

FACTS, INFERENCES, AND SHAMELESS SPECULATIONS

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Rivets of Life



I THINK ABOUT RIVETS QUITE A BIT these days, Ehrlichian rivets. No, these aren't the pieces of steel with which foes of population planning would like to contain Paul's formidable tongue. They are the rivets that Paul and Anne Ehrlich wrote about in their 1981 book, *Extinction*. These rivets are the metaphor that the Ehrlichs spun to make the case for protecting biological diversity.

The hard-nosed folks ask one very predictable question when challenging the value of biodiversity: Why care? Many of these cynics incidentally, are the same ones Oscar Wilde dismissed as knowing the price of everything and the value of nothing. Yet even if you and I know their price, as well as their value, we can't simply dismiss their questioning as amusingly moronic, as tender reminders of "Lucy" and our other fossil australopithecine ancestors. All too often these modern-day Lucys make decisions that matter. That is where Ehrlichian rivets become useful.

The Ehrlichs' metaphor is simple. Imagine you are walking down the boarding gate to a plane and happen to notice a few workers standing on the wing, popping random rivets here and there. There are buckets of rivets imbedded in the wing, and not surprisingly, despite the fact that quite a few rivets have wound up on the tarmac, the wing has yet to sag perceptibly. Not being one of Boeing's designers, you probably have no clue as to what any one rivet does in linking wing to fuselage. Prudence, nonetheless,

would keep you off the plane.

For the Ehrlichs, species are the rivets that make our global ecosystem work. Let me give you two examples, one Amazonian, one Aleutian.

A new understanding of what makes the Amazon basin Amazonian has emerged from studies of trees, climate, and hydrology over the last 10 years (Salati and Vose 1984, *Science* 225:129–138). The rainfall that permits rain forest growth comes originally from the tropical Atlantic as its water is heated by the sun and evaporates. That water vapor becomes clouds and it is then blown westward over land by the trade winds. It falls as rain on the forest but is sent immediately back to the atmosphere by evapotranspiration, a process whose rate and magnitude is determined by the vegetation—in this case primary forest. The trade winds pick up the water vapor again and move it farther westward, where it falls once again as rain. Thus the water that came from the

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oceans is recycled many times before it finally reaches the western edge of Amazonia—the Andes.

Without this massive recycling of water, the rain forest would not exist.

New computer simulations show that if you deforest the Amazon basin you reduce evapotranspiration so greatly that the forest would not regenerate (Shukla *et al.* 1990, *Science* 247:1322–1325). There simply wouldn't be enough rainfall, and the Amazon basin would become a scrubby savannah at best. It takes forest to make forest. As-yet unpublished analyses by Eneas Salati, the Brazilian climatologist, suggest that the system may be disrupted by as little as 20% deforestation, and we are already nearing 10%.

The story doesn't end there. These analyses indicate that a drop in evapotranspiration in the Amazon basin would reduce rainfall farther south, in Brazil's principal agricultural areas. The models even suggest that rainfall might be reduced far to the north, in the United States breadbasket of the central plains. Hence the individual rivets that make rain forest viable in the Amazon basin have immense and direct value to people. We ignore these facts at our peril.

The Aleutian tale is about sea otters.



The rivets are the metaphor to make the case for protecting biological diversity, they make our global ecosystem work.

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Studies over the last 20 years by Estes and colleagues (*Science* 200:403–411; *Science* 245:170–172) reveal that the otters change entire ecosystems. Their impact hinges on the fact that sea otters eat sea urchins and lots of them. Sea urchins, left uneaten, consume kelp.

Around islands in the Aleutians where the otters have not been hunted to local extinction, sea urchins are minor elements of the subtidal invertebrate community. The otters keep them in check. Without abundant sea urchins, the undersea kelp forests flourish and become a major contributor to the basic productivity of these near-shore waters. With higher primary productivity, the entire ecosystem is richer with life—more species and more individuals of those species.

This impact carries all the way through the food chain, including fish-eating birds, such as Bald Eagles, and fish-seeking people.

Around islands without sea otters, the opposite prevails. Sea urchins become so abundant that they devastate the kelp forest. Their impact cascades through the ecosystem, impoverishing the life of Aleutian waters by reducing diversity and lowering abundance. The net result is an environment less valuable to wildlife and to people.

I thought about these Aleutian rivets a lot as the Valdez oil spill spread. A large number of the sea otters in Prince William Sound perished. At the time I wondered how you fix a price per oiled sea otter, a fair value whose amount

would reflect the profound role they play in the ecosystem. Exxon knew how to deal with it. They ignored it altogether.

I am on a plane as I write, and can report that no rivet poppers cluttered the wing as I boarded. I wouldn't have left San Francisco had they been there. Our common tragedy is that we cannot say the same for the planet. Folks are out there popping the rivets of biodiversity every day, at a pace and scale the likes of which Earth has not experienced for at least 65 million years.

True, biodiversity recovered its splendor after that last mass extinction at the end of the Cretaceous. Mankind lives off that accumulated capital today. But the recovery took over 10 million years.

A prospect of restoration 10 million years in the future affords me no solace. Nor can we look for an excuse in the fact that during the earth's last 600 million years, life has experienced at least five mass extinctions. The dinosaurs neither caused their demise nor knew how to prevent it. We are causing it and we do know how to prevent it. The next time you see a Lucy blithely popping rivets, nail that sucker to the wall. ■

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