Africa has been heavily impacted by human population growth, infrastructure development, and rapid agricultural and urban expansion. If current population and development trends continue, and Globio models suggest they will, then over the next 40 years more than 60 percent of elephant range will disappear, with the heaviest losses in Central and West Africa.

Habitat loss is neither new nor dramatic. A few more acres of land cleared for cotton or corn in Chad or Nigeria, another oil palm plantation in Cameroon, escapes the attention of everyone not within sight.

By contrast, a bull elephant killed for its tusks with a high-powered rifle and left to rot in a Kenyan or Tanzanian park, is a sure-fired winner in the competition for clicks, tweets, and dollars. From there it is but a small step to the claim, (utterly without foundation), that Africa's elephants could be extinct in ten years.

The elephant crisis we should be reading about is the loss of habitat — a trend that has been building, quietly and inexorably, for decades.

Such hyperbole misrepresents the data and masks the real challenge. Some populations of elephants are in fact at grave risk in the near term from a revived ivory trade, but demand for ivory is just one factor driving the decline. The others — notably poverty, civil conflict, and failed states — defy both simple solutions and tidy narratives, and conservation tales often need a villain. Hunters and Chinese ivory dealers are tailor made for the role.

The elephants most at risk from the ivory trade are found not on East Africa's savannas but in Central Africa's forests. Forest elephants — either a separate species or a subspecies depending on which taxonomist you consult — have been under intense and unrelenting hunting pressure for years, unlike most savannah elephant populations, which were stable or growing slowing from roughly 1997 until 2008. By one estimate, forest elephants now occupy just 25 percent of their historical range and the population is just 10 percent of its what the 2.2 million km^2 Central African forest could conservatively support.

The devastating drop in the forest elephant population gets as little media coverage as the loss of habitat. While savanna elephants are Africa's iconic species, forest elephants are nearly invisible. Forest elephants thus have until recently been largely left out of one of the most reliable headline-generators in conservation science: the elephant census.

Accurate data are without question integral to designing effective conservation programs, be they local efforts to manage a protected area or global efforts to control the ivory trade. The fundraising value of a dire-sounding report, however, far outweighs whatever scientific value it may have and quickly buries the caveats and assumptions that must be part of the effort to count any species over such a large area.

As with polar bears, counting elephants is tricky business and making sense of the numbers and trends from hundreds of studies across the continent requires a gasp of sophisticated statistical modeling techniques (hierarchical Bayesian analysis, anyone?) and a keen eye for such nuances as whether an aerial survey plane has high-definition cameras and what kind of altimeter it uses.

To make matters even more complicated, the number of elephants is just one piece of the puzzle and not necessarily the most important. The shape of some pieces, like those that help define the dynamics of the ivory trade by tracing the source of the ivory using isotope or DNA analysis, are just beginning to emerge. Still others, like those regarding the market forces driving the trade — speculation and leakage of ivory from government stockpiles into the market, for example — are still blank because the data are lacking.

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Putting the whole thing together will require combining different types of data — live elephants, dead elephants, seized shipments of tusks, the number of ranger patrols, levels of customs enforcement and on and on — that are collected in different ways in different places and with different ends in mind. Analyzing it all in a way that makes sense is not as photogenic as soaring over the plains looking for elephants, but it may be more important.

People have been counting savanna elephants from the air for almost 50 years, but that method does not work for forest elephants. A forest elephant census requires the most mundane and painstaking kind of work imaginable: counting dung. Census takers count the dung along transects and estimate the population by combining the results with estimates of the rates of elephant defecation and dung decay. No glamour or drama here, but done properly the dung-counting technique can be more precise than aerial sample counts.

Elephants live over far too vast an area for a complete, scientifically rigorous census for all of Africa. Estimates of elephant population and range at the continental scale still include the best guesses of the most informed person in a particular area, often a single park administrator. That is why maps of elephant range often have nice, crisp lines that correspond to protected areas; elephants almost certainly move back and forth across many of those borders, but such movements are simply impossible to document.

The range maps and data tables in the African Elephant Database provide more information on the conservation status of elephants than is available for any mammal. Yet even with all that data, crucial questions about population trends defy simple answers. A reliable trend requires repeat surveys — same area, same technique, ideally the same people doing the counting. Such repeat surveys are hard to come by. In fact, some areas in Africa don't get resurveyed for years, if ever.

There are other ways to get a handle on trends. The most useful come from a program called Monitoring Illegal Killing of Elephants, or MIKE, in operation since 2002 as part of the effort to control the ivory trade. Now with 60 sites across Africa, MIKE relies on park rangers to report when they find elephant carcasses and whether they were killed illegally or died of natural causes. Such reports pose a challenge from a statistical perspective because they are not random and the level of patrol efforts varies considerably from place to place — here is where the Baysian analysis comes in — but MIKE data are increasingly important in understanding poaching trends.

More and more reliable data, especially for Central Africa and on an ongoing basis, can only deepen our understanding of elephants and the threats to them. But if we focus single-mindedly on what is in front of us, the short-term threat of poaching for the ivory trade and the most up-to date census figures, we will find that when we turn around elephants will have even fewer places to live.

Another database, the Elephant Trade Information System, tracks seizures of illegal ivory. It is invaluable, but poses some of the same analytical challenges as the carcass data from rangers. Still, the data from MIKE and ETIS provides the most reliable basis for concluding that hunting of elephants has spiked since 2008 and now exceeds the natural growth rate. In some places, 80 percent of the elephant carcasses that rangers find are elephants that were killed illegally for their ivory. That level of poaching cannot be sustained.

Do we need to know more? Yes and no. More and more reliable data, especially for Central Africa and on an ongoing basis, can only deepen our understanding of elephants and the threats to them. But if we focus single-mindedly on what is in front of us, the short-term threat of poaching for the ivory trade and the most up-to date census figures, we will find that when we turn around elephants will have even fewer places to live. Then the crisis will truly be upon us, and those headlines will be more frightening than ever. SC

Drinking from the Fire Hose

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

1. Should we save the useless? The always interesting Richard Conniff takes on the question of whether the utility of wildlife is a proper consideration for conservation: "Wildlife connects "us not just to what's weird, different, other, but to a world where we humans do not matter nearly as much as we like to think. And that should be enough." It should be, but is it?

2. As China goes, so goes the planet: One of best articles on the politics of climate change negotiations, from Jeff Goddell in *Rolling Stone*. "The mismatch between the urgency of taking action and the self-destructive diddling of diplomacy is frightening to witness. ... If Bonn [location of a recent UNFCC meeting] was a preview of how things will go next year in Paris, then you can kiss human civilization goodbye. Because nothing will get done."

3. Could saving the planet be free? That would be welcome news indeed and perhaps not out of the question, according to studies from the IMF and the New Climate Economy Project. One the other hand (you knew there had to be one), Michael Levi throws some cold water on the optimism.

4. A tipping point? The Rockefeller Brothers Fund divests from fossil fuels. And here is where some of those investments may be going.

5. Consumer goods and deforestation: According to a new report from Forest Trends, nearly three-quarters of all tropical deforestation between 2000 and 2012 was caused by commercial agriculture. In addition, almost half was due to illegal conversion for commercial agriculture and nearly one-quarter was the direct result of illegal agro-conversion for export markets.

6. The Elwha River runs free: In late August, workers demolished the last portion of the Glines Canyon Dam on the Elwha River. The downstream Elwha Dam was removed in 2012, so now the river again goes unvexed to the sea for the first time in 102 years. Just weeks after last dam came down, fisheries biologist confirmed that chinook salmon had already found their way upriver.

7. Evidence-based conservation advocacy in action: The government of Western Australia had proposed a major shark-culling program in the interest of reducing shark attacks. The WA Environmental Protection Agency rejected the proposal, however, based on evidence presented by marine scientists that such programs actually do not make people safer and needlessly kill many sharks.

8. And finally, the coolest creature you will see today. Maybe ever. **SC**

Announcements

Chronicles Holiday Book Issue Needs You

Take one book, any topic; read. Write 250-300 words, distilling your opinions about said book. Send to pangolin19@gmail.com by December 5 for inclusion in the ever popular Holiday Book Issue of *Science Chronicles*. (Send me the titles you want to review first, so I can avoid duplicates.)

—Jonathan Adams **SC**

New Conservancy Publications

Conservancy-affiliated authors highlighted in bold.

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

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

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