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contents

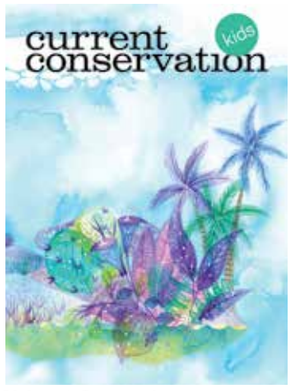
cc kids

Cover art by Prabha Mallya

This issue brings together old problems and new possibilities. First, the old. We interview Corey Bradshaw about that permanent elephant in the conservation room – human population growth. Corey argues, provocatively, that there are no "quick fixes" to population growth, and that therefore, conservation action will be better-served by focussing elsewhere in the near future. GBSNP Varma spotlights a Nature paper that examined threats faced by over 8000 species on the IUCN red list and found that agriculture and over-exploitation of species continue to remain the most important drivers of biodiversity loss.

Now, for the new: Anjali Vaidya writes about the work of anthropologists Piers Locke and Paul Keil, who are trying to build a bridge between ethnography and ethology to better understand human-elephant interactions. Caitlin Kight discusses a project that's using cameras to remotely monitor nests of the critically-endangered Californian Condor.

And of course, like always, this issue also features exciting new content in our old (and not-so-old) regulars: the second volume of CC Kids, a Research in Translation piece by Vrushal Pendharkar on why sparrowhawks come in different colour morphs, and reviews of Paolo Bacigalupi's novels by Caitlin Kight.



Kalyani Ganapathy

The invaders are coming, and they're everywhere!! Whether they're slithering like the Burmese python, sliding like the African land snail or are hiding in the poo of a buffalo like the mesquite plant, they are finding ways into new areas. In this issue of CC Kids, we interview Geetha Ramswami, an expert on the spread of Lantana plants, and ask how it is getting into your neighbourhood. We also give you an introduction into various other types of invaders you might encounter.

And have you ever listened to an island speak? The voice of a land surrounded by water? What would it say if the water was rising? Climate change is meaning seas are rising in many places. In Sshhhhhhh, an island finds its voice. Try reading it out loud, counting 1, 2, 3, 4 for the rhythm. Find the rhythm of the Earth… And on 'The Flip Side' we feature Jim Jourdane's spectacularly illustrated 'field- adventure- gone-wrong' stories.

Happy reading!

Why do black sparrowhawks come in different colours?

Of the 10,000+ known bird species in the world, only 3.5% have been documented to show colour polymorphism—a phenomenon in which individuals of the same species occur in two or more distinct colour patterns. However, this phenomenon, for reasons unknown, is much more common in birds of prey. And among birds of prey, the genus *Accipiter* is a standout example, in which around a quarter of about 50 species appear in two or more morphs. Why polymorphism is prevalent in birds of prey is still a puzzle to evolutionary biologists. Gareth Tate and colleagues decided to test one long-standing explanation—that different morphs have better hunting success under different light conditions. By setting up video cameras in nests, Gareth and team were able to compare rates of prey brought back by black and white coloured male black sparrowhawks (*Accipiter melanoleucus*) at different times of the day. Their analysis revealed that black morphs were more successful in capturing prey in low light conditions while lighter morphs were more successful in brighter conditions.

The team also explored whether there is a relation between frequency of black sparrowhawks' morphs and seasonal variation in its range within South Africa. They found that, during the breeding season, the frequency of black morphs declines from more than 75% in the southwest to less than 20% in the northeast of the country. The southwest region of the country experiences cloudy wet winters, whereas winters in the northeast are clear and dry. In other words, dark morphs are predominant in areas with higher rainfall. Thus this study provides compelling evidence to show that polymorphic birds spread across large geographic landscapes are impacted by local light conditions in their ability to hunt and survive.

Tate GJ, JM Bishop and A Amar. 2016. Differential foraging success across a light level spectrum explains the maintenance and spatial structure of colour morphs in a polymorphic bird. *Ecol Lett*, 19: 679–686. doi:10.1111/ele.12606

Vrushal Pendharkar is a writer covering nature, science and health stories.

photos: Gareth Tate, Doctoral candidate, Percy FitzPatrick Institute of African Ornithology, University of Cape Town.

Bridging the gap between humans and elephants: from anthropology to ecology

By its very name, anthropology tends to restrict itself to the study of humans. But in the early 2000s, anthropologist Piers Locke found himself questioning that constraint, while conducting fieldwork for his PhD, which dealt with the lives and practises of elephant handlers in Nepal.

"I suddenly realized that it's not just the humans that are my informants," explains Locke, who is now faculty at the University of Canterbury in New Zealand. The training of an elephant involves active participation on all sides: the human and the non-human must get to know each other during this process, forming a bond that may last decades. In Locke's terms, elephant training is a "multi-species rite of passage." To focus on just one half of this process is to miss the actual picture—and yet there is a clear practical challenge to focusing on both halves. Anthropologists are not trained to work with or think about animals. How do you begin to perform ethnographic research on a subject whose language you do not speak?

One step that Locke took was to fully immerse himself in the process by which trainers themselves get to know young elephants. Over the course of his PhD research, Locke served an apprenticeship with elephant handlers at the Khorsor Elephant Breeding Center in Chitwan, Nepal. In anthropology, such immersion is called "active participant observation." Anthropologists recognise that they are always a participant in that which they study: as in the case of Schrödinger's proverbial cat, there is no way to fully decouple one's data from the act of observing that data. To actively participate in observation, then, is to accept and control one's participant role, while seeking a fuller comprehension of the object of study.

Such an approach may seem alien to an ecologist. In ecology, as with all of science, the invisible wall between (human) researcher and (non-human) observed is held to be almost sacred. Scientists are trained to detach, to efface themselves and their own subjectivities from the research that they do. It wasn't so long ago that Jane Goodall was criticised just for naming her chimpanzee subjects. But to go beyond that, and attribute to animals their own agency, histories, and emotions is to step far outside the traditional bounds of the subject. Ecology, as a discipline, is largely lacking in the vocabulary to speak about the inter-species relationships that Piers Locke saw in Nepal, just as anthropology grasps for the right tools of study when it comes to personal interactions that involve the non-human.

The present "animal turn" across the social sciences and humanities attempts to address this particular disciplinary blind spot—as does the rising body of work in animal behaviour studies that looks at non-human culture and cognition. But Locke points out that the paucity of academic precedent in examining how humans and nature intertwine is no accident. This gap goes back to the historical divide between the natural and social sciences, which itself says something about how we conceive of humanity. As a species, we tend to view ourselves as transcendent above the natural world. The Enlightenment ideal of "civilisation" places, as its opposite, the primordial soup from which we rose, along with the entire animal kingdom.

But we live right now in the so-called Anthropocene, where our culpability as a species in the dismal state of the natural world far outweighs our ability to rectify the damage, or outrun its effects. As boundaries between nature and civilization break down, Locke points out that we need to be blurring disciplinary borders as well.

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"[In academia], you've got all these increasingly specialised people who don't understand how to talk to each other," Locke explains. "And yet all the real world problems—climate change, disasters, how humans and elephants share environments—require the kind of expertise that traverses [academic specialities]."

A desire to foster conversations about human-elephant coexistence across academic specialities brought an unlikely assortment of people—including Locke and his graduate student, Paul Keil—to a conference on the Indian Institute of Science (IISc) campus in Bangalore, on a series of sun-burnt days in April 2016. The School of African and Oriental Studies (SOAS), University of London, has held many cross-disciplinary animal-themed conferences in past years (revolving around the camel, the donkey and the war horse), but the conference held by SOAS and hosted by the Centre for Ecological Sciences at IISc was the first to deal with the elephant. The SOAS conference spanned a wide swathe of topics: from the need to take elephant individuality into account in Gudalur's crisis-level human-elephant conflict situation (by Tarsh Thekaekara of the Shola Trust) to how mammoths once migrated the globe in response to a changing environment (by Régis Debruyne of the Muséum National d'Histoire Naturelle, Paris). Each talk was an act of translation: Debruyne diagrammed phylogenetics for the non-biologists in the audience, while Rachel Dwyer of SOAS defined the concept of *umwelt*—a German word adopted here to describe one's personal experience of the world. In this case, Dwyer referred to the challenge of understanding the parallel world that is viewed through an elephant's eyes. But given that it can be an impossible task even to understand the *umwelt* of another human being, how do we come close to knowing the world of an elephant?

Piers Locke and his graduate student, Paul Keil, talked about the idea of how to know someone else's world: how to translate between long-divided disciplines, and what changes when you view an animal as a person. Locke has coined the term "ethnoelephantology" as an umbrella term for the interdisciplinary conversation he hopes for, borrowing a page from ethnoprimatology.

Sitting over coffee on the morning after the conference, Piers Locke and his graduate student, Paul Keil, talked around the idea of how to know someone else's world: how to translate between long-divided disciplines, and what changes when you view an animal as a person. Locke has coined the term "*ethnoelephantology*" as an umbrella term for the interdisciplinary conversation he hopes for, borrowing a page from *ethnoprimatology*. The term echoes both *ethnography* and *ethology*, two disciplines that Locke says have much to learn from each other.

One could argue that the word *ethnoelephantology* represents an objectively impossible task. As described above, ethnography and ethology have deep philosophical differences that are difficult to reconcile. And viewing animals as people runs the real risk of anthropomorphism: instead of describing an animal's point of view, we might just be reflecting our own.

But more than natural scientists, researchers in the social sciences and humanities are trained to think deeply about words and metaphors as entities in themselves. Word choice matters, because words both shape and reflect thought. How you label a problem decides how you approach it.

Thus, for Locke and Keil, *ethnoelephantology* represents not an endpoint where widely divergent disciplinary methodologies and philosophies are evened out, but a dialogue. Likewise, introducing the word *umwelt* into animal studies is an invitation to a question: how do our stories and our methods change when we see animals as thoughtful, biased beings?

Paul Keil's research out of Macquarie University in Australia deals with elephant trails in Assam. The rugged terrain of Assam comes under a region that some scholars have called Zomia—a geographically contiguous area across the mountains of Southeast Asia, from China to Nepal to Burma. Political

Phanit bathing his elephant without getting wet

Piers Locke

scientist James Scott argues, in *The Art of Not Being Governed*, that Zomia has managed to stay marginally autonomous until the present day because of its inhospitable geography that only locals know how to traverse. What Keil's work builds upon is the theory that the human world of this isolated realm was shaped by elephants. People followed in the footsteps of elephants, who physically broke trails through the forests.

And what difference does it make to see these migrating elephants as thinking beings? Keil says that this mind-set allows him to push back against anthropocentrism. In Assam, wild elephants live in the midst of human turmoil. "I like to think – are [the elephants] creating their own worlds, their own pockets?" he says. "Are there places that humans can't go because elephants go there?"

Locke echoes this concept by saying we need to view elephants as "world-makers" alongside humans. For example, in 2013, Locke worked with Charles Santiapillai and Shanmugasundaram Wijeyamohan, researchers at Rajarata University in Sri Lanka, who were developing new methods to resolve human-elephant conflict. The village that they focused on was under a huge amount of stress at that time. "[The villagers] weren't getting any sleep, they were being harassed by elephants," says Locke.

But what was vital here wasn't just to examine the present crisis but also its historical context, and what that context said about how both sides of the dispute related to this particular landscape. The villagers revealed that they had been absent from the village for 17 years, displaced three times by war. They returned at last to land that had been taken over by elephants. Or, as Locke puts it: "A non-human person was thinking of their land as home."

The solution that Santiapillai and Wijeyamohan came up with was novel. Rather than penning the elephants inside sanctuaries with electric fences (which elephants can learn to circumvent in any case), they put the fences around the people. In addition, the fences were solar-powered and built such that locals could easily fix them and shift them around. "[Locals] can expand [the fence] if their crops expand," explains Locke. "They can move it in. It's easy to manage. If it's easy to manage, it can work. So far, the results are encouraging."

Locke points out that the tools of anthropology can also help conservationists work with local communities, in the case of participatory conservation efforts. Ecology students have approached him in the past with the problem that they could not get locals to answer their questionnaires when they needed to gather data about ecological issues. What these researchers really needed, Locke says, was formal training in ethnographic methods. With such training, they would learn that "you need to build relationships of trust and rapport with people before you can start asking questions." And such closer relationships with people might tell you, for instance, that clipboards and questionnaires can be intimidating for some. "They might associate [questionnaires] with government, and they may have a problematic relationship with government," says Locke.

Both Locke and Keil feel that conservation biology could benefit from engaging with the social scientific approach to human communities. "As anthropologists we give a lot of privilege and gravity to [human] histories and culture," says Keil.

And yet that empathetic engagement has the potential to go too far, once transferred from the human to the animal. It can be too easy to cross the thin line between accepting that animals have an inner world, and assuming we know what that world must be. "That's why we need [input from] the biological sciences as well, who make concerted efforts to try and detach themselves," says Keil. "We need the biological sciences to keep us in check."

It can be difficult to stimulate such cross-talk between disciplines. But one prerequisite, says Locke, is the willingness on all sides to step back and examine disciplinary assumptions and limitations. Only with that deeper understanding of where we stand can we reach out to others and find common ground. This includes researchers across the academic spectrum engaging with the philosophy and history of science: from Karl Popper's formulation of falsifiability as a driver of scientific progress, to Thomas Kuhn's notion that scientific evolution occurs through paradigm shifts, to Bruno Latour on the social construction of scientific knowledge. "How do we know what we know?" says Locke. "How do we conduct research? What kinds of claims to the status of knowledge do we make?"

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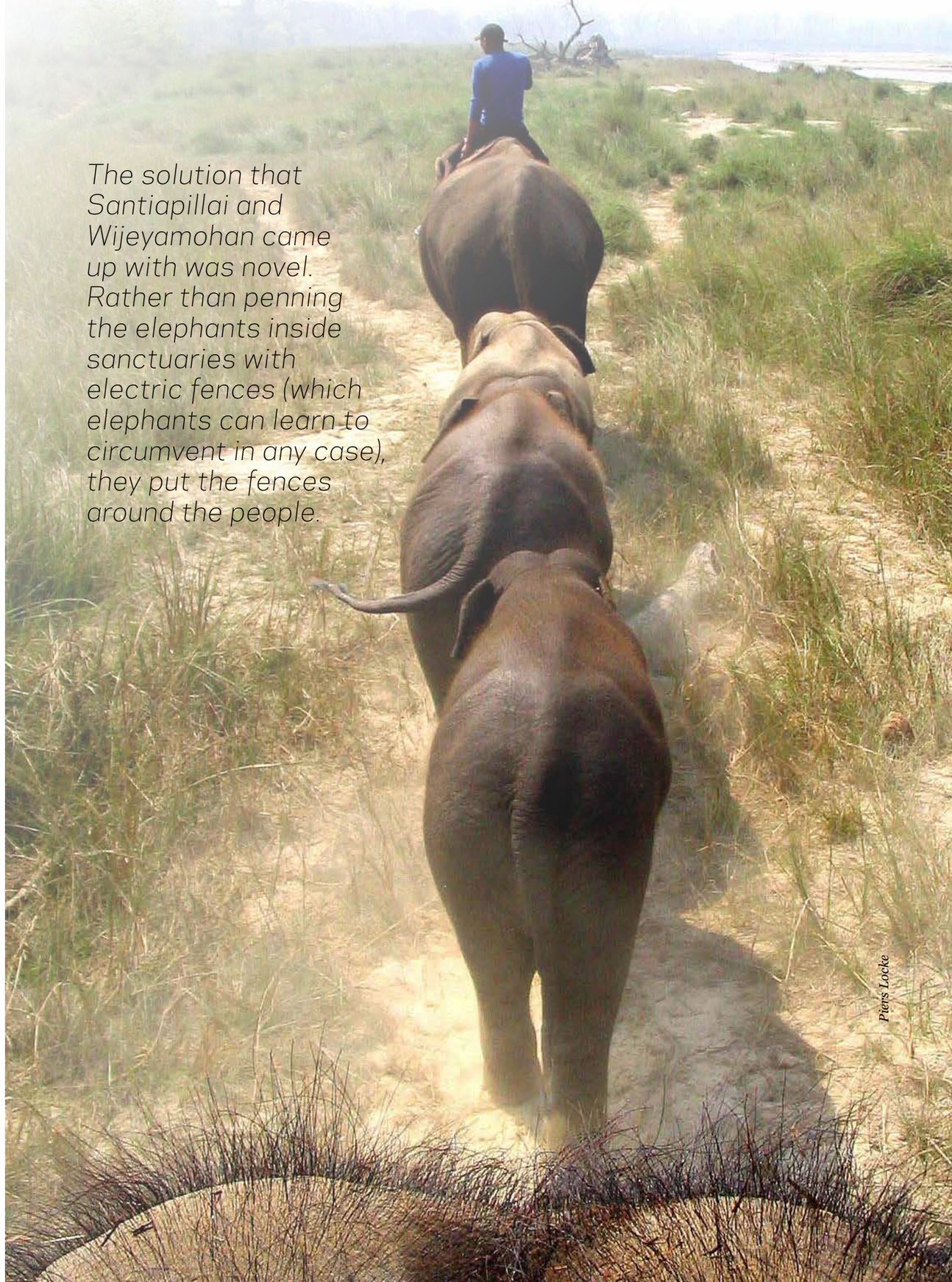

Piers Locke

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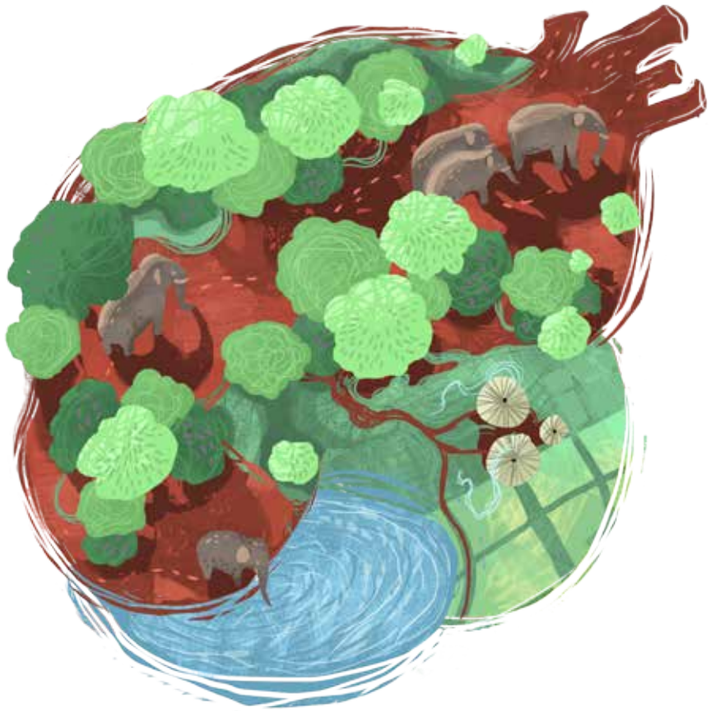


The SOAS elephant conference was the second gathering thus far to fall under the umbrella of ethnoelephantology. The conference followed a symposium along similar lines held at the University of Canterbury, New Zealand in 2013. The result of that symposium was a book titled *Conflict, Negotiation, and Coexistence: Rethinking Human-Elephant Relations in South Asia*, edited by Piers Locke and Jane Buckingham, which will come out in September 2016.

"[The book] is trying to suggest that greater interdisciplinary collaboration can provide new perspectives and policy approaches to dealing with all the dilemmas of elephant conflict and coexistence," says Locke.

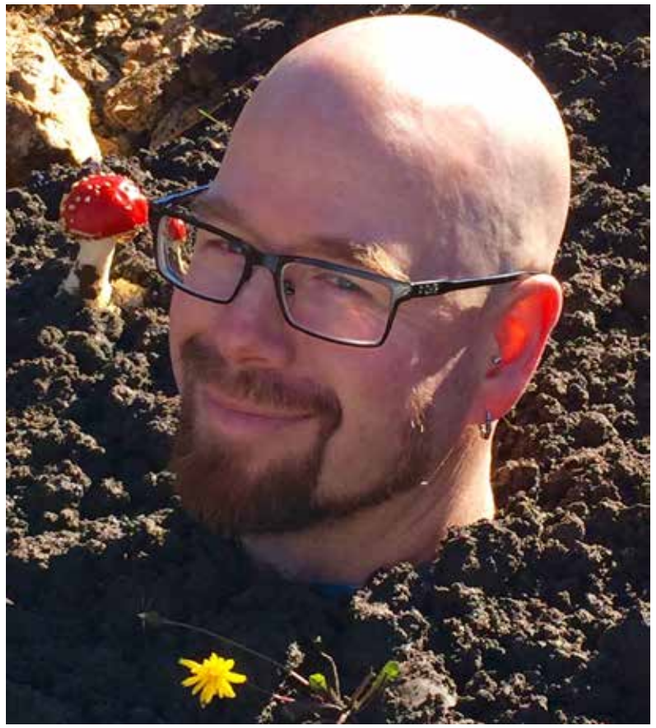
With the current need for better dialogue between the social and natural sciences about human-elephant coexistence, Locke hopes that these two conferences will inspire something much deeper than "a trendy term." The disciplinary gap where human meets nature could provide us with a new window into troubling environmental times, by re-centring our vision of a world in which humanity is only one small part."

Anjali Vaidya is a freelance writer based out of Bangalore and Southern California.

Illustrations: Sonali Zohra

In conversation: Corey Bradshaw with Hari Sridhar

In a paper published in the* Proceedings of the National Academy of Sciences USA *in 2014, Corey Bradshaw and Barry Brook argued that, given the current momentum of human population growth, no demographic "quick fixes" will be enough to change its trajectory in the near future. Therefore, environmental policy will be served better by prioritising measures such as technological and social innovation and reductions in consumption, while treating population reduction as a long-term goal. On his recent visit to Bengaluru,* **Hari Sridhar** *spoke to* **Corey Bradshaw** *about the genesis of this study and its implications.*



Patricia Michel

Hari Sridhar: You say "our models clearly demonstrate that the current momentum of the global human population precludes any demographic "quick fixes." If that is the case, what do you suggest should be done instead?

Corey Bradshaw: I'll back up a little bit and give you some of the context for writing the paper, which will sort of explain the title and that particular conclusion. Often when I gave public seminars, where I would talk about some environmental problem and future predictions of its worsening, some member of the audience would stand up at the end and say: "Well, the problem is humans. There are just too many of us. So all we need to do is focus on reducing the human population and we will fix all of these other problems. "That came up so often that I began to think: "Well, how quickly could we fix the overpopulation problem?" Being, among other things, a population dynamics modeller, I decided I could model the human population just as well to look at that question. What would it take, and how long, for human population to start to decline, either from interventions or catastrophes? Human demographers don't typically consider catastrophe scenarios when they project human populations. It's

**Bradshaw CJ & BW Brook. 2014. Human population reduction is not a quick fix for environmental problems.* Proceedings of the National Academy of Sciences, *111: 16610-16615.*

instead done under very strict policy criteria, typically under the expected status quo, with some slight variation in things like family planning and structural change; you know, things like age structure. But we decided to try out more extreme scenarios as well to address that question. So first we said "let's just see what happens when we only adjust fertility." We did that and the population trajectory was more or less insensitive. Then we said "let's see what happens if we impose mass mortality events of various types – a third world war, pandemics, nuclear warfare" - and still the population was fairly resistant, even to these big changes. What we took away from these results was this: yes, population size must be addressed and we should have started looking into this seriously, probably post World War 2 when we were just under two billion people. We need to address over-population, but it's not going to be something that can be fixed suddenly or be reduced anytime in the next few decades. It's a century-scale issue. Should we be aiming to reduce the total human population? Yes. Should we be encouraging fertility reduction and family planning? Yes. It's just that these will have positive outcomes at the century scale. Now most of our environmental problems are not things that we can ignore for a century. They have to be dealt with now. So our argument basically was that if we can't address the human population problem, in the sense of reducing its size quickly, then we need to turn our attention to more immediate fixes, such as addressing consumption and various environmental mitigation policies. That was our main message. But in so doing we managed to anger both sides of the ideological position on the human population debate. In saying that something must be done but it can't be done quickly, we upset the low-growth proponents. And by saying that we should nevertheless aim for long-term population reduction, we upset the people who are utterly opposed to any sort of fertility reduction or any action on human population growth.

HS: That's something I want to ask you about – tell us about the attention this paper got within academia and in the media.

CB: Yeah, in the academic setting it was interesting. There were only a few critiques written about the paper and they were fairly weak. As the saying goes "All models are wrong but some are useful", but what our model said was defensible. I suppose some of the terminology and the interpretation were points of contention with some people, but by and large the scientific community was satisfied with the result. But in the media it was completely different. Almost every single journalist I talked to put a particular slant on the results. Because of those two diametrically opposite opinions, people appeared to read anything they wanted to into it. Most people in the media didn't of course read the paper. They read the title and maybe the abstract and the odd sentence here and there, and took from that whatever their ideological position dictated. There was right-wing media, there was left-wing media, and each had its own bias. I think only a handful of interviewers seemed to grasp the concept, which I didn't think was that difficult. It also got a lot of responses on these comment streams. I don't read those most of the time, but there are a lot of crazy people on the internet now. I got all sorts of hate mail, and even indirect death threats. Not serious ones. Just some random person telling me I should be removed from the face of the planet, and things like that. That happens from time to time when you deal with controversial topics.

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HS: In the paper, you come up with some figures for what the population will be in 2100, under different scenarios. Could you tell us how much uncertainty there was around these figures?

CB: There was probably much less uncertainty than for most other species that are modelled. Humans tend to census themselves fairly well and we have a reasonable understanding of how many of us there are right now. While demographic data like age-specific survival rates are missing from some parts of the world, generally speaking, at the scale of regions it's well-known. So in terms of measurement error, the current and even the trends in those demographic rates are robust. Some of the assumptions, such as how much longer we'll live given future medical innovations, are somewhat uncertain. But as it turns out, we are living so long now that even slight adjustments to longevity don't make much difference in the long-term to total population size. And even large assumptions about, say, juvenile mortality, don't make a huge difference, because for a long-lived mammal the most important parameter that modifies population growth generally is the survival of breeding females. And breeding-age women around the world tend to have the highest survival rates, so all the other parameters have smaller effects on population size. So while environmental variability has a large effect on small populations, it has a comparatively small effect on large populations. And we are a very large population. Incorporating a lot of uncertainty didn't really make much of a difference. But the future scenarios were uncertain – will there be a war, will there be climate change reductions in food availability that will lead to higher juvenile mortality, etc.? We know little about the probability of these things occurring and how important they'll be.

HS: You say that the momentum is such that we are not going to be able to do much about population growth in the near future, but we could have done something in the past? What do you think we could have done and when?

CB: Well, I will come back to my colleague and friend, Paul Ehrlich and his book "The Population Bomb", where he was saying in the late 60s and early 70s that we really should have been addressing this issue right after the Second World War when we had the opportunity to keep populations small.

But the philosophy or ethic was quite the opposite. The emphasis was on recovery and population and economic growth, fuelled by an economic system that depended on a large number of consumers. And the environmental damage wasn't as obvious as it is today. I think people are still generally of the mind-set that we live on an infinite planet and there isn't any way the human population could change things, like the climate, and kill off entire species. Today, pollution, deforestation and climate change are in everyone's face, even though some people still prefer to bury their head in the sand. But that wasn't in the psyche of most countries 70 years ago. Some perhaps, like China, clearly had a different view of things, but the Chinese have nearly always had a different view on most things over the course of the last 150 years. And they dealt with it in their own way, controversially of course. And India has had some controversial interventions as well – forced sterilisations and that sort of thing. I think very few countries could put their hands on their hearts and say they haven't done something wrong in the past with respect to family planning. But Paul was a lone voice in the 1960s in a sea of promotion of growth. Now lots of people argue that Paul Ehrlich was wrong then. But he wasn't wrong, he was just perhaps a little out of date. He projected what we are going through now, a little bit earlier than it has actually happened. But everything he talked about is coming true. That's another reason why modelling this stuff mathematically is useful, because it gives you a timeline. It's approximate, but it tells you whether you need to deal with issues on decadal or century scales.

HS: That brings me to a question I had about this debate of overconsumption versus overpopulation, which is often set up as a developed versus developing world debate. What is your personal take on this?

CB: They are inseparable and can't be seen as a dichotomy. Several analogies have been used, for example, "two sides of the same coin". Or the one Paul uses all the time: he says that "arguing whether consumption or population is more important for sustainability is like arguing whether the length or width of a rectangle is more important for calculating its area". It's obvious that total damage arising from a population is a product of those two components. If you have a large population with low consumption or small population with large consumption you have the same result. It's the same amount of damage, same total consumption. But it is a very sensitive topic; when someone like me, a white fellow from a developed nation, says that the world must reduce its consumption. It seems hypocritical and I would be the first to agree with that. Australians, for example, while only 23 million people, have the highest per capita emission rates in the OECD (Organisation for Economic Co-operation Development). We are one of the highest per capita water users on the planet, even though we live in a desert. We are superlative wasters. Do we need to address that? Absolutely. The possible advantages, I think, many developing nations have is that they have seen the paths that developed nations have gone down: fossil fuel exploitation, reduction of natural resources, and the rising pollution as a result.

Illustrations: Sheena Deviah

Today, pollution, deforestation and climate change are in everyone's face, even though some people still prefer to bury their head in the sand. But that wasn't in the psyche of most countries 70 years ago.

current conservation

kids

Kalyani Ganapathy

poem Matthew Creasey

S S H
H H H
H H H

SSSSHHHHHH,
WISH WASHA-WAAAAAAAAAAH,
WISH WASHA-WAAAAAAAAAAH,
WISH WASHA-WAAAA fall the waves on my shore,
SCHLOOP GLUP PA air escapes from the mud,
HSSSSSSSSSSSSSSSSSSS,
HSSSSSSSSSSSSSSSSSSS,
Sand drifts.....,
Sand drifts .....,

HUSH TICA HAAAA sing the grasses in the meadow,
SWEEP SWAPA SWEEP call the birds in the trees,
SUPAAPA SIP SUPAAPA the whisper in the leaves,
A BRRRR TICA TAC... bird flies to the sky,
Mountains soar.....,
Mountains soar.....,

CRACKLE HISS-SIH... temperature is rising,
SAAAAAA CCCSH... ice in the North,
PIP-PIP... the ice melts away,
CHURGLE GLAGA GLUG... so much water,
.....Seas riiiiise.....,
.....Seas riiiiise.....,

A BRRRR TICA TAC... the last bird leaves,
HSSSSSSSSSSSSSSSSSSS,
HSSSSSSSSSSSSSSSSSSS,
Sand drifts .....,
Sand drifts .....,
SSHHHHHHHHHH.....,

Kalyani Ganapathy

Alien invaders—our top six!

Burmese python
(Python bivittatus)

The Burmese python is one of the largest snakes in the world. In the US many pet shops sell baby Burmese pythons. But these snakes grow fast, and aren't such cute pets after some time. People release pet snakes into the wild once they grow big and become difficult to look after at home. These snakes have become a huge problem in places like the Florida Everglades, where they have eaten up most of the wildlife. They have even been known to eat alligators!

Mesquite
(Prosopis juliflora)

This is a medium sized thorny tree with yellow flowers and pods that goats, buffaloes and camels feed on (they also help to spread it!). It was introduced to India in the 1850s because it grew fast and could rapidly provide lots of fuel wood. Now it is an invasive plant all across the hot, dry parts of the country, and has taken over grasslands and farms. Because it spreads so fast, it is called the 'mad babool' in some places! But people have also figured out a use for it—in many places, people make charcoal from its wood.

Giant African snail *(Achatina fulica)*

The first know pair of African giant snails was brought to Kolkata by a British malacologist in the 1800s from Mauritius. (A malacologist is a scientist who studies animals like snails and oysters and even octopuses!) He presented this pair of snails to a friend to keep in his garden. Very soon, the snails had multiplied and were all over Kolkata! These large and unusual snails got carried as pets to other parts of the country and are now found in huge numbers, in places like Kerala and Assam. They are hungry creatures and chomp through crops like potatoes, spinach, bananas, and tomatoes, doing a lot of damage.

Archana Sreenivasan

The brown tree snake
(Boiga irregularis)

This snake is native to Australia and Papua New Guinea and was accidentally transported to Guam as a stowaway on ships some time in the late 1940s or early 1950s. On Guam there are no animals that eat the brown tree snake, but the snake has found lots of things that it can eat, like birds, rodents and reptiles. So much so that some birds have even gone extinct on Guam, thanks to this invasive snake!

Mile-a-minute weed
(Mikania micrantha)

This climber, from the American tropics, is called a "mile-a-minute" weed for good reason. It grows extremely fast, and can quickly blanket entire trees. In fact, the story goes that it was introduced to India during the 2nd World War, to camouflage air fields! It clambers all over trees in plantations and forests, very quickly smothering what is underneath.

Congress grass
(Parthenium hysterophorus)

This is a small herb with tiny white flowers. It arrived in India by accident, people think, because its seeds got mixed up with wheat that was being imported for food! It is a very common plant along roadsides and in open areas. Some people are quite allergic to it.

What can you do to reduce the spread of invasive plants and animals?
1. If you are arriving from abroad, don't bring plants and animals back with you!
2. Don't buy exotic pets. And certainly don't release exotic pets into the wild. Even tiny goldfish can become big and invasive.
3. If you are planting a garden, try to use native plants. Even if you do not intend to attract pollinators and dispersers, be aware that colourful flowers will get pollinated and sweet fruit will get eaten! So help prevent accidental garden escapes via bird- and bat-mobiles.
4. Join the SPAIS programme and report the occurrence of invasive plants and animals *(http://indiabiodiversity.org/group/spotting_alien_invasive_species)*.
5. Don't remove creatures from where they belong and put them in places where they don't.

lantana! lantana!

EVERYWHERE...

You've seen Lantana everywhere, yet you probably don't know very much about it. It has pretty little flowers but has prickly leaves and thorny stems. Gardeners like it. Elephants and deer avoid it. Butterflies and birds love it! Biologists call it an invasive plant. GEETHA RAMASWAMI **studies it, and tells us a little more about it.**

CC Kids: Tell us about invasive plants and animals. What are they?

Imagine that you are a brightly coloured little frog living on an island in the Carribean. You would be a 'native' frog on that island. But suppose you caught the fancy of a visiting pet trader from Sri Lanka, who thought that you would look great in an aquarium. He captures some of you and brings you home. You are now an 'introduced' frog in Sri Lanka.

Shreyas R Krishnan

Supposing some of you frogs get washed down the drain when your aquarium in the pet shop is being cleaned. You end up in a pond outside, have lots of baby frogs, and spread to other ponds. There are soon so many of you that you start to compete for food with all the Sri Lankan frogs. You might also eat up all the useful insects. This is when you will be called an invasive frog.

How can a little frog become such a nuisance, you ask? Well, it could be because you don't get eaten by

other animals the way local frogs do. Or perhaps you are just better at catching insects than the local frogs. And so one way or another the locals don't stand a chance against you! People introduce lots of plants and animals to new places. Many of these become invasive. Others don't, maybe because they didn't find the right things to eat, or they couldn't deal with the weather, or weren't able to spread very far.

CCKids: Tell us a little more about the invasive plant that you work on.

I work on a thorny, bushy plant called *Lantana*. In India it is spread over many millions of hectares. You are sure to have seen it – it has clusters of pretty pink flowers and juicy, sweet, black berries. I am interested in all the mischief it brings about in the forests that it invades.

CCKids: How did Lantana get here? And how did it become invasive?

Well, Lantana was introduced from South America to grow in gardens, because its flowers looked so pretty. It was brought to India by British botanists more than 200 years ago!

Lantana was able to invade because it has several ways to ensure that it can get around and grow. Lots of birds and some animals eat the fruit, and poop the seeds out in different places, helping to spread it far and wide! Lantana can also sprout right back if its top is cut off or if it is burnt.

CCKids: Ok, so we know how Lantana is able to spread. But is it also harmful, like the invasive frog?

Yes, Lantana can change a lot of things. It can grow so fast, that many native plants just cannot compete with it. It can change soil conditions. Lantana also grows in dense thickets and sometimes this can make it difficult for large animals to move around! Also, not many animals can eat lantana leaves without getting really sick, so it is bad for herbivores.

CCKids: Is Lantana always this harmful or do some animals benefit from it?

Oh yes! Many insects drink nectar from its flowers and in return transfer its pollen to other plants, helping it to produce more fruits and seeds and so, more baby plants. Lantana also has delicious, juicy, sweet berries that lots of birds and some animals like to eat. (Because these birds and animals help spread Lantana seeds, they are also called 'seed dispersers'.)

CCKids: Why are you studying Lantana?

I am trying to understand if Lantana steals away seed dispersers from other plants. (Many plants need fruit-eating animals to visit them and spread their seeds.) But Lantana could be more attractive to animals than other plants, thanks to all those juicy berries it produces. This will eventually result in more lantana plants spreading instead of native plants.

CCKids: Do we have ways to deal with Lantana? It sure seems like quite a problem.

Well, Lantana has been around for a long time now, so there's probably no getting rid of it completely. But people try. Forest Departments remove Lantana by the thousands every year. It's a lot of work! And farmers definitely don't want Lantana on their lands, so they till it. But Lantana's seeds keep arriving, thanks to its dispersers. Keeping lantana at bay is hard work indeed, but we must definitely strive to control it in areas that are important for people and wild animals.

The flip side

Jim Jourdane illustrates some of the misadventures experienced by field biologists in our new 'The flip side'.

Jim Jourdane (fieldworkfail.com)

Agata Staniewicz

Accidentally glued herself to a crocodile while attaching a radio transmitter.

In other words, the developing world has very good examples of what not to do, what not to follow. Moreover, the consumption pathway has led to all sorts of corollary issues – obesity, diabetes, heart diseases. Even political stability is not guaranteed. There are plenty of things to avoid. Now I know every country has a set of issues and problems, but I always argue that taking Western societies as examples of what not to do is how developing nations can learn to do better. Because now the technology and knowledge are there, and alternative pathways are now available, which weren't necessarily the case when Western nations were developing. We didn't have access to renewable technologies or nuclear power and we didn't have family planning on the mind. So in some ways the developing world is at an advantage and I guess that's the message I try to get out. Absolutely, I will be the first to scream out that my government isn't doing enough on the consumption side, just as I will say that to Indians, the Chinese or Africans. In fact, I would also say that my country is probably not doing enough on the population side either.

HS: When you say Australia isn't doing enough in terms of population, do you mean in controlling immigration? That is something you briefly touch upon in the paper, but which you didn't include in the regional analysis.

CB: Not in that paper, but I've written a subsequent paper about Australia in particular that specifically deals with the immigration issue, which of course is a loaded gun as well; it's entirely politicized. In Australia, right now, that's almost the number-one election issue: how we deal with refugees in particular, but with migration in general. I myself am an immigrant to Australia: I came from Canada and was naturalised twenty-odd years ago. And there is a certain amount of racism involved there. I happen to be the same colour as most Australians, and so my entry into Australia was probably a little bit easier than someone from say, Sudan or Indonesia. But Australia has a classic European-like demographic structure, in that we don't really have any intrinsic growth. We are hovering at slight increase or stability. All of our growth - pretty much all of it (98%) - is from immigration. And that's a political choice. We have approximately 2,15,000 net immigrants per year, which is about 1% of the population. So in that paper we put this in the context of meeting future emission targets. We are already such high emitters, and the addition of more people makes reaching those targets even more difficult. How much more difficult? As it turns out, we have so far to go that even high immigration rates are only going to modify that capacity by 10% or so over the next 50 years. But the other issues are that Australia is a very dry place and has poor soils. The continent has had no glaciation since the Permian, and no major volcanism, so our soils are depleted. We need lots of area to grow food for our own population and we are sustained in a large way by global trade, like many countries these days. One could even argue that we have already exceeded our carrying capacity, so any additional people will put more pressure on our natural systems. We have already lost over 40% of our forest cover in the last 200 years, and the remainder is highly fragmented. We are losing our world-class coral reef system from agricultural practices and climate change. Overfishing has also been an issue, and we have some of the highest densities of feral animals in the world. We also have the world's highest mammal extinction rate. People cannot point to Australia as a model for conservation. We have a large protected area network, but even in our largest park, Kakadu,

mammal reductions of upto 95% have happened in the last 35 years. On paper we might look good, but we're still having conservation issues like everyone else. Because our lands are marginal and because agricultural development is the primary determinant of deforestation, historically as well as recently, adding more people is just going to put more and more pressure on our natural systems. It will be a case of diminishing returns – every extra person will require food from increasingly marginal resources.

HS: Part of this paper also focuses at the regional level. Could you say a little about what the future scenario for the Indian region looks like?

CB: India is an interesting case. With projected declines in fertility and the rising middle class, the likelihood of increasing much more than doubling, by the end of the century, is low in India. In many parts of Africa it's likely to be five to seven times. Therefore, while doubling the number of Indians is definitely something to be concerned about because there are so many already, the main problem is population density; the subcontinent will have the highest population density on the planet by 2100. That's pretty much non-debatable. What that means

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for regional political stability, for water availability, for rural politics, etc. is anyone's guess. Being a population ecologist, one of the truisms I subscribe to is that density feedback happens to every single species and population. The likelihood of conflict is higher, the denser the population. In addition, India is one of the most biodiverse parts of the world. You have the Western Ghats Biodiversity Hotspot next door to Bangalore, for example, which has lots of species but is also highly threatened — this region is probably where we stand to lose a high number of species, maybe second only to Africa. And more than political stability, what concerns me is that all these amazing endemic creatures are going to disappear. Big mammals like the tiger are probably some of the first to drop off the perch, but there are many smaller species that have already been lost and that are in the process of being lost.

HS: I have a couple of questions not specifically about this piece of work. One is about your research interests: correct me if I'm wrong, but it seems like, though you started doing very small-scale, often single-species studies, most of the work you do now is at much larger scales - primarily spatially, but also temporally, i.e., related to long-term datasets. Was that a conscious shift? Do you feel that this kind of research might be more relevant for conservation?

CB: Yes and no. First of all, it's probably because I get bored easily. I'm a little bit autistic, so I get easily distracted by things. So, I look for different topics and approaches because they interest me more than anything else. On the side of incorporating more than biology into what I do, I think most conservation people who have been in the field for a bit will have the same feeling. I have a bit of a joke about this. I say "Old ecologists never die. They just turn into untrained social scientists". That's gotten a bit of a chuckle from many of my friends. When you've been around for a while, you realise that the basics of conservation biology have been covered reasonably well. We know that fragmentation is a problem, we know that small populations are a problem, we know that low diversity leads to lower resistance, etc. These basics we established over the last 50 years or so, and now the conservation issues that remain are largely to do with managing human systems-economics, psychology, marketing and the like—that we are not trained in. I've tried to delve into that myself. You realise that, as a biologist, you are just sort of fine-tuning our narrative of the devastation. That maybe we can contribute more, I think, societies like the Society for Conservation Biology (SCB) and other national societies are starting to realise. If we want to be relevant, we will have no choice but to incorporate the human component into our work. I think the Society for Conservation Biology is even contemplating a name change because of this phenomenon. There's also the fact that I enjoy the quantitative side of things. I feel that maths has less nonsense than pretty much any other human endeavour, because it's not ideologically based. One plus one equals two; it's simple, it's straightforward. It's the implications of the mathematics that have the politics associated with it. But because I am 'in the zone', so to speak, when I do my maths, that skill set has allowed me to address questions that are outside of my field with relative ease. Of course, I collaborate with people that are specialists, but that skill has given me the capacity to shift around a bit. That's something I often say to younger people in the field – if you want to make yourself attractive to employers, supervisors or funding agencies, train yourself to be able to address different problems using mathematics. It's not the only way of course, but it's a powerful way.

HS: What first got you interested in ecology and conservation?

CB: That's a bit of a long story, but I can summarise by saying that it probably began during my childhood in western Canada. I grew up in a small, remote town surrounded by bush and mountains. My father was a fur trapper and hunter, so he took me 'out bush' so often that I began to value the very systems we were exploiting for fur and meat. Yes, it was entirely consumptive, but I learned to appreciate functioning ecosystems and the bounty of biodiversity from an early age. My father was also something of a counter-intuitive conservationist in his own way. While a hunter and trapper living off the land, he and his ilk were commonly the most vocal opponents of deforestation by logging companies. When the forests were felled, their livelihoods disappeared. I didn't know it at the time, but that exposure laid the foundation for my future conservation ethic. But conservation advocacy was never going to be enough for me. The call to science appealed to me greatly and through a fortunate set of

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circumstances, I was able to complete several degrees and pursue a career in academia. Initially I was more focussed on mainly ecological theory, but I eventually turned to more applied pursuits in the field.

HS: This is my last question –what according to you are the big issues that conservation research has to tackle in the near future?

CB: I think there are several issues that represent ways forward, in not just conservation biology, but in ecology and the interface with many other disciplines. The first one is that moving out of your comfort zone is hard to do. Lots of people avoid this because it takes courage. But moving into a different space, not just working with people in another field, which I call a 'multi-disciplinary' approach, but actually engaging in these disciplines yourself; this is true 'trans-disciplinarity'. Moving out of your chosen discipline gives a fresh perspective on things, when you cross disciplines with appropriate guidance and the expertise of your collaborators. Often you will discover novel ways to deal with problems. In terms of what to study, I think moving more towards the demonstration of how changing biodiversity affects humans directly. Now a lot of people worry about monetization of conservation values, for example, the controversy over REDD+ and things like that. But even demonstrating little things that the average person, who doesn't necessarily value biodiversity intrinsically, can understand is essential. We've done some work on deforestation and flooding events, and the epidemiology of emerging infectious diseases and agricultural practices and how that's affected by removal of natural systems. Or looking at wetland dynamics and the production of filtered freshwater, or the frequency of cyclones and other devastating events that kill children and the elderly. Or how much your crop yields will go down if you reduce your pollinators in adjacent forests. Those are things that farmers understand, that the average person on the street understands. No one wants a child to suffer. Putting a service value on everything might sound a little bit contrived sometimes, but I don't think that we are getting anywhere fast without doing it. And I also think we need more quantification; we need to quantify these relationships and show them to people. It's one thing to quantify, but it's another thing entirely to get the message out. But eventually even

the politicians get the message: this is bad for us, so we shouldn't do it. But to achieve this uptake, just by publishing your results in a journal and then moving onto the next thing isn't really going to cut it. We have to be good communicators to a much wider audience. But we are getting better at that; however, as the sea of nonsense in the great Twitter-sphere drowns out all messages, we have to be even more vocal. We have to get into that marketing side of things. And I would promote advocacy. I think scientists can be advocates without sacrificing their objectivity. That said, I don't think science is the pursuit of objectivity; it's the pursuit of subjectivity reduction. That's a topic for another discussion, but a strong argument I have heard many times is that advocating a position based on evidence somehow sacrifices objectivity. I think this view is utter nonsense. We are the people (scientists) who are best informed about these issues, and if we have strong evidence underlying a recommendation we should be vocal about it. Of course there are associated value systems and ideologies underlying these things, but we shouldn't just stand back and say we've done our job merely by writing about the problems. If that's all we do, nothing will change for the better.

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Illustrations: Sheena Deviah

'Live' from the Wild

Cameras have long been a critical part of the conservationist's toolkit. Both still and moving images have been used, among other things, to record the existence of new species (or those once so rare as to be considered extinct), document the appearance of species in new or unexpected habitats, capture evidence of interesting and unusual animal behaviours, and captivate audiences who might never have a chance to interact with wildlife in person.

Over the past few years, it has become progressively easier for nature enthusiasts to set up their own outdoor cameras in order to record footage of a variety of species. For less than £100, bird lovers can purchase nest boxes with hidden built-in cameras that will wirelessly stream footage of breeding activity to the owner's computer. For a similar or slightly larger investment (usually around £125-£150), it is possible to acquire a trail cam that can be positioned at watering holes, feeding stations, and paths frequently used for animal commutes; these motion-sensitive devices are generally fitted with infrared lights to facilitate the collection of images of shy, nocturnal animals as well as more commonly seen diurnal species.

Luckily for those nature-lovers who lack technology of their own, there are a number of websites where it is possible to view footage—in many cases real-time streams—from cameras that have been set up around the world. A number of zoos and aquaria broadcast live feeds of animals in their collections, while nature preserves and conservation organisations provide films of animals living in the wild. Birds are perhaps the easiest and most common subjects, but mammals such as bats, wild cats, and ungulates are also frequently targeted.

Although some viewers find it difficult to watch the footage when things go"wrong"—nests are abandoned, individuals are injured in fights, a predator is seen dismembering its prey—the public has generally responded very positively to these behind-the-scenes glimpses into the daily routines of animals. This has been true even in the case of species that are not particularly attractive or popular. Case in point: the California condor, an impressively large (if not beautiful) bird whose online feed has captivated hundreds of thousands of viewers despite the species' lack of obvious star quality.

The condor is one of many live-streamed animals whose video feeds were originally developed not for entertainment, but for the purpose of research and conservation. In the American state of Ohio, for example, trail cams have been used to document the return of apex predators such as bobcats and coyotes to a watershed that was once ravaged by mining activity; footage showing a female bobcat and her young kittens has suggested that the ecosystem is finally rebounding. Elsewhere in the state, a separate

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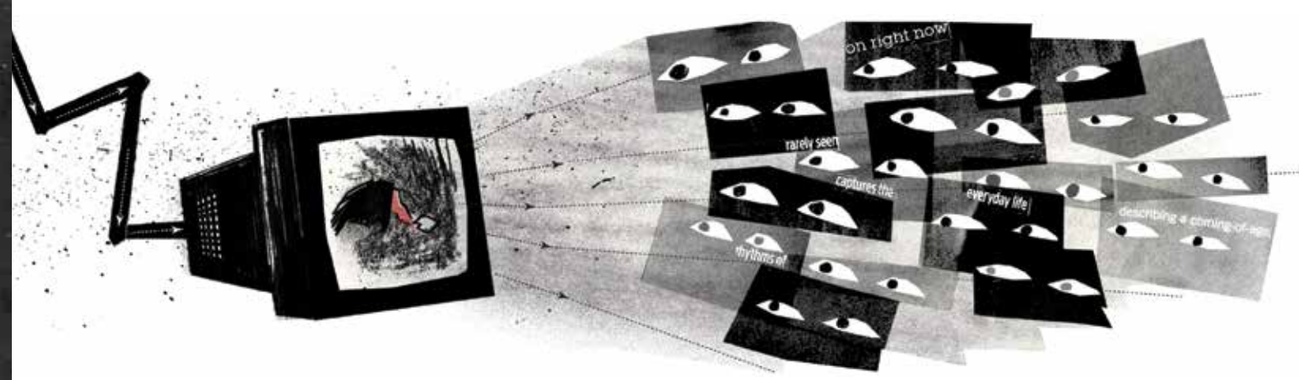


project uses the same technology to locate and eradicate invasive pigs that destroy the habitat.

As the technology improves, the devices will likely become smaller, more affordable, and more energy-efficient, with greater storage capacity and the ability to produce clearer images. Perhaps they will be coupled with audio and image recognition so computers can automatically analyze content, or be paired up with citizen science efforts so that viewers can collect rigorous data while watching footage for fun. There has been a similar trajectory in the realm of audio recording, which has led to, for example, the creation of publicly accessible databases of recordings and also free analytical software for lay enthusiasts. Comparable developments for film recordings could increase public interest even further and help even more people establish their own camera feeds.

Given the popularity of digital media in general and videos / video feeds in particular, live nature feeds are likely to continue multiplying, adding more species and habitats as time goes on. Cameras have come a long way since they were first invented in the 19th century, and this latest application is a powerful way to both bridge knowledge gaps and engage non-scientists. Although one day video footage might be all that remains of many species, there is also every reason to hope that film technology could be a critical factor in collecting the data and promoting the attitudes needed to save threatened wildlife.

Case study: Interview with Supervisory Wildlife Biologist Joseph Brandt, from the Fish and Wildlife Service (USFWS) California Condor Recovery Program

How did you first get the idea to install monitoring cams for your project?

From 2001 through 2005, the US Fish and Wildlife Service (USFWS) observed low reproductive success in condors nesting in California. Many of the condor nests were failing because parents were collecting small, coin-sized pieces of trash such as pieces of plastic, bottle caps, glass, and metal washers and bolts (collectively referred to as microtrash) and feeding these items to their chicks. Over time, this would lead to an impaction in the digestive track, causing the chicks to slowly starve, suffer from stunted growth, and eventually die.

The Service partnered with the Santa Barbara Zoo in 2007 to develop a nest management strategy that was meant to closely monitor nests and reduce nest failure by intervening when problems such as microtrash were observed. Nests were monitored by human observers for 30-40 hours each week, and once a month biologists would enter the nest to check on the egg or chick.

In 2010, a USFWS student biologist, Katie Chaplin, spent countless hours researching and learning how to set up Internet protocol (IP) cameras, wireless networks, and solar power systems in order to improve the condor program's ability to monitor breeding activities and more quickly identify potential problems at the nests. Her work to develop the camera system was instigated by a condor nest that had failed despite being monitored and checked. She believed that cameras placed in nests would allow the team to better monitor the nesting behaviors and the development of the eggs/chicks. She was right.

After testing the system at a feeding site at Bitter Creek National Wildlife Refuge (NWR) in 2011, we installed the first nest camera in 2012 at the South

Potrero nest. For the first time, biologists were able to closely watch and record condor nesting behavior in the wild. Since that time, we have used cameras to monitor 11 of 35 condor nests. Six of the nests monitored with cameras have successfully fledged chicks (16 chicks in total fledged during that time).

What unique benefits did the technology add to your project?

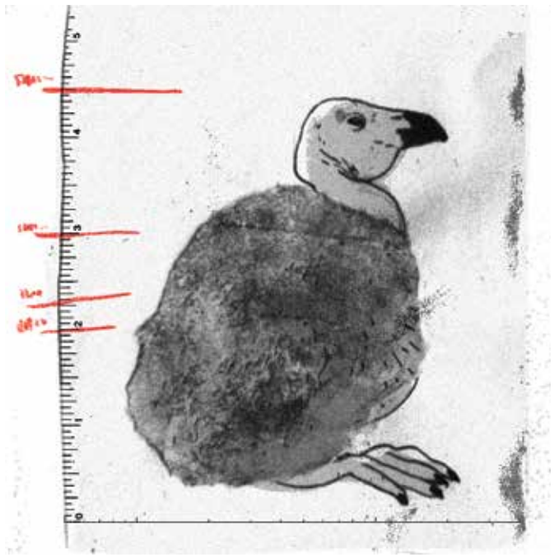
Camera systems have provided us with a much more detailed and efficient way to monitor condor nests in the wild. Previously, biologists would spend hundreds of hours watching nests over the course of the breeding season, and they could only do this from hundreds of meters away using a scope. With the cameras, we have a record of all daylight hours at each nest; observers only watch for a few hours every few days and can quickly review footage at an increased frame rate in less than an hour. We also no longer need to disturb the birds at the nest by visiting in person. Ultimately, while it does take a lot of work to set the cameras up, we end up using a lot fewer resources—and recording much more detailed data—than when monitoring the nest directly in the field.

Thanks to our partnership with the Cornell Lab of Ornithology, the camera has also been an incredible outreach tool. We approached the Lab in 2013 with the hope of streaming one of our nest cameras live on their website (allaboutbirds.org/condors). This required some additional funds and the introduction of infrastructure capable of connecting the nest camera feed (in a remote site) to a location 20 miles away that had the capacity to upload the footage to the Internet. We were finally successful in 2015, when we were able to broadcast a live stream of a condor chick that was four months old. In 2016, we were able to start our live stream much earlier and viewers were able to watch a condor egg hatch in the wild; audiences have since been following the development of a condor chick that is now very close to taking its first flight.

Many hundreds of thousands have now had the opportunity to observe condors as they nest and interact with their young. It has been incredible to see people's reactions change as they begin to develop a connection with condors. Being North America's largest vulture (and largest land birds), condors might not be the easiest on the eyes, but they make up for their looks with comical and endearing personalities.

Do you have plans to continue using this technology?

We will continue to use cameras for monitoring nests and as an outreach tool. We may try using different styles of cameras and power systems to improve our view of the nests. We also may use IP cameras to help us with other types of monitoring; for example, cameras could be used to observe the behaviors of captive-reared condors that are held in our flight pen



for a time before they are released into the wild. We have also advocated for the use of nest cameras at other condor release sites.

Additionally, we have been able to provide technical advice to other researchers and conservationists who have approached us in the hopes of setting up cameras to monitor other bird species, such as white pelicans, seabirds, grasshopper sparrows, and golden eagles.

What are the greatest conservation benefits of using the camera technology?

The work that we are doing proves that camera technologies can be used as a tool for endangered species management. The remote and less intrusive form of monitoring that cameras allow could be used in a variety of applications to better understand specific threats to particular individuals, species, or habitats.

In terms of our particular project, the footage we collect is influencing condor management decisions in real time. It has allowed us to prevent nest failure in a number of ways. We have rapidly detected egg predation such that we were able to substitute a missing egg with a captive-laid egg so that the wild nest could continue. Cameras have also allowed condor chicks that were treated for injuries to remain in the nest rather than be held captive, since the cameras allow us to monitor their recovery closely. For example, we had a chick with a broken bone in its foot; a consulting veterinarian could inspect our footage remotely rather than disturbing the chick and/or taking it into captivity.

Nest cams aside, what else should people know about the condor project?

While we are managing nests to increase the number of condors produced by the wild population, the leading impediment to recovery in condors is mortality from lead poisoning. Condors are exposed to lead by ingesting the remains of animals that have been shot with lead ammunition. We are doing a lot of work to educate the hunting and ranching communities about the impacts of lead ammunition and how making the switch to a non-lead alternative can provide an uncontaminated food source to condors and other scavenger species. For more information about those

efforts, please see huntingwithnonlead.org, a website managed by our partners at the Institute for Wildlife Studies.

We also are reaching out to schools with award-winning curriculum called CondorKids (condorkids.net). We will soon be rolling out an educational tablet-based game called Condor Country (condorcountrygame.com). Both target youth who might not otherwise be exposed to conservation efforts such as the California Condor Recovery Program, with the goal of connecting them to the natural world and teaching them about the importance of endangered species conservation. While the condor program has many partners, The Santa Barbara Zoo has partnered with us on these educational projects, our Facebook page (Condor Cave), and the condor field program in Southern California.

We also produce a comprehensive annual report of our condor field program, and this is available online at https://www.fws.gov/uploadedFiles/Region_8/NWRS/Zone_1/Hopper_Mountain_Complex/Hopper_Mountain/Sections/What_We_Do/Conservation/PDFs/2015_Annual_HMNWRC_Condor_Field_Report_Final_24AUG2016.pdf.

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Illustrations: Prabha Mallya

Old threats continue to drive biodiversity decline

Agriculture and overexploitation of species continue to drive the decline of biodiversity, according to a study published in the journal *Nature*. The authors analyzed threats facing more than 8,000 near- threatened and threatened species listed on IUCN red list.

"Quantifying the relative prevalence of biodiversity threats is important because it can help guide discussions and resources towards the biggest threats," says the lead author, Sean Maxwell of the University of Queensland, Australia, in an email.

Maxwell says the study was motivated by pure curiosity, "to actually quantify the relative prevalence of more traditional threats."

The team, comprising researchers from the University of Queensland, the Wildlife Conservation Society (WCS) and the IUCN, found that three-quarters of the assessed species were threatened by over-exploitation such as hunting, logging and fishing at rates that cannot be met by reproduction or regrowth.

The Sumatran rhinoceros, Western gorilla, Chinese pangolin—three of more than 2,700 species— are hunted for their meat and body parts or for pet trade; illegal logging is contributing to the decline of more than 4,000 forest-dependent species, such as the Bornean wren-babbler and the Myanmar snub-nosed monkey. Above sixty percent of the species, the study says, are threatened by land converted to growing food, fodder, fuel crops, livestock, and aquaculture.

The species include Africa's cheetah, Asia's hairy-nosed otter, and South America's huemul deer are among more than 2,300 species affected by livestock farming and aquaculture. Land-conversion for growing food, fodder or fuel crops is affecting species such as the Fresno kangaroo rat and the African wild dog, two among more than 4,600 species facing a similar threat. Human-induced climate change—whose effects include extreme temperatures, drought, flooding, and severe storms—is currently affecting less than 20 percent of species listed as threatened or near-threatened.

Hooded seals-one among the 1,688 species affected by climate disruption-fell by 90% in abundance in the northeastern Atlantic Arctic, the result of warming and consequent melting of regional sea ice over the past few decades and the lack of availability of sites for resting and raising pups.

Maxwell says that he is surprised at the prevalence of threats from over exploitation and agricultural activity,"Demonstrating that 72% and 62% of near threatened and threatened species are impacted by over exploitation and agriculture means that we need serious action to minimise the impact of these activities if we are to tackle the biodiversity crisis."

The paper, published a month before IUCN World Conservation Congress (1-10 September) in Hawaii, garnered great attention at the Congress, according to Thomas Brooks, a co-author of the analytical study and the head of science and knowledge at the IUCN.

Brooks says, in an email, IUCN deliberated on the theme mentioned in the paper. He adds that two out of three themes discussed in the Members' Assembly aligned with the most prevalent threats mentioned in the paper:"Conserving nature in the face of industrial agriculture","Preserving the health of the world's oceans", (which had a heavy focus on unsustainable fisheries) and the third theme,"building constituencies for nature".

These themes also feature heavily in the new IUCN Programme 2017–2020, he adds, and were dominant discussions in the Forum and the subject of much attention from the Resolutions process.

Although it's obviously very hard to tie a single specific publication to discussions and debates among more than 10,000 people over two weeks, Brooks says, his "overall impression is that the threats identified in the paper based on analysis of the IUCN Red List of Threatened Species as the most prevalent ones facing biodiversity were indeed the issues that received the greatest discussion at the Congress, along with invasive species, given, in particular, that invasives are such a prevalent threat on islands like Hawaii."

The most important outcome of the WCC is the establishment of a system for members to make pledges of what actions they intend to contribute to the overall IUCN One Programme 2017–2020,-the idea of operating IUCN's Programme as a"One Programme" dates back to 2011.

"This is the first time that Members have been able to document their planned actions towards the Programme,"Brooks says.

This innovation, he thinks, will be a great step forward in understanding the extent and impact of conservation in addressing threats to biodiversity, and thus what the gaps are and how they can be filled.

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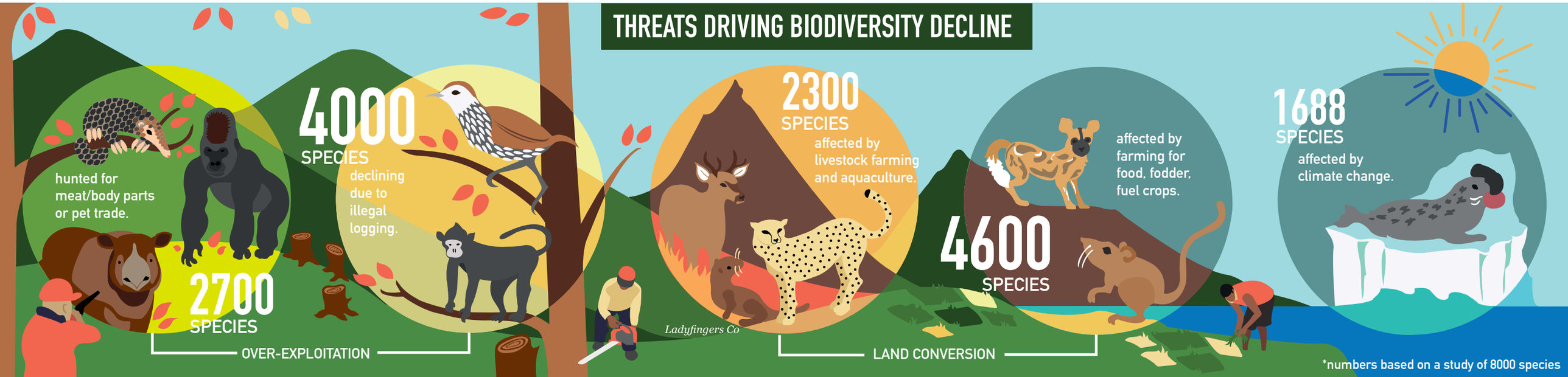
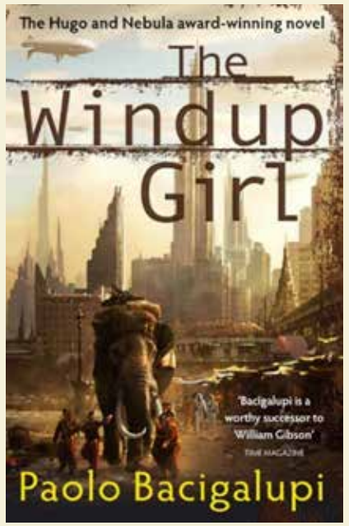
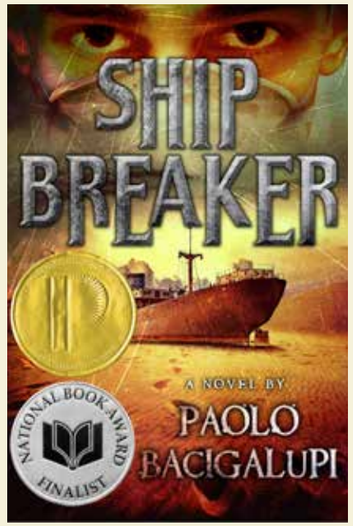


Is today's fiction tomorrow's reality?



The Windup Girl
by Paolo Bacigalupi

ISBN-13: 978-1597808217
Night Shade Books



Ship Breaker
by Paolo Bacigalupi

ISBN-13: 978-1907411106
Little, Brown Book Group

The Water Knife
by Paolo Bacigalupi

ISBN-13: 978-0356502120
Little, Brown Book Group

Many writers have described seemingly far-fetched inventions that eventually leapt off the pages of a manuscript and became a reality. E-readers, closed circuit television, credit cards, universal translators, and "smart" homes are all good examples of real-life tools that had their start in fiction. In some cases, the authors' imaginative ideas anticipated the technological and social developments that would lead to innovation; in other cases, inventors were inspired by what they read and worked to make those literary products and processes a reality. Either way, this is a powerful example of how fiction can help readers to envision and connect with the idea of astounding new objects unlike anything in their own contemporary universe.

The collision of science and literary art has also had enlightening effects beyond the technological realm. For example, fiction has helped readers learn about and consider the ramifications of genetics (as in Michael Crichton's *Jurassic Park* and Guillermo del Toro's and Chuck Hogan's *The Strain series*), computing (as in Robin Sloan's *Mr Penumbra's 24-Hour Bookstore* and Neal Stephenson's *Snow Crash*), and astrophysics (as in Cixin Liu's *Remembrance of Earth's Past* trilogy).

One field that has been surprisingly absent to date is conservation science and its ecological underpinnings. There are certainly stories with pro-nature themes—Barbara Kingsolver's *Prodigal Summer* uses the character of Deanna Wolfe to send the message that top carnivores should be treasured rather than hunted; Laline Paull's *The Bees* takes a stand against pesticide use and the over-development of urban spaces; EO Wilson's *Anthill* is both a blatant indictment of destructive human activities and a rallying cry for conservationists.

These narratives, however, occur in our own, familiar world—unlike science fiction stories, which tend to plunge the reader into more unfamiliar settings by sending them off to the future, out into space, or onto an entirely different planet. There is something powerful about that total immersion, which can force readers to grapple with focal issues and ultimately lead to a more visceral response to, and connection with, the material. Surely this is exactly what is needed to generate a sense of urgency about the environment.

The potential of this technique is on full display in the work of Paolo Bacigalupi, who is best known for the Hugo Award-winning *The Windup Girl* (2009), The Locus Award-winning *Ship Breaker* (a young adult novel, 2010), and his most recent publication, *The Water Knife* (2015). Bacigalupi's settings are dystopian, resulting from environmental degradation caused ultimately by human greed and an unwillingness to admit and respond to the reality of incipient environmental disasters.

The Windup Girl explores the impacts of sea-level rise, fossil fuel depletion, and misuse of biotechnology. Bacigalupi imagines the miserable weather conditions that would prevail in a much warmer 23rd Century, and the infrastructure that might be required to keep this hotter, wetter nature at bay. He explores possible alternative sources of energy and ponders the nearly nonstop deluge of disease we might face if we create a world filled with homogeneous agricultural crops and antibiotic-resistant diseases. Global warming and inundated coastlines are also a feature of *Ship Breaker*, which, among other things, questions what type of economy might arise when humans must revert to an almost Neolithic survival mode in the wake of extreme ecological disaster.

Bacigalupi's most recent novel is set in an imagined future that is as dry as the others are wet. *The Water Knife* takes place in the American Southwest in a not-too-distant future when residents can survive only in "Arcologies", which are apartment complexes that act as perfectly calibrated ecosystems carefully recycling and reusing that most precious of resources: water. The complex plot is based on the actual geological, hydrological, and climate conditions in the Colorado River basin, and considers the impacts of politics and policy on the environment—and vice versa. The arcologies that Bacigalupi describes may not be in existence today, but are certainly the ultimate goal of the sort of sustainability architecture advocated by real-life organisations such as the Building Research Establishment (BRE). Bacigalupi's characters drink from "Clearsacs", which filter urine so that it can safely be consumed as clean water—not dissimilar from actual technology that has been developed for American astronauts living on the International Space Station.

Each of these novels is primarily about people: what they believe, how they react to different situations, how they interact with each other, what they are capable of. These things can, of course, be explored in any fictional setting but are particularly poignant in the context of a hypothetical future ecological disaster because most readers will recognise that we are, in real life, standing on the brink of such a disaster *right now*. Bacigalupi's descriptions—whether of an agricultural crop succumbing to a devastating pestilence, or a corporation greedily acquiring natural resources at any cost, or of regular people refusing to help each other in times of crisis—are all too familiar. The books may be fiction, but they are, quite obviously, based on truths.

The horror of Bacigalupi's imagined futures is strikingly well realised and is, therefore, both memorable and motivating. Within a few chapters, readers are likely to find themselves monitoring electricity and water use, rethinking what they buy in the produce aisle, appreciating the biodiversity

outside their windows, donating to a conservation group. The worlds in which Bacigalupi's fiction occurs are not places we ever want to find ourselves, and so it seems prudent to make better choices in our own world now. It doesn't hurt that the stories have intricate plots, excellent pacing, and realistic characters; these features just draw the reader even further in and make the events of the books all the more compelling.

Conservation-minded authors should consider taking a page out of Bacigalupi's book—no pun intended—in order to better help readers comprehend what scientists really mean when they raise warnings about environmental issues. Rather than talk about how many metres the sea level might rise, create a fictional world in which that has happened and think about what it would be like to live there. Instead of saying that invasive species are pushing out ecologically important natives, describe a future where invaluable ecosystem functions are missing and consider how humans might have to deal with the resulting stresses. When people are drawn in and can imagine themselves in those circumstances, the implications suddenly seem much more real—plus there is always the chance that a creative writer could come up with a solution that can be implemented in reality.

It may seem a bit far-fetched to suggest that literature could have a noticeable impact on public opinion and policy, but there are precedents. Zombie apocalypse stories such as *The Walking Dead* have sparked discussions about serious issues like morality and the meaning of civilisation, as well as prompting people to learn a few survival skills and stock up on canned goods "just in case". As these stories have increasingly captivated the public imagination, zombie apocalypse scenarios have been run by public health officials practicing for major disease outbreaks, and by epidemiologists modelling transmission patterns.

If authors created equally engrossing tales about environmental apocalypses, might that open more dialogues about the relationship between humans and nature, and perhaps lead to greater awareness and more eco-friendly behaviours? Could it help readers better visualise a world with harsher weather, fewer ecosystem services, and less natural beauty?

Bacigalupi's canon suggests the answers to these questions might just be "yes". Writers, consider this your call-to-pens.

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