



END GAME ANTHONY D. BARNOSKY and ELIZABETH A. HADLY TIPPING POINT FOR PLANET EARTH?

**'Eloquently lays out the ecological perils
we face ... Now we know the challenges
for the 21st century; we just need to act'**

NEW SCIENTIST

Professor Barnosky

**End Game: Tipping
Point for Planet Earth?**

«HarperCollins»

Barnosky P. A.

End Game: Tipping Point for Planet Earth? / P. A. Barnosky —
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overconsumption / population growth / dwindling resources / climate change / disease / contamination / storms / thirst / war ... will the struggle to simply stay alive become humanity's future rather than its past? What happens when vast population growth endangers the world's food supplies? Or our water? Our energy needs, climate, or environment? Or the planet's biodiversity? What happens if these all become critical at once? Just what is our future? In 'End Game', world-renowned scientists Anthony Barnosky and Elizabeth Hadly draw on their work to explain the growing threats to humanity as the planet edges towards a resource war for remaining space, food, oil and water. And as they show, these wars are not the nightmares of a dystopian future but are already happening today. They explore the origins of Ebola in densely populated areas of south-eastern Guinea, witness raging fires in Yellowstone and Colorado and explain how drought-induced food shortages are already causing problems in the Sudan, Gaza Strip and Iraq. Finally, they ask: at what point will inaction become the break-up of the intricate workings of the global society? The planet is in danger now, but the solutions, as Barnosky and Hadly show, are still available. We still have the chance to avoid the tipping point and to make the future better. But this window of opportunity is closing fast and will shut within ten-to-twenty years. 'End Game' is the call we need.

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**ANTHONY
AND ELIZA**

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Tipping Poi

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'Tipping Point for Planet Earth', by Cheng 'Lily' Li

Dedication

To our parents, Emma & Michael Barnosky and
Jane Grassman Hadly & William McKell Hadly,
whose work to make a better world, each in
their own way, made us who we are.
And to our daughters, Emma and Clara,
who carry on with the future.

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Introduction

The Journey

This is a story of a journey. Like most journeys, it started out as a personal quest, but for us it has also been a professional one. It began when we were young scientists, driven mostly by curiosity and looking for the next big adventure. We found adventures aplenty, because our jobs as palaeoecologists – people who study how our planet changes through time – took us to remote places all over the world. Along the way we fell in love and got married, and then the personal and professional adventures started inexorably to intertwine. We had one daughter, and a few months later got her a passport and hopped a plane to Australia. Then another daughter, same routine, but this time it was six weeks in Patagonia. By the time our kids were two-year-olds, they'd spent many nights in wilderness tents with us, buried their fingers in koala fur, been carried on our backs as we forded waist-deep rivers and stared down grizzly bears, and fallen sound asleep in their snugglies as we skied back-country trails. By the time they were fifteen, they had their own list of exploits: they'd hunkered down in their own tent as lions paced through camp, taught our graduate students the Latin names of various species, trapped rodents in Patagonia, faced off angry rattlers in the Oregon desert, and watched grapefruit-sized chicken-eating spiders lead around their hundreds of young on a dark Amazonian night.

By now we've travelled to every continent in the world, save Antarctica; sometimes together, sometimes alone, sometimes with our daughters, sometimes not. All those trips were research expeditions as well as adventures, each of them undertaken to learn something about how nature worked in the places on which we hoped humans had not yet laid a heavy hand. And we did discover answers to some of the questions we were asking – like how animals respond to climate change that isn't caused by people, what causes mass extinctions, how ecosystems are assembled, and how evolution works at the genetic level to keep species alive.

But we also discovered that as the years went by and the personal and professional experiences added up, the questions we were asking ourselves began to change. From the personal perspective, the more different places we visited, the more they seemed the same in a very important respect: the values that people hold dear. Eventually we came to understand that the basic wants, needs and emotions that draw people together are much more deep-seated than those that separate cultures and countries. It didn't matter whether we were with the native Inupiat in an Arctic fishing village, with an indigenous tribe in the jungle of Peru, with scientific colleagues in India, or with executives imbibing at a fancy hotel in one of the great cities of the world. Everyone seemed united in wanting a healthy, comfortable life, putting family and friends first, and in the joy they took in basic pleasures like a good meal, a good laugh, or a pleasant stroll through a pretty place. And without exception, no matter the religion, the country, the political views or the economic class, everyone wanted the best for their children, and hoped that as their sons and daughters grew up, the world would just get better and better. As we watched our own daughters grow up, listening to their own dreams and hopes, we realised that we were no different from anyone else in those respects. Adventure and curiosity were no longer the be-all and end-all; giving our kids, and everyone else's, the future they deserve became much more important. And our lives in science began to change.

The more we saw, the more our professional perspective shifted. At some point the individual expeditions came to seem more and more like beads on a string, each bead distinct, but when all were taken together, forming a pattern that was hard to miss. And the pattern was that the world was changing before our eyes, much faster than any past changes we were familiar with from our studies of the deep-time history of the planet. Much of our earlier work had revolved around climate change before people got in on the act, so we knew what pace and magnitude of warming temperatures could be considered normal in the planet's history, and there was no doubt about it: what was happening today was way too much and way too fast. Likewise, we'd worked hard to figure out why species died out in the past, and what normal levels of biodiversity should be, both in terms of numbers of species

and their genetic diversity. Again, the losses we were seeing now – from giant otters in Amazon lakes, to wild dogs in Africa, to amphibians in the Rocky Mountains – were way too many.

We started to wonder, long and hard, about what exactly was driving the unusual and rapid changes that were happening all over the world. We knew, of course, the broad brush of the answer: people. The ecologists whose articles we had studied and who we now worked with on a daily basis were more senior than us, and had been publishing research about how people were changing the planet for decades. In some cases they had been reaching out and trying to spread that message to the world. But reading it in a scientific journal or book, or hearing about it in a professional presentation, didn't resonate at the gut level as much as it should have. Yes, we knew we'd been born into a world that held fewer than three billion people, and that as we progressed through our lives and careers, that number had more than doubled. But like most people, we'd also grown up in a world of limited horizons that made it pretty hard to observe first-hand the connection between more people and planet-sized changes – Tony was born into a poor working-class family in small-town Colorado and never saw much else until well into his twenties, and Liz grew up as a military brat, moving from one army base to another every couple of years, each one looking very much like the next, albeit in many different states and different countries. But eventually we began to connect the dots from all the places we'd travelled to in our careers, and we saw the links between the added billions of people in our lifetime, and hunger, poverty and unhappiness.

Through the years we also saw how it was getting harder and harder to find places that felt they hadn't been changed in a big way by people. The haze from faraway cities or power plants or wildfires would often obscure our view, even when we thought we were in the middle of nowhere. On our plane journeys from one part of the world to the next, the features we saw on the landscape below were usually farms and pastures, unless they were barren desert, open ocean or rough mountainous terrain. On night-time flights, the lights from cities and highways seemed to spread out below us everywhere. When we started compiling some numbers, we knew why: almost 50 per cent of Earth's land has been changed from forests and prairies to farms and pavement. That meant that each person on Earth requires about two acres of land, on average, to survive, given current diets, expectations and ways of doing business. We realised that the ratio of used land to people can't keep up for very much longer, given how fast we're adding human bodies to the world, and that we've already used up nearly all the good land.

As more years went by, we did more research, and we found that the number of humans and their domestic livestock on Earth now is about ten times higher than the planet could support before we – people – discovered how to increase its carrying capacity for big animals, including us, by mining fossil fuels from the ground. We watched HIV/AIDS take the world by storm, and realised that new diseases can, and do, crop up to kill us, and can change things as basic as people's sex lives. We went into the jungles of Costa Rica and found out that as far as disease goes, HIV/AIDS is not unusual in being transmitted from wild animals to humans, and that such transfer of disease happens more frequently as more people, looking for places to live and make a living, take over rapidly diminishing areas of wild lands.

All of these things made us wonder, just what was the future up against? It didn't help that in recent years we read seemingly ever more often about conflicts and genocides that were springing up around the world, many of them triggered by scarcities in such basics as food, water or oil. We knew about wars from our growing up – in elementary school, duck-and-cover drills, which amounted to hiding your head so you wouldn't see the nuclear bombs fall before they vaporised you, were an ingrained part of the routine. We dodged that bullet, but not the Vietnam War – Liz's dad did two tours of duty, and our generation lost friends there. Nobody wants that for their children. And then came the ever-present crises in Africa, the breakup of Yugoslavia and the USSR, 9/11, Iraq, Afghanistan, Ukraine, recurrent Israel–Palestine tensions, and now the rebel Islamic State. Was the world going into a downhill slide?

We grasped that, strange as it would have seemed to us when we started out as palaeoecologists, the kinds of data we had spent decades examining held the answer to that question. At that point our lives and careers, as lives and careers do, took an unlikely turn. About the time we were pondering the magnitude of current global changes and how they compared with those past, along came one of the most exciting and revolutionary realisations in ecology in recent years: that what we like to think are gradual environmental changes in fact turn into sudden ones that we don't expect. In popular parlance, these are tipping points, and they happen because, in all walks of life, gradual change accumulates slowly until it hits a certain threshold, and then all hell breaks loose. We saw that in our own lives, when we fell in love – a gradually developing friendship, and then, boom, things suddenly changed forever, luckily in a good way. The sudden changes can just as easily be bad, though – like the death of a loved one, which also changes lives forever. On a larger scale, ecologists and theoreticians now know that sudden tipping points are not unusual in biological systems of all scales – think about a lake going overnight from clear, clean water to green algae scum, once the water reaches a certain temperature and nutrient load.

As we reflected on our palaeoecological research, we realised that we'd actually seen the entire Planet Earth hit tipping points before. Times like sixty-six million years ago, when an asteroid struck the planet and acted as the coup-de-grâce in killing three out of every four of the species known at the time. Or twelve thousand years ago, when the one-two punch of natural climate change and growing human populations wiped out half the big-bodied animals on Earth, at the same time that it went from a cold planet largely covered in ice to the warmer one we know today, which then fostered the growth of human civilisation.

Those past tipping points made us sit up and take notice. Since it has happened before, could Earth be headed for yet another planetary tipping point? And if so, just what does that mean for our children, and for theirs? Or, for that matter, given the lightning speed at which we have seen the world change, what does it mean for our own future?

We've now spent a few years, along with many other scientists, trying to answer those questions. And what we've discovered has surprised us: first dismaying us, and then giving us hope. The dismay is that if we keep on with the way we've been doing things, it is inevitable that the world will soon tip into a permanent state that is worse than what we are used to now. That end game will not be one we want for ourselves, and certainly not one we want for our children. The hope comes from learning that there are feasible ways to change the future, heading it towards an end game with the outcome of a better life, a better world – but only if we, as in all of us, act fast.

These things are what this book is about – our journey of discovery about ourselves, and about the planet we love. We hope that reading it will be a journey for you as well, one that ends in your own personal tipping point, where you comprehend that you really do have the power to change the world.

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