1-Page Book Summary of The Sixth Extinction

In *The Sixth Extinction*, journalist Elizabeth Kolbert argues that humans are rapidly changing the shape of the earth and the composition of the atmosphere, unleashing a mass extinction of most living things, quite possibly including ourselves. Scientists have identified five previous mass extinction events over 500 million years and many believe a Sixth Extinction, set in motion by humans, is underway.

Humans began impacting the world from the start. As modern humans spread from East Africa around the globe, they found archaic humans similar to themselves and gigantic animals (megafauna)—both of which they wiped out.
They—we—started demolishing forests to grow food and spreading animals, plants, and other life forms to new continents, thus changing the face of the earth. With the discovery of energy sources underground, we began our greatest and most deadly transformation—of the composition of the atmosphere and the oceans. Some plants and animals have survived by migrating. But many, perhaps millions, are stranded where they are unable, or lack time, to adapt. Extinction rates are skyrocketing. No other species has so drastically changed life on earth.

The Big Five Mass Extinctions

Until the eighteenth century, scientists and naturalists had no concept of extinction. They believed life was a long, unbroken “chain of being”—that the animals and other life forms existing at the time were the only ones that had ever existed or would exist. Then bones of huge creatures such as mastodons and mammoths began turning up and naturalists puzzled over why they had disappeared.

Some theorized there had been “lost worlds” of fantastic species that were obliterated by catastrophes. Others believed that extinction only happened slowly as part of the process of evolution—animals with non-beneficial traits eventually died out. Eventually, with the discovery in the 1980s of the site of an asteroid strike on the Yucatan Peninsula, the idea of sudden mass extinctions gained adherents.

Today, scientists believe in both gradual and sudden extinctions. They've identified five mass extinction events of the distant past—the “Big Five”—plus a number of smaller extinctions. Each of the Big Five suddenly decimated the earth’s diversity of life.

(Shortform note: The Big Five extinctions were:

1) *The End Ordovician period*, 444 million years ago, 86% of species lost. The cause was a sudden cooling of the climate (carbon dioxide levels and temperatures dropped and things froze—glaciation) plus a huge drop in sea levels plus an ocean chemistry change resulting from the drop in CO2.

2) *Late Devonian*, 375 million years ago, 75% of species lost.

3) *End Permian*, 251 million years ago, 96% of species lost. This extinction seems to have been triggered by a sudden warming of the climate. For unknown reasons, an enormous amount of carbon was released into the air. Temperatures shot up and the seas heated up and became acidified. Oxygen levels in the water plummeted, probably suffocating nearly all life.

4) *End Triassic*, 200 million years ago, 80% of species lost.

5) *End Cretaceous*, 66 million years ago, 76% of all species lost when an asteroid traveling at 45,000 miles an hour crashed into the Yucatan Peninsula. A scorching cloud spread across North America, vaporizing everything. Dust blocked much of the sunlight, creating an “impact winter” or prolonged cooling.)

The Anthropocene Epoch

Each of the Big Five had its own unique causes, but in every case, species faced drastic changes for which they had no time to adapt.

Scientists believe we’ve entered a new epoch: the Anthropocene or human-dominated geological epoch, characterized by man-made, planet-altering changes.

Among the first signs that our actions are leading to catastrophe was the disappearance of amphibians beginning in the 1980s. Researchers in Panama first noticed that an iconic local species, the Golden Frog, was dying. Then they realized frogs were disappearing all over the globe.

In 2008, citing the precipitous drop in amphibian populations, an article in the *Proceedings of the National Academy of Sciences*, asked, “Are We in the Midst of the Sixth Mass Extinction?” The authors concluded that, based on the extinction rates among amphibians, a sixth catastrophic event is underway.

Besides amphibians, animals are in trouble everywhere. Among those suffering steep declines are reef-building corals, sharks, rays, fresh-water mollusks, reptiles, mammals, and birds. While different animals are disappearing for seemingly different immediate reasons, in every case you can ultimately trace the cause to humans.

Global Warming
Most importantly, we’ve changed the composition of the atmosphere by adding vast amounts of carbon dioxide—over two hundred years, the level of carbon dioxide in the air has risen by 40%. As a result, the earth’s climate is likely to behave significantly differently for many millennia to come.

By burning fossil fuels, we’ve added 365 billion metric tons of carbon to the atmosphere. By cutting down forests, we’ve contributed another 180 billion tons and each year we add 9 billion tons more.

The concentration of carbon dioxide in the atmosphere—over four hundred parts per million—is higher than it’s been in more than a million years. At our current emissions rate, it will exceed five hundred parts per million by 2050, boosting temperatures, which will melt what remains of the glaciers and the Arctic ice cap and flood islands and coastal cities, such as New York and Washington, D.C.

Plant and animal species adjust to both short- (seasonal) and long-term temperature changes by migrating. During the multiple warming-cooling cycles of the ice ages, there were mass migrations—even insects moved thousands of miles. Scientists project that the temperature change in the next century will be comparable in magnitude to the temperature fluctuations of the ice ages.

Many species are already responding to climate change by adjusting their ranges. For instance, some tree species in Manu National Park in the Andes are “moving” to higher elevations as temperatures warm by dispersing their seeds up the mountain. The average genus (a group of closely related species) is moving eight feet higher per year. One species is even moving a hundred feet a year.

### Habitat Destruction

Species need to migrate for survival. However, our transformation of the earth by fragmenting forests (dividing them by highways, cities, mining operations, cropland, and other human development) makes it difficult, if not impossible.

In addition, by cutting down forests entirely, we’ve reduced the amount of available habitat, which reduces species diversity by hindering their ability to reproduce and making the smaller populations more vulnerable to extinction.

Big animals like elephants, bears, and rhinos are threatened by both habitat loss and poaching. For example, humans have killed so many rhinos and destroyed so much of their habitat that all five species of rhinos are at risk.

Other large mammals that are also in trouble:

- Six of eight species of bears are listed as “vulnerable” to extinction or “endangered.”
- Asian elephants have declined by half; African elephants are under pressure from poachers.
- Most large cats are decreasing.
- In a hundred years, pandas, rhinos, and tigers may exist only in zoos or in reserves so small and closely guarded that they constitute zoos.

### Ocean Acidification

Oceans absorb a lot of the carbon we’re pumping into the air—two-and-a-half-billion tons a year when this book was written in 2014—which is changing ocean chemistry.

In the past, there was a fairly even exchange of gases: the ocean absorbed gases from the atmosphere and also released dissolved gases back into the atmosphere. At this point, however, more CO2 is entering the oceans than they can release, resulting in acidification. (Carbon dioxide dissolves in water and forms carbonic acid.)

As a result, the pH of the oceans’ surface water has decreased, making them 30% more acidic than they were in 1800. The pH is on track to fall to 7.8 (from today’s average of 8.1) by the end of this century, making the oceans 150 percent more acidic than before the industrial revolution.

In terms of destructive effects, ocean acidification has been called global warming’s “evil twin.” There are numerous reasons, which add up to a steep loss of biodiversity, including:

- Acidification affects the internal processes of marine organisms—for instance, metabolism and enzyme activity.
- It changes the composition of microbial communities and thus the availability of key nutrients like iron and nitrogen.
It changes the amount of light passing through water.
It stimulates toxic algae growth.
It affects photosynthesis.

Among the biggest victims are calcifiers—animals and plants that construct shells or external skeletons. They include starfish, sea urchins, mollusks (clams and oysters), barnacles, and many coral species (the ones that build reefs). Many kinds of seaweed, some algae, and some plants also are calcifiers.

To build shells and skeletons, they combine calcium ions and carbonate ions to create calcium carbonate. But to do so, they have to change the chemistry of the seawater. Acidification makes this more difficult, in part by decreasing the number of available carbonate ions. In addition, water with too much acid dissolves or eats holes in their shells.

**Invasive Species**

In the past, the range of many species was limited by geographic...

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**The Sixth Extinction Summary Introduction**

Around two hundred thousand years ago, in eastern Africa, a new species emerged. While not especially strong, fast, or prolific, the newcomer—*Homo sapiens*—proved to be uniquely inventive.

In *The Sixth Extinction: An Unnatural History*, journalist Elizabeth Kolbert argues that our species today is rapidly changing the shape of the earth and the composition of the atmosphere, in the process unleashing a mass extinction of most living things, quite possibly including ourselves. **Scientists have identified five previous mass extinction events (plus smaller disasters) over 500 million years and many believe a sixth extinction, set in motion by modern humans, is underway.**

Humans began impacting the world from the start. As their population grew, modern humans spread from East Africa into new regions, undeterred by climate or geographic barriers like rivers and mountains. Humans adapted to the conditions and food supply wherever they landed—for instance, along coasts, they ate shellfish, while inland, they hunted mammals.

When they arrived in Europe, they found Neanderthals, archaic humans similar to themselves, and interbred with them before wiping them out. As modern humans spread, they encountered gigantic animals—huge bears, elephant-sized turtles, fifteen-foot-tall sloths—which they also were able to wipe out by killing them faster than they could reproduce. Humans even found ways to cross the seas, reaching islands inhabited by fantastic creatures, such as giant skinks and birds that laid foot-long eggs, many of which they annihilated. (Shortform note: Learn more about how modern humans became the world's dominant species in our summary of *Sapiens*.)

They—we—rapidly multiplied and started demolishing forests to grow food and spreading animals, plants, and organisms to new continents, thus changing the face of the earth. With the discovery of fossil fuels underground, we began our greatest transformation—of the makeup of the atmosphere and the oceans. Some plants and animals have survived...
Amphibians such as frogs and toads have been around longer than mammals, birds, and even dinosaurs—yet today they’re on the leading edge of another mass extinction. Amphibians’ ancestors emerged from the water 400 million years ago and early forms of today’s amphibian orders appeared 250 million years ago.

"Amphibian" means having a “double life”—they start their lives in water and live on both water and land. Some frogs lay their eggs in streams while others lay them in vernal ponds; some make nests or carry their eggs on their bodies. Amphibian eggs have to stay wet in order to develop because they lack shells.

Amphibians live in a variety of habitats on every continent except Antarctica. Of the seven thousand species we’ve identified, the largest number live in tropical forests—however, one lives in the desert of Australia (the sandhill frog) and one can live above the Arctic Circle. Spring peepers and other North American frogs can revive in the spring after being frozen solid.

Today, amphibians are the most endangered of the six main classes of animals. Researchers started realizing frogs were in trouble in the late 1980s.

Golden Frogs Disappear
Panamanian golden frogs, native to the rainforests and higher-elevation cloud forests of western-central Panama, are less than two inches long and are bright yellow with dark brown spots. Their bright color warns of their extremely toxic skin—a single frog contains enough poison to kill twelve hundred mice.

Golden frogs were once common in the village of El Valle de Anton in central Panama, where they were considered a symbol of luck. The golden frog’s image appeared on lottery tickets and stores sold figurines of the frogs in all kinds of poses. The frogs could easily be seen and heard in the hills around town. Then they started disappearing.

An American graduate student studying the golden frogs in western Panama went back to the U.S. to write her dissertation—and when she returned sometime later to...
belemnites, and ammonites. In addition, mammoth bones had been uncovered in Siberia, although they were thought to be from elephants.

Finally, in revolutionary France in the mid-1700s, a visionary naturalist, Georges Cuvier, began connecting the dots, starting with a giant molar found in New York state in 1705 and shipped to London, plus a cache of mastodon bones found in a sulfurous marsh along the Ohio River in 1739 by a French expedition. Today the site of the discovery is a state park in Kentucky called Big Bone Lick.

The mastodon bones, which included a three-and-a-half-foot thigh bone, a gigantic tusk, and several teeth, ended up at the Paris Museum of Natural History. A second shipment of bones from the site was sent to London. The bones seemed elephant-like, but naturalists were confused by the teeth, which were different from elephant teeth.

One scientist described it as a new animal, the American incognitum. Some naturalists thought the bones were parts of two or three different types of animals, such as an elephant and a hippo. In 1781, Thomas Jefferson also described it as a new animal, which he thought could still be living in unexplored territory—because naturalists believed nature had never allowed a species to become extinct.

A Lost World

Cuvier went to work at the Paris Museum and began studying the Kentucky bones in 1795. A year later, he presented his findings in a ground-breaking lecture. He contended that because of the different teeth, the Kentucky bones plus others found in Siberia belonged to two new species of animals, which he called “lost species” or extinct species, since no living animals had ever been found.

He continued...
However, during Darwin's time, humans drove one of Europe's most unusual species, the great auk, to extinction, contradicting his theory that extinction was always slow.

The great auk was a large, black-and-white, penguin-like bird (although it didn't actually belong to the penguin family). It had a big beak and a white spot under each eye. The great auk inhabited the islands of the North Atlantic, where it bred and raised young in massive colonies. It was a great swimmer but couldn't fly, which made the two-and-half-foot bird easy prey for...

The Sixth Extinction Summary Chapter 4: Evidence of an Asteroid Strike

In the late nineteen-seventies in Italy, American geologist Walter Alvarez discovered traces of the asteroid that ended the Cretaceous period, causing the fifth mass extinction, which wiped out 75% of all species.

He was studying rock layers in the Gola Del Bottaccione gorge outside the town of Gubbio, Italy, which is north of Rome. The region once lay at the bottom of the sea. The remains of marine animals built up through millennia, eventually creating the Apennine Mountains and elevating limestone cliffs.

Between the diagonal bands of limestone reflecting different time periods, Alvarez saw a thin layer of clay that contained none of the marine lifeforms seen in the limestone layers below or above it. Something had wiped out the foraminifera—tiny creatures with calcite shells that fossilize—below the clay layer; when forams appeared later in the limestone layer above the clay, they were different species and much smaller. Alvarez determined that the larger forams seen below the clay layer had vanished at the time dinosaurs were known to have died off (the End Cretaceous period).

Further, Alvarez and his father Luis, a physicist at UC Berkeley, tested the samples from the clay layer and found it contained a huge amount of iridium, a chemical element rare on the surface of the earth but common in meteorites. Similarly, the Alvarezes found high levels of iridium in samples of late-Cretaceous clay in limestone cliffs in Denmark and from the South Island of New Zealand.

Finally, after ruling out numerous possible explanations for the astronomical iridium levels, they theorized that 65 million years ago, a six-mile-wide asteroid struck the earth. It exploded on impact, releasing energy equivalent to more than a million H-bombs. Dust including iridium spread around the earth, creating darkness and causing temperatures to plunge. There was mass extinction.

The Alvarezes published their asteroid strike theory in 1980 in an article in Science titled “Extraterrestrial Cause for the Cretaceous-Tertiary Extinction,” which generated excitement in the science...

The Sixth Extinction Summary Chapter 5: A New Science of Extinction

Today's science of extinction developed from a series of paradigm shifts.

Sociologist Thomas Kuhn came up with the paradigm shift idea in 1962 to explain how a fundamental change in the basic concepts of scientific discipline leads to a totally new way of thinking. Kuhn showed through studies that when people receive “disruptive” information, which goes against their beliefs, they first try to fit it into their current thinking or framework. They disregard aspects that don't fit for as long as possible.

When the inconsistencies between the new information and their old way of thinking become too great to ignore, they reach a crisis point. They have what psychologists call a "My God!" reaction and begin to assimilate the new reality.

Both individuals and entire fields of study experience this process. In science, new data that doesn't fit accepted assumptions and principles is dismissed or rationalized. As the contradictory information grows, the explanations become crazier until people finally acknowledge the new reality. The old framework collapses and the paradigm shifts, opening the way for new insights.

The science of extinction evolved in this way. There wasn't any concept of extinction until the latter part of the eighteenth century. When strange bones were found, naturalists tried to match them to something familiar—for instance, arguing that mammoths
were a type of elephant. Then Cuvier changed the paradigm by showing through fossils that life had a progression and suggesting that species disappeared due to a catastrophic event.

However, so many extinct creatures were discovered in different time periods that the single-catastrophe framework weakened. Counter-arguments for slow extinction—the uniformitarian explanation—lasted for a century, until the discovery of the iridium layer, showing that a catastrophe did occur. And science faced a crisis undermining the uniformitarian view.

Today, the paradigm for extinction combines elements of both Cuvier's and Darwin's beliefs: **Life on earth consists of long periods of almost imperceptible change...**

**Shortform Exercise: Your Carbon Footprint**

Humans have changed the composition of the atmosphere by adding vast amounts of carbon dioxide—over two hundred years, the level of carbon dioxide in the air has risen by 40%. This is heating up the climate and acidifying the oceans, possibly setting in motion a sixth mass extinction.

Use this [Carbon Footprint Calculator](#) to determine your contribution to global warming. What are some ways you could decrease your carbon footprint? What could you do immediately?

**The Sixth Extinction Summary Chapter 6: Impacts—Ocean Acidification**

Oceans, covering 70% of the earth's surface, absorb a lot of the carbon we're pumping into the air—two-and-a-half-billion tons a year when this book was written in 2014—which is changing ocean chemistry.

In the past, there was a fairly even exchange of gases: the ocean absorbed gases from the atmosphere and also released dissolved gases back into the atmosphere. At this point, however, more CO2 is entering the oceans than they can release, resulting in acidification. (Carbon dioxide dissolves in water and forms carbonic acid.)

As a result, the pH of the oceans' surface water has decreased, making them 30% more acidic than they were in 1800. The pH is on track to fall to 7.8 (from today's average of 8.1) by the end of this century, making the oceans 150 percent more acidic than before the industrial revolution.

Ocean acidification may have played a major role in the most recent mass extinction event—the End Cretaceous. It's believed to have been a factor in two more of the Big Five—the End Permian and End Triassic and possibly in two lesser extinction events.

**Why Acidification is Dangerous**

In terms of destructive effects, ocean acidification has been called global warming’s “evil twin.” There are numerous reasons, which add up to a steep loss of biodiversity, including:

- Acidification affects the internal processes of marine organisms—for instance metabolism and enzyme activity.
- It changes the composition of microbial communities and thus the availability of key nutrients like iron and nitrogen.
- It changes the amount of light that passes through water.
- It stimulates toxic algae growth.
- It affects photosynthesis. Some species will benefit from higher CO2 levels, but others will be harmed.

Among the biggest victims will be calcifiers—animals and plants that construct shells or external skeletons. They include starfish, sea urchins, mollusks (clams and oysters), barnacles, and many coral species (the ones that build reefs). Many kinds of seaweed, some algae, and some plants also are calcifiers.
To build shells and...

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The Sixth Extinction Summary Chapter 7: Impacts—The End of Coral Reefs

Corals have endured for many geologic epochs, but researchers believe they won’t survive the Anthropocene. Instead, they’re on a course to be the first major ecological system to go extinct. The driving forces are acidification and climate change.

Some scientists project they’ll last out the century; others don’t give them even that long.

One paper in Nature predicted that visitors to the Great Barrier Reef in 2050 will find it rapidly disintegrating.

Coral reefs stretch around the middle of the globe. The largest is the Great Barrier Reef, which extends, with breaks, for more than fifteen hundred miles; in some places, it's five hundred feet thick. The next largest is off the coast of Belize. There also are sizeable reefs in the Pacific, the Indian Ocean, and the Red Sea, plus smaller reefs in the Caribbean.

Reefs are enchanting in their beauty—Darwin described them as “amongst the wonderful objects of the world.” Biologically, they are even more distinctive. Yet they are under dire threat.

How Reef-Building Corals Work

Coral reefs are strong enough to destroy ships, yet they're built by generations of tiny marine invertebrates called polyps that work together as communities, each secreting calcium carbonate to form a hard exoskeleton. Corals get nutrients from a microscopic plant (zooxanthellae) that lives in their tissues.

Among calcifiers, corals are master builders. Billions of individuals belonging to one hundred different species join forces to build a reef, which is a living, constantly growing structure.
Reefs are comparable to rainforests in the immense variety of life they support. **Millions of marine species spend part of their lives on reefs, depending on them for protection or food.** Additional species prey on those using reefs for protection or food. Researchers have cracked open small chunks of coral and found hundreds of species—one volleyball-sized piece contained fourteen hundred worms of one hundred and three species.

Coral are highly sensitive to ocean acidification. They need a certain “saturation state” or...

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**The Sixth Extinction Summary Chapter 8: Impacts—Rainforests and Biodiversity**

Most people think of global warming primarily as a threat to cold-climate species such as polar bears, penguins, and seals. Their worlds are changing dramatically as polar sea ice declines and gets thinner. And as the ice declines, the larger areas of open water absorb more heat, which melts more ice.

Half of the Arctic’s perennial sea ice has disappeared in the last thirty years and the rest may be gone in thirty more. Perennial sea ice, also known as multiyear ice, is thicker ice that survives the summer season. As the earth warms, the outlook for species that rely on the ice is grim.

But according to researchers, **global warming will have an even greater impact in the tropics because that’s where the most species live.** In Canada’s boreal forest of nearly a billion acres, there are only about twenty species of trees. In the U.S., eastern deciduous forests contain fifty to two hundred species. In contrast, Belize, in Central America, has some 700 native tree species. Manu National Park, in the Andes of Peru, is a forest reserve where researchers have counted more than a thousand species of trees.

The same pattern—fewer species in cold climates and many more in warmer climates—applies to birds, butterflies, frogs, and fungi. Biodiversity is lowest at the poles and increases as you go from the poles to the equator. There are three theories for why more species live in tropical rainforests:

- Just as farmers produce more in warmer climates because of a longer growing season, species produce more generations. The more they reproduce, the more likely there will be genetic changes and new species.
- More-stable temperatures in the tropics benefit species with low tolerance for wide swings in temperature.
- Rainforests have more species because they’ve been around longer (millions of years) with more time for species to develop; ice still covered Canada twenty thousand years ago.

Species in Manu National Park in the Andes are already responding to climate change. The reserve is a biodiversity “hot spot”—for instance, the cloud forest (a...

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**The Sixth Extinction Summary Chapter 9: Impacts—Fragmentation of Habitat**

As humans have reshaped the earth’s landmass, we’ve constrained the ability of other species to survive the life-altering effects of global warming.

Currently, the earth contains about fifty million square miles of land not covered by ice. We’ve transformed more than half—27 million square miles—into cities, highways and shopping centers, cropland and pasture, logging and mining operations, and manufacturing plants. That leaves 23 million square miles, which are mostly (three-fifths) forest; the other two-fifths are high mountains, tundra, and desert.

Another way of looking at how we use the planet is by dividing the landmass into “anthromes,” or human-altered zones, such as urban, irrigated cropland, and populated forest. Researchers have identified eighteen anthromes covering 39 million square miles.
That leaves 11 million square miles of wildland, including parts of the Amazon, Siberia, northern Canada, and the deserts.

However, there's virtually no area left that's truly untouched—roads, logging, and mining have sliced up and cut off every wild area to some extent. There are two results: **1) species lose the ability to move or flee, and 2) their ability to reproduce declines and extinction becomes more likely.**

Brazil's Reserve 1202, a twenty-five-acre block of untouched Amazon rainforest surrounded by cut-over forest and brush, illustrates the survival challenges we've created for other species.

It's part of a string of forest “islands” known as the Biological Dynamics of Forest Fragments Project or BDFFP, an experiment enabled by cooperation between ranchers and conservationists. In the 1970s, the Brazilian government gave ranchers a stipend as an incentive to create new ranchland by clearing rainforest. At the same time, they had to leave at least half the forest on their property intact. Scientists now known as “fragmentologists” have been managing and studying these untouched fragments for thirty years. What they're learning is how species respond to isolated, shrinking habitats.

Birds are an example. Reserve 1202 has at least thirteen hundred...

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**The Sixth Extinction Summary Chapter 10: Impacts—Dispersal of Species**

In the past, the range of many species was limited by geographic barriers such as oceans, rivers, and mountains. Today, however, species are being dispersed widely by humans, with disastrous consequences.

Darwin believed each species originated in one place. It spread by dispersing seed via the wind or it moved under its own power. With a lot of time, any organism could eventually spread widely. However, geographic features like oceans, mountains, and deserts set limits, which explained why flora and fauna on one continent could be different from those on another—they'd evolved separately.

However, Darwin struggled to answer the question of how the original colonizers got started. Also, his theory didn't explain why fossils of the same types of reptiles and plants were found on different continents. In later years, scientists wondered whether land bridges had once spanned oceans, allowing travel, or whether the continents had once been larger and then separated and shifted. The latter theory suggested there was originally one giant continent, Pangaea.

**In the Anthropocene, humans are, in a sense, reuniting the continents into a New Pangaea by dispersing species all around the globe** via various means of transportation—and with unprecedented speed. There are no barriers to species travel when they hitch rides with humans. As a result, in some regions, non-native (invasive) plants have exceeded native species. At any given time, an estimated ten thousand species are traveling around the world in ships’ ballast water. **Our constant reshuffling of species is unraveling millions of years of geographic separation.**

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**Invasive Species Spread**

The way we're moving species around the world is a type of Russian roulette—sometimes nothing much happens; other times, catastrophes result.

In the no-harm-done scenario, the new species doesn't survive because the climate is inhospitable, it can't find food, or it gets eaten by predators. This probably is what happens most of the time. But in the worst-case scenario, the new species thrives, reproduces, and becomes...

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**Shortform Exercise: Invasive Species**

Humans have spread invasive species around the world through various means of travel, shipping, and trade. Often, the invasives wipe out local species by predation, damaging crops, or spreading new diseases.
Visit the following website to identify the common invasives in your state. Which ones have you encountered near you or even in your backyard? How can you help get rid of them?

**The Sixth Extinction Summary Chapter 11: Last of the Megafauna**

A great variety of supersized animals—megafauna—once stalked the earth. Near the end of the Cretaceous period, there were many groups of huge dinosaurs besides *Tyrannosaurus*. Members of the *Saltasaurus* group weighed around seven tons. A member of the *Therizinosaurus* group was thirty feet long.

Near the end of the last ice age, there were enormous animals all over the world. In Europe, the roster included woolly rhinos, cave bears, giant elk, and hyenas. North America had mastodons, mammoths, giant camels, grizzly-size beavers, saber-toothed cats, and a giant ground sloth. South America had *glyptodonts*, which resembled armadillos the size of small cars. Australia's even weirder animals included *diprotodonts*, a group of huge marsupials called rhinoceros wombats; a marsupial lion, and a ten-foot-tall kangaroo. New Zealand had giant birds—the South Island giant moa was twelve feet tall.

Being very big was an evolutionary advantage—large animals had no predators. So the question of why the megafauna died out has puzzled scientists dating back to Cuvier's day, when the fossils of huge unknown creatures began turning up.

Scientists have debated whether megafauna disappeared due to climate change (possibly multiple events) or were killed by humans. But most researchers today lean toward blaming humans. The big animals' disappearance in Australia and the Americas coincided with the appearance of humans. There's also evidence that Maori killed off the giant birds in New Zealand: the remains of outdoor ovens and "middens" containing bones of large birds.

The advantage of being too big to have predators disappeared when humans came on the scene. At that point, the flipside of being extra-large—being slow to reproduce—became a disadvantage. If humans killed off large numbers of a species—or even killed small numbers continually for millennia—the rest wouldn't have been able to reproduce fast enough to avoid extinction.

**Big Animals in Trouble Today**

Human pressure plus slow reproduction are also why big animals like elephants, bears, and rhinos are...

**The Sixth Extinction Summary Chapter 12: Pruning the Family Tree**

From the day that modern humans migrated from Africa to the Middle East a hundred twenty thousand years ago, something in humans' genes set them apart from all other species, driving them to cross oceans, explore, and take over new areas, by killing off the locals and by altering the environment as they chose.

It might be called a restlessness or insanity gene, in that we've been pressing the envelope ever since, exploring the outer reaches of space but also altering our own world in ways that are driving other species—and maybe eventually ourselves—extinct.

**Pre-Modern Humans Discovered**

We share DNA with an archaic human, the Neanderthal, who didn't survive contact with us. The first bones of these distant relatives were found in 1856 in the Neander Valley in Germany is north of Cologne. The valley was lined with limestone cliffs, which were being quarried when workers discovered the bones in a cave.

They tossed the bones aside and they might have been lost, if the quarry's owner hadn't heard about them. Believing they were from a cave bear, the owner passed them on to a fossilist, who recognized them as resembling human bones and called them "a primitive member of our race."
This was around the time Darwin's *On the Origin of Species* had been published. Opponents of evolution dismissed the claims that the bones were a species of human. But over the next few decades, more bones of the same type turned up.

In 1908, a nearly complete skeleton was discovered in France. The Neanderthals (named after the valley where they were first discovered) were deemed to be more like apes than humans, although there's no evidence they were hairy, as they were depicted in drawings at the time.

However, starting in the 1950s, scientists began piecing together a different, more human-like story. They concluded that Neanderthals walked upright with a human-like gait. A set of bones found in the 1960s in Iraq had a head injury, which had healed, suggesting the victim been cared for by others. Another skeleton had been buried with flowers, a researcher contended,...

**The Sixth Extinction Summary Chapter 13: Saving Species, Saving Ourselves**

At the San Diego Zoo's Institute for Conservation Research, researchers are maintaining cell cultures of critically endangered and extinct species preserved in vials in tanks of nitrogen. One of them is the black-faced honeycreeper from Maui, believed to have gone extinct in the early 2000s.

In its Frozen Zoo, the institute has saved cell lines of about a thousand species, most of which still exist. The Cincinnati Zoo is doing something similar, as is England's University of Nottingham. (Shortform note: According to Wikipedia, genetic material can be stored in nitrogen indefinitely for possible use for artificial insemination, in vitro fertilization, embryo transfer, and cloning.)

While humans as a species have been destructive and shortsighted, researchers and conservationists also have joined together in heroic efforts, like the Frozen Zoo and the El Valle Amphibian Conservation Center in Panama, to save threatened species. Examples include:

- The British Act for the Preservation of Sea Birds (to stop their wholesale slaughter by sailors and hunters in Darwin's time).
- The creation of Yosemite National Park.
- The successful effort to save the California condor, launched in the mid-1980s.
- An effort launched in 1986 to save the whooping crane from extinction. Conservations taught captive-raised juvenile cranes how to migrate from Wisconsin to Florida, by leading them with ultralight aircraft.

But no matter how much people care about saving species from extinction, the fact remains that our presence changes the world—we've done so since we migrated out of Africa—and we've set in motion a mass extinction event. *We're all contributors,* whether a poacher in Africa, a logger in the Amazon, a commuter in Washington, D.C., or the reader of a book made of...
In the Sixth Extinction, what does the future...

Shortform Exercise: Your Representative’s Record

The U.S. Congress has voted on 257 environment-related bills this session.

Track your Congress member’s votes on environmental issues [here](#). What is his or her overall record? How would you like to see it change?