An early surprise is that the organism responsible for the bioluminescence is likely not *Pyrodinium bahamense*. Salinity averages 24 parts per thousand at all water depths in the HNR lagoons, a low level for *Pyrodinium bahamense*, which usually lives in full-strength seawater at 32 parts per thousand.

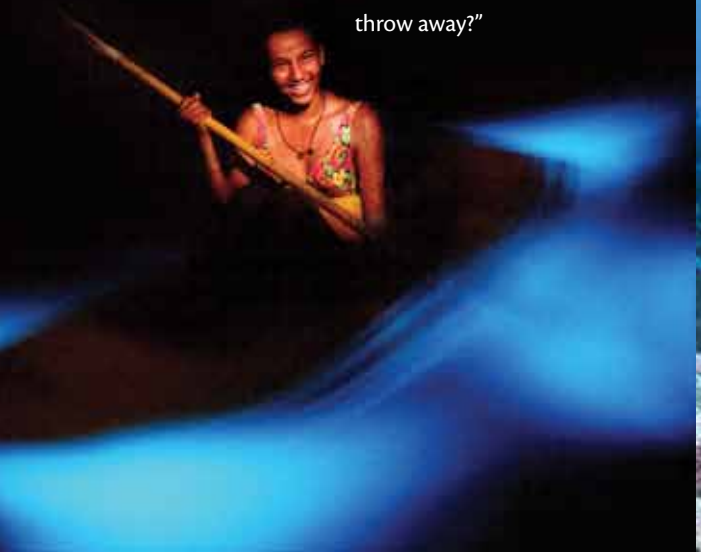
"In our samples, there are only a few *Pyrodinium bahamense*, even when the bioluminescence is very bright," says Zayas-Santiago. "Instead of *Pyrodinium*, there are large concentrations of other dinoflagellates we haven't yet identified."

The researchers' efforts are focused on the taxonomy of the dinoflagellates, and whether they're perhaps from the genus *Gonyaulax* or *Protoperidinium*. These dinoflagellates were the main ones collected in water samples during nights when the bio-bay glowed brightest, says Zayas-Santiago.

"This bio-bay wasn't among the world's known such places," says Colón-Rivera. "The discovery started when we were there working on the effects of sea level rise on coastal wetlands. Local fishers and tour guides started telling us about displays of bioluminescence in the lagoons. When we investigated, we found that they were right."

Along with their research, the scientists hope to develop conservation plans for the bio-bay.

To dive into a bioluminescent bay on a moonless night "is to share universal fires," writes Elizabeth Langhorne in her book *Vieques: History of a Small Island* (Vieques, Puerto Rico, is home to Mosquito Bay). "It is as though a million stars were caught in the sea. Is that not a gift of the Gods, one that would be madness to throw away?"



27 Earths Needed by Year 2050: Protected Areas Not Enough to Stem Biodiversity Loss

Twenty-seven Planet Earths.

The number of Earths it would take in a business-as-usual scenario to meet human demands by the year 2050.

That cumulative overshoot, or excess use of our planet's resources, already has resulted in an "ecological debt" that would require 2.5 Planet Earths to pay.

The debt, including a loss of biodiversity, is unstoppable if we rely on a strategy of setting aside land and ocean territories as protected areas. So found scientists Camilo Mora of the University of Hawaii and Peter Sale of the United Nations University in Ontario, Canada. They published their results in the journal *Marine Ecology Progress Series* on July 28, 2011.

Despite rapid growth of protected land and ocean areas worldwide—totaling more than 100,000 in number and covering 17 million square kilometers of land and two million square kilometers of ocean—biodiversity is in steep decline.

"Biodiversity is humanity's life-support system, delivering everything from food, to clean water and air, to recreation and tourism, to novel chemicals that drive our advanced civilization," says Mora. "Yet there is a sharp global trend in biodiversity loss triggered by a host of human activities."

Those activities include over-harvesting of species, habitat loss due to human encroachment on wilderness areas, introduction of invasive species, and the effects of global warming and pollution.

"Ongoing biodiversity loss and its consequences have prompted strong calls for protected areas as a remedy," says Sale. "While protected areas have helped preserve some species at local scales, use of this strategy as a worldwide solution to biodiversity loss has happened without knowing whether it's meeting its goal."

Mora and Sale warn that long-term failure of protected areas could erode public and political support for biodiversity conservation, and that disproportionate allocation of resources and human capital precludes the development of more effective approaches.

"We need to reassess our heavy reliance on this avenue," says Sale.

The current global network of protected areas has five main limitations, Mora and Sale believe.

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Photo courtesy of National Oceanic and Atmospheric Administration/Department of Commerce, photographer Linda Wade

EXPANSION OF PROTECTED AREA COVERAGE IS TOO SLOW. At current rates, it will take 185 years on land and 80 years in the ocean to cover 30 percent of the world's ecosystems with protected areas—the minimum advocated for effective biodiversity conservation. This slow pace is out of sync with threats that will likely cause the extinction of many species by 2050. In several places, options for a network of protected areas are limited; in Africa, for example, less than 12 percent of the continent is uninhabited by humans.

THE SIZE AND CONNECTIVITY OF PROTECTED AREAS ARE INADEQUATE. To ensure the survival of wild species, protected areas must be large enough to sustain viable populations, and the areas must be close enough together for a healthy exchange of individuals. Globally, however, more than 30 percent of protected areas in the ocean, and 60 percent of those on land, are smaller than one square kilometer—too small for many larger species. "And they tend to be too far apart," says Sale.

PROTECTED AREAS AMELIORATE ONLY CERTAIN THREATS. Protected areas are primarily useful against overexploitation and habitat loss. But other stressors, such as climate change, pollution, and invasive species, are equally harmful, says Mora.

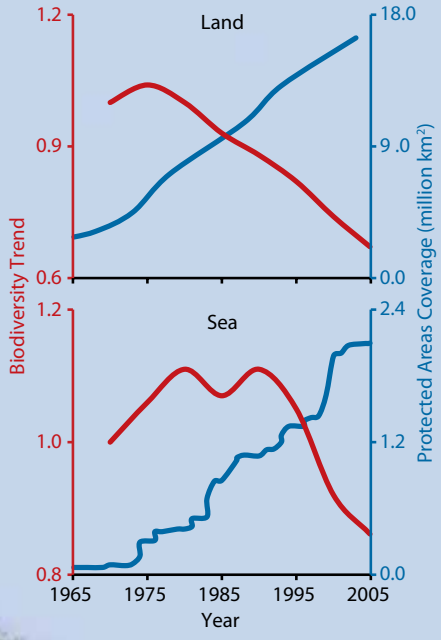
UNDERFUNDING. Protected areas are not well-enough funded for effective management. Mora and Sale estimate that it would require $24 billion per year to meet that goal—four times the current expenditure of $6 billion.

CONFLICTS WITH HUMAN DEVELOPMENT. Humanity's footprint on Earth is ever expanding. Meeting basic needs such as housing and food will become more difficult and exert more pressure on ecosystems. "If it were possible to place the recommended 30 percent of world habitats under protection, intense conflicts with competing human interests would be inevitable," state Mora and Sale. "Forcing a trade-off between human development and sustaining biodiversity is unlikely to lead to a solution with biodiversity preserved."

We are faced with a choice between two paths, says Sale. "One option is to continue a narrow focus on creating more protected areas with little evidence that they curtail biodiversity loss. That path will ultimately fail.

"The other path requires that we get serious about addressing the growth in size and consumption rate of the global human population."

In the end, we have not 27 Earths, but one.



Comparison of the global trend in biodiversity status (red lines) on land (top) and in the sea (bottom), and the global coverage of protected areas (blue lines) from 1965 to 2005. The biodiversity status includes the population trends of nearly 2,000 species monitored worldwide (data from the *World Wildlife Fund 2008 Living Planet Report*). The data on protected areas are from the World Database on Protected Areas. *Figure courtesy of Camilo Mora and Peter Sale*

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