

CUMULATIVE IMPACTS: DEATH KNELL FOR COST-BENEFIT ANALYSIS

[Rachel's introduction: The impacts of our various economic activities are now adding up to a damaged world -- a world in which Earth's natural capacity for self-renewal has been exceeded and permanent degradation is evident. Our legal and regulatory systems were never intended to limit the accumulation of small impacts. Instead, U.S. law relies on cost-benefit analysis to justify individual impacts -- a practice that is now obsolete because it is destroying the planet as a place suitable for human habitation.]

By Peter Montague

In the beginning, planet Earth seemed limitless. Yes, humans could see that they were making big changes locally -- hunting the woolly mammoth to extinction, for example, or permanently altering forest ecosystems with fire. However, for eons there was never a hint that humans could become a force of geologic proportions, capable of diminishing the entire planet's capacity to sustain human life. Then in 1864 George Perkins [Marsh](#) published **Man and Nature**, subtitled "Physical Geography as Modified by Human Action," the first scientific study of accumulating harm.

In the U.S., "environment and health" only became a public issue in the [1950s](#), starting with cancer-causing food additives and radioactive fallout from A-bomb tests. In 1962, Rachel Carson's book **Silent Spring** described widespread effects from pesticides, offering evidence that humankind was damaging whole ecosystems.

Congress passed the Water Quality Act in 1965 because people knew something was wrong when they saw rivers covered with mounds of foam (from detergents). Even more people started paying attention when the Cuyahoga River caught fire in Cleveland in 1969.

In 1970, M.I.T. Press published [Man's Impact on the Global Environment](#), which estimated that the total human "load" on the natural environment was increasing 5 to 6% each year -- thus doubling every 12 to 14 years. (By this measure, since 1970 the total human impact on the global ecosystem has increased somewhere between 7-fold and 10-fold. At these growth-rates, by

2050 (just 41 years from now), if nothing changes, the total human impact will have grown another 7- fold to 10-fold beyond where it is today. Can you image such a world?)

Public concern, validated by scientific information, forced Congress to pass more than a dozen new national laws in the 1970s, intended to limit specific harms to the environment. But those laws were not designed (or intended) to control the cumulative effects of many small environmental impacts.

As time passed, harm to the natural world grew more ominous and a few scientists and legal scholars began to nibble around the edges of this "cumulative impacts" problem. However, only in the past 2 years have we seen a real breakthrough in analysis -- thanks chiefly to the work of [Joseph H. Guth](#), a biochemist and lawyer, and his colleagues at the [Science and Environmental Health Network](#), where Guth serves as Legal Director.

Acknowledging the problem

In his 1980 book, [Overshoot](#), William Catton, Jr., wrote, "Infinitesimal actions, if they are numerous and cumulative, can become enormously consequential." [pg. 177] And he noted that, by 1973, "The world was becoming a place wherein actions that used to be quite harmless to others became harmful to all of us." [pg. 59]

This is the essence of the "cumulative impacts" problem. Actions that are tolerable or even harmless at the individual level can degrade the planet if thousands or millions of people do them. One person fertilizing a lawn near the Chesapeake Bay makes no real difference -- but when thousands do it, the Bay is degraded and the storied blue crab begins to [disappear](#).

People routinely cut down forests and woods, displacing habitat for wildlife to make space for crops and domestic animals. One small farm makes no difference, but in 1986 [Peter M. Vitousek and others estimated](#) that the world's human population (then 4.9 billion) was appropriating for its own use 40% of net primary productivity from Earth's total available land. Net primary productivity on land is the mass of plant material produced each year by photosynthesis using energy from sunlight; it is the total food resource for land-based life. (There is also net primary productivity in the oceans; if you include this, then humans in 1986 were appropriating 25% of total global net primary productivity, Vitousek estimated.)

Vitousek did not extrapolate into the future, but his finding meant that humans would appropriate 100% of net primary productivity from land when their numbers grew just 2.5-fold, which will occur around the year 2050 at the current rate of population growth (1.3% per year) if nothing changes.

In 1991, two researchers at Oak Ridge National Laboratory in Tennessee examined 11 industrial chemicals [[5 Mbyte PDF](#)] that have contaminated the entire globe (PCBs, benzene, mercury, etc.). Using cancer risk estimates provided by U.S. Environmental Protection Agency (EPA), they calculated that the worldwide lifetime risk of cancer from just these 11 chemicals was one-in-a-thousand. They commented, "Current regulatory approaches for environmental pollution do not incorporate ways of dealing with global pollution. Instead, the major focus has been on protecting the maximally exposed individual."

This is an important point. U.S. risk assessments (used in conducting "cost-benefit" analyses) evaluate the danger of a single risk to a hypothetical most-endangered ("maximally exposed") individual. If the threat to that individual is found to fall within "acceptable" limits, then no regulation occurs and "acceptable" amounts of contamination can be released forever after. Then another risk assessment and cost-benefit analysis gives a green light to another "acceptable" release of contaminants. Then another and another. No one ever asks, "What is the total impact of all these 'acceptable' risks?" That is the "cumulative impact" problem in a nutshell.

Now Joe Guth has analyzed this problem and offered solutions in three scholarly papers[1,2,3], one of which has already been published (in the [Vermont Journal of Environmental Law](#)), and two of which are "in press" -- soon to appear in the [Barry Law Review](#)[2] and the journal [Transnational Law and Contemporary Problems](#). [3]

To me, the centerpiece of this triad is the paper, "Cumulative Impacts: Death-Knell for Cost-Benefit Analysis in Environmental Decisions," though **all three papers are essential reading.**

In "Cumulative Impacts," Guth lays out the problem in the opening paragraph:

1. We have always assumed that we could tolerate unlimited small increments of harm as byproducts of economic growth.
2. But now things have changed because numerous studies are telling us that the cumulative impacts of our economic activities are degrading the Earth's capacity to support humans.
3. Therefore, humans will have to abandon the use of cost-benefit analysis to justify individual environmental impacts and, instead, focus on limiting our cumulative impact to a sustainable size.

As evidence of cumulative harm, Guth cites the authoritative United Nations-sponsored [Millennium Ecosystem Assessment](#) (MEA)[4] -- a five-year study of the condition of the Earth's ecosystems, involving 1360 scientists from all across the globe.

When the Board of Directors of the MEA issued the first volume of the study [in 2005], they [said](#), "At the heart of this assessment is a stark warning. Human activity is putting such strain on the natural functions of Earth that **the ability of the planet's ecosystems to sustain future generations can no longer be taken for granted.**"[5]

Guth also cites the United Nations-sponsored Global Environment Outlook (known as [GEO-4](#)), published in 2007. The GEO-4 report concluded (among other things) that human activities now require 54 acres (22 hectares) per person globally, but Earth can provide only 39 acres (16 hectares) per person without suffering permanent degradation. We are living well beyond Earth's means.

(For additional corroboration, see Mathis Wackernagel and others, "[Tracking the ecological overshoot of the human economy](#)," Proceedings of the National Academy of Sciences (Vol. 99, No. 14, July 9, 2002), pgs. 9266-9271 and see the web site of the [Global Footprint Network](#).)

How did we get into this shape?

How did this happen? Joe Guth finds the answer in our laws, which are the rules by which society generally operates. If we want society to operate differently, we've got to change the rules, change the law.

Guth examines legislative law (laws passed by legislatures, such as the federal Clean Air Act and the Clean Water Act) **and** the common law (the body of law created by judges, such as negligence and nuisance). Guth finds that both bodies of law share similar goals and assumptions, and both assign the "burden of proof" in similar ways, which I'll explain.

Guth writes, "Our current property and environmental law,[6] including both federal statutes and the common law, is intentionally designed to promote unending growth in economic activity. It harbors the presumption that economic activity generally provides a net benefit to society despite any accompanying damage it may cause. Grounded almost invisibly in this starting presumption, most of our property and environmental laws permit interference with economic activity only where that starting presumption is proved false, that is, where a particular activity can be demonstrated to fail to provide a net benefit to society. These laws for the most part do not forbid damage to human health or the environment. Rather, even when fully enforced they permit protection of human health or the environment only where the benefits of doing so can be proved to outweigh the costs.... So it is that cost-benefit analysis has become the legal system's primary tool for deciding when economic activity may be regulated in the interest of protecting human health and the environment."

But there's more. As Guth has said, the law does not allow economic activity to be curtailed just because it is harming someone. The law will only allow an economic activity to be curtailed if a cost-benefit analysis shows that the activity is creating more harm than good. **And** the law puts the burden of proof on the harmed party, or on the government, to prove that costs are exceeding benefits before an economic activity can be curtailed or regulated. If the harmed party (or the government) cannot meet that burden of proof, the law defaults to its starting presumption: it allows the damaging activity to continue.

"This allocation of the burden of proof transforms doubt and missing information into a barrier to legal protection of human health and the environment," Guth writes. "This explains why industrial interests are rationally motivated under our legal system to invest in the manufacture and spread of doubt and confusion." [See David Michaels' book, [Doubt is their Product](#), describing an industry devoted to [manufacturing doubt](#).]

So, if information is missing, or there exists scientific doubt, then the law

presumes that an economic activity should continue -- even when the law acknowledges that harm is occurring. The default presumption is that the benefits of economic activity always outweigh the costs unless a specific cost-benefit analysis can show otherwise.

This explains why the environmental movement -- which has made truly heroic efforts since 1970 -- has been unable to stem the degradation of human health and the environment.

Another unspoken presumption of the law is that damage to human health and the environment can continue to grow forever. Guth shows this in in [Figure 1](#). The upper curved line in [Figure 1](#) represents endlessly growing benefits from economic activity. The lower curved line shows smaller (but also endlessly growing) legally-permitted harms from economic activity. The space between the upper line and the lower line is "net benefit" or "net social benefit" or "net social utility" -- it is the residue of good that remains after costs have been subtracted from benefits.

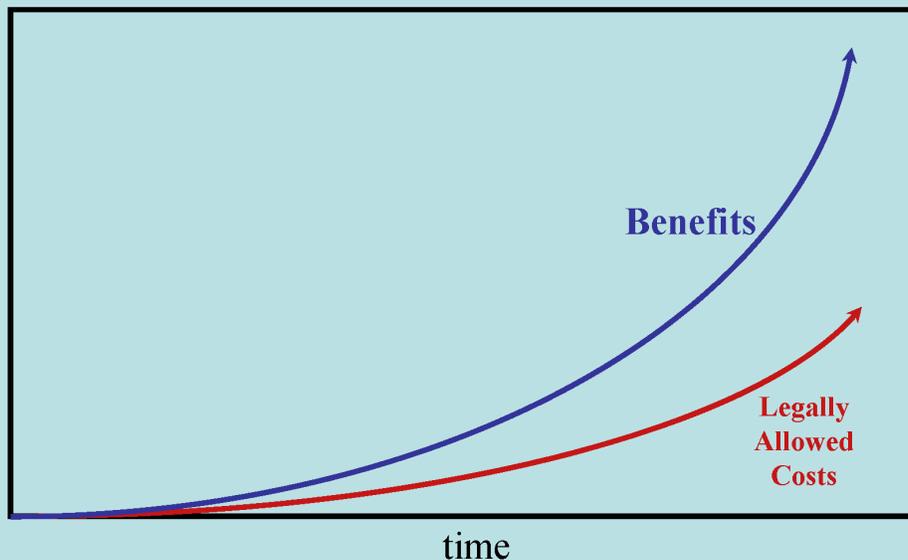
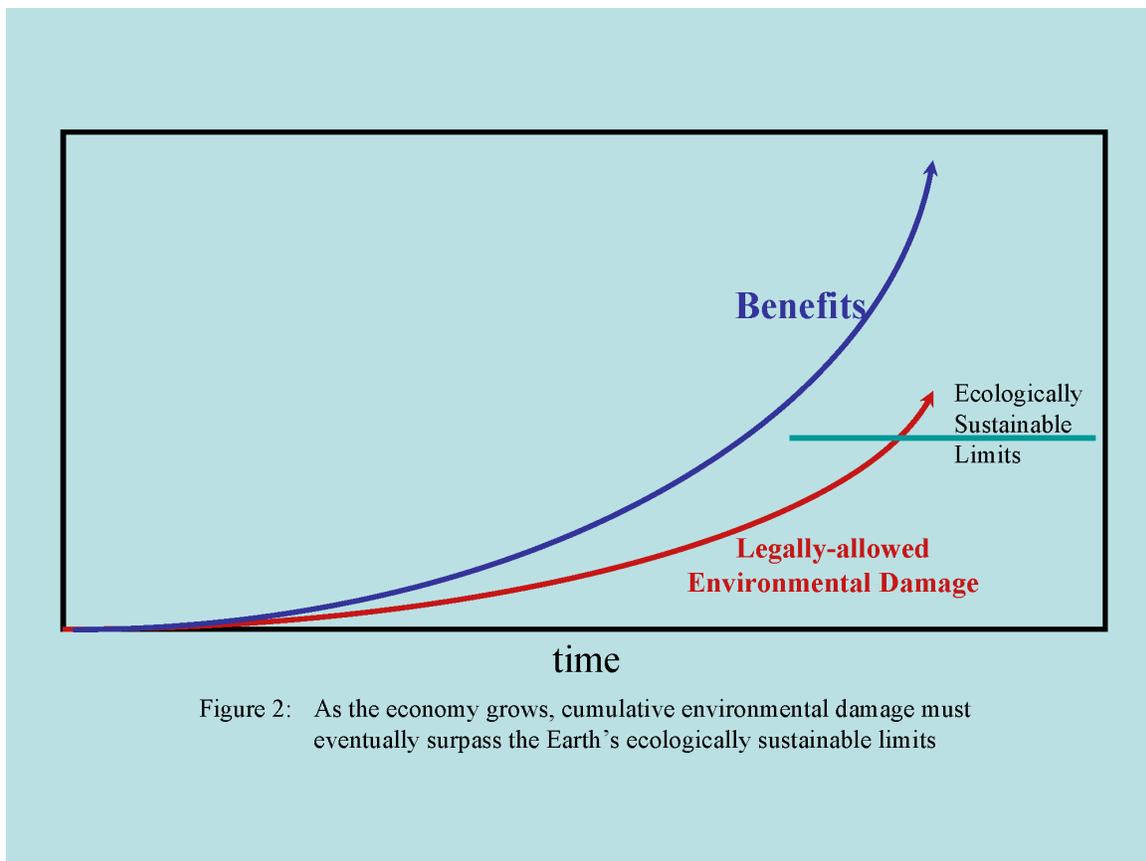


Figure 1: The law promotes all economic activity having a net benefit, allowing both benefits and costs to grow forever as the economy grows

The world is new: on our finite planet, ecological limits exist

What's been slowly dawning on people in the last 2 decades is that there really **are** limits on how much harm the Earth can tolerate. There are limits to the total costs the Earth can sustain before it is permanently damaged. The lower curved line in [Figure 1](#) (which you can think of as the growing human footprint), by growing without limit as the law assumes it should, will eventually make the planet unsuitable for human habitation. And since this planet is the only place that anyone has ever found in the universe that supports human life, the law is now allowing -- even promoting -- the destruction of humankind's only home.



Guth's Figure 2 includes a horizontal line that represents the ecological limits of the Earth -- the point at which the planet starts to be permanently degraded, the point at which human damage has exceeded the Earth's natural capacity for self-renewal. As Guth says, "This is a limit that our current legal system is utterly blind to." Our legal system does not acknowledge that such a limit exists.

Joe Guth continues, "Thus we see the fatal flaw inherent in our system of environmental decision-making. Routinely allowing all environmental impacts except those proved to fail a cost-benefit test, it permits those impacts to grow without limit even when their cumulative effect results in ecological overshoot. Many of these impacts occur not because they actually satisfy the law's cost-benefit test but because whenever we do not know enough, the law's default structure permits them to continue."

Importantly, Guth points out a fundamental flaw in trying to use cost-benefit analysis after we reach ecological limits: "Even [though] cost-benefit analysis can effectively evaluate impacts when we are far below ecological limits, it cannot do so once we exceed those limits. Each incremental impact, if taken alone in an empty world, might have caused cost-benefit-justifiable harm or even, in many cases (such as carbon emissions), no harm at all. But under conditions of ecological overshoot each incremental impact contributes to a total loss that is immeasurable. Indeed, the permanent loss of the ecological integrity of the Earth, since we need it to survive and prosper, might fairly be considered an infinite loss."

If you are going to suffer an infinite total loss, your cost-benefit analysis of each increment of damage ceases to have any meaning. Under conditions of ecological overshoot, cost-benefit analysis is a meaningless exercise and a diversion from what's really important -- shrinking the human footprint back down to a size that Earth's ecosystem can tolerate, learning to [live well below the horizontal line](#) in Figure 2.

Guth concludes, "To maintain the ecological integrity of the Earth, **we need a new decision-making structure designed not to promote endless growth in net benefits, but to accommodate the ecological limits of the biosphere**, the horizontal line of Figure 2." [Emphasis added.]

Summary: U.S. law is dominated by cost-benefit analysis

To summarize, then, Joe Guth has described how, in general, the law works (both statutory law and common law):

** Its goal is perpetual economic growth, even if some damage occurs as a byproduct

** It presumes that the benefits of economic growth outweigh any costs (or

harms) until someone can prove otherwise

** It places the burden of proof on anyone who wishes to curtail or regulate any economic activity, even a harmful activity, requiring them to prove that the harms outweigh the benefits. If such a showing cannot be made because of missing information, or scientific confusion or uncertainty or doubt, then the law presumes that the economic activity should continue.

** Seeking endless growth in net benefit, the law assumes that both benefits and costs can grow without limit. The law has no way to acknowledge that there exist ecological limits that sooner or later **must** be exceeded by the endless growth of cumulative costs (because the planet has a finite size), and which we exceed at the peril of making our only home uninhabitable for our species.

Federal laws contain a few limited exceptions (which I'll describe below) but, as Guth says, "Taken as a whole... the federal environmental statutes are not directed toward an overarching goal such as preservation of ecological integrity. Instead, with some exceptions, they are deeply committed to a highly fragmented, cost-benefit-driven evaluation of each individual action proposed by the government to protect human health and the environment."

The way our laws are written, government regulators are not allowed to take into consideration, or try to control, cumulative impacts.

Joe Guth continues: "These laws do not permit regulators broadly to take account of what is happening to the world around them. They embed regulators in a decision-making structure that may seem scientific but in fact is profoundly unscientific because it prevents them from responding to the ever more detailed findings by the world scientific community that we are overshooting the Earth's ecological capacities. Rooted in the assumption that ecological overshoot does not occur, our current statutes are incapable of containing the cumulative scale of ecological damage. Their approach to environmental protection is firmly based in the conception of the world as an empty one rather than as the full one that is in fact arising all around us. It is an approach that has become outdated because it is based on assumptions that are no longer valid."

Guth then discusses the common law, showing that modern liability doctrines -- both negligence and nuisance -- do not prohibit all harmful

impacts, but require the same kind of cost-benefit balancing that is pervasive in the federal statutes:

"Negligence and nuisance apply broadly to many different circumstances, including cases arising from damage to human health and the environment. These doctrines do not seek to prevent or impose liability for all harm to human health and the environment. Negligence, for example, places the burden of proof on damaged plaintiffs to demonstrate that defendants created an "unreasonable" risk of harm in order to make them liable for the damage they cause. "Unreasonable" is defined not as a moral principle, but in cost-benefit terms that compare the social utility of the particular challenged act to the risks of resulting harm...."

"Similarly, nuisance, the quintessential environmental [tort](#), now places the burden of proof on plaintiffs to prove that the defendant's intentional acts are 'unreasonable.' As in negligence, 'unreasonable' is defined explicitly by a cost-benefit test...."

By placing the burden of proof on those who are harmed, the common law "resolves cases of doubt and missing information in favor of economic actors, allowing their damaging activities to continue and rewarding confusion and ignorance," Guth writes.

All is not lost: a new decision structure is possible

With a new decision-making structure, we can learn to enjoy the fruits of modern technologies while living within the Earth's ecological limits.

This is where the [precautionary principle](#) fits in. Because we can never be certain exactly where the ecological limits lie, once we understand that we are approaching or exceeding those limits, there is only one way to avoid ecological overshoot: eliminate or reduce every environmental impact that we can. This means applying the precautionary principle to **all** activities, large and small, that cause an environmental impact:

- (a) shifting the burden of proof by assuming that every action that causes an impact on the Earth may be harmful unless proven otherwise;
- (b) always seeking, then choosing, the least-harmful alternative; and

(c) paying attention to consequences after decisions have been made, monitoring, looking for evidence of environmental harm, and being prepared to reverse course if necessary.

(d) This last requirement means we should favor decisions and courses of action that are [reversible](#), avoiding irretrievable commitments (such as the current coal-industry proposal to curb CO2 emissions by [pumping liquid carbon dioxide deep below ground](#), hoping it will stay there forever).

Hints of a new decision structure in some existing U.S. laws

In Section II of his "Cumulative Impacts" paper, Joe Guth argues that "Our legal system already harbors examples of decision-making structures that establish a principle or standard of environmental quality or human health and do not rely on cost-benefit balancing. **These examples... show that such legal principles or standards can enable the legal system to contain the growth of cumulative impacts.**" [Emphasis added.]

However, to succeed, Guth argues, we must apply these legal approaches broadly to our entire economy: "We must subject **all** our actions to a new decision-making structure designed to defend and maintain the ecological integrity of the Earth."

One of these approaches is to establish "environmental rights," as several states have done by amending their constitutions to give citizens an explicit right to clean air and water, for example. But Guth argues that judges typically balance "environmental rights" against other kinds of rights when they conflict, so environmental rights (like other rights) cannot be enforced to their full extent. "Establishing these kinds of [environmental] rights is a critical and valuable step, one that requires care if the rights are to be effective."

Meanwhile, as work to establish environmental rights "can and must continue," Guth argues, "both the common law and legislation are quite capable of defining and enforcing standards of environmental integrity and human health."

He then shows how U.S. common law in the 18th and 19th centuries (before the modern doctrines of negligence and nuisance were developed) was capable of controlling cumulative impacts. The older liability rule was

expressed (in Latin) as "*sic utere tuo ut alienum non laedas*" ("use your own so as not to injure another"). If your economic activities harmed your neighbor, you were liable for the harm regardless of what benefits your economic activity might provide to society.

"The principle of *sic utere tuo* was built around the presumption that material damage to property was socially undesirable, and it imposed a rule of strict liability without regard to the social utility of the interfering activity," Guth writes. In other words, there was no cost-benefit balancing in the older doctrine -- you could not harm your neighbor and get away with it by arguing that your actions created net social benefits. (In his published paper, "[Law for the Ecological Age](#)[1], Guth traces legal history, showing how the common law changed profoundly in the 19th century, from "*sic utere tuo*" to cost-benefit balancing.) Under "*sic utere tuo*" every economic actor who contributed to a demonstrable harm could be held liable for the cumulative results to which his or her actions contributed.

"Under rules of law that were focused on protecting defined interests [usable water in a river, for example], rather than on whether a defendant's acts provided a net benefit to society, the law was able to protect those interests from the cumulative impact of individually harmless acts," Guth says. He cites older cases in which businesses contributing small amount of toxicants to a river were held liable for the end result, which was a totally-polluted river. They were forced to stop contributing even small increments to the problem. Then, as industrialization increased, cost-benefit balancing was introduced, and economic actors were presumed to create "net benefits" and were allowed to continue polluting unless their pollution could be shown to fail the cost-benefit test.

Besides showing that profoundly different legal structures are possible, this history of U.S. property law reveals an important and encouraging fact: in the past, we have changed our law dramatically to suit the goals and circumstances of the times, so we can change it again.

Guth then offers some examples indicating that, in small ways at least, some federal environmental laws are beginning to address cumulative impacts of individual pollutants. He points to particular provisions in the federal Clean Air Act and Clean Water Act requiring the government to take into consideration total emissions of particular pollutants into air and water and then allocate those emissions among economic actors, holding the total

emissions of each particular pollutant within fixed limits. He points to the "cap" part of the "cap and trade" system created to limit sulfur emissions in the U.S. Acid Rain program. This "cap" puts a limit on cumulative emissions from large industrial facilities emitting sulfur.

Similarly, once a species is designated as "threatened" or "endangered" under the Endangered Species Act, government must prevent all actions that contribute to the demise of that species.

These are examples of federal statutes and early common laws that are able to control cumulative impacts, but they have been applied only to a few pollutants or impacts on species or common-law-protected interests, each controlled one at a time. They do not broadly seek to prevent ecological degradation as a whole.

A broad legal principle of preservation of ecological integrity

Ultimately, Guth argues, the law will need to expand this conceptual approach to define a broad legal principle of preservation of ecological integrity: "For in ecology we can discover how to evaluate ecological systems, what impacts the Earth can tolerate and what we need to maintain and protect from degradation," he says, acknowledging that it will not be simple or easy.

Some progress in this direction has already been made, he points out. The Swedish government has set 16 environmental quality goals that should be met and maintained for the foreseeable future, with many measurable benchmarks. The [Natural Step](#) organization has defined four principles of sustainability that aim to allow economic activity to occur within ecological limits. Various ecological studies and organizations have defined what constitutes "degradation" of an ecosystem. Much more work is needed, but we're not starting from scratch.

Joe Guth offers some new ideas of his own for how to restructure the law around a principle of preservation of ecological integrity. In his paper, "[Law for the Ecological Age](#)," Guth has proposed creating a new "ecological [tort](#)," a "legal rule of the common law that would presumptively impose liability for impacts on the environment that may contribute to ecological degradation."

He has also proposed a "[Model State Environmental Quality Act](#)" that "defines a threshold level of environmental impacts that would trigger placing the burden of proof on defendants, a definition of who should have standing to assert this rule of law, and a temporary affirmative defense for those engaged in a meaningful search for less damaging alternatives."

This does not exhaust the list of suggestions and proposals that Joe Guth briefly describes in his "Cumulative Impacts" paper. The more important point is that Guth's three papers have clearly outlined the specific ways the law will have to change if we are to reverse the slide (driven by cumulative impacts) toward ecological degradation and irreversible destruction of humankind's only home, planet Earth.

He has also excavated our legal history to show that, in the past, we in the U.S. have significantly changed our law in response to new social objectives and realities, and therefore we can do it again.

Joe Guth concludes,

"The American government and legal system bear a duty to respond to the rise of cumulative impacts. The growing human ecological footprint has made untenable the assumptions on which our current environmental decision-making structure is based. The central goal of property and environmental law must shift from promoting endless growth in costs and benefits to maintaining the ecological systems we need to survive and prosper.

"By adopting such a new goal, the law would transform the shape of the economy. If the law contains the permissible scale of cumulative environmental impacts, the economy would become one that continues to develop but accommodates rather than undermines the ecological systems our welfare ultimately depends on. Cost-benefit analysis might remain useful as we seek less damaging alternatives in a quest to reduce the scale of cumulative impacts, but it could no longer be used to justify limitless increments of ecological degradation."

Now it's up to all of us to decide how best to change the law, and then to get those changes made. The world is new -- because for the first time in human history the regenerative capacity of the Earth is being palpably damaged by the human economy. In this new world, many of our old assumptions,

attitudes, and goals are obsolete and getting in the way. But we can fix all that, so let's get to it. Survival is not negotiable.

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[1] Joseph H. Guth, "Law for the Ecological Age," Vermont Journal of Environmental Law, Vol. 431 (2008), pgs. 431-512. Available at http://precaution.org/lib/guth_law_for_ecological_age.20080601.pdf

[2] Joseph H. Guth, "Cumulative Impacts: Death-Knell for Cost-Benefit Analysis in Environmental Decisions," Barry Law Review, 2009. In press. http://precaution.org/lib/guth_death_knell_for_cba.081101.pdf

[3] Joseph H. Guth, "Resolving the Paradoxes of Discounting in Environmental Decisions," Transnational Law & Contemporary Problems Vol. 18 (Winter, 2009). http://precaution.org/lib/guth_paradoxes_of_discounting.090403.pdf

[4] Millennium Ecosystem Assessment -- a series of reports issued by the United Nations starting in late 2005, assessing the status of ecosystems worldwide, including (but by no means limited to) effects on human health. The work began in 2001 and involved 1360 scientists <http://www.millenniumassessment.org/en/Global.aspx>

[5] Millennium Ecosystem Assment Board of Directors, Living Beyond Our Means: Natural Assets and Human Well Being (2005). <http://www.millenniumassessment.org/en/BoardStatement.aspx>

[6] By "property and environmental law," Guth is referring to "all our laws that control the impacts people may have on the environment, both by altering their own lands and by externalizing impacts onto the lands of others, or of the commons."