

# ADDRESSING THE PROBLEM OF SCALE IN CONSERVATION

---

ALEX DEHGAN AND CASSIE HOFFMAN

While examining innovation in the ocean conservation space, we asked ourselves a difficult question: why hasn't the circle hook—a novel, conservation-friendly improvement on fishing gear—achieved scale? This is an important and relevant question in the development field, where we constantly seek to improve the livelihoods of more individuals within a greater geographic range, using our funding as efficiently as possible. Scaling innovations is a critical piece of improving reach and impact, yet it is a notion that hasn't been examined much in the conservation field. As we investigated the circle hook case and its scaling problem, we learned, as we frequently do, that it's complicated.

The circle hook was created as an alternative to the more traditional J-hook. The circle hook's more rounded shape was designed to decrease the unwanted by-catch of threatened or endangered species (mostly sea turtles) while maintaining or improving species targeted for commercial, recreational, and artisanal fishing (Read, 2007). Conservation groups lauded and promoted the circle hook for enabling fishermen to maintain their income while meeting conservation goals, yet nearly two decades after its introduction, it has not gone to scale.

Myriad factors influence the circle hook's ability to meet both conservation and catch goals, including geographic location, targeted species, environmental factors, type of bait, hook size, and release

training of fishermen. The circle hook has reduced the mortality rates of by-catch in some places, especially of sea turtles, but it also has reduced fishery yields for targeted species (Serafy, Cooke, Diaz, & Swimmer, 2012). Given these variable results, especially on fishing yields, it has been difficult to put into place the policies and regulations that would support adoption of the circle hook, the result being fewer conservation benefits for endangered marine species.

With all sea turtles under some form of protected or endangered status and a device in hand that can greatly reduce the number killed unnecessarily, why can't we figure out how to scale the circle hook? To answer that question, we began to think beyond the circle hook and about

the problem of scale in conservation more generally. What innovations in conservation have achieved scale? Can anything get to scale in conservation? What does getting to scale actually mean? Is reaching scale different for social ventures than for the private sector?

## **EXPONENTIAL PROBLEMS, LINEAR SOLUTIONS**

As conservationists and international development practitioners, we focus our hopes and our diligent efforts on scalable conservation innovations like the circle hook because we need tools and approaches to conservation challenges that will have a broad and significant impact. Ecological change and degradation are accelerating around the globe, and every major clade of species is in decline.<sup>1</sup> Current extinction rates are estimated to be 1,000 times higher than the background extinction rate (Pimm et al., 2014) and may be underestimated by as much as a factor of ten (De Vos, Joppa, Gittleman, Stephens, & Pimm, 2015).<sup>2</sup> By 2050 the planet will hold 9.6 billion people, and with a growing middle class seeking increasing amounts of meat, dairy, and energy, that population will put unprecedented demands on our planet's resources. The planet's biodiversity is already in the midst of a sixth mass extinction event.

Current conservation efforts have a scale problem. Our conservation interventions

remain piecemeal, marginal, and highly site specific. There certainly have been conservation successes—protected areas that are flourishing, and locally managed conservation schemes that have had a significant impact, such as payments for ecosystem services or ecotourism. But many of these approaches have high transaction costs and have neither scaled nor had a sufficient impact to slow extinction rates. Ironically, what humans have scaled successfully are industrialization, consumption of wildlife, and mass-produced consumer products, which are what drive much of the extinction and global change we are experiencing at present. In the face of such radical environmental change that is driven by consumer demand, we must fundamentally rethink our approach to conservation. Put simply, our response must be scaled to match the speed and magnitude of the challenge.

## **CAN CONSERVATION INTERVENTIONS BE SCALED?**

Some international development practitioners argue that all conservation and development interventions are local and therefore can't be scaled. They warn against the appeal of the "big idea" and one-size-fits-all solution (Hobbes 2014). This line of reasoning contends that conservation projects will thrive, or tank, according to the dynamics of the place in which they're applied, and that each place

---

### **ABOUT THE AUTHORS**

Alex Dehgan is Co-founder and Chief Executive Officer at Conservation X Labs.

Cassie Hoffman is Director of Field Operations at Conservation X Labs

© 2017 Alex Dehgan and Cassie Hoffman

is different and thus has different project design requirements. This perspective requires significant investment at the local level to create highly tailored solutions and accepts that development is an inherently measured and slow process.

However, there are countervailing examples from both the private sector and international development, namely, global health and food security. In the private sector, the cell phone has spread across the world exponentially, with only minimal modifications for local context other than language; social networks such as Facebook and Twitter are globally ubiquitous; and products such as Coca-Cola (which is sold in more than 200 countries) and Pringles (more than 140 countries) are distributed globally. The global health community has brought a number of innovations to scale, including oral rehydration therapy, which is estimated to have reduced the number of infant deaths from diarrheal diseases by two million per year (Gerlin, 2006); vaccines, which have helped eradicate two major diseases in livestock and humans (rinderpest and smallpox) and are on the brink of eradicating polio; and malaria nets, which have dramatically cut the burden of the disease. The Green Revolution—which helped spread a set of innovations such as improved varieties of rice and wheat, agricultural mechanization, improved inputs such as fertilizers, and better irrigation—is estimated to have saved a billion people from starvation in South Asia (Easterbrook, 1997). Through the CGIAR system, the Green Revolution continues to share new innovations for food security around the globe.<sup>3</sup>

How or what innovations are scaled will depend on context and form. It's generally not so much that a product is highly contextual but that the strategy for scaling it may be contextualized. Scaling is a process challenge, and the appropriate strategy to achieve the desired outcome must be considered at the beginning of

the development of a product or intervention, not at its end. Not every product or intervention can or should scale, but if we are to address the major challenges affecting conservation, we need to prioritize those that can.

Traditional corporations, technology startups, and social ventures can all provide insights into scaling for the field of conservation, as volumes of research have been dedicated to growing and scaling traditional commercial ventures. Researchers recently analyzed what makes social interventions and enterprises successful and capable of expanding and/or deepening their impact (see, e.g., the Center for the Advancement of Social Entrepreneurship at Duke University's Fuqua School of Business). Additionally, exponential increases in global connectivity, coupled with the democratization of science and technology (driven by similar increases in the power of and access to technology and a decrease in the cost), have created new digital industries and innovations that are innately scalable because the incremental costs of adding additional users is negligible.

While some of these strategies cannot be applied across the board, there are opportunities to observe how they have been applied successfully in international development and to experiment with and adapt them as appropriate to the global conservation field. We synthesize approaches from all these fields, not only to help conservation with its scale problem but, more fundamentally, to transform the practice and science of conservation itself.

## **SCALE IN SOCIAL AND COMMERCIAL VENTURES**

For commercial ventures, scalability and sustainability are tied to profit and demand—both for the individual product (how well it meets a need or want) and for

the health of the overall enterprise (can the enterprise sustain itself?). Commercial ventures focus on scaling from a growth perspective—how they will increase production, distribution, revenues, and overall return to the company through efficient operations. Research has shown that resources—a sufficient mix of human, financial, and social capital—to execute a growth strategy are a key determinant of commercial success (Gilbert, McDougall, & Audretsch, 2006). Scaling also can take on different meanings: one may refer to “scaling out,” which is the replication or franchise of a tested concept, pilot, product, etc., to different locations, or “scaling up/deep,” which means increasing the resource intensity of a tested concept, pilot project, or initiative in terms of inputs, outputs, or impact in the same location (Creech, 2008).

Scholars have defined scaling for social enterprises as “increasing the impact a social purpose organization produces to better match the magnitude of the social need or problem it seeks to address” (Dees, 2008, p. 18). Having such an impact can occur through scaling out or scaling deep, but it also can occur through the open dissemination of an idea, model, or intellectual property and/or by creating new social norms (Nash, 2015). Bloom and Smith (2010) contend that, as social ventures are usually promoting a public good (better environment, less crime, better education, etc.), there may be a need but not the market demand to attract investors, employees, and/or customers with a financial payoff or benefit, or at least not a very large one. Moreover, they note that demand for public goods is hard to define and quantify, and individual willingness to pay for such goods even harder. Finally, they point out that social enterprises frequently serve marginalized populations who do not all have the capacity to pay the full price of a good or service up front.

Although there are of course differences, there also are many similarities in how the private sector and social entrepreneurs approach scaling and scaling strategies. Bloom and Smith (2010) have empirically analyzed what affects the success of social enterprises’ scaling efforts and, not surprisingly, some of the components are similar to those of commercial ventures and organizational readiness: staffing (sufficient, appropriate, and adequate human capital), generating earnings (the ability to get sufficient financial capital and generate revenue that exceeds costs), replication capacity (the ability to expand the delivery of a service or product without losing quality control), and, lastly, stimulating market forces (creating incentives that encourage people or institutions to pursue private interests while also serving the public good), which is not as easily achievable for a social program.

Second, much like the private sector, social entrepreneurs need to cultivate their political and social ecosystems in order to scale. Communication (building social capital), building alliances (relationships that may bring more resources and capacity to the table), and lobbying (building political capital and/or advocating for social change in the political system) have analogues in traditional product marketing, in creating industry associations, and in lobbying for commercial ventures. Social and private enterprises both may need to create systemic change that addresses the underlying causes of a social problem and influences the mechanics of the political and social landscape they are working in (Bloom & Dees, 2008).

Finally, we argue that social entrepreneurs and, given the vagaries of politics and foundations’ funding fads, conservationists in particular need to do much more to harness private market forces. This more difficult approach requires serious thinking about the needs of the user and an understanding of who is cur-

rently paying the costs of the problem and how to redirect such payments to underwrite solutions that address the problem.

## **SCALE FOR GLOBAL HEALTH AND FOOD SECURITY**

Although global health and food security face many challenges similar to those of conservation—translating scientific research into tangible solutions and policies, addressing issues that transcend national borders, coordinating between multiple ministries in one government, overcoming underdeveloped distribution systems and remote access—professionals in the global health and food security arena have capitalized on some private-sector scaling strategies that conservationists have not. Three reasons for their successes stand out.

First, global health and food security have been successful in building markets and systems to bring innovations to scale. The global health industry works diligently from the concept stage of a new drug or medical technology to begin preparing their future customers and beneficiaries, distribution systems and value chains, and solution administrators. Scale and sustainability are built into a new venture or innovation from the beginning to reduce future transaction costs for distribution, improve access to market information, and ensure product quality (USAID, 2015).

Second, by tailoring a care treatment or farm package to the individual user, global health and food security solutions provide a direct personal benefit to the user/customer while simultaneously creating a public good: Get a polio vaccine and you avoid getting polio yourself while also helping minimize the spread of the disease. Adopt better land-management practices—reduce erosion, increase soil, forest, and carbon conservation—and potentially increase your agricultural

yield. This ability to overlay personal benefits with a contribution to the public good, which relies on the concept of human-centered design, cannot be undermined (Dust & Prokopoff, 2009).

Third, there are underlying financial returns in both cases that allow the private sector to help drive the scalability and sustainability of a product. Tapping the private sector and its financial capital to assist with the spread of an innovation is key. While the Green Revolution centered around making a unique package of seeds, fertilizers, and weed and pest control agents available to farmers (the innovation), there also was money to be made from developing, manufacturing, and distributing these products. Similarly, new strategies for developing vaccines and drugs for neglected tropical diseases have focused on creating advance market commitments to build demand and incentivize private markets. We may use similar mechanisms to scale new solutions, such as cellular agriculture, which could relieve substantial pressures for deforestation. Even when a small financial return per unit is available, the market size may be sufficient to incentivize investors. Social enterprises may need to consider how they can roll up investments and package them on a large enough scale to yield a sufficient financial return.

## **SCALE IN DIGITAL ENTERPRISES**

Advances in technology, the falling price of mobile platforms (cell phones, smart phones, and computers), and expanding Internet coverage and availability around the globe are increasing everyone's connectivity, as well as the speed of communications, transactions, and exchange of information. There currently are more than 7.5 billion mobile subscriptions around the world, including 3.9 billion for smartphones (Ericsson, 2016). These mobile phones can serve as gateways to

knowledge, new financial platforms, sensors for the environment, and platforms for research, education, and capacity-building.

This new reality and paradigm fundamentally affect opportunities to design and deploy conservation innovations. First, mobile platforms allow for direct feedback, which gives us a greater opportunity to ensure that we are meeting customer demand for products. Moreover, prototyping and iterative testing of new technologies and solutions can now be done more rapidly and in a distributed fashion. Second, our digitally connected world allows powerful technologies (such as those in mobile platforms) to reach those at the bottom of the pyramid and enables us to interact directly with these potential customers/beneficiaries/natural resource managers, who may be thousands of miles away in remote places. Third, widely available phone applications, programs, and messages can be honed, tested, tailored, distributed, and scaled-up with marginal additional financial investment. If planned appropriately and maintained regularly, cost efficiencies in technology adoption, improvements in data quality, and increased speed, availability, and access will be inevitable (Waugaman, 2016).

Finally, the distributed nature of mobile platforms will allow us to leverage additional human capital at scale. Individuals making and reporting observations of the natural world provide the capability to understand changes in the earth both at scale and with high granularity, and to harness increasingly powerful sensor systems in mobile platforms with ever-expanding connectivity and bandwidth. In conservation, digital technologies to monitor species have scaled successfully, harnessing the passion from citizen science such as the Audubon Christmas counts. Over the past 15 years, eBird, the world's premier birding citizen science mobile application, has captured 370 mil-

lion bird sightings, representing more than 10,000 bird species in every country in the world (eBird, 2016). Similarly, iNaturalist electronically collects observations from citizen scientists and naturalists from around the world of any species and boasts almost five million observations. The data compiled on these platforms represent millions of hours of human effort and provide new insights into species populations and movement, which allows us to better monitor species globally at scale.

The democratization of technology creates unprecedented opportunities to harness the collective ingenuity of a wide range of experts, technical fields and disciplines, and bodies of research for creating new solutions to conservation challenges through open innovation—including for those who are closest to the problem.

## **SCALE FOR CONSERVATION**

Conservation has failed to match global health and food security and the private sector in scaling its successes and is only beginning to harness new digital technologies. As market forces are frequently a driver of environmental change and degradation, there is an ever greater need to ensure that we are also using market forces to create new and more sustainable solutions, and to address the underlying drivers of extinction rather than the symptoms. Traditional conservation activities such as protected areas have multiple benefits as a public good, which are borne unequally across the planet. We ask those closest to the problem to bear the highest economic burden—even when they are frequently the ones who can least afford to pay—yet we all share the benefits of conservation actions.

Conservation is different from global health and food security in a few significant ways. First, while the problems are

no less important in either field than in conservation, the speed and scale of the challenges, particularly those related to extinction, are much greater in conservation. We are losing species before we know they exist. Although conservation and environmental challenges may not directly affect human well being, they significantly magnify the underlying threats to global health, and undermine our ability to meet food security goals. Accordingly, the pressure on global biodiversity requires a new approach to conservation, one that places the scalability and sustainability of the solutions at the heart of the challenge.

So what does it mean to scale for conservation and what are the guidelines for getting to scale? We propose that a conservation product, service, or intervention can be said to have scaled when either its distribution matches the level of demand (for commercial ventures or tech) or its impact meets the social need (for social enterprises). Conservation impact is achieved through products or programs that directly or indirectly reduce the risk of extinction and maintain biological diversity. Such impact is scaled when the risk of extinction for a target population, species, or ecosystem has become negligible, and where the intervention has not created inadvertent negative issues for other species.

While this defines scale for conservation, we also must consider how we get to scale. Based on the lessons learned from commercial and social ventures' growth strategies and scaling, and from the application of these lessons in other fields of international development, we offer the following guidelines, in combination with the rise in global connectivity, for scaling conservation innovations.

## **Understand the Problem**

The sustainability and scalability—and thus the success—of your conservation program, innovation, or campaign will be based on how well you understand the problem, the constraints that must be overcome, the context in which it takes place, and the underlying drivers of human behavior. Any approach to solving a conservation challenge may need to change the incentive structures, both in biodiversity-rich countries and in countries that generate demand for the products and goods that put pressure on ecosystems and species. By understanding whether you are solving the right problem or constraint, you can design your intervention, assess demand for it, market test it, and bring it to scale more effectively.

## **Design for Scale and Sustainability from the Beginning**

Considering scale and sustainability for your product up front means considering the target market/s and demand—who is willing to pay, how much, and why—and the barriers to scale—regulatory, financial, and competitive. Conservation innovations may serve more than one market, and a secondary market, where demand for the solution and ability to pay may be greater, can help scale the application. While conservation traditionally has been funded through philanthropy and government support, we need to reexamine how we harness market forces. As many of the drivers of extinction are at scale (e.g., demand for meat and dairy or traditional medicines), we can consider replacement products that can achieve similar scale (e.g., cellular meats or synthetic milk or shrimp) that would relieve pressure on natural systems.

### **Create a New Science for Conservation Implementation**

Although we apply the scientific method in conservation science, we rarely apply it to conservation interventions. Conservation has failed to recognize that implementation is its own discipline and science. We need to take a lesson from the private sector in succinctly defining core assumptions about a problem, applying design principles, creating a minimally viable product/program, prototyping it, and iteratively testing and improving it while also testing our understanding of our scaling strategy. Advances in technology now allow us to conduct iterative testing, assess the efficacy of our innovations, and modify prototypes in near real time, which goes well beyond the traditional impact-evaluation process that occurs months after the close of a program—if it occurs at all.

### **Harness Exponential Technologies**

There is a clear need to accelerate conservation solutions by harnessing new technologies and connectivity, which will enable conservation to operate at the pace and on the scale necessary to keep up with—and perhaps get ahead of—the planet’s most intractable environmental challenges. The Makers Movement, coupled with the democratization of technology, will allow for the development of a new set of problem-solvers and new solutions, including in states rich in biodiversity, to help us rethink conservation solutions.

First, while there have been many pitfalls and hard lessons learned from unsuccessfully applying digital solutions in the past, these solutions do offer new opportunities to harness innovation and democratize conservation solutions. Moreover, digital technologies are inherently scalable. When combined with mass collaboration approaches, citizen science, and open innovation such as prizes and chal-

lenges, digital technologies can drive innovation forward, accelerate understanding of our challenges, and harness the insights, efforts, and brainpower of citizens around the globe. Such technologies can also facilitate the use of financial incentives, such as a pay-for-performance approach, through mobile money, lead social campaigns, and collect data on efficacy. For example, there could be a platform to rate and comment on conservation interventions, *à la* Yelp, by the very communities where the interventions are taking place. The success or failure of many conservation programs depend on the buy-in of local communities.

Second, advances in molecular and microbiology have equipped us with new tools for mapping the blueprint of life. In the 1990s, the human genome experiment cost \$2.7 billion, and it took 13 years to create a reference genome of the human species. By 2014, commercial technology could sequence 55 genomes a day at \$1,000 per genome. Concordant with information technology, the efficacy and speed of sequencing efforts have been accompanied by miniaturization and portability, while new techniques such as gene editing and synthetic biology provide us with new “superpowers”: we may render extinct emerging infectious diseases such as chytridiomycosis, control and eliminate invasive species through gene drives, engineer greater resistance to environmental change among coral reefs, generate replacement products for feed and food, and restore degraded environments.<sup>4</sup> These solutions are now not only feasible but monetizable.

Finally, we have new ways of observing and understanding the existing rate of change. Technology has gained exponentially in processing power, memory capacity, sensor quantity, pixel capacity, storage, machine vision, and artificial intelligence. Thus we now have the capacity to monitor entire ecosystems, such as the Amazon or Congo basin, including



the changes they are undergoing, in nearly real time through new sensors, ranging from a planetary scale (nanosatellites) to the local scale (citizen scientists). If we can measure and understand changes while they are under way, we can better estimate the costs to mitigate them—and who will pay for the solutions.

### **Cultivate the Conservation Innovation Ecosystem**

Scaling-up conservation innovations and interventions requires the ability to change the system in which they operate. This means not merely finding new ways of doing business but changing the rules of doing business, making them more flexible to allow for more creative solutions. Ultimately this will create an environment and a system more receptive to the change one is trying to create.

Acknowledging the dynamics of your ecosystem—competitors, the legal and regulatory environment, social norms, potential partners, etc.—will make you aware of what’s possible and, more importantly, what needs to change in that ecosystem to make the impossible possible. In a strictly commercial sense, this can mean readying the market for your product and driving consumer demand for a new innovation through advertising, distribution channels, focus groups, and market testing. In terms of a social enterprise, it could mean lobbying and formally seeking policy changes, doing advocacy work, and building political and social capital to give you credibility and resilience. This is what design firm IDEO calls “sticky systems.”

It is nearly impossible to create large-scale systemic change single-handedly; it requires distributed ownership and an army of motivated and capable supporters. Many have talked about the need to bring new players and disciplines (engineers, entrepreneurs, data scientists) into

the conservation field in order to bring in new ideas and new diversity, and to take advantage of the digital age and increasing connectivity. These new players not only will provide different approaches to familiar challenges, they also will become new ambassadors for the conservation field. Reaching scale requires mobilizing a whole new tribe that can inspire and support others and positively affect the policy, political, and social landscapes.

### **Focus on Market-Based Solutions for Conservation**

Many of the products conservation needs to address the underlying drivers of extinction will require resources. Traditional conservation funders seem reluctant to consider the types of solutions that may be scalable—those that will have an impact on the problem. Therefore, it is time to think radically about where funding and sustainable finances will come from. We have the opportunity to create new financial innovations and products, including new investment funds, advanced market commitments, and pay-for-performance mechanisms, that are based on incentivizing conservation-friendly actions but also return a profit, harness products that replace the underlying drivers of extinction, and create new technologies and companies that are focused on engineering resilience or restoring natural systems.

### **REVISITING THE CIRCLE HOOK**

And so we revisit the case of the circle hook: why couldn’t this simple technology scale? There’s probably no single reason the circle hook has been so controversial and difficult to scale. The problem likely comes down to a failure to understand the dynamics and complexities of commercial and small-scale fisheries

markets. There's been an acceptability issue and serious questioning of whether the device was ever proven to work consistently in any environment before it was disseminated, and whether scaling it was considered from the beginning.

What the circle hook does tell us is that many assumptions were made about the efficacy of the product, its design, the customer base and their drivers and product preferences, and the market itself. Field testing, adaptation, and acceptability would have been needed in every subsegment of the market to ensure that the circle hook had a chance of getting to scale. We owe it to the planet—and its millions of surviving species—to learn from the struggle to scale the circle hook, and from the many lessons and opportunities other disciplines and venture models provide, to ensure the success and scale of conservation innovations going forward.

## REFERENCES

- Bloom, P. N., & Dees, J. G. (2008). Cultivate your ecosystem. *Stanford Social Innovation Review*, Winter, 46-53.
- Bloom, P. N., & Smith, B. R. (2010). Identifying drivers of social entrepreneurial impact: Theoretical development and an exploratory empirical test of SCALERS. *Journal of Social Entrepreneurship*, 1, 126-145.
- Creech, H. (2008). *Scale-up and replication for social and environmental enterprises* (SEED Research and Learning Programme 2007-2008). Manitoba, Canada. International Institute for Sustainable Development (June).
- Dees, J. G. (2008). *Developing the field of social entrepreneurship: A report from the Center for the Advancement of Social Entrepreneurship*. Durham, NC: Duke University.
- De Vos, J. M., Joppa, L. N., Gittleman, J. L., Stephens, P. R., & Pimm, S. L. (2015). Estimating the normal background rate of species extinction. *Conservation Biology*, 29, 452-462.
- Dust, F., & Prokopoff, I. (2009). *Designing systems at scale*. Toronto: Rotman, p 53-56.
- Easterbrook, G. (1997). Forgotten benefactor of humanity. *The Atlantic* (January). Retrieved from <http://www.theatlantic.com/magazine/archive/1997/01/forgotten-benefactor-of-humanity/306101/>
- eBird. "eBird 2016—Year in review." Retrieved on June 6, 2017 <http://ebird.org/content/ebird/news/2016review/>
- Ericsson (2016). Ericsson mobility report (November). Retrieved from <https://www.ericsson.com/assets/local/mobility-report/documents/2016/ericsson-mobility-report-november-2016.pdf>
- Gerlin, A. (2006). A simple solution. *Time* (October 8). Retrieved from <http://content.time.com/time/magazine/article/0,9171,1543876,00.html>
- Gilbert, B., McDougall, P., & Audretsch, D. (2006). New venture growth: A review and extension. *Journal of Management*, 32, 926-950.
- Hobbes, M. (2014). "Stop trying to save the world: Big Ideas are destroying international development." *The New Republic* (November 17). Retrieved from <https://newrepublic.com/article/120178/problem-international-development-and-plan-fix-it>
- iNaturalist. Observations. Retrieved from <https://www.inaturalist.org/observations>
- Nash, M. (2015). *Planning for scale: Are you ready to amplify your impact?* Paper presented at the Social Entrepreneurship Accelerator at Duke, Duke University, Durham, NC (July 15).
- Pimm, S. L., Jenkins, C. N., Abell, R., Brooks, T. M., Gittleman, J. L., Joppa, L. N. . . . Sexton, J. O. (2014). The biodiversity of species and their rates of extinction, distribution, and protection. *Science*, 987 (May 30).
- Read, A. J. (2007). Do circle hooks reduce the mortality of sea turtles in Pelagic Longlines? A review of recent experiments. *Biological Conservation*, 135, 155-169.
- Serafy, J. E., Cooke, S., Diaz, G. A., & Swimmer, Y. (2012). Circle hooks in commercial, recreational, and artisanal fisheries: Research status and needs for

improved conservation and management.  
*Bulletin of Marine Science*, 88, 371-391.  
USAID, Center for Accelerating Innovation  
and Impact. (2015). *Idea to impact: A  
guide to introduction and scale of global  
health innovations*. Washington, DC:  
USAID.  
Waugaman, A. (2016). *From principle to  
practice: Implementing the principles for  
digital development*. Washington, DC: The  
Principles for Digital Development  
Working Group

- 
- <sup>1.</sup> A clade is a group of organisms believed to have evolved from a common ancestor, according to the principles of cladistics; see <https://www.google.com/search?q=clade&ie=utf-8&oe=utf-8>.
  - <sup>2.</sup> The background extinction rate is the rate of extinction that has occurred throughout the earth's biological history before increased pressure from human activity.
  - <sup>3.</sup> CGIAR is a global research partnership for a food-secure future; see <http://www.cgiar.org/>.
  - <sup>4.</sup> Chytridiomycosis is an infectious disease in amphibians, caused by the chytrid *Batrachochytrium dendrobatidis*, a nonhyphal zoosporic fungus; see <https://www.google.com/search?q=chytridiomycosis&ie=utf-8&oe=utf-8>.