Biodiversity: The Interplay of Science, Valuation, and Policy

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Biodiversity: The Interplay of Science, Valuation, and Policy

Report from the AIBS 2006 Annual Meeting

CHERYL LYN DYBAS

In recent years, policymakers have recognized the economic values associated with biodiversity; economists have found ways to incorporate values associated with biodiversity into economic thinking; and scientists have documented the variety of services that diverse ecosystems provide. Those present at the 2006 AIBS annual meeting had the opportunity to explore the diverse linkages among these fields.

More species exist in the fossil record than are alive on Earth today. For birds alone, for example, some 90 percent of species are now extinct. Habitat loss is now a major cause of extinction. Of the world's coral reefs, 20 percent have been lost and another 20 percent are endangered. More than 30 percent of water-loving tropical mangrove trees are gone.

Land converted for crops in the last half-century far exceeds acreage farmed in the 150 years between 1700 and 1850, according to the 2005 Millennium Ecosystem Assessment (MEA) report *Ecosystems and Human Well-being: Biodiversity Synthesis*. Between 1960 and 2000, the report states, the amount of water in reservoirs quadrupled. About three to six times as much water is stored behind dams as flows through rivers. "Virtually all of Earth's ecosystems have been dramatically transformed through human actions," the report continues. Half of the 14 biomes the MEA reviewed have undergone as much as a 50 percent conversion to human use.

The effect, as measured by the 2006 IUCN (World Conservation Union) Red List of Threatened Species, is stunning—the number of such species has reached an all-time high: 16,119. The ranks of those facing extinction now include familiar animals like the polar bear, hippopotamus, and desert gazelle.

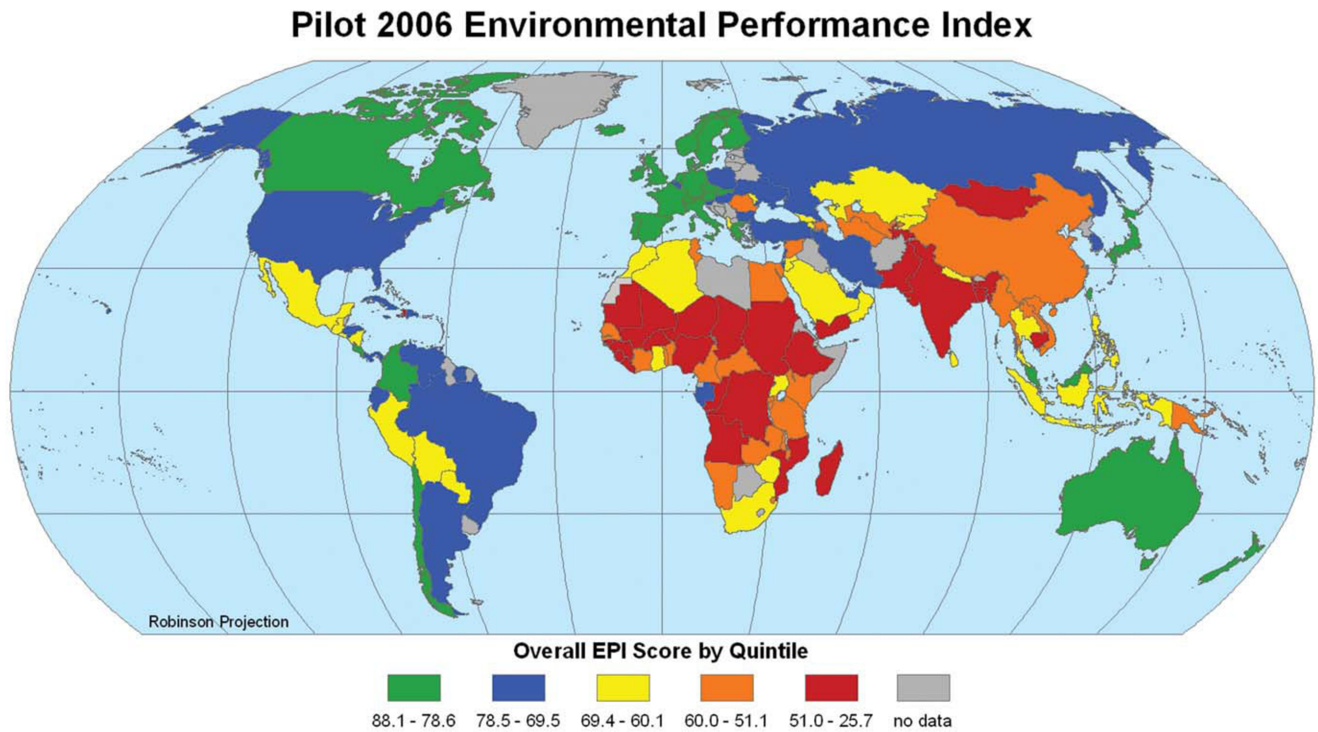
Biologists believe that mass extinctions have happened only five times in Earth's history, and that all arose from natural forces such as volcanic eruptions and meteor impacts. For thousands of years, though, humans have been landscape architects redesigning much of our planet's surface. Earth's new look, while meeting our requirements, is often in direct opposition to the needs of the fauna and flora displaced by our actions. The result? We're on the brink of a sixth mass extinction.

With this sobering thought, 300 scientists, economists, journalists, educators, and others met at the American Institute of Biological Sciences (AIBS) 56th annual meeting in Washington, DC, 24–25 May 2006. Central themes were communicating about science in public and policy arenas, valuing ecosystem services, the influence of science on policy and vice versa, and the value of monitoring and assessing biodiversity. Participants in plenary sessions, discussion groups, and an evening poster session sought ways to preserve Earth's biodiversity.

The language of biodiversity is undergoing a metamorphosis, all agreed. Biodiversity must move beyond the mere tallying of species numbers to a larger look at land and sea, habitat, and ecosystem health. These ideas echo those of Rachel Carson in her 1956 book *The Sense of Wonder:* "I think the value of the game of identification depends on how you play it. If it becomes an end in itself I count it of little use. It is possible to compile extensive lists of creatures seen and identified without ever once having caught a breath-taking glimpse of the wonder of life."

Understanding biodiversity

The term "biological diversity," from which the word "biodiversity" is derived, was coined in 1980 by conservation biol-



The Pilot 2006 Environmental Performance Index *(EPI) rankings allow comparisons of environmental health between countries worldwide and among relevant peer groups. The goal of the EPI is to provide a powerful analytic tool for improving policymaking. "I'm actually not that interested in whether the US ranks 28th or 50th or 45th," said Daniel Esty. "What I am interested in is drawing people into a conversation about why some countries are doing well and others not so well." Source: Yale Center for Environmental Law and Policy and the Center for International Earth Science Information Network (*www.yale.edu/epi*).*

ogist Thomas Lovejoy, now president of the H. John Heinz III Center for Science, Economics, and the Environment in Washington, DC. "Biodiversity" as a word developed in 1986 at the National Forum on Biological Diversity organized by the National Research Council, and it first appeared in print in 1988 when entomologist E. O. Wilson used it in the title of the forum's proceedings.

Since then, the concept has spread worldwide among biologists, environmentalists, political leaders, and concerned citizens. Its use has coincided with the growing concern about increasing rates of extinction.

Biodiversity has no single definition. There's genetic diversity, the diversity of genes within a species; species diversity, diversity among species; and ecosystem diversity, diversity at a higher level of organization, the ecosystem. The 1992 United Nations Earth Summit in Rio de Janeiro defined biodiversity as "the variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems, and the ecological complexes of which they are a part." This definition was then adopted by the United Nations Convention on Biological Diversity.

But an understanding of biodiversity is complicated by the fact that it's not evenly distributed on Earth. It's highest in the tropics and declines toward the polar regions, where larger populations of fewer species exist.

"Whether at the tropics or elsewhere, though, biodiversity has been instrumental in humans' success on Earth," said biologist Richard O'Grady, executive director of AIBS. "In turn, humans have affected biodiversity in major ways at all levels—genetic, species, and ecosystem." We need to reach a new level in our understanding of biodiversity, said O'Grady, one in which we take into account the many important biodiversity goods and services that provide us with ecological and economic benefits.

Commodities and consumers: The new biodiversity players

In his plenary presentation, resource economist and lawyer Daniel Esty, of Yale University's School of Forestry and Environmental Studies, asked one of the most important questions of the meeting: "What is the right measure of success with regard to protecting biodiversity?" Esty reviewed new approaches to environmental regulation in his talk, "From Science to Policy: Biodiversity Protection, Metrics, and Results."

He discussed the results of a report, *Pilot 2006 Environmental Performance Index* (EPI), published by Yale University's Center of Environmental Law and Policy; Columbia University's Center for International Earth Science Information Network; the World Economic Forum in Geneva, Switzerland; and the Joint Research Centre of the European Commission. The EPI identifies specific targets for environmental performance and measures how close the world's nations come

Jamie Rappaport Clark, former director of the US Fish and Wildlife Service, speaks with Robert Stanton, former director of the National Park Service, during a break in the talks. Stanton gave the diversity luncheon presentation, "Diversity in Resources Stewardship: An Imperative for Achieving and Sustaining Environmental Quality." Photograph: Carroll Photography.

to those goals. "It provides benchmarks for current pollution control and natural resource management results," said Esty. Issue-by-issue and aggregate rankings provide country-by-country comparisons.

The EPI centers around two environmental protection objectives: reducing environmental stresses on human health, and protecting ecosystem vitality. Efforts are tracked using 16 indicators in six policy categories: environmental health, air quality, water resources, biodiversity and habitat, productive natural resources, and sustainable energy.

"Top-ranked countries," said Esty, "like New Zealand, Sweden, Finland, the Czech Republic, and the United Kingdom, all commit significant resources and effort to environmental protection." The lowest-ranked countries—Ethiopia, Mali, Mauritania, Chad, and Niger—are developing nations with little capacity to invest in environmental infrastructure such as drinking water and sanitation systems, or aggressive pollution control and systematic natural resource management.

Where does the United States stand? In the Americas, Canada is the top-ranked nation at 84.0. The United States is fifth at 78.5. Lowest is Haiti at 48.9.

To put the US score of 78.5 in perspective, the European Union's scores ranged from Sweden's high at 87.8 to Belgium's low at 75.9. Many Asian and Pacific nations scored higher than the United States, such as Malaysia at 83.3, Japan at 81.9, Australia at 80.1, and Taiwan at 79.1.

What explains the differences? Wealth emerges as a major determinant of environmental performance, said Esty. "But at every level of development, some countries manage environmental challenges better than their peers, suggesting that policy choices and effort applied also matter." They matter a lot. Differences in governance explain a significant part of the variation in EPI scores, Esty believes.

"What should the metrics be if we're serious about protecting biodiversity?" Esty asked. Shouldn't we be focusing on ecosystem health, not on counting species?

How do endangered species fit in?

In March 2006, some 5738 biologists sent a letter to the US Senate about science in the Endangered Species Act. "With the Senate considering policies that could have long-lasting impacts on this nation's species diversity, we ask that you take into account scientific principles that are crucial to species conservation," the biologists wrote.

Richard O'Grady, AIBS executive director, with Judy Scotchmoor, 2006 AIBS Education Award recipient. Scotchmoor is assistant director for education and public programs at the University of California Museum of Paleontology in Berkeley. Photograph: Carroll Photography.

In her plenary talk, "The Endangered Species Act under Attack: The Dynamic Interplay between Science and Policy," Jamie Rappaport Clark, executive vice president of Defenders of Wildlife and former director of the US Fish and Wildlife Service, agreed that "getting science and policy to the church on time, and together, has never been more difficult."

Scientific research, she said, is sponsored by an ever-increasing diversity of interests and agendas, "making it more difficult for decisionmakers and the general public to distinguish the credible from the incredible." Policy challenges are increasingly complex and require expertise from a wider variety of disciplines, Clark believes. "It is unusual—in fact, almost doesn't happen—that we can rely on biological information alone to rescue an endangered species." We need to know the economic consequences, what various stakeholders think about achieving conservation goals, and how successful species recovery will be measured, she submits.

The "emergency room role" of the Endangered Species Act necessarily limits the science that is required through its mandates, said Clark. "Conservation science can sometimes confuse restoration and other entirely legitimate yet broader goals with the more narrow expectations and requirements of the ESA."

It's essential that both partners in the relationship to protect biodiversity—policymakers and scientists—"avoid being played against each other on the public stage or in the courts," said Clark. Otherwise "the relationship will become increasingly strained. And a divorce [between science and policy] is unthinkable.”

Discussions continue in the breaks between plenary sessions of the AIBS annual meeting. In the top photograph, plenary speakers Shahid Naeem and Stephen Polasky talk with AIBS past president Joel Cracraft; below, speakers Stephen Bocking, Richard Norgaard, and Daniel Esty converse during a break. Photographs: Carroll Photography.

Ecology with no apology

“Ecology with No Apology” is the slogan of biologist Shahid Naeem’s laboratory in Columbia University’s Department of Ecology, Evolution, and Environmental Biology. Naeem is the founder of BioMERGE (Biotic Mechanisms of Ecosystem Regulation in the Global Environment), a project whose mission is to bring scientists together to analyze data on Earth’s biota and determine how those data relate to ecosystem function. In his plenary talk, “Applications of Biodiversity Research to Human Wellbeing,” Naeem stressed the importance of scientists “working with one another to make biodiversity more relevant for environmental decisionmaking.”

Declining biodiversity, in Naeem’s view, either through local extinction or biological invasions, is the single most important problem in contemporary biology. “If you have the human genome [figured out], you can begin to understand very complex things about human beings and how they work,” Naeem said. “Well, we don’t even have a list of what or how much biota exists on the planet.” Through BioMERGE, Naeem and his colleagues are identifying how ecosystems are affected when biota change.

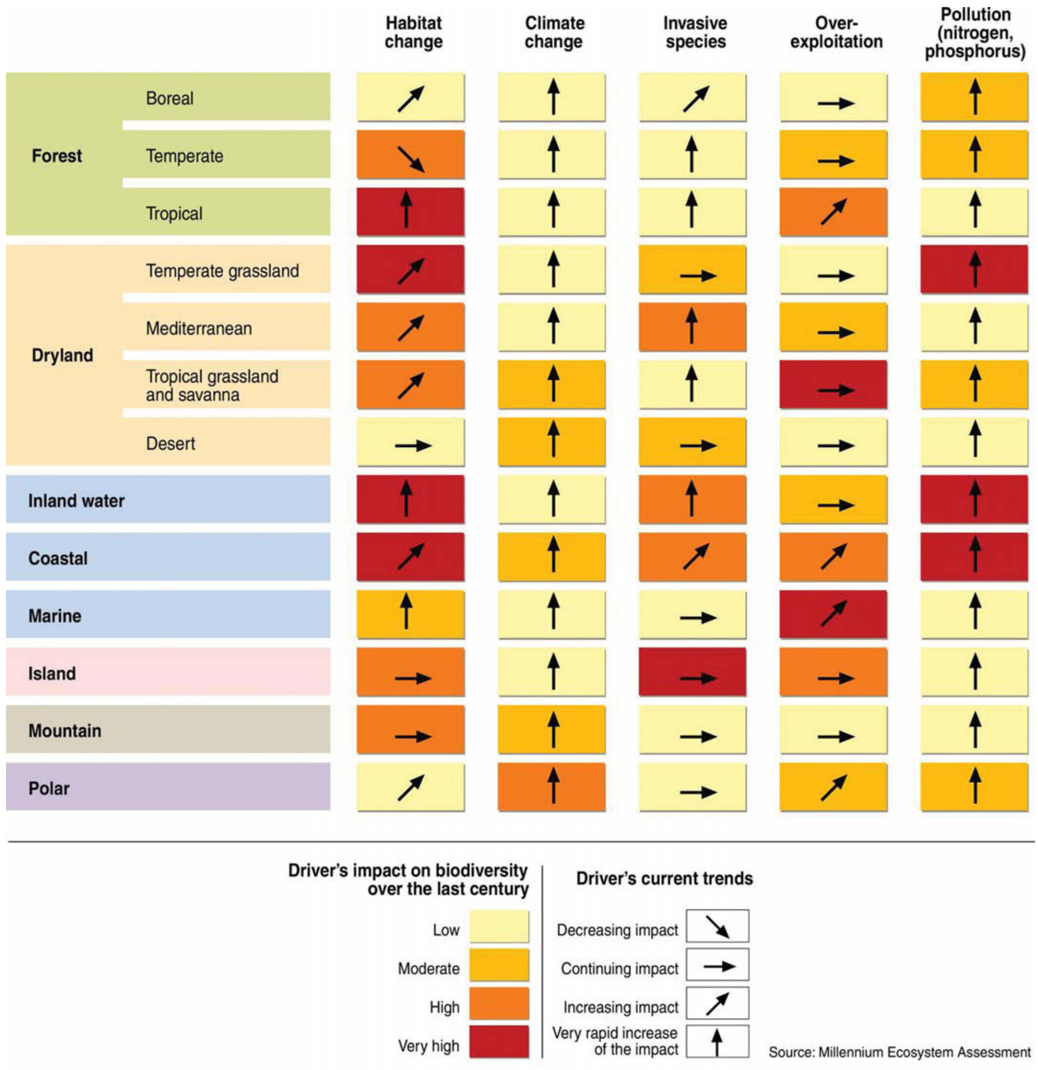
Naeem focused on biodiversity conservation as a means of ensuring ecosystem services for human well-being. “Conserving biodiversity is critical because it is not just the species but the metabolic activities of plants, animals, and microbes that collectively supply oxygen, regulate greenhouse gases, and through a complex set of processes make up life-sustaining systems”—life-sustaining for humans in particular, said Naeem. “Most of what we value as human beings relies on the healthy functioning of diverse ecosystems.”

Naeem demonstrates the complexity of biodiversity processes to classes at Columbia by auctioning off a desktop computer that starts out in perfect shape. After the auction, Naeem opens the computer casing and pulls out a small part at random. Then the auction starts again, but the computer no longer works as it should. He asks students to extrapolate this exercise to the loss of species in the environment. “I want to show that like diversity in an ecosystem, you lose function in surprising ways.

“We have a chance now to rethink how ecologists do science and communicate it to the rest of the world,” said Naeem. “I’m not saying that we shouldn’t go out and collect butterflies and that we shouldn’t ‘farm’ species and do our best to conserve them. But I think we are very short in terms of understanding the functional significance of biodiversity. If we can bring that into our deliberations, we can speak to decisionmakers and policymakers a lot more clearly than we have been able to in the past.”

From the robber baron era to economic thinking

In his plenary talk, “Values and Valuation in a Rapidly Changing World,” Richard Norgaard of the University of California–Berkeley spoke of a transition from a robber baron era to today’s “economic thinking.” As an ecological economist, Norgaard studies how environmental problems challenge scientific understanding and the policy



"This is one of the best diagrams coming out of the Millennium Ecosystem Assessment," said Richard Norgaard, and one "that many of the scientists that participated could agree to." The colors of the squares indicate the impact of each driver over the past 50 to 100 years. The arrows indicate whether the impact of the driver is increasing, continuing at its current level, or decreasing. Source: Ecosystems and Human Well-being: Synthesis, *Millennium Ecosystem Assessment (*www.maweb.org*).*

process, how ecologists and economists understand systems differently, and how globalization affects environmental governance.

"Throughout history," he said, "we have had environmental problems.... If you think of the robber baron era, [there's] the realization that we had gone from an innocent agricultural society to a rapidly industrializing society.... Next was probably the Great Depression, and again...economics played an important part. We are now in a third great sort of realization that the economy itself is driving change rapidly."

Norgaard pointed out that in a worldview from the perspective of the environment, we're saying "something is out of hand here." But from an economic view, "things are getting better and better." Can we combine the two to solve environmental crises? he asks. "Can we save nature using the same line of reasoning [as that used to understand economic change]?"

Norgaard spoke about the development of the MEA using both economic and environmental views. "I think the MEA is telling us something that is important and new and interesting. It's telling us that something has changed, that we do have alternatives, that we can blend science and policy and put different sciences together in an assessment process and come up with richer advice."

The biggest problem for biodiversity, Norgaard believes, is that "we have constructed this knowledge among ourselves. We have to expand this understanding from 1400 scientists [involved in the MEA] to 14,000 scientists, then to 140,000 scientists and people with experiential knowledge and indigenous people, then to 1.4 million people, including the general public, truck drivers, beauticians, and everyone else, then to 14 million and on outward."

Norgaard summed up by quoting Albert Einstein: "We can't solve problems by using the same kind of thinking we used when we created them."

Keynote speakers Matthew Nisbet, a social scientist who focuses on political communication and public opinion at Ohio State University, and Chris Mooney, author of The Republican War on Science, *spoke about the interface between science and politics at the AIBS Council Meeting. Here they are shown speaking with Judy Scotchmoor, who received the 2006 AIBS Education Award. The names of all of this year's award recipients can be found at* www.aibs.org/about-aibs/awards_2006.html. *Photograph: Carroll Photography.*

Valuing ecosystem services

"Valuing Ecosystem Services" was the title of the plenary talk delivered by Stephen Polasky of the University of Minnesota. Polasky's research interests include biodiversity conservation, valuing ecosystem services, and endangered species policy.

"A concrete example of valuing ecosystem services," he said, "is the value of fisheries productivity. If we want to protect coastal estuaries and nearshore ecosystems for fisheries, how valuable is that in the end?" If there were optimal management of a fishery, he said, "you might get one answer and it might be quite good. If you have traditional, open-access, vacuum-up-the-fish-as-fast-as-you-can management, there is typically not very much economic value."

Clear evidence exists that things can be done differently, said Polasky. "The Montreal Protocol to phase out compounds causing the ozone hole to expand is an example. To have science find out something in the 1970s and 1980s and come up with an international agreement signed by all the major players in 1987 is stupendous progress. It shows it can be done.

"Information placed in the hands of the people has led to better decisions, better management, better interactions of humans and the environment. The time is right, but at present we don't have a base of credible quantitative estimates for values of ecosystem services.

"We need to come up with these indicators or measures. We need to look at the value of pollinators, for example, or try to get at the value of water in a watershed. Those are things that we can make a lot of progress on and that can sway public and private decisionmaking."

The role of science in environmental politics

In his plenary talk, "Defining Effective Science for Biodiversity Policy," Stephen Bocking of Trent University, Ontario, Canada, looked at the value of California condors, salmon, bald eagles, the Chesapeake Bay, and other species and locales from an environmental politics viewpoint. Bocking's research is focused on the role of science in environmental politics.

"Bringing back the California condor in the 1980s, for example, wasn't just about science; it was also about all kinds of intrinsic issues, including the cultural value of the condor, and about values generally," said Bocking. "It's the same kind of phenomenon with a lot of species that have iconic value, like wolves and grizzly bears and salmon and bald eagles. While there is the best available science to inform a decision, at the same time there are all kinds of other values in play."

The classic popular image of science, said Bocking, "is of a body of knowledge that is value free, completely separate from human values, but it's very hard in practice to separate science from our values."

What if we thought of knowledge more ecologically, asked Bocking, as a complex ecosystem that's highly productive: "an ecosystem that has currents that flow to meaningful destinations, but also currents that have certain backwaters," he explained. "In short, an ecosystem in which you need guidance to find your way around. And it has to be guidance that is not simply aware of the science itself but takes into account what people need out of that ecosystem.

"There are all kinds of experiments in providing this guidance. We need to meld

Visit these Web sites for more information:

- *www.aibs.org/annual-meeting/annual_meeting_2006.html*
- *www.aibs.org/virtual-library*
- *www.biodiv.org*
- *www.maweb.org*
- *www.yale.edu/epi*
- *www.columbia.edu/cu/biomerge*

them into accumulated experience, and make sure the results are transferred as widely as possible."

Whither from here?

The answer perhaps can be found in a passage from Jared Diamond's bestselling book *Collapse: How Societies Choose to Fail or Succeed* (Viking Adult, 2004). "My remaining cause for hope," writes Diamond, "is another consequence of the globalized modern world's interconnectedness.

"While the Easter Islanders were busy deforesting the highlands of their overpopulated island for agricultural plantations in the 1400s, they had no way of knowing that, thousands of miles to the east and west at the same time, Greenland Norse society and the Khmer Empire were simultaneously in terminal decline, while the Anasazi had collapsed a few centuries earlier, Classic Maya society a few more centuries before that, and Mycenean Greece 2000 years before that.

"Today, though, we turn on our television sets or radios or pick up our newspapers, and we see, hear and read in graphic detail...why societies collapse" because of environmental degradation and consequent losses of biodiversity.

Have we learned enough to keep *Homo sapiens* and its contemporaries on Earth from following countless species down a path that leads straight to extinction and the fossil record?

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