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Paleontologist Dr. Niles Eldredge is the Curator-in-Chief of the permanent exhibition "Hall of Biodiversity" at the American Museum of Natural History and ...

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The Sixth Extinction

By Niles Eldredge, Ph.D.

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Can we stop the devastation of our planet and save our own species? We are in a biodiversity crisis -- the fastest mass extinction in Earth's history, largely due to:

- *human destruction of ecosystems*
- *overexploitation of species and natural resources*
- *human overpopulation*
- *the spread of agriculture*
- *pollution*

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June 2001

The Sixth Extinction

By Niles Eldredge, Ph.D.

About 30,000 species go extinct annually.

There is little doubt left in the minds of professional biologists that Earth is currently faced with a mounting loss of species that threatens to rival the five great mass extinctions of the geological past. As long ago as 1993, Harvard biologist E.O. Wilson estimated that Earth is currently losing something on the order of 30,000 species per year -- which breaks down to the even more daunting statistic of some three species per hour. Some biologists have begun to feel that this biodiversity crisis -- this "Sixth Extinction" -- is even more severe, and more imminent, than Wilson had supposed.

Extinction in the past

The previous mass extinctions were due to natural causes.

The major global biotic turnovers were all caused by physical events that lay outside the normal climatic and other physical disturbances which species, and entire ecosystems, experience and survive. What caused them?

- First major extinction (c. 440 mya): Climate change (relatively severe and sudden global cooling) seems to have been at work at the first of these-the end-Ordovician mass extinction that caused such pronounced change in marine life (little or no life existed on land at that time). 25% of families lost (a family may consist of a few to thousands of species).
- Second major extinction (c. 370 mya): The next such event, near the end of the Devonian Period, may or may not have been the result of global climate change. 19% of families lost.
- Third major Extinction (c. 245 mya): Scenarios explaining what happened at the greatest mass extinction event of them all (so far, at least!) at the end of the Permian Period have been complex amalgams of climate change perhaps rooted in plate tectonics movements. Very recently, however, evidence suggests that a bolide impact similar to the

end-Cretaceous event may have been the cause. 54% of families lost.

- Fourth major extinction (c. 210 mya): The event at the end of the Triassic Period, shortly after dinosaurs and mammals had first evolved, also remains difficult to pin down in terms of precise causes. 23% of families lost.
- Fifth major extinction (c. 65 mya): Most famous, perhaps, was the most recent of these events at the end-Cretaceous. It wiped out the remaining terrestrial dinosaurs and marine ammonites, as well as many other species across the phylogenetic spectrum, in all habitats sampled from the fossil record. Consensus has emerged in the past decade that this event was caused by one (possibly multiple) collisions between Earth and an extraterrestrial bolide (probably cometary). Some geologists, however, point to the great volcanic event that produced the Deccan traps of India as part of the chain of physical events that disrupted ecosystems so severely that many species on land and sea rapidly succumbed to extinction. 17% of families lost.

How is the Sixth Extinction different from previous events?

The current mass extinction is caused by humans.

At first glance, the physically caused extinction events of the past might seem to have little or nothing to tell us about the current Sixth Extinction, which is a patently human-caused event. For there is little doubt that humans are the direct cause of ecosystem stress and species destruction in the modern world through such activities as:

- transformation of the landscape
- overexploitation of species
- pollution
- the introduction of alien species

And because *Homo sapiens* is clearly a species of animal (however behaviorally and ecologically peculiar an animal), the Sixth Extinction would seem to be the first recorded global extinction event that has a biotic, rather than a physical, cause.

We are bringing about massive changes in the environment.

Yet, upon further reflection, human impact on the planet is a direct analogue of the Cretaceous cometary collision. Sixty-five million years ago that extraterrestrial impact -- through its sheer explosive power, followed immediately by its injections of so much debris into the upper reaches of the atmosphere that global temperatures plummeted and, most critically, photosynthesis was severely inhibited -- wreaked havoc on the living systems of Earth. That is precisely what human beings are doing to the planet right now: humans are causing vast physical changes on the planet.

What is the Sixth Extinction?

We can divide the Sixth Extinction into two discrete phases:

- Phase One began when the first modern humans began to disperse to different parts of the world about 100,000 years ago.
- Phase Two began about 10,000 years ago when humans turned to agriculture.

Humans began disrupting the environment as soon as they appeared on Earth.

The first phase began shortly after *Homo sapiens* evolved in Africa and the anatomically modern humans began migrating out of Africa and spreading throughout the world. Humans reached the middle east 90,000 years ago. They were in Europe starting around 40,000 years ago. Neanderthals, who had long lived in Europe, survived our arrival for less than 10,000 years, but then abruptly disappeared -- victims, according to many paleoanthropologists, of our arrival through outright warfare or the more subtle, though potentially no less devastating effects, of being on the losing side of ecological competition.

Everywhere, shortly after modern humans arrived, many (especially, though by no

means exclusively, the larger) native species typically became extinct. Humans were like bulls in a China shop:

- They disrupted ecosystems by overhunting game species, which never experienced contact with humans before.
- And perhaps they spread microbial disease-causing organisms as well.

The fossil record attests to human destruction of ecosystems:

Wherever early humans migrated, other species became extinct.

- Humans arrived in large numbers in North America roughly 12,500 years ago-and sites revealing the butchering of mammoths, mastodons and extinct buffalo are well documented throughout the continent. The demise of the bulk of the La Brea tar pit Pleistocene fauna coincided with our arrival.
- The Caribbean lost several of its larger species when humans arrived some 8000 years ago.
- Extinction struck elements of the Australian megafauna much earlier-when humans arrived some 40,000 years ago. Madagascar-something of an anomaly, as humans only arrived there two thousand years ago-also fits the pattern well: the larger species (elephant birds, a species of hippo, plus larger lemurs) rapidly disappeared soon after humans arrived.

Indeed only in places where earlier hominid species had lived (Africa, of course, but also most of Europe and Asia) did the fauna, already adapted to hominid presence, survive the first wave of the Sixth Extinction pretty much intact. The rest of the world's species, which had never before encountered hominids in their local ecosystems, were as naively unwary as all but the most recently arrived species (such as Vermilion Flycatchers) of the Galapagos Islands remain to this day.

Why does the Sixth Extinction continue?

The invention of agriculture accelerated the pace of the Sixth Extinction.

Phase two of the Sixth Extinction began around 10,000 years ago with the invention of agriculture-perhaps first in the Natufian culture of the Middle East. Agriculture appears to have been invented several different times in various different places, and has, in the intervening years, spread around the entire globe.

Agriculture represents the single most profound ecological change in the entire 3.5 billion-year history of life. With its invention:

- humans did not have to interact with other species for survival, and so could manipulate other species for their own use
- humans did not have to adhere to the ecosystem's carrying capacity, and so could overpopulate

Humans do not live with nature but outside it.

Homo sapiens became the first species to stop living inside local ecosystems. All other species, including our ancestral hominid ancestors, all pre-agricultural humans, and remnant hunter-gatherer societies still extant exist as semi-isolated populations playing specific roles (i.e., have "niches") in local ecosystems. This is not so with post-agricultural revolution humans, who in effect have stepped outside local ecosystems. Indeed, to develop agriculture is essentially to declare war on ecosystems - converting land to produce one or two food crops, with all other native plant species all now classified as unwanted "weeds" -- and all but a few domesticated species of animals now considered as pests.

The total number of organisms within a species is limited by many factors-most crucial of which is the "carrying capacity" of the local ecosystem: given the energetic needs and energy-procuring adaptations of a given species, there are only so many squirrels, oak trees and hawks that can inhabit a given stretch of habitat. Agriculture had the effect of removing the natural local-ecosystem upper limit of the size of human populations. Though crops still fail regularly, and famine and disease still stalk the land, there is no doubt that agriculture in the main has had an enormous impact on human population size:

Earth can't sustain the trend in human population growth. It is reaching its limit in carrying capacity.

- Estimates vary, but range between 1 and 10 million people on earth 10,000 years ago.
- There are now over 6 billion people.
- The numbers continue to increase logarithmically -- so that there will be 8 billion by 2020.
- There is presumably an upper limit to the carrying capacity of humans on earth -- of the numbers that agriculture can support -- and that number is usually estimated at between 13-15 billion, though some people think the ultimate numbers might be much higher.

This explosion of human population, especially in the post-Industrial Revolution years of the past two centuries, coupled with the unequal distribution and consumption of wealth on the planet, is the underlying cause of the Sixth Extinction. There is a vicious cycle:

Overpopulation, invasive species, and overexploitation are fuelling the extinction.

- More lands are cleared and more efficient production techniques (most recently engendered largely through genetic engineering) to feed the growing number of humans -- and in response, the human population continues to expand.
- Higher fossil energy use is helping agriculture spread, further modifying the environment.
- Humans continue to fish (12 of the 13 major fisheries on the planet are now considered severely depleted) and harvest timber for building materials and just plain fuel, pollution, and soil erosion from agriculture creates dead zones in fisheries (as in the Gulf of Mexico)
- While the human Diaspora has meant the spread, as well, of alien species that more often than not thrive at the detriment of native species. For example, invasive species have contributed to 42% of all threatened and endangered species in the U.S.

Can conservation measures stop the Sixth Extinction?

Only 10% of the world's species survived the third mass extinction. Will any survive this one?

The world's ecosystems have been plunged into chaos, with some conservation biologists thinking that no system, not even the vast oceans, remains untouched by human presence. Conservation measures, sustainable development, and, ultimately, stabilization of human population numbers and consumption patterns seem to offer some hope that the Sixth Extinction will not develop to the extent of the third global extinction, some 245 mya, when 90% of the world's species were lost.

Though it is true that life, so incredibly resilient, has always recovered (though after long lags) after major extinction spasms, it is only after whatever has caused the extinction event has dissipated. That cause, in the case of the Sixth Extinction, is ourselves -- *Homo sapiens*. This means we can continue on the path to our own extinction, or, preferably, we modify our behavior toward the global ecosystem of which we are still very much a part. The latter must happen before the Sixth Extinction can be declared over, and life can once again rebound.

About the author: Paleontologist Dr. Niles Eldredge is the Curator-in-Chief of the permanent exhibition "Hall of Biodiversity" at the American Museum of Natural History and adjunct professor at the City University of New York. He has devoted his career to examining evolutionary theory through the fossil record, publishing his views in more than 160 scientific articles, reviews, and books. ***Life in the Balance: Humanity and the Biodiversity Crisis*** is his most recent book.
http://www.gc.cuny.edu/directories/faculty/E.htm

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The Sixth Extinction

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Consequences of the sixth extinction on evolution
The authors describe how the current loss of biodiversity will affect evolution in the long run.
http://www.actionbioscience.org/newfrontiers/myers_knoll.html

American Museum of Natural History Statement on Mass Extinction
National survey reveals biodiversity crisis -- the fastest mass extinction in Earth's history.
http://www.amnh.org/museum/press/feature/biofact.html

National Geographic
An article about the 6th extinction, with views from several leading scientists.
http://www.nationalgeographic.com/ngm/9902/fngm/index.html

Extinction through time
Find out about cycles of life and death and extinction patterns through time.
http://www.wf.carleton.ca/Museum/extinction/tablecont.html

Is Humanity Suicidal?
Edward O. Wilson asks us why we stay on the course to our own self-destruction.
http://www.well.com/user/davidu/suicidal.html

A Field Guide to the Sixth Extinction
Niles Eldredge writes about a few of the millions of plants and animals that won't make it to the next millennium.
http://www.well.com/user/davidu/fieldguide.html

Global Environment Outlook 3
The United Nations Environment Programme released this major report in May 2002. The report collated the thoughts of more than 1,000 contributors to assess the environmental impact of the last 30 years and outline policy ideas for the next three decades. It concluded that without action, the world may experience severe environmental problems within 30 years. The entire report can be read online. Each section is a PDF file and requires Acrobat Reader to view or download. The report can also be purchased online.
http://www.unep.org/geo/geo3/index.htm

Population growth impacts
A paper by David Pimentel and Mario Giampietro on the conflict between population, energy use, and the ecology of agriculture.
http://dieoff.org/page40.htm

World Atlas of Biodiversity -- interactive map

The United Nations Environment Programme (UNEP) released the first *World Atlas of Biodiversity* in August 2002. This link takes you to their online interactive map that helps you search for data about species/land/water loss, extinction over time, and human global development. Click on the "?" for a help page that explains how to interact with this map.
http://stort.unep-wcmc.org/imaps/gb2002/book/viewer.htm

Read a book 
» *The Biodiversity Crisis: Losing What Counts* by The American Museum of Natural History (New Press, 2001).
» *The Sixth Extinction: Patterns of of Life and the Future of Humankind* by Richard Leakey and Roger Lewin (Doubleday and Company, 1996).

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The Biodiversity Project
Choose a way to get involved in protecting biodiversity -- from educational resources to community outreach.
http://www.biodiversityproject.org/resources.htm

International Biodiversity Observation Year
Choose from a variety of activities that you can do to protect the diversity of life and ecosystems from the action list on this site. Second link takes you to the calendar of events.
http://www.nrel.colostate.edu/IBOY/youpublic.html

http://www.nrel.colostate.edu/IBOY/meetings.html 

The Nature Conservancy
Select a state from the menu and find out how you can become an environmental volunteer in that state.
http://nature.org/volunteer/

articlereferences

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» Cohen, J.E. 1995. *How Many People Can the Earth Support?* W.W. Norton, New York.
» Eldredge, N. 1998. *Life in the Balance. Humanity and the Biodiversity Crisis*. Princeton University Press, Princeton.
» Wilson, E.O. 1993. *The Diversity of Life*. Harvard University Press, Cambridge.

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Lessons for high school - undergraduate
Actionbioscience.org provides two *original* lessons for the high school to undergraduate levels, written by an educator to accompany this article. The two lessons open in one PDF file:

» » ***Extinction: Is It Inevitable?*** « «
Both lessons explore the cycle of extinction and biotic recovery, with special emphasis on the causes of extinction. Activities include debates, reports, and geologic time charts.
http://www.actionbioscience.org/newfrontiers/lessons/eldredge2lessons.pdf

This PDF file requires Adobe Acrobat Reader software that you can download for free. If you already have Acrobat Reader, make sure it's the latest version. Download the latest Acrobat Reader.

Lessons for middle school
The following links will take you to middle school lessons available on other web sites:
» Dinosaur Detectives
Students learn how paleontologists (just like the author, Niles Eldredge) solve dinosaur mysteries.
http://school.discovery.com/lessonplans/programs/dinosaurdetectives/
» Hunting the Elephants Out of Extinction
Students follow clues to a mystery about disappearing elephants.
http://www.rich.frb.org/pubs/econ/fall98/hunting.html

Useful links

In addition to the links in the "learn more" section above:

» Klamath Basin Crisis

Farmers in the Klamath Basin region of northern California are fighting with environmentalists about the use of water - for irrigation or for the protection of endangered salmon and suckerfish. These sites are useful for students conducting the debate listed in Handout 2 of the actionbioscience.org lesson "Extinction: Is It Inevitable?"

http://www.klamathbasincrisis.org/articles/highanddry-Jasper.htm

http://www.ecologycenter.org/terrain/2001winter/warontheriver.html

http://www.redding.com/specials/klamath/

» The World Resources Insititute

Their biodiversity page has an overview of biological diversity issues and information.

http://www.wri.org/biodiv/biodiv.html

Be sure to also check out the section for information on threats to biodiversity.

http://www.wri.org/biodiv/bri-why.html

» The Extinction Files

A well organized discussion on the cycle of mass extinctions, from Late Cambrian to the Pleistocene.

http://www.bbc.co.uk/education/darwin/exfiles/index.htm

» Geologic Time

Concise explanation of geologic time, relative time, radiometric time, and major divisions of geologic time.

http://pubs.usgs.gov/gip/geotime/contents.html

The New York Times Magazine
The Times Capsule

A Field Guide to The Sixth Extinction

Millions of plants and animals won't make it to the next millennium. Here's a glimpse of some species the future will never see.

By NILES ELDREDGE

FORM
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• How to Make a Time Capsule
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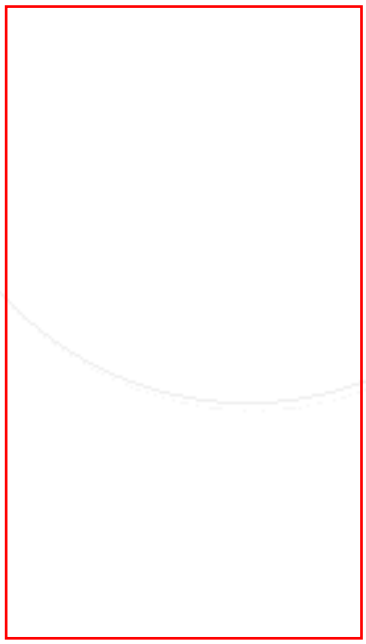
CONTENT
• A Few of Our

Species are built to last. The rich fossil record of marine life over the past half-billion years tells us that the likes of clams, corals and crabs typically endure well over five million ye ars. On land, where environmental change more readily upsets the ecological apple cart, the life expectancies of mammals are shorter (though still impressive, on the order of one million to two million years). And yet, here we are at the brink of the year 2000, asking an unnerving question: what species on earth right now will not be here when people open the Times Capsule in the year 3000?

Only in times of momentous ecological tumult would such doomsaying be justified. And such upheavals are vanishingly rare. In fact, during the past half-billion years, there have been just five global mass-extinction events (like the comet impact that mos t likely felled the dinosaurs 65 million years ago). Yet the sad fact is that we are living amid a sixth extinction event -- one that, according to the Harvard biologist E. O. Wilson, is costing the earth some 30,000 species a year. Biologists estimate th at there are at least 10 million species on earth right now. At this rate, the vast majority of the species on earth today will be gone by the next millennium.



Illustrations by Dugald Stermer

When the icy current that had cooled their island dissipated, Galapagos penguins succumbed to the tropical heat.

Slide Show

Ever since humans domesticated plant crops and barnyard animals beginning some 10,000 years ago, our numbers have shot up from an estimated six million to six billion. We have engaged in a radical, systematic transformation of the world's ecosystems -- replacing grasslands and woodlands with arable fields, cities, suburbs, malls and roadways. We have exploited dwindling stands of timber and

fisheries; we have fouled the earth, the atmosphere and even much of the oceans; and we have introduced alien spec ies around the globe. In short, we bear an uncanny resemblance to those Cretaceous comets.

Species depletion isn't merely the concern of nature lovers. Each day, humans make use of some 40,000 species for food, shelter, clothing and fuel. We rely on the natural pharmacopoeia locked up in the plant species that are still mostly unknown and in a wide assortment of marine invertebrates. We need the wild congeners of our increasingly homogeneous domestic crops to replenish their genetic diversity. But beyond such practical matters lies a moral question: how can we condone, however passively, the d estruction of our fellow species?

Niles Eldredge, a paleontologist and a curator at the American Museum of Natural History, is the author of "Life in the Balance: Humanity and the Biodiversity Crisis."

What follows is a short list -- culled from the vast array of potential candidates -- of species likely to be victims of the sixth extinction. It would be wonderful if these predictions proved inaccurate. By confronting what we are doing to the species a nd ecosystems of our planet, we can perhaps change our consumption patterns and conserve what remains of our ecosystems and species. If not, however, this field guide to the soon-to-be dead will give the inhabitants of the year 3000 some sense of what the y're missing.

OVERHARVESTING

The reason for the extinction of many species was easy to trace -- humans killed them faster than they could reproduce. Even species whose populations teemed in the millions in 2000 fell victim to wanton slaughter or overharvesting.

Prairie Dogs: These little ground-dwelling rodents once lived by the millions in extensive colonies on the grasslands of North America. But by the year 2000, black-tailed prairie dogs were being shot by the thousands by "sportsmen" at ranches in the Ameri can West, who usually didn't even bother to collect the dead carcasses. As the hunting practice spread, colonies fell below critical size -- and the entire species suddenly vanished.

Pollock: With the love for sushi having gone global around the year 2000, it was easy to predict that the succulent blue-fin tuna would soon succumb to overfishing. Much less obvious was the damage being done to more mundane (and abundant) commercially ha rvested fishes. The several species of pollock -- a large, silvery fish that looked much like cod -- were then a staple of the world's marine fisheries. Known as the poor man's cod, pollock had done yeoman service as a stand-in for that fish, as well as b eing a component of the crab substitute surimi. But mechanized international fishing fleets in places like the Bering Sea became so efficient -- not only netting but also literally vacuuming the ocean floors clean (and discarding most of the other fish an d invertebrates sucked up) -- that extinction was inevitable. Pollock stocks simply had no opportunity to replenish themselves.

Mahogany: It wasn't long before the world was stripped bare of these tropical hardwood trees. Mahogany, celebrated for the rich, dark color of its wood, had

been highly coveted by the makers and owners of fine furniture. Indeed, it was but one of many tro pical trees exploited for a specialized use. The dark wood of ebony trees was harvested to make fine piano keys. Indeed, the losses to the musical world through deforest-ation were manifold: granadilla, which provided the traditional wood for clarinets, v anished, as did the high-quality cane reeds that served as reeds for clarinets, oboes and saxophones. In fact, almost every single tropical hardwood species in demand in the world's markets was wiped out -- not only through direct harvesting but also as a byproduct of the relentless cutting and burning down of tropical forests from Brazil to Borneo.

Truffles: The delights of truffles -- small, fleshy fungi that had been avidly sought after for centuries -- will never be experienced firsthand again. The intense, earthy flavor of these fungi (usually found below ground near tree roots, sniffed out by h ogs or dogs) was matched by their potent mushroomy smell. Celebrated particularly by the chefs of Western Europe, truffles never had a chance, since they resisted the most determined attempts to farm them. They were gourmandized to extinction.

HABITAT DESTRUCTION

Here are two species that used to roam the open savannas of East Africa, an ecologically rich habitat that eventually fell prey to development and overhunting.

The African Black Rhinoceros: No mammals conjured up the remote past of early mammalian evolution more vividly than rhinos -- with their ponderous gait, primitive leer and not altogether undeserved reputation for stolid stupidity. Although all five specie s of rhinoceros on the planet in the year 2000 were doomed, the black rhino of the African plains was the first to go. For one thing, its numbers had already dwindled to a precious few. Relentless demand for powdered-rhino-horn aphrodisiacs eventually won out over the captive-breeding programs of zoos and African conservation parks.

The black rhino was a prime example of a type of African megafauna known in 20th-century ecotourism circles as "the big hairies." More large mammals survived to 2000 in Africa than anywhere else because Homo sapiens evolved on the same primordial savanna ; as a result, animals there developed a tactical wariness toward humankind, while species elsewhere, unaccustomed to human hunters, were defenseless. Alas, we humans eventually returned to Africa with modern hunting technology -- and an even more devasta ting capacity to convert savannas into pastures.

The African Wild Dog: In 2000, these feral canines were still clinging to life in such outposts as the Okavango Delta, in Botswana. But they soon became the permanent victims of disappearing habitats and disease. Their intricate social structures provided a role and place for each dog, no two of which looked alike. To watch wild dogs hunt, whether in packs or as dominant loners (as often happened in the Okavango); to see them kill a small impala only to have it wrested away by a pack of spotted hyenas; to see the wizened, almost mummified remains of last

night's meal -- such sights are no more.

INVADING SPECIES

A species transplanted into a foreign habitat can ravage local species that have not had time to evolve survival mechanisms. Humans never absorbed the lesson of the dodo -- the giant flightless pigeon of the island of Mauritius, driven to extinction by 1 665 by rats and people not long after initial European contact.

The Helmet Vanga of Madagascar: Islands, in their splendid isolation, are notorious "laboratories of evolution," and Madagascar's biodiversity was particularly remarkable. At one point, there were 13 species of vangid -- a melodious family of birds relate d to shrikes -- endemic to the island. But only a few of these birds (like the hook-billed vanga) were able to cope with the transitional habitats created when encroaching rice fields met forests. The helmet vanga, a more delicate creature, couldn't survi ve outside the deep rain forest. The bird was doomed by the clear-cutting of Madagascar's jungles.

The Hawaiian Coot: During World War II (1939-1945), the brown tree snake started moving around the Pacific, hitching rides in airborne cargo. Despite determined efforts to police air shipments and prevent the snake from eating the eggs of many of Hawaii's native birds, the snake won out. Its appetite accelerated the job already begun by human development in obliterating most of the island's indigenous flora and fauna. The ducklike Hawaiian coot, a slate gray bird of ponds and marshes, succumbed to this ma rauding invader despite its penchant for laying eggs on floating nests sequestered in vegetation.

GLOBAL WARMING

The heating of the earth's atmosphere, a process gripping the planet progressively since the 20th century, claimed numerous victims.

The Galapagos Penguin: The only penguin ever known to have lived on the Equator, this 14-inch-tall bird, with its bold black stripe crossing the upper part of its white breast, used to be seen within a mile or two of flocks of the quintessentially tropica l flamingo. It owed its presence there to the frigid Humboldt current, which cooled down an island that would otherwise have been fatally warm. For a while, the rapidly melting ice sheets of Antarctica kept the cold waters flowing northward, but finally t hings became far too warm on land, the current pattern changed -- and the Galapagos penguin was no more.

Musk Ox: Global warming eliminated most of the tundra -- the frozen stretches of grasses and lichens in the far reaches of the Northern Hemisphere. As the earth warmed, shrubs, then finally trees, invaded these primordially flat and open spaces. The gorge ous musk oxen, with their silken brown coats hanging nearly to the ground and their flattened horns plastered to their foreheads, needed the tundra's wide-open spaces, and native flora, to graze. The loss of their habitat finished them off for good.

Related Sites

- Writings and Works of E.O. Wilson
- American Museum of Natural History
- The Problem of Species Extinction