CONSTITUTIONAL RIGHTS FOUNDATION

BILL OF RIGHTS IN ACTION

SUMMER 2009 VOLUME 25 NUMBER 1

Are We Headed for a 'Sixth Mass Extinction'?

Earth has gone through five major mass extinctions of plant and animal species. Many scientists are convinced we are in the middle of a sixth mass extinction, caused mainly by human activity. If this is so, what can we do about it?

The extinction of plant and animal species has occurred on Earth since living organisms emerged, more than 3 billion years ago. Typically, a species will appear, thrive, and then die off over a span of millions of years. In fact, nearly all species that have ever lived on Earth are now extinct.

In the history of Earth, five rare but catastrophic events have caused "mass extinctions," the disappearance of many species. These "big five" along with smaller extinctions lasted up to a few million years.

Steller sea lions frolic in waters near San Francisco. Once plentiful throughout the North Pacific, the animals are today on the federal government's endangered species list. (National Ocean Service)

They had a number of natural causes, including widespread volcanic activity and large asteroid or comet impacts. These natural events projected dust into the atmosphere, causing periods of global cooling or warming. The dust also blocked plant photosynthesis, which eliminated the food supply of many animals. If plants and animals could not adapt to abrupt changes in the environment, they became extinct.

CURRENT ISSUES

The last mass extinction, about 65 million years ago, ended the reign of the dinosaurs, and opened the way for the evolution of mammals. Scientists think that most mass exterminations took place when long-term stresses on the environment like global climate change combined with a "short-term shock," like a large comet hit.

Species of plants and animals normally die off at about the same rate as new species arise. Biologists call this the "background rate" of extinction. When extinctions speed up sharply over a relatively short period, however, a mass extinction may be underway. Many biologists and other scientists are convinced that we are living right now in the middle of a sixth mass extinction.

Biologists have named about 1.8 million species of plants and animals. Probably tens of millions of species, mostly microorganisms, have yet to be discovered and studied.

The World Conservation Union maintains a worldwide "Red List" of at-risk species. The Red List now includes more than 16,000 known species in danger of extinction. Many unknown species, however, may become extinct before we even discover them.

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Environmental Issues

This edition of *Bill of Rights in Action* looks at issues related to the environment. The first article examines whether we are headed for a massive extinction of species. The second article explores the Columbian Exchange, the interchange between the New and Old World beginning in 1492. The last article looks at the reasons for the collapse of Egypt's Old Kingdom, the society that built the pyramids.

Current Issue: Are We Headed for a "Sixth Mass Extinction"?

U.S. History: The Columbian Exchange

World History: What Caused Egypt's Old Kingdom to Collapse?

This edition of *Bill of Rights in Action* was made possible by a generous grant from the Environmental Section of the Los Angeles County Bar Association.

The Red List includes 20 percent of the 6,000 mammal species, including large animals such as giant pandas, Asian elephants, and nearly half of all primates. Also on the Red List are 12 percent of the world's bird species, and a third of amphibian species, such as certain frogs.

What disturbs biologists most, however, is the increasing rate of the extinctions taking place today. Species are dying off thousands of times faster than the normal "background rate."

Harvard biologist Edward O. Wilson states that the extinction rate today is the highest ever and is accelerating. He predicts that if the extinction rate continues at its present pace, 20 percent of all plant and animal species are likely to be gone or near extinction by 2030. Half of all species, he warns, could be extinct by the end of the 21st century.

Aside from its unprecedented speed, extinction today has one other feature that makes it different from the "big five." For the first time, the major short-term shock, triggering the current upsurge of extinctions, appears to be human activity.

Biodiversity and Extinction

The opposite of species extinction is robust biological diversity (called biodiversity for short). Biodiversity means the widest possible variety of ecosystems like rainforests and deserts, species of plants and animals, and genes among members of a species.

Biodiversity promotes healthy organisms, enables the emergence of new species, and guards against disease and other threats to survival. When biodiversity collapses, as may be underway today, a mass extinction is the catastrophic result.

Biodiversity not only maintains species of plants and animals but humans, too. Stable and productive ecosystems with many healthy species provide what biologists call "ecosystem services" such as:

- regulating the world's climate
- purifying air and water
- forming and enriching soil for farming
- eliminating toxic substances
- pollinating crops
- preventing erosion

About 100 cultivated plant species provide 90 percent of the world's food supply for humans. In addition, scientists use the genetic diversity of wild plants to produce hybrids that improve food crop yields and resist pests and disease.

In the U.S., 40–50 percent of all prescription drugs contain substances first discovered in plants, animals, and microorganisms. The most famous is aspirin, originally developed from the bark of a willow tree.

Other examples include antibiotics, anti-malaria medicine, blood thinners, drugs to treat HIV-AIDS, and chemicals to stop organ transplant rejection. "Bioprospectors" discovered a powerful anti-cancer substance in the rosy periwinkle, a plant found only in Madagascar's disappearing tropical rainforest.

Plant and animal species in a biodiverse ecosystem depend on each other for food, shelter, their reproductive cycle, and other needs. When one species becomes extinct, others may follow in an accelerating cascade. Eventually, entire ecosystems with their many species and gene pools are doomed to extinction. The quickening rate of species extinctions today puts biodiversity at risk throughout the world.

Humans began to cultivate crops and domesticate animals on a large scale about 8,000 years ago. People began to cut down forests and clear grasslands for farming. They commonly cleared wild areas by burning the plant cover, called "slash and burn" farming, which released carbon dioxide and other gases into the atmosphere. Scientists say the increase of such gases in the atmosphere turned what should have been another ice age into a warming climate.

The invention of agriculture added greatly to the food supply and caused a boom in the human population. It also, however, eliminated some native plant and animal habitats, leading to more extinctions and less biodiversity.

The Industrial Revolution in Europe in the mid-1700s caused a rapid growth in the burning of fossil fuels like coal. As our energy demands have increased, scientists have observed a sharp increase in global warming. This climate change may cause the extinction of species unable to adapt.

Meanwhile, the human population exploded. Two-thousand years ago, there may have been 300 million humans on Earth. By 1800, there were about 1 billion. In 2000, the world's population reached 6 billion, and it may rise to 10 billion by 2100.

The Human Impact Today

As the human population continues to grow, biodiversity is shrinking, and the rate of plant and animal extinction is accelerating.

Habitat Damage and Loss

Today, farms, factories, cities, roads, dams, housing, mines, and logging operations help to make up the "human footprint" on the natural environment. As this footprint gets bigger, the habitats of plants and animals get smaller. For example, the extent of the world's forests peaked about 8,000 years ago, before the invention of agriculture. Only half of these forests remain today. Farmland, roads, and development fragment many of them into isolated "inland islands" too small to sustain some native species.

Invasive Species

Invasive species are plants and animals that enter an area where they did not naturally evolve. Invasives may take over the habitat and resources used by native species and eventually force them to extinction.

Humans themselves are the ultimate invasive species. But humans have also been the main carriers of invasive plants and animals, either on purpose or accidentally. Farmers introduced the Asian kudzu vine into U.S. Southern states to control erosion. The vine, which can grow a foot a day, was impossible to manage and took over the countryside, ruining the habitats of many native plant and animal species.

Pollution of air, water, and land can imperil the survival of species. (Wikimedia Commons)

Pollution

The damage to plants and animals caused by pollution has increased with the expansion of agriculture and industry. Some of most important sources of environmental pollution have been automobile exhaust, pesticides, farm fertilizer runoff, acid rain fallout from industry smokestacks, oil and sewage spills in the ocean, and fresh-water chemical dumping.

Some pollutants are long lasting in the environment. They may also move up the food chain, affecting the health and survival of many species.

Overharvesting and Poaching

Overharvesting involves hunting or fishing a species to extinction. This almost happened to the American bison in the late 1800s. Only a few hundred North American right whales, an overhunted marine mammal, survive today. Biologists count them among the "living dead" since there is little chance that they will avoid extinction.

Poaching is illegal hunting or fishing. In some parts of the world, people hunt endangered animals for "bushmeat" or for a valuable part of their body. Poachers have long killed elephants just for the ivory of their tusks. There is still a thriving market in Asian countries for powdered rhinoceros horn, which many people erroneously believe increases their sexual potency.

Global Warming

Most of the global warming (also called "climate change") occurring today has resulted from the burning of fossil fuels like coal, oil, and natural gas. When these fuels burn, gases such as carbon dioxide, methane, and nitrous oxide escape into the atmosphere and trap heat from the sun like a glass greenhouse. Average annual global temperatures over the past decade are among the 12 warmest since 1850. They are also rising faster than previously predicted.

Debate surrounds all aspects of global warming—its cause, its extent, what to do about it, and even whether it exists. But an overwhelming majority of scientists recognize the problem as real as have the Democratic Obama and Republican Bush administrations.

Nearly all climate scientists in the world agree that global warming today is mainly due to the greenhouse gas effect. The main culprit among the greenhouse gases is carbon dioxide (CO_2), which the U.S. government recently classified as a form of pollution. CO_2 makes up 56.6 percent of all greenhouse gas emissions and already exceeds what scientists think should be its maximum level in the atmosphere.

Global warming will force many heat sensitive plants and animals to seek a cooler climate northward or southward toward the poles or in higher altitudes. Some plants may not be able to migrate fast enough. Migrating animals may become invasive and replace native species. Other animals, like polar bears, will have nowhere to go.

The Intergovernmental Panel on Climate Change, an organization of world scientists, reports on the causes and projected impacts of global warming. The panel's latest assessment report (2007), states that up to 30 percent of species will be at increasing risk of extinction if the global average temperature increases from 1–4 degrees Celsius (1.8–7.2 degrees Fahrenheit) relative to 1980–99. If the

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average increase in tempreature exceeds 4 degrees Celsius, "significant extinctions around the globe" will occur.

'Hot Spots' and Endangered Species

"Hot Spots" are ecosystems of the world that contain the richest biodiversity and largest numbers of species found nowhere else. They are also under the greatest threats of species extinction.

On land, most hot spots are located in tropical rainforests, home to more than half the world's plant and animal species. Thousands of square miles of rainforests along with their plant and animal habitats are lost each year to logging, farming, ranching, mining, and similar human activities.

The rainforest of the large island of Madagascar off the coast of East Africa had perhaps the most biodiverse environment anywhere in the world before humans arrived about 1,500 years ago. Today, Madagascar is a hot spot that has lost 80 percent of its rainforest, mainly to "slash and burn" farming.

Most people would probably never guess that biologists sometimes call lush tropical Hawaii "America's extinction capital." More than 70 species of native birds have gone extinct since humans first landed about A.D. 330. Today, this hot spot has more native bird species at risk of extinction than anywhere else in the U.S.

Hawaiian birds have especially suffered from invasive species of birds and mammals such as wild pigs, introduced into the islands by humans. Native birds are vulnerable to diseases carried by mosquitoes, another invasive species. To avoid the mosquitoes, birds have moved to higher elevations. But global warming has allowed mosquitoes to live in higher altitudes, forcing the native birds into smaller habitats at even higher altitudes where mosquitoes cannot live.

Coral reefs are the rainforests of the ocean. Corals are marine organisms that build the reefs, usually in tropical waters. Already, the world has lost about 20 percent of its coral reefs. The Coral Triangle, located in the ocean waters of Southeast Asia, is the world's center of marine biodiversity and an endangered species hot spot. Covering an area half the size of the U.S., these reefs provide cover and feeding areas for 3,000 fish species plus whales, dolphins, sea turtles, and other marine animals.

Although tsunamis, overharvesting, fishing with explosives, pollution, and urban development have damaged or destroyed many coral reefs, the chief threat today is "coral bleaching." This kills corals when the water temperature increases due to global warming.

In the Arctic, sea ice is a key part of the habitat of polar bears. Sea ice is rapidly shrinking each year because of global warming. Polar bears depend on the ice as a platform to hunt seals and other marine animals. The bears also use the ice to migrate to land for mating.

The loss of sea ice means polar bears will eventually starve and fail to reproduce. In 2007, the U.S. Geological Survey (USGS) projected that two-thirds of the world's 25,000 polar bears, including all in Alaska, could be extinct by 2050. The USGS warned that by 2100 all polar bears may be extinct if greenhouse gas emissions continue at the current level.

Preventing the 'Sixth Mass Extinction'

The Endangered Species Act (ESA), signed by President Richard Nixon in 1973, was one of the earliest efforts by the U.S. to save species in danger of extinction. The ESA lists species at risk as "endangered" or "threatened," and identifies areas of "critical habitat." The ESA prohibits the killing, harming, or damaging of listed species and habitats.

The ESA also requires recovery plans to increase the numbers of the endangered and threatened species so they no longer need to be on the list. As of August 2008, the government has delisted about 20 species, including the bald eagle and grizzly bear, due to their recovery. More than 1,300 other species remain on the list.

The U.S. is currently debating how best to slow down global warming. Some propose a carbon tax on emitters of C02 such as coal power plants. Others want to increase required miles-per-gallon standards for cars and trucks or boost taxes on the sale of gasoline to reduce driving.

Another approach involves a "cap and trade" system. Companies would be required to get government permits and credits, limiting them to specific amounts of greenhouse gas emissions (the "cap"). Those that exceed their cap would have to buy credits from other companies that emitted less than their cap (the "trade").

Those calling themselves "green conservatives" reject taxes and cap and trade because they would make driving, electricity use, and many consumer products more expensive. Conservatives favor such approaches as developing clean coal technology, building more nuclear power plants, and granting tax credits to auto companies for the cost of switching to hybrids and hydrogen cars.

Biologist Edward O. Wilson argues that we should focus our efforts to avoid another mass extinction by preserving biodiversity. Doing this, he says, would force us to find workable ways for saving the world's hot spots, protecting habitats, and slowing down global warming. For example, he suggests making conservation profitable to local economies by encouraging "ecotourism" that takes advantage of healthy biodiverse environments.

Preserving biodiversity and preventing plant and animal extinctions will require changes in how we currently use the environment. For example, the U.S. Forest Service issued a "Travel Management Rule" in 2005 that restricts the use of motorized vehicles to certain trails, roads, and areas in federal forests and grasslands.

The Forest Service rule regulates off-highway vehicles (OHVs), which may include dune buggies, motorcycles, ATVs (all-terrain vehicles), snowmobiles, and jet skis. The rule considers national forests and grasslands closed to motorized use unless posted notices permit specific types of vehicles. One of the reasons the Forest Service introduced this rule was because the increased popularity of off-roading was causing damage and pollution to natural areas and habitats.

The current loss of biodiversity and upsurge of extinctions is complex and affects every area of the world from rainforests and coral reefs to the Arctic and our own backyards. The question is: Do we have the will to make the difficult decisions necessary to save endangered species?

For Discussion and Writing

1. What evidence do scientists present that Earth is headed for a sixth mass extinction?

2. The U.S. Fish and Wildlife Service lists all endangered species by state at http://ecos.fws.gov/tess_public/pub/stateListingAndOccurrence.jsp. Go to this site and click on your state. A list of endangered (E) and threatened (T) species in your state will appear. Clicking on the scientific name of one of the species will bring up information about it. What information can you find about the status of this species in its Recovery Plan?

3. What do you think is the most important action the U.S. should be taking right now to improve biodiversity and reduce plant and animal extinctions? Defend your choice.

For Further Reading

Walsh, Bryan. "The New Age of Extinction." Time. 13 April 2009:43–50.

Wilson, Edward O. *The Future of Life*. New York: Vintage Books, 2002.

A C T I V I T Y

Restricting Vehicles and Bicycles on Public Land

Form small groups. In your groups, do the following:

A. Discuss whether to support or oppose the following proposed rules to restrict the use of street vehicles, OHVs, and bicycles on public land. Public land includes national and state forests, grasslands, parks, deserts, marshlands, ocean beaches, and fresh water lakes and rivers. You may change a rule to make it more acceptable to the group.

   1. Hunters may not use motorized vehicles off-road to retrieve game.

   2. Motorized vehicles may not be used off-road for camping, fishing, or picnicking.

   3. OHVs are prohibited on beach or desert sand dunes.

   4. OHVs must be equipped with air pollution devices that meet the same standards as automobiles.

   5. Bicycle use is prohibited for cross-country travel or in areas likely to cause significant soil erosion, trail damage, or disturbance of wildlife or their habitats.

   6. Motor vehicles and bicycles may only be used on roads, trails, or other areas posted for their use.

B. Write another rule to regulate the use of OHVs or bicycles on public land.

C. Report and defend your conclusions on the six rules and the one written by your group to the rest of the class.

The Columbian Exchange

In 1492, Columbus brought the Eastern and Western Hemispheres back together. The resulting swap of Old and New World germs, animals, plants, peoples, and cultures has been called the "Columbian Exchange."

Humans from Asia probably first entered the Western Hemisphere between 20,000 and 30,000 years ago. They could have traveled by foot across a land bridge, by small boats along the bridge coastline, or by both methods.

About 10,000 years ago, the sea level rose, submerging the land connection between the two hemispheres. The two hemispheres took separate biological and cultural paths.

The Columbian Exchange began with Columbus landing in the New World, establishing the first significant connection between the peoples of the Eastern and Western Hemispheres in 10,000 years. (Library of Congress)

Christopher Columbus, an Italian sailing for King Ferdinand and Queen Isabella of Spain, landed his three ships on an island in the Caribbean in 1492. Columbus explored several nearby islands, including a large one the Spanish called Hispaniola, shared today by Haiti and the Dominican Republic.

On Hispaniola, Columbus found the Taino, a people who grew crops he had never seen before, such as sweet potatoes, manioc, peanuts, and tobacco. The Spanish and Taino traded and enjoyed friendly relations. Columbus noted the Taino possessed small objects made of gold, which they mined on the island.

U S HISTORY

Columbus established a settlement on Hispaniola, Villa de la Navidad, the first European outpost in America. He left about 40 of his men there and headed back to Spain with astounding news.

Aboard ship, Columbus wrote a report of his discoveries: "I discovered a great many islands inhabited by people without number, and of them all I have taken possession on behalf of Their Highnesses." He described strange trees, fruits, birds, and "beautiful thick soil."

Columbus described the Taino people as "very good looking" but "unbelievably fearful." They had no iron or steel and only bows and arrows for weapons. "They still think I come from heaven," he wrote with amazement. Columbus declared at the end of his report that in the future he could bring the king and queen gold, spices, cotton, and slaves.

At first, Columbus thought he had reached the Indies, islands off the southeast coast of Asia, and called the people he encountered "Indians." In fact, Columbus had made a connection between the two hemispheres for the first time in 10,000 years.

On his second voyage in 1493, Columbus returned to America with 17 ships and 1,300 men, including several Catholic priests to convert the Taino to Christianity. Columbus discovered the Taino had killed all the men he had left at Navidad. He used this news as justification to take Taino slaves.

Of even greater long-term significance were the plants and animals that Columbus carried in the holds of his ships. He brought seeds and cuttings for Old World vegetables, wheat, grapevines, sugarcane, and fruit trees. In addition, he transported live pigs, cattle, chickens, sheep, goats, and horses, none of which lived in the New World. Horses had actually originated in America, spread to the Eastern Hemisphere over the land bridge, and then became extinct in their homeland.

Thus, in 1493, Columbus began a process of swapping Old and New World plants and animals along with stowaway pests, weeds, and germs. As a result, both the Old and New Worlds were changed. Texas historian Alfred W. Crosby called this global enterprise the "Columbian Exchange."

Why Did Europeans Conquer America So Easily?

Estimates of the population of the Western Hemisphere before Columbus generally range between 30 and 100 million people. Recent studies lean to the high end of this range. Possibly more people lived in the New World in

1492 than in Europe. Early reports indicate that Hispaniola alone held a million Taino Indians.

How did the Spanish and other Europeans so easily conquer America when huge numbers of potentially hostile people outnumbered them? Although they were superior farmers, the peoples of the New World lagged far behind the Spanish in technology. Some knew about the wheel, but since they had no horses, donkeys, mules, or oxen, they never developed wheeled vehicles. They made no steel tools or weapons. Neither did they possess gunpowder.

The greatest weakness of New World peoples, however, proved to be their lack of resistance against Old World diseases. Some of the people who entered America from Asia before the land bridge disappeared might have carried Old World pathogens (bacteria or viruses causing disease). But biologists think these people or the pathogens themselves would not have survived long in the Arctic cold.

New World peoples were relatively healthy compared to their Old World cousins. Without exposure to Old World pathogens, however, the people of New World had no chance to pass on genetic resistance or acquire lifetime immunities by surviving diseases in childhood.

Europe and later Africa exported, unintentionally, more than a dozen diseases that killed large numbers of American natives. Some, like measles and chickenpox, were childhood diseases that usually did not cause many deaths in the Old World but killed millions of American natives.

The Old World disease that killed more New World people than any other was smallpox. A person caught this disease by breathing in the smallpox virus or by coming into contact with the pus-filled boils or scabs on a victim's skin. Death often occurred after a high fever, the eruption of boils, and massive vomiting of blood. Scars from the boils disfigured victims who survived. Survivors were also usually immune from another smallpox infection.

The first smallpox epidemic in the New World began in 1518 on Hispaniola among the Taino. Up to 50 percent of them, about a half-million people, died within two years. Few of the Spanish suffered the disease since most acquired immunity after surviving smallpox as children. Within 100 years, the Taino were extinct, mainly due to smallpox and other diseases.

The Taino disaster was repeated many times in the New World. The native peoples had no experience with quarantines. Their medicines and religious beliefs could not stop the sicknesses. The epidemics struck down their leaders, farmers, and warriors, leaving few to care for or protect those who might have survived. Famine, something rare in the Western Hemisphere before Columbus, often went hand-in-hand with the epidemics.

In 1519, Hernando Cortez invaded Aztec Mexico with 600 soldiers, 14 cannons, 13 muskets, and 16 horses. After gaining the support of discontented peoples ruled by the Aztecs, Cortez seized their capital city. Tenochtitlan, with a population of 200,000, was larger than Paris, Europe's greatest city.

After the Spanish abused the people, the Aztecs revolted, and drove the Spanish out of their city. By the time Cortez regrouped and returned, however, smallpox was raging within Tenochtitlan, wiping out a third of the people. Cortez had little difficulty defeating the sick and starving Aztecs.

Once they reached the mainland, smallpox and other Old World diseases spread unbelievably fast. Epidemics actually struck before the Spanish conquistadors entered new lands in Central and South America. Infected natives fleeing an epidemic made better carriers of the disease than the Spanish themselves.

Smallpox killed the Inca leader, which set off a civil war before Francisco Pizarro reached Peru in 1530. In 1620 when the Pilgrims landed in New England, typhus or the bubonic plague had depopulated the entire coastal region a few years before. In 1837–38, smallpox killed up to 50 percent of the North American Plains Indians.

Most historians now agree that over a period of about 300 years, about 90 percent of New World peoples died of Old World diseases or related causes such as lack of care and starvation. Taking the average of the low and high estimates of people living in the Western Hemisphere before 1492 (65 million), at least 58.5 million people would have perished. Geographer W. George Lovell has called this "the greatest destruction of lives in human history."

Did New World diseases go the other way and devastate Old World peoples? The only candidate is syphilis, a sexually transmitted venereal disease.

A syphilis epidemic erupted suddenly and killed many in Europe only a few years after Columbus returned from his first voyage. The deadliness of this epidemic seems to be evidence that it was new to Europeans. A recent genetic study indicates that a bacteria subspecies of American yaws, a non-venereal skin disease, may have mutated into syphilis in Europe's cooler climate. Scientists, however, still debate the origin of this disease.

Old World Animals

Old World domesticated animals caused major changes in New World nutrition, cultures, and ecology. The only significant New World domesticated animal capable of carrying small loads was the llama in the South American Andes.

The pigs that Columbus first brought in 1493 flourished on Hispaniola and eventually everywhere in the New World. Soon, wild herds of them roamed the land, eating almost everything in sight, including the food crops of the natives.

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Major Biological Contributions to the Columbian Exchange		
Type of Contribution	**Old World to New**	**New World to Old**
Domesticated Animals	Pigs Cattle Horses (reintroduced) Sheep Goats Chickens Donkeys and Mules	Llamas Alpacas Turkeys
Food Crops	Wheat Barley Rice Soybeans Lettuce and other vegetables	Maize (corn) Potatoes (white & sweet) Manioc (tapioca) Peanuts Beans (many varieties) Squash Tomatoes
Cash Crops	Sugarcane Coffee Bananas Citrus and Stone Fruits Olives Wine Grapes	Tobacco Long-fiber cotton Cacao (chocolate) Vanilla Chile Peppers & Paprika Pineapples Avocados Papayas and Guavas Rubber Coca (cocaine)
Invasive Organisms	Black Rats Weeds and Grasses	Gray Squirrels Potato Fungus
Human Diseases	Smallpox Measles Plague Influenza Chickenpox Malaria Yellow Fever Typhoid Fever Typhus Whooping Cough Cholera Diphtheria Scarlet Fever	Syphilis (?)

But they provided a plentiful supply of protein for the Spanish and natives alike.

European cattle, too, soon multiplied into vast wild longhorn herds in the highlands of Mexico and the Pampas, the grassy plains of Argentina. The Spanish established ranchos with hundreds of thousands of cattle that provided beef for local consumption and hides for export.

Some native people adopted livestock ranching as a new way of life. No European domesticated animal, however, had a bigger impact on New World peoples than the horse.

The horse amazed the Aztecs, who at first believed men were riding huge deer. Once horses migrated into the grasslands of North and South America in the late 1500s, they exploded in population and were free for the taking.

Horses were a weapon of war, hauled freight, made cattle ranching possible, and totally transformed the cultures of American Great Plains Indians. For a few generations, the Great Plains Indians became buffalo hunters and warlike raiders on horseback, the last of the New World peoples to hold out against the European invasion.

Old World domesticated animals contributed mightily to the food supply, hauling power, and transportation of New World peoples. But there were also some negative ecological consequences. Steel plows pulled by horses, oxen, and mules plus overgrazing by herds of pigs, cattle, sheep, and goats speeded up erosion of rich soil.

Along with the feed for animals transported to America came Old World grasses and weeds like the dandelion. Old World plants sometimes displaced native plants and threatened animal habitats. Then there were the European rats that competed with small native animals and spread the bubonic plague through the fleas that infested them.

New World Crops

The Spanish discovered that wheat, Europe's basic food crop, did poorly in tropical America where they first established colonies. Maize (corn), potatoes, beans, and other New World crops, however, eventually flourished in Europe and spread to the rest of the Old World.

Corn produces more food per acre than wheat or any crop imported to America from Europe. The leaves covering the ears of corn help to protect the kernels from hail, birds, insects, and drought. People can eat corn raw as well as roasted on the cob, baked into bread, popped, and made into cornmeal mush. It can also be stored for long periods.

Indian farmers had created corn from a wild grass several thousand years ago. By carefully selecting seed kernels and controlling pollination, farmers gradually increased the size of ears of corn. Humans must plant seed corn for it to grow because the leaf husk protecting the kernels prevents natural germination.

The farmers inserted several corn kernels into small hills about a yard apart and added fish heads or bird guano as fertilizer. Then they planted beans, squash, and other vegetables among the hills. This method of cultivation, called *milpa* farming, prevented exhaustion of the soil, and produced a balanced human diet.

At first, people in Europe grew corn as animal fodder. But the value of corn as human food proved itself. Capable of growing fast in a variety of climates, corn prevented starvation when wheat crops failed. It soon spread throughout Europe, Africa, and then the rest of the world.

Pizarro discovered Indians growing white potatoes in the Andes Mountains of Peru. The white potato was a wild plant that the Indians developed into thousands of varieties. This plant produces more food on less land than any other crop. It is also easy to grow from seed or potato cuttings.

For a long time, most people in Europe considered the white potato merely as food for animals or the poor. But this New World crop again came to the rescue when grain failures occurred. In addition, since potatoes grow underground, bad weather and rampaging armies did not destroy them.

The potato proved to be a major food for England's new industrial workers. It did best, however, in Ireland's soil and climate. Poor people could grow enough potatoes on tiny plots to feed their families.

The fatal flaw was that the Irish grew only one or two varieties, which turned out to be vulnerable to an American fungus that made its way to Ireland in the 1840s. The resulting potato famine caused a million Irish to die of starvation and even more to leave the country, especially to the United States.

The New World provided many other popular food crops. Among them were root crops like sweet potatoes and manioc (tapioca), which grow in poor soils and resist drought. American peanuts offered a new source of protein.

New World crops helped create a food revolution in Europe and most of the rest of the Old World. This helped set off a population explosion.

Europe's population went from about 70 million in 1492 to 90 million in 1600 and 180 million by 1800. The world's population doubled between 1650 and 1850. Today, one-third of all food for people and animals comes from plants with New World origins.

The Desperate Need for Labor

The Spanish conquistadors quickly put Indians to work, often as slaves, mining gold and silver. Mine owners discovered that if Indian miners working at high altitudes in the mountains chewed coca leaves, they were stimulated to work longer each day. The gold and silver sent back to Spain financed a new European global trading system.

The Spanish conquistadors also found they could make a lot of money ranching cattle and growing plantation cash crops like sugar, tobacco, and long-fiber cotton for export to Europe. The Spanish crown granted the conquistadors *encomiendas*, which gave them the right to use the labor of Indians to work their ranchos and plantations.

The continuing epidemics and harsh working conditions, however, caused most Indian workers to die off quickly. The Spanish and other Europeans colonizing the New World needed a new source of labor. They tried European indentured servants, convicts, and even kidnap victims. But by about 1550, African diseases like yellow fever and malaria had crossed the Atlantic and were killing Europeans and Indians alike.

The African slave trade then began. The Portuguese were the first to cash in on selling African slaves in the New World, but the Dutch, English, French, and Danes soon joined this business. Africans proved resistant to yellow

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fever and malaria and survived working in the tropical heat better than Indians or Europeans.

From the 1500s until 1870, when the slave trade finally ended, Europeans transported an estimated 10 million Africans to America. Europeans also came in large numbers. Prompted by Europe's rapidly growing population, shortage of cheap land, and poor industrial conditions, about 50 million Europeans had crossed the Atlantic by 1930. In effect, the African and European mass migrations helped repopulate the New World.

The Global Exchange

Around 1630, Indians in Peru passed on their knowledge of a tree bark that produced quinine, which treated and helped prevent malaria in tropical regions around the world. Europeans in the mid-1800s also extracted cocaine from coca leaves, unleashing a global plague of drug trafficking and addiction.

Kudzu, a fast-growing vine from Japan, appeared at the Philadelphia Centennial Exposition of 1876 as an animal fodder. Farmers later used it to control erosion. But the plant took off in the South, smothering everything it could reach.

On the other hand, the Asian soybean helped restore nutrients to the soil in the Dust Bowl of the U.S. during the 1930s. Rich in protein, the versatile soybean can be processed into flour, cooking oil, milk, ice cream, paint, plastics, and even silk.

Today, diseases can spread much faster than in the days of Columbus, as the recent pandemic of swine flu proved. The mobility of people throughout the world in an age of air flight has enabled germs to rapidly spread and sometimes mutate into deadly diseases.

Thus, the swapping of germs, animals, and plants that Columbus began has continued and expanded worldwide to the present day. Today's "Global Exchange," like the Columbian Exchange before it, also has its positive and negative consequences.

For Discussion and Writing

1. In what ways did the New and Old Worlds change as a result of the "Columbian Exchange"?
2. What do you think was the best Old World contribution to the New World and best New World contribution to the Old World? Why?
3. Do you think the "Columbian Exchange" was more of a positive or negative development in world history? Give evidence from the article to support your view.

A C T I V I T Y

What Should We Do With Bambi?

The Point Reyes National Seashore is a 70,000-acre park located north of San Francisco. In the 1940s, before this park was established, a local landowner bought a few axis and fallow deer from the San Francisco Zoo and released them there. The deer, native to India and the Mediterranean region, flourished and currently number about 1,100. These non-native deer are now threatening to drive the native tule elk and black-tailed deer in the park from their natural habitat. This could result in a severe decline in their population or even extinction.

Procedure

1. Form small groups. Each group is to discuss and decide which of the measures below it believes would be best to deal with the fallow deer problem.
2. Each group should do the following:
   a. Discuss which community or activist groups might favor and oppose the measure. If a measure is likely to get more support than opposition, it makes it a more realistic option.
   b. Discuss the pros and cons of the measure.
   c. Decide which measure to recommend.
   d. Be prepared to report its recommendation and defend it with reasons.

Measures

1. Start a program of hunting and slaughtering the deer to provide meat for charities serving poor and homeless people.
2. Use contraceptive methods to prevent any more new births among the axis and fallow deer; they will then die out naturally.
3. Remove the deer to zoos or wildlife sanctuaries
4. Leave the deer alone.

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What Caused Egypt's Old Kingdom to Collapse?

The farmers of Egypt's Old Kingdom did not have to worry much about local rainfall, irrigated fields, or poor soil. If the annual Nile River floods were too low, however, disaster could strike the kingdom.

Egyptian farmers depended on the annual Nile flood. (Wikimedia Commons)

The Agricultural Revolution appeared relatively late in ancient Egypt. The lush environment of the Nile River provided an abundant food supply of wild edible plants and seeds, fish, birds, and big game to the people who lived there.

Nile is a Greek name for what the ancient Egyptians simply called "the river," which flows northward through Upper and Lower Egypt. Upper Egypt begins in the southern end of the country at the first Nile cataract (waterfalls), near present-day Aswan. The river then heads downstream about 600 miles through the Nile Valley to where it forms a wide delta before emptying into the Mediterranean Sea. The marshes and islands of the delta form Lower Egypt.

WORLD HISTORY

A branch of the Nile breaks away in the middle of Egypt. The branch flows roughly parallel to the main channel for a couple hundred miles, turns sharply west into the Sahara Desert, and fills a lake and marshlands called the Faiyum Oasis.

Around 5000 B.C., Egypt's growing population required a larger food supply. This forced the early Egyptians to domesticate animals like cattle and to plant grain crops such as barley, which depended on winter rainfall. But the Egyptians soon developed a unique method of growing their crops by taking advantage of the Nile River flood that occurred each summer.

The Nile Flood

The annual Nile flood happened because of heavy summer rains far away to the south in the highlands of what are now Ethiopia and East Africa. Rivers from these areas drained into the Nile. The river's floodwaters surged northward through Upper and Lower Egypt to the Mediterranean.

The Nile overflowed its banks each year around September. The water went onto a flood plain that extended the length of the river and averaged a dozen miles wide. Each year, the floodwaters deposited new fertile silt into natural basins. Farmers did not have to add fertilizer to the soil.

After the water soaked into the earth in the late fall, farmers cast seeds onto the moist rich soil and turned it over with wooden plows pulled by oxen. Nature did the rest until it was time to harvest the crops in the spring. The cycle started all over again with the next Nile summer flood.

The annual Nile flood made it unnecessary to construct complex irrigation projects, as was the case in Mesopotamia (present-day Iraq). Local authorities merely directed farmers to dig channels and construct small earthen dams and riverbank levees to divert floodwaters into or away from certain areas.

The first extensive Egyptian irrigation projects did not occur until after 300 B.C. in the area of the Faiyum Oasis. The early Egyptians had largely ignored this area as a major farming region.

Furthermore, the early Egyptians did not have the technology to lift or pump water from one level to another except by physically carrying buckets. The Nile flood did this work for them. Only much later in Egyptian history did farmers use a pole and bucket lever (*shaduf*) to lift water from the Nile during the dry season to grow a second or even third crop.

The ideal flood in the Nile Valley was about 30 feet above the usual river level. A flood above this level could destroy villages, drown livestock, and cause loss of human life. A low flood could also cause great damage. Less land could be cultivated resulting in food shortages.

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Before its collapse, Egypt's Old Kingdom built the Great Sphinx and all the major pyramids. (Library of Congress)

A series of Nile failures, lasting several years or even decades, had disastrous consequences. When these Nile failures periodically occurred, famine stalked the land, causing mass starvation.

The ancient Egyptians kept records of the Nile floods using Nilometers. These were usually stone structures with markings that measured the highest level of each flood.

Following the unification of Upper and Lower Egypt under King Narmer around 3000 B.C., surviving Nilometer records show the beginning of a trend toward lower than normal floods. This eventually spelled trouble for the Egyptian people.

The Rise of the Old Kingdom

Historians have traditionally organized Egypt's history by groups of dynasties (families of kings or pharaohs). The Old Kingdom includes the first important dynasties that made Egypt an advanced civilization. The Old Kingdom began with the Third Dynasty of kings in 2686 B.C. and ended with the Eighth Dynasty, more than 500 years later.

Memphis (also a Greek name) was the capital of the Old Kingdom. It was located on the banks of the Nile where Upper and Lower Egypt joined (near modern Cairo). Upper and Lower Egypt were organized into about 40 districts, called *nomes*, each with a governor who owed his post and loyalty to the king.

The king, wearing the double crown of Upper and Lower Egypt, held absolute authority. Officials kissed the ground before his feet. Egyptians believed only the king could speak to the gods on their behalf.

By carrying out sacred rituals and ceremonies, the king assured order, protection of the people, and the seasonal Nile flood. When trouble occurred, such as a low flood or plague, Egyptians believed the king had failed to perform his duties adequately.

A capable bureaucracy of officials, literate in reading and writing hieroglyphics, served the king. During the early Old Kingdom dynasties, members of the royal family made up this elite class. Later, the king chose those without royal blood, largely by merit, to administer the kingdom.

Since no monetary system yet existed in Egypt, the king paid his most important government officials by granting them estates, including the people who worked on them. When these officials died, the estates went back to the king.

The highest official and adviser of the king was the vizier, who was in charge of all government departments. Surprisingly, no department had responsibility to oversee the annual Nile flood.

The common people in the Old Kingdom lived mostly in small towns and farming villages attached to large estates. The king claimed ownership of all land in Egypt, but he handed out estates to royal family members, to high government officials, and for temples to the gods or former kings.

The common people who worked on these estates were bound to them. They did not have the freedom to leave. But they were not slaves who could be bought and sold. Men and women bound to an estate had a duty to work the land to feed themselves and to hand over a portion of their crops to the landowner. The king occasionally drafted men to work on royal construction projects and to serve as soldiers.

During most of the Old Kingdom, the population remained stable at around 1.5 million. In times of normal floods, Nile flood-plain agriculture could easily supply food for this number of people.

Unless exempted by the king, estate owners paid taxes in the form of grain, cattle, or other agricultural products. The king's treasury consisted of storehouses for these products to be used as pay for government workers and craftsmen, donations to temples, and trade goods in foreign commerce.

The Old Kingdom was almost economically self-sufficient. The Nile Valley of Upper Egypt supplied staple crops such as barley, wheat, and vegetables along with fish and wild game. The less populated and wetter Lower Egypt delta had fruit orchards, grape vineyards, and grazing areas for herds of cattle and sheep.

But Egypt had no forests, so it imported timber from Syria and Lebanon. Old Kingdom kings also sent expeditions south of Aswan into Nubia to trade for luxury items like ivory, incense, spices, gold, and animal skins.

No major foreign powers threatened Egypt, so the Old Kingdom had no permanent army. Occasionally, however, kings would draft men for a military campaign into Nubia or North Africa to take resources such as cattle and slaves.

The Age of Pyramid Building

Religion evolved during the Old Kingdom. Most common people worshipped local gods, but the king increasingly became the central figure of an official state religion that emphasized life after death.

Tomb artists portrayed most traditional Egyptian gods as having the body of a man or woman with the head of an animal or bird. Egypt's kings early on adopted Horus, the hawk god "who is high," as their protector.

During the Fifth Dynasty of the Old Kingdom, the sun god Ra took a dominant place in the state religion. When the king died, Egyptians believed he accompanied Ra on his trip each day through the sky in a "solar boat." In addition, Osiris, who judged the dead in the underworld, became increasingly important. Strangely, there never was a god of the Nile River.

Egyptians believed in preserving a dead person's body to sustain his *ka* or life force in the afterlife. This belief led to mummification. The Old Kingdom kings seemingly became obsessed with creating tombs that would protect their mummies along with all the comforts they would need in the afterlife. Thus the age of pyramid building began.

The first tombs for kings were rectangular structures with flat tops. Next came step pyramids, huge square-based pyramids with six big steps. Finally, kings built true pyramids with four smooth sides. Khufu (also called Cheops), who reigned from about 2589 to 2566 B.C., built the largest true pyramid, known today as the Great Pyramid of Giza, next to modern Cairo. It rises to a height of almost 500 feet.

For about 20 years, Khufu's builders moved 2 million blocks of stone, each weighing from 2 to 17 tons. Recent evidence indicates that they may have used an ingenious stone ramp, spiraling upward inside the pyramid as they constructed it.

The kings built their pyramids not far from Memphis. The builders quarried most of the stone blocks nearby, but transported higher quality stone on barges from as far away as Aswan during the flood season.

The Egyptians knew about the wheel but did not have wheeled vehicles or even major roads at this time. They also did not have horses or camels. The pyramid builders used only oxen and the drafted labor of tens of thousands of men to haul stone blocks on wooden sleds over sanded or mud surfaces. The most active building time took place in the summer when the Nile flood prevented much farm work.

Nearly 300 years after Khufu's death, a 6-year-old became king of Egypt in 2278 B.C. Pepy II remained on the throne for an astounding 94 years.

When Pepy II reached old age, his authority weakened, his government officials grew ineffective. Many nome governors evolved into semi-independent local rulers. The government was beginning to fall apart.

Pepy II (also called Neferkara) died in 2184 B.C. He was buried in the last major Egyptian pyramid, which was named "Neferkara is established and living."

Then, 19 kings, including one woman, took and lost the throne in less than 25 years. By the end of this chaotic period in 2160 B.C., the Old Kingdom had completely collapsed.

Why Are There No More Nile Floods Today?

In A.D. 1971, Egypt with the aid of the Soviet Union completed a dam across the Nile at Aswan, forming Lake Nasser. This dam replaced a smaller one built by the British in the early 1900s. The purpose of the Aswan High Dam is to keep the river at a constant level throughout the year to irrigate more farmland and produce hydroelectric power. Thus, the Nile flood now stops at Aswan.

The Aswan High Dam has increased Egypt's agricultural production and electricity, but at a cost to the environment. The dam traps the fertile silt upstream in Lake Nasser. Farmers depend on chemical fertilizers rather than the natural rich soil deposited by the Nile floods. In addition, the dam has caused the water table to rise along the Nile, which allows mineral salts to penetrate and damage nearby ancient buildings and monuments.

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What Caused the Collapse?

We know from ancient writings that Egypt was experiencing many low Nile floods toward the end of the Old Kingdom. Why were these Nile failures happening? Scientists are assembling increasing evidence that drought conditions helped caused the collapse of a number of ancient civilizations from the eastern Mediterranean to India around 2200 B.C. This date coincides with the last years of the long reign of Pepy II.

Soil borings from Ethiopia's Lake Tana, the source of a major river that flows into the Nile, show the lake was very shallow around 2200 B.C. Downstream at the same time, borings from the lake at the Faiyum Oasis indicate it dried up entirely.

Scientists think that a shift in the circulation of the atmosphere may have reduced rainfall and caused widespread climate change in many places, including Ethiopia and East Africa. This would account for the series of low Nile floods at the end of the Old Kingdom.

Climate change alone, however, probably did not cause the Old Kingdom to collapse. Dry periods had taken place earlier in Egypt's history.

When the Nile failures were reaching their peak and drastically shrinking the food supply, Pepy II was in his 80s or 90s. At the end of his extremely long reign, he and his government administrators undoubtedly lacked the vigor and creativity to cope with such a natural disaster. After his death, as the drought continued, the lack of any strong king to emerge and handle this crisis guaranteed the permanent collapse of the Old Kingdom.

Over the next 100 years, Egypt split apart. A civil war raged in the Nile Valley between kings at a new capital near Memphis and rival kings at Thebes. In addition, some nome governors challenged the kings on both sides.

Meanwhile, below-normal Nile floods persisted, causing widespread starvation and death among the common people. No one authority was in charge to deal with this crisis. One nome governor probably exaggerated in his tomb inscription about how he saved his own people from starving:

> I gave bread to the hungry, and clothing to the naked. . . .
>
> All of Upper Egypt was dying of hunger and people were eating
>
> their children, but I did not allow anybody to die of hunger in his nome.

Finally in 2055 B.C., King Mentuhotep II of Thebes reunited Upper and Lower Egypt under his rule. His dynasty launched a new era in Egyptian civilization called the Middle Kingdom.

For Discussion and Writing

1. Why did farmers in the early Old Kingdom not have to worry much about local rainfall, irrigation, or poor soil?
2. Why did Old Kingdom kings build pyramids? Why do you think they stopped building them not long after the death of Pepy II?
3. What do you think was the most important reason for the collapse of Egypt's Old Kingdom? Why?

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A C T I V I T Y

Acting Before Catastrophe Hits

In 2005, UCLA geographer Jared Diamond published a book titled *Collapse*. It describes case studies of civilizations facing environmental challenges and how some societies collapsed and others met the challenges successfully. Diamond does not believe that environmental challenges doom any society, including our own, as long as the society acts to meet the challenges.

Imagine the year is 2250 B.C. and Pepy II is 34. His vizier has informed him that Nilometer records for the past 10 years show Nile floods getting lower and lower. Food production has also been dropping. The king has ordered his vizier to assemble the best minds of the kingdom to advise him what to do about the Nile failures before catastrophe hits.

1. Form small groups to each develop a strategy to deal with the Nile failure crisis. Get ideas by reviewing the information on the Old Kingdom in the article.
2. Each group of advisers will explain its strategy. Then, all the advisers will vote to decide which one is the best.

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Standards Addressed

Extinction

National High School Civics Standard 21: Understands the formation and implementation of public policy. (1) Knows a public policy issue at the local, state, or national level well enough to identify the major groups interested in that issue and explain their respective positions.

National High School Civics Standard 23: Understands the impact of significant political and nonpolitical developments on the United States and other nations. (5) Understands historical and contemporary responses of the American government to demographic and environmental changes that affect the United States.

California History Social Science Standard 11.11: Students analyze the major social problems and domestic policy issues in contemporary American society. (5) Trace the impact of, need for, and controversies associated with environmental conservation, expansion of the national park system, and the development of environmental protection laws, with particular attention to the interaction between environmental protection advocates and property rights advocates.

Columbian Exchange

National High School U.S. History Standard 2: Understands cultural and ecological interactions among previously unconnected people resulting from early European exploration and colonization. (4) Understands the long-range social and ecological impact of the Columbian Exchange (e.g., how the horse, the pig, and the dandelion brought about changes in the land . . .).

California History Social Science Standard 7.11: Students analyze political and economic change in the sixteenth, seventeenth, and eighteenth centuries . . . . (2) Discuss the exchanges of plants, animals, technology, culture, and ideas among Europe, Africa, Asia, and the Americas in the fifteenth and sixteenth centuries and the major economic and social effects on each continent.

Old Kingdom

National High School World Standard 3: Understands the major characteristics of civilization and the development of civilizations in . . . Egypt . . . .

National High School World History Standard 4: Understands how agrarian societies spread and new states emerged in the third and second millennia BCE. (4) Understands how environmental conditions such as the prevailing wind, current, and flooding patterns, influenced civilizations in the Tigris, Nile, and Huang He valleys.

California History Social Science Standard 6.2: Students analyze the geographic, political, economic, religious, and social structures of the early civilizations of . . . Egypt . . . . (2) Trace the development of agricultural techniques that permitted the production of economic surplus and the emergence of cities as centers of culture and power. (5) Discuss the main features of Egyptian art and architecture.

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Constitution Day Lesson and Showcase

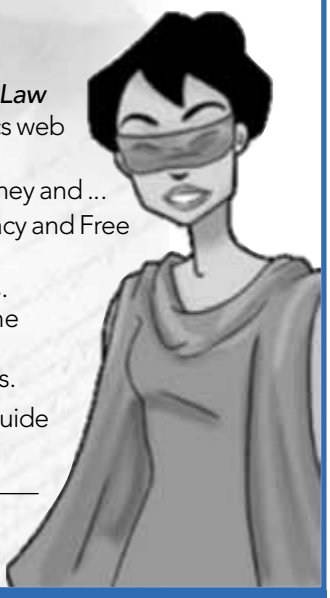
CRF and the Judicial Branch of California are offering an exciting lesson and showcase. Students role play appeals-court justices and decide a constitutional issue. The site provides a step-by-step lesson plan. From the site, students learn background on the constitutional issue. Then they decide the case and write a short opinion. You can submit student written opinions to the site, and we will showcase the best ones.

To get the lesson and participate in the showcase, visit our new collaborative web site ***Judges, Courts, and the Law*** **www.courtsed.org** and click on Constitution Day.

Also on the ***Judge, Courts, and the Law*** web site is our our exciting new civics web resource ***Courts in the Classroom***!
Students can take an **animated** journey and ...

- Examine Big Ideas (such as Privacy and Free Expression).
- Learn about judges and courts.
- Look at Landmark U.S. Supreme Court Cases.
- Take quizzes to test themselves.

Teachers can download a teacher's guide for using the site in the classroom.



Additional lessons and resources for grades K–12 can be found on CRF's main web site **www.crf-usa.org**. Click on Constitution Day on our home page.

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