EcoWest mission

Inform and advance conservation in the American West by analyzing, visualizing, and sharing data on environmental trends.
## EcoWest decks

This is one of six presentations that illustrate key environmental metrics. Libraries for each topic contain additional slides.

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Download presentations and libraries at ecowest.org
Key points

Biological diversity in the American West is . . .

- **Impressive** in terms of the number of native species and the sheer **variety of ecosystems** in one part of the continent
- **Highly variable** across the region and across types of species, but tends to be concentrated in geographic hotspots, many of which are imperiled
- **Increasingly threatened** by habitat loss, invasive species, and **climate change**, but overhunting and collecting are less of a concern today
- **Undergoing major changes** as warming temperatures and altered precipitation patterns are causing **range shifts** for plants and animals
- **Biased**, on the policy level, toward protecting **charismatic megafauna** and species listed under the **Endangered Species Act**
Overview

- Biodiversity basics
- Biomes and ecoregions
- Species diversity and extinctions
- Red List and endangered species
Narrative: Let’s begin by discussing some of the basics of biodiversity. What explains why one part of the West has one set of species and another area close by has such a different suite of plants and animals?
Narrative: The biological diversity of a particular place depends on many factors, but there are some basic building blocks that influence which species live where. The basic geography of a place—its latitude, its elevation above sea level, its distance from the ocean—plays a huge role in determining what the climate will be like. The temperature and precipitation patterns, even the humidity and rate of evaporation, establish critical parameters for species. These forces in combination explain why certain types of soils, vegetation, and animals are found in some places, but not others.

Source: EcoWest
URL: ecowest.org
Narrative: Temperature and precipitation play critical roles in determining the distribution of plant communities around the globe. Plant distributions, in turn, determine what types of animals are found in various places. This graphic shows how the climate zones compare for various types of plant communities. Because climate change is expected to affect both temperature and precipitation, major shifts in plant communities are projected in the West and elsewhere.

Source: U.S. Global Change Research Program
URL: http://www.usgcrp.gov/usgcrp//Library/nationalassessment/overviewecosystems.htm

Notes: Both temperature and precipitation limit the distribution of plant communities. The climate (temperature and precipitation) zones of some of the major plant communities (such as temperate forests, grasslands, and deserts) in the U.S. are shown in this figure. Note that the grasslands zone encompasses a wide range of environments. This zone can include a mixture of woody plants with the grasses. The shrublands and woodlands of the West are examples of grass/woody vegetation mixes that occur in the zone designated as grasslands. With climate change, the areas occupied by these zones will shift relative to their current distribution. Plant species are expected to shift with
their climate zones. The new plant communities that result from these shifts are likely to be different from current plant communities because individual species will very likely migrate at different rates and have different degrees of success in establishing themselves in new places.
Narrative: Here’s a close-up of the U.S., using a different scale. You can see that the West has some of the coldest and hottest areas, sometimes in close proximity to one another.

Source: Climate Wizard
URL: www.climatewizard.org
Narrative: Now let's look at precipitation. You can see that west of the 100th meridian, conditions are generally drier, except for the Pacific Northwest and the highest mountains in the region. But what's perhaps most striking about the West is how varied the precipitation is and how spotty the patterns are, largely due to the influence of mountains and the rain shadows they cast.

Source: Climate Wizard
URL: www.climatewizard.org
Let’s talk a bit about biomes.
Narrative: An area’s climate more or less determines what types of plants can grow there. At the broadest level, we can classify the planet’s land masses according to the predominant vegetation, or lack thereof. There are 16 terrestrial biomes, ranging from snow and tundra to tropical forests.


URL: http://www.nature.org/ourscience/sciencefeatures/conservation-atlas.xml

Notes: “Biomes group ecoregions that have similar vegetation. Although each ecoregion has its distinctive features, ecoregions can be grouped into larger units based on their similar climate and habitat structure and ecological similarity.”
Narrative: Here’s a close-up of the U.S. Much of the interior West is dominated by desert and xeric (dry) shrublands, but the higher elevations support temperate conifer forests. California has Mediterranean forests along much of its coast and the Sierra Foothills. There’s a bit of subtropical forest in the mountains of Southeast Arizona and temperate broadleaf forest in Oregon’s Coastal Range. As with temperature, rainfall, and elevation, there is more uniformity in the East than the West. Look, for example, at how many different types of communities are found in California, or how isolated mountains in Great Basin create little biome islands.


URL: http://www.nature.org/ourscience/sciencefeatures/conservation-atlas.xml

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The U.S. leads the world in the number of biomes and smaller ecoregions within its borders, even exceeding countries that are much larger in size.


URL: http://www.natureserve.org/publications/preciousHeritage.jsp
Narrative: So it’s no surprise that the U.S. also ranks high in species diversity. In this graphic, blue bars show the number of species that are found in the U.S., broken down by species type. Orange diamonds show what percent of the world’s species are found in the U.S. and the number in parenthesis in the labels indicate the U.S. ranking worldwide. The highest levels of diversity for several groups are found in the U.S., including freshwater mussels, freshwater snails, and crayfishes; several other groups, such as freshwater fishes and gymnosperms, are also well represented in the U.S.


URL: http://www.natureserve.org/publications/preciousHeritage.jsp

Notes: Several species groups have their highest levels of diversity in the U.S., including freshwater mussels, freshwater snails, and crayfishes; several other taxonomic groups, such as freshwater fishes and gymnosperms, are also well represented in the U.S. U.S. figures refer to accepted, described species and are from Natural Heritage Central Databases 1999; world figures are estimates of described species and are from various sources. Flowering plants have been removed from graphic due to scale issues.
Let’s take a closer look at ecoregions, which are a helpful unit of analysis for examining the incredible diversity of species and ecosystems that inhabit the world and the West.
Narrative: A more fine-grained view than biomes classifies the terrestrial world into 825 unique ecoregions. These areas are sort of like ecological neighborhoods with similar habitat. The slides that follow are based on The Nature Conservancy’s *Atlas of Global Conservation*, which analyzes the global environment using terrestrial and freshwater ecoregions.


URL: [http://www.nature.org/ourscience/sciencefeatures/conservation-atlas.xml](http://www.nature.org/ourscience/sciencefeatures/conservation-atlas.xml)

Notes: “Ecoregions divide the world into regions of similar habitat. Terrestrial ecoregions draw boundaries that approximate where one set of similar habitats blends with another. Each of the world’s 825 terrestrial ecoregions bounds a natural area in which a unique collection of ecosystems, natural communities, and species is found.”
Narrative: Here’s a close-up of the West. If you were to drive through several ecoregions on an interstate road trip, you’d notice the differences simply by looking out the window.


URL: http://www.nature.org/ourscience/sciencefeatures/conservation-atlas.xml

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Narrative: The Nature Conservancy’s atlas also analyzes the Earth according to its 426 freshwater ecoregions. Each of the regions has a unique collection of fish species, other aquatic species, and freshwater habitats.


URL: http://www.nature.org/ourscience/sciencefeatures/conservation-atlas.xml

Notes: “Freshwater ecoregions divide the world into regions that contain similar freshwater species. Each of the world’s 426 freshwater regions contains a distinctive suite of fish species, other aquatic species, and freshwater habitats.”
This close-up of the West shows its two-dozen or so freshwater ecoregions. The geographic definitions don’t always line up with the boundaries of river basins. The Colorado River Basin, for example, includes the Colorado, Bonneville, Vegas-Virgin, and Gila freshwater ecoregions.


URL: http://www.nature.org/ourscience/sciencefeatures/conservation-atlas.xml

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Narrative: One way to summarize biodiversity is to look at the evolutionary distinctiveness of species in a given location. This map shows the phylogenetic diversity of terrestrial vertebrate species (animals with a backbone). Phylogenetics is a measure of how closely related a group of species is. An ecoregion with high phylogenetic diversity has species that are more distinct from one another. The measure is calculated by using something called a cladogram, which is what most people know as the “tree of life,” a diagram showing how species have branched out due to evolution. Phylogenetics takes measurements of the cladogram to calculate the evolutionary distinctiveness of species, which is greatest around the tropics.


URL:  
http://www.nature.org/ourscience/sciencefeatures/conservation-atlas.xml  
http://app.databasin.org/app/pages/datasetPage.jsp?id=4c0ab10592b14a7fb29588eda42a0d42

Notes: We calculated the phylogenetic diversity of vertebrate species by terrestrial ecoregion using Faith’s (1992) statistical model of PD = ∑Dij, where
PD is a phylogenetic diversity score, and $\sum_{ij}$ is the sum of the pairwise distances for the minimum spanning distance among a selected set of species (i.e., the species occurring in an ecoregion) on a taxic cladogram of all vertebrate species worldwide, using WWF’s WildFinder database. Data derived using:


Narrative: In the West, phylogenetic diversity of vertebrate species tends to be highest in the desert Southwest. In general, measures of species diversity are greater at lower latitudes due to the past effects of Ice Age glaciation at higher latitudes and the configuration of landforms on the Earth, both past and present.


URL: 
- http://www.nature.org/ourscience/sciencefeatures/conservation-atlas.xml
- http://app.databasin.org/app/pages/datasetPage.jsp?id=4coab10592b14a7fb29588eda42a0d42

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Another high-level measure of biodiversity is the number of species that are found in one area but no other place on Earth—what’s known as endemism. This map shows the number of endemic vertebrate species, by terrestrial ecoregion. Endemic species of birds, mammals, and reptiles have typically evolved in isolated habitat, such as islands. Endemism tends to be greatest in the tropics and in places with many islands.


URL: http://www.nature.org/ourscience/sciencefeatures/conservation-atlas.xml
http://app.databasin.org/app/pages/datasetPage.jsp?id=87b2386f92a84e30aa91f90be086c73a

Notes: The number of terrestrial endemic species refers to the number of endemic mammals, birds, and reptiles in each terrestrial ecoregion. We compiled data on these endemic species by querying the WWF WildFinder database for their occurrences by ecoregion. The WWF WildFinder database is a spatially explicit online database of vertebrate species occurrences by ecoregion.
Narrative: In the U.S., the number of endemic vertebrate species is highest in the Southwest and Gulf Coast states. Even arid areas have “islands” of isolated habitat, such as mountaintop forests surrounded by deserts, that can give rise to endemism.


URL: http://www.nature.org/ourscience/sciencefeatures/conservation-atlas.xml
http://app.databasin.org/app/pages/datasetPage.jsp?id=87b2386f92a84e30aa91f90be086c73a

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Narrative: In the U.S., freshwater endemism is greatest in Virginia, the Carolinas, and Georgia; out West, hotspots include California, Oregon, Utah, and Arizona.


URL: http://www.nature.org/ourscience/sciencefeatures/conservation-atlas.xml
http://app.databasin.org/app/pages/datasetPage.jsp?id=c36f49c00c8d4494986befe0ec1e39d3

Notes: The map of the number of freshwater endemic species shows the number of endemic fish, freshwater turtles, crocodiles, and amphibians found in each freshwater ecoregion. To calculate the total number of endemic species by ecoregion, we simply added the number of endemic species in these four taxonomic groups. Fish endemics are from Abell et al. (2008). Extirpated fish species are included in these tallies, but resolved extinct species, as determined by the Committee on Recently Extinct Organisms, and introduced species are excluded. Data on amphibian species were generated from distribution maps for 5,640 amphibian species gathered by the Global Amphibian Assessment.
Data on freshwater turtles were generated from species distribution maps provided by Dr. Kurt A. Buhlmann, the Savannah River Ecology Laboratory, University of Georgia, U.S.; and the International Union for Conservation of Nature–Species Survival Commission (IUCN-SSC) and Conservation International/Center for Applied Biodiversity Science (CI/CABS) Global Reptile Assessment (preliminary results). For both amphibians and turtles, species distribution maps were used to determine endemism by ecoregion. If at least 90 percent of a species’ range occurred in only one ecoregion, that species was said to be endemic. Some ecoregions with a long and narrow shape may have an overestimation of species given the way the range polygons were drawn. Our primary data sources for the maps were the following:


Narrative: In the U.S., the Southwest, the foothills around California’s Central Valley, the Southeast, and Appalachians have the most threatened animals.


URL: http://www.nature.org/ourscience/sciencefeatures/conservation-atlas.xml

http://app.databasin.org/app/pages/datasetPage.jsp?id=190e424f4b62481985f5fa6776668628

Notes: We compiled a vertebrate species list for each ecoregion from WWF’s WildFinder database (WWF 2006). This list was then compared against the IUCN Red List of Threatened Species (2008) to determine the number of species per ecoregion that are threatened. Threatened species are those listed by IUCN Red List as Vulnerable, Endangered, or Critically Endangered (www.redlist.org). Data derived from: World Wildlife Fund (WWF). 2006. WildFinder: Database of species distributions, ver. Jan-06: www.gis.wwf.org/WildFinder. IUCN Red List of Threatened Species summary statistics: www.redlist.org.
Narrative: This map shows the number of plant species by terrestrial ecoregion. Worldwide, there are more than 420,000 of the so-called higher order plants: trees, vines, grasses, fruits, vegetables, and legumes.


URL: [http://www.nature.org/ourscience/sciencefeatures/conservation-atlas.xml](http://www.nature.org/ourscience/sciencefeatures/conservation-atlas.xml)  
http://app.databasin.org/app/pages/datasetPage.jsp?id=43478f840ac84173979b22631c2ed672

Notes: Kier et al. (2005) estimated the number of plant species in each terrestrial ecoregion.
Narrative: Deserts and arid lands typically have fewer plant species, while tropical rainforests have the most. But in North America, some drier parts of the inland West actually have more plant species than wetter climes along the coast. Compare, for example, the Great Basin in Nevada to Washington State.


URL: http://www.nature.org/ourscience/sciencefeatures/conservation-atlas.xml

http://app.databasin.org/app/pages/datasetPage.jsp?id=43478f840ac84173979b22631c2ed672

Notes: Kier et al. (2005) estimated the number of plant species in each terrestrial ecoregion.
Narrative: In the U.S., the number of mammal species is greatest in the inland West and highest in the archipelago of “sky island” mountain ranges in southeast Arizona and southwest New Mexico, plus some higher elevation areas in West Texas.


URL: http://www.nature.org/ourscience/sciencefeatures/conservation-atlas.xml
http://app.databasin.org/app/pages/datasetPage.jsp?id=863c20b7776d41d68612fa181b50e10a

Notes: We compiled data on terrestrial mammals by querying the WWF WildFinder database for species occurrences by ecoregion. The WWF WildFinder database is a spatially explicit online database of vertebrate species occurrences by ecoregion.
Narrative: In the U.S., most areas have between four and eight freshwater mammal species, but there are upwards of 20 in the Pacific Northwest, parts of the Midwest, and along the eastern seaboard.


URL: http://www.nature.org/ourscience/sciencefeatures/conservation-atlas.xml  
http://app.databasin.org/app/pages/datasetPage.jsp?id=fe75950e6b524b548d30053861d884be

Notes: Freshwater mammals include aquatic or semiaquatic species that spend a considerable amount of time in freshwater to feed and that usually live in the riparian vegetation close to rivers, lakes, marshes, swamps, and other freshwater habitats. We used species range maps, visual assessment of locations based on literature descriptions, and expert opinion to assign mammal species presence to ecoregions. Range species maps and distribution information for individual species were obtained from multiple sources and literature sources were used to determine whether a species is considered a freshwater mammal. Rodents make up at least 50 percent of all mammal
species, and this percentage is probably underestimated given that every year more than thirty to forty new rodent species are recognized. In general, rodents are a poorly studied group; therefore, the number of species considered “freshwater rodents” in this data set is underestimated, and the species numbers are likely to be much higher.
Narrative: In the U.S., the diversity of bird species is highest in Arizona, New Mexico, and Texas, with many tropical and subtropical species at the northern extent of their ranges.


URL: [http://www.nature.org/ourscience/sciencefeatures/conservation-atlas.xml](http://www.nature.org/ourscience/sciencefeatures/conservation-atlas.xml)

[http://app.databasin.org/app/pages/datasetPage.jsp?id=798de47afddb48df9458338b04c995a4](http://app.databasin.org/app/pages/datasetPage.jsp?id=798de47afddb48df9458338b04c995a4)

Notes: We compiled data on terrestrial birds by querying the WWF WildFinder database for species occurrences by ecoregion. The WWF WildFinder database is a spatially explicit online database of vertebrate species occurrences by ecoregion.
Narrative: In the U.S., Texas has the most freshwater bird species, but virtually all other parts of the country have at least 60 species.


URL: http://www.nature.org/ourscience/sciencefeatures/conservation-atlas.xml
http://app.databasin.org/app/pages/datasetPage.jsp?id=eb185e881fe54f3ea40977cfac8bf927

Notes: Freshwater obligate birds include those species that need freshwater habitats for breeding (e.g., ducks, herons) or feeding (i.e., birds that depend almost exclusively on food found in freshwater habitats, such as freshwater fish, mollusks, and crustaceans). In all, 815 bird species were found to meet this criterion, with almost all bird families represented. We mapped freshwater bird species to freshwater ecoregions for North and South America using NatureServe GIS data by freshwater ecoregion. Literature sources were used to determine whether a species was considered a freshwater bird.
Narrative: The Southeast U.S. has the greatest number of amphibian species and an especially large number of salamanders. There aren’t as many amphibian species out West, but there are still plenty in places that aren’t especially wet, such as the Colorado Plateau and Mojave Desert.


URL:
http://www.nature.org/ourscience/sciencefeatures/conservation-atlas.xml
http://app.databasin.org/app/pages/datasetPage.jsp?id=08a1ba612a744b88bb5c37c7da4d6975

Notes: We calculated the number of amphibian species per freshwater ecoregion using species range maps of the Global Amphibian Assessment (GAA, www.iucnredlist.org/amphibians) (IUCN et al. 2006). The 2006 GAA assessed 5,918 amphibian species and provided distribution maps for 5,640 of those species. When a range overlapped several ecoregions, we counted species as present in all those ecoregions that had part of the range. This may have resulted in an overestimate of species numbers in some ecoregions, especially those that are long and narrow in shape. Distribution maps from the GAA
represent the “extent of occurrence” for each species—that is, the area contained within the shortest continuous imaginary boundary, which can be drawn to encompass all the known, inferred, or projected sites of present occurrence of a taxon. Because of the conservative approach taken in the GAA to mapping species, the ranges for many species are likely to be minimum estimates. The GAA followed a rule of allowing interpolation of occurrence between known locations if the ecological conditions seem appropriate, but not permitting extrapolation beyond known locations. Some species are therefore almost certain to occur much more widely than the GAA has mapped. Because of this, some regions were recorded as having much lower numbers. Finally, the percentage of data-deficient species (23.4 percent) were very high compared to other taxa in the GAA. Data derived from: International Union for Conservation of Nature (IUCN), Conservation International, and NatureServe. 2006. Global Amphibian Assessment. www.iucnredlist.org/amphibians. Digital media.
In the U.S., Texas has the most threatened amphibians. There are three to seven such species in California, Oregon, and the Four Corners states.


URL: http://www.nature.org/ourscience/sciencefeatures/conservation-atlas.xml

http://app.databasin.org/app/pages/datasetPage.jsp?id=461e58214aa54ad79382066ab829c05f

Notes: We generated the map of the number of freshwater amphibian species per ecoregion that are threatened with extinction using data from the Global Amphibian Assessment (GAA) (IUCN et al. 2006). The GAA assessed the conservation status of 5,918 amphibian species, and we analyzed the subset of 4,035 that depend on freshwater during some stage of their life cycle. Strictly arboreal species that do not require freshwater for their larval stage, species that develop directly from eggs without a larval stage, as well as few live-bearing species were excluded from this analysis. As of 2006, 1,356 freshwater amphibians were considered threatened. It is important to note, however, that for 1,427 amphibian species, there were insufficient data to
assess their conservation status—these are classified by the GAA as “data deficient.” Therefore, these estimates for threat are conservative. Data derived from:

Narrative: The number of snake and lizard species in the U.S. is highest in Arizona and New Mexico.


URL: http://www.nature.org/ourscience/sciencefeatures/conservation-atlas.xml
http://app.databasin.org/app/pages/datasetPage.jsp?id=c4755297e4074a0cb1c550d9263498a3

Notes: We compiled data on terrestrial lizards and snakes by querying the WWF WildFinder database for species occurrences by ecoregion of the following taxonomic groups: Sauria, Serpentes, Amphisbaenia, and Rhynchocephalia. The WWF WildFinder database is a spatially explicit online database of vertebrate species occurrences by ecoregion.
Narrative: There aren’t many crocodiles outside of Florida, but even in drier areas, such as the Southwest and Northern plains, there are plenty of turtles.


URL: http://www.nature.org/ourscience/sciencefeatures/conservation-atlas.xml
http://app.databasin.org/app/pages/datasetPage.jsp?id=4d31febd58db4fcc878a6f8e745a3101

Notes: We generated the map of freshwater turtle and crocodilian species richness—the number of species present in each ecoregion—from species distribution maps, primarily drawing on the sources listed below. Distribution maps for 260 freshwater turtle species were provided by Buhlmann et al. (2007). The original distribution maps represented coarse ranges of where species were thought to be present in the wild; however, they were not exact ranges. Buhlmann et al. compiled data from museum and literature records. They correlated verified locality points with GIS-defined hydrologic unit codes (HUCs) and subsequently created “projected” distribution maps for each species by selecting additional HUCs that were
representative of similar habitats, elevations, and physiographic regions as the HUCs with the verified point localities. The amount of information available varied by species, as some species and regions are better studied than others. In addition, many species names, especially in the tropics, actually represent complexes of several turtle species that have not yet been disaggregated. In developing our map, when a range overlapped several ecoregions, we counted species as present in all those ecoregions that had part of the range. Some ecoregions with a long and narrow shape may have an overestimation of species in our map given the way the range polygons were drawn. For crocodilians, species range maps are from the IUCN-SSC Crocodile Specialist Group and Britton (2007). Species range maps were assessed visually, and species presence was assigned to ecoregions. When a range overlapped several ecoregions, we counted the species as present in all ecoregions of range overlap.

The following were our primary data sources:
Narrative: In the U.S., the ecoregions around the Mississippi and its tributaries harbor many freshwater fish species, in some cases five times as many as in Western ecoregions.


URL: http://www.nature.org/ourscience/sciencefeatures/conservation-atlas.xml

http: //app.databasin.org/app/pages/datasetPage.jsp?id=4f8f2f8e3ace42dca7141ca7781c0e4f

Notes: The map of freshwater fish species richness—the number of species present in each ecoregion—was generated from a variety of sources by Abell et al. (2008). Only species using freshwater for at least a portion of their life cycles, as identified using the habitat assignments in FishBase, are included. For the U.S., NatureServe provided presence/absence data for individual species, coded to eight-digit hydrologic unit codes (HUCs); these HUC occurrences were then translated into ecoregions, and the data were manually cleaned of erroneous occurrences derived from species introductions.
and problematic records. For all other ecoregions, species lists were provided by experts based on published literature as well as from gray literature and unpublished sources. Abell et al. (2008) generated data on fish species for some small islands using FishBase and then augmented where possible with information from published literature. For a small number of ecoregions, it was impossible to generate species lists; therefore, richness estimates are provided instead. Extirpated species are included in these tallies, but confirmed extinct species, as determined by the Committee on Recently Extinct Organisms (data provided by Ian Harrison), and introduced and undescribed species are excluded.
Narrative: In the U.S., there are more than a dozen migratory fish species in the Pacific Northwest and many parts of the East, but such species are relatively rare in the Great Basin and Arizona.


URL: http://www.nature.org/ourscience/sciencefeatures/conservation-atlas.xml

http://app.databasin.org/app/pages/datasetPage.jsp?id=61528bc77dce4fada2a7610dbc1ca2fc

Notes: We derived the map of long-distance migrant (LDM) fish—the number of LDM species per ecoregion—from published literature, online databases (NatureServe), and expert inquiries. Potadromous, anadromous, amphidromous, and catadromous fish species were judged to be LDMs if they made regular journeys (i.e., for breeding, dispersal, feeding) of at least a hundred kilometers or more in freshwater. These species were then assigned to ecoregions based on the fish species lists database from Abell et al. (2008). Although we used many resources, two key data sources for the map were the following:

Narrative: In the U.S., which has nearly 80,000 dams, virtually all ecoregions have seen their fish runs significantly disrupted. In the West, the problem is especially bad along the Columbia and Colorado Rivers, both of which have major hydroelectric dams.


URL: http://www.nature.org/ourscience/sciencefeatures/conservation-atlas.xml
http://app.databasin.org/app/pages/datasetPage.jsp?id=b8b04bdfd89b4647bf64c92e615cfe1

Notes: The level of disruption of fish runs was determined by Reidy-Liermann, C. A., C. Nilsson, J. Robertson, and R. Ng (unpublished) by calculating the average proportion of undammed distance among the longest connected freshwater pathways (including lakes) in each ecoregion, regardless of stream order. This metric considered only the five longest water courses or river segments between or without dams. Depending on the confidence in the underlying dam and reservoir data, ecoregions without known dams may have been deemed either as fully free-flowing or as having insufficient data. When
dams data were deemed unreliable for a river, those dams were excluded from the analysis, so results tend to underestimate actual river obstruction.
Narrative: Virtually all of the country has at least some harmful invasive species, with the greatest number found around the Great Lakes and Northeast.


URL: http://www.nature.org/ourscience/sciencefeatures/conservation-atlas.xml
http://app.databasin.org/app/pages/datasetPage.jsp?id=11a22d0ce62142258baaa1cbaf520fb2

Notes: The occurrence and ecological impact for freshwater invasive species were compiled in a geographically referenced database according to the methods of Molnar et al. (2008). Information about 550 species was systematically collected from a wide variety of global, regional, national, and subnational data sources. Non-native distributions were documented by freshwater ecoregion. The threat of each species to native biodiversity was scored using the following categories: 4, disrupts entire ecosystem processes with wider abiotic influences; 3, disrupts multiple species, some wider ecosystem function, and/or keystone species or species of high conservation
value (e.g., threatened species); 2, disrupts single species with little or no wider ecosystem impact; 1, little or no disruption. Species in the top two categories (scores of 3 or 4) are considered “harmful invasive species” in this atlas (n=367), and the number of these are displayed in the map by ecoregion. The following work was used:

Narrative: Invasive species are an especially big problem in Europe and the U.S. This graphic shows that the number of invaders reported on the European coast and in marine waters of North America has been steadily increasing.

Source: Millennium Ecosystem Assessment

Let’s turn now to species diversity: one of the key metrics used to analyze biodiversity.
Narrative: For starters, nobody knows just how many species there are in the world. Biologists have described fewer than 2 million species, but they know that many more exist, especially among insects.

Source: EcoWest
URL: ecowest.org
This graphic shows the breakdown of named species. Well-known species, such as birds and mammals, aren’t so numerous compared to insects, plants, and arachnids.


URL: http://www.natureserve.org/publications/preciousHeritage.jsp
Narrative: We know from the fossil record that more than 99 percent of the species that have ever inhabited the planet are gone forever. Scientists have identified five mass extinction events in the earth’s history, the most recent occurring about 65.5 million years ago, when an asteroid struck near the Yucatán Peninsula and three-quarters of the planet’s species died out. Many researchers believe we are in the early days of the earth’s sixth great extinction event, with some scientists predicting that one-third or more of all species will be gone or doomed by the end of the 21st century if emissions of heat-trapping greenhouse gases continue to increase. This graphic shows how the number of genera (plural for genus) has changed over the past 542 million years.


Notes: This image shows the biodiversity during the Phanerozoic, the current eon in which animal life has been abundant on Earth. Note that this is a result of changes in both the rate of extinctions and the rate of new originations. The Dresbachian extinction event in particular is obscured by nearly immediate replacement with new genera. Color code: grey = total known genera from Sepkowski’s catalogue (cited by Rohde & Muller)
green = "well-defined genera", i.e. known genera excluding those represented by "single occurrences" and those whose dates are uncertain.
red = trend for "well-defined genera". Derived by fitting a third-order polynomial to the data.
yellow = the "Big Five" mass extinctions.
blue = other extinction events.
Narrative: Scientists believe the current rate of extinction may be up to 1,000 times faster than the pace that prevailed before humans entered the scene. This graphic from the Millennium Ecosystem Assessment shows that the rate of future extinctions may increase further due to climate change and other threats.

Source: Millennium Ecosystem Assessment
Narrative: On the global level, the International Union for the Conservation of Nature, or IUCN, has evaluated more than 61,000 of the earth’s species. That’s just a fraction of the total named species, and an even smaller share of the total number of species. The status of nearly 10,000 of those species is still unknown because of a lack of data. Almost half are in the “least concern category.” But nearly 1,000 species have already gone extinct in the wild, and nearly 20,000 species are classified in one of the three threatened categories: vulnerable, endangered, and critically endangered.

Source: IUCN Red List
URL: http://www.iucnredlist.org/
Notes: Excludes 257 “lower risk/conservation dependent” species

**EXTINCT (EX)** A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon’s life cycle and life form.

**EXTINCT IN THE WILD (EW)** A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in
the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

**CRITICALLY ENDANGERED (CR)** A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered, and it is therefore considered to be facing an extremely high risk of extinction in the wild.

**ENDANGERED (EN)** A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered, and it is therefore considered to be facing a very high risk of extinction in the wild.

**VULNERABLE (VU)** A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable, and it is therefore considered to be facing a high risk of extinction in the wild.

**NEAR THREATENED (NT)** A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

**LEAST CONCERN (LC)** A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.

**DATA DEFICIENT (DD)** A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and a threatened status. If the range of a taxon is suspected to be relatively circumscribed, and a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.

**NOT EVALUATED (NE)** A taxon is Not Evaluated when it is has not yet been evaluated against the criteria.
Narrative: Here’s the breakdown for the U.S. Scientists believe there are at least 200,000 species, but they have only evaluated about 5,000 of them, and half of those are considered “data deficient.” The IUCN classifies 269 species as extinct or extinct in the wild and places nearly 1,200 in the three threatened categories.

Source: IUCN Red List
URL: http://www.iucnredlist.org/
Notes: Excludes 10 “lower risk/conservation dependent” species.

**EXTINCT (EX)** A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

**EXTINCT IN THE WILD (EW)** A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame
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**NOT EVALUATED (NE)** A taxon is Not Evaluated when it is has not yet been evaluated against the criteria.
Narrative: IUCN has been making progress in evaluating species, with more than three times as many species assessed today compared to a decade ago. As a result, the number of recognized threatened species has also been increasing and now approaches 20,000, or about one-third of the total.

Source: IUCN Red List
URL: http://www.iucnredlist.org/
Notes: Increase in the number of species assessed for The IUCN Red List of Threatened Species™ (2000-2010). In addition to species changing status, The IUCN Red List grows larger with each update as newly described species and species from the less well-known groups are assessed for the first time. IUCN and its partners are working to expand the number of taxonomic groups that have full and complete Red List assessments in order to improve our knowledge of the status of the world’s biodiversity.
Narrative: The number of species on the IUCN Red List of threatened species has increased from about 10,000 in the mid-1990s to nearly 20,000 today, with many of the new additions classified as critically endangered.

Source: IUCN Red List
URL: http://www.iucnredlist.org/
Narrative: It’s important to note that IUCN assessments have focused on certain types of species. IUCN has classified virtually all birds, mammals, and amphibians. But with many other taxa, including the insects and plants that make up the lion’s share of species, the IUCN has assessed hardly any of them.

Source: IUCN Red List
URL: http://www.iucnredlist.org/
Narrative: How are U.S. species doing? This graphic uses a slightly different categorization, the Natural Heritage ranking, and shows what percent of species fall into the most threatened categories. Nationally, freshwater mussels, crayfish, stoneflies, and fish are the most at risk, while mammals and birds are the least at risk.

URL: http://www.natureserve.org/publications/preciousHeritage.jsp
Overall, about 30 percent of plants and animals in the U.S. are considered vulnerable or worse according to this ranking system used by The Nature Conservancy and state governments.


URL: http://www.natureserve.org/publications/preciousHeritage.jsp

Notes:
Narrative: Now let’s turn to a subset of imperiled species: the plants and animals that have received protection under the Endangered Species Act, or ESA.
Narrative: There are more than 1,200 endangered species in the U.S., but a small subset tends to generate the lion’s share of attention. Here are some of the notable endangered species in the West, where they’re found, and how they’re figured into public policy debates. Although species protected by the ESA sometimes do have significant economic and regulatory impacts, most of the plants and animals protected by the law are not lighting rods for controversy.

Source: EcoWest.org
URL: ecowest.org
Narrative: This chart shows how many species have been listed as threatened or endangered, on a cumulative basis. Although the ESA was enacted in 1973, some species were listed under a precursor to the law in the late 1960s. Species are supposed to be added to the endangered list solely on the basis of biology and whether they’re endangered, regardless of the economic impact, but many studies of the act have found that politics frequently intrude in the listing process. If you overlay the terms of the U.S. presidents, you can see that listings really leveled off during George W. Bush’s two terms.

Source: U.S. Fish and Wildlife Service

URL: http://www.fws.gov/endangered/
     http://www.fws.gov/ecos/ajax/tess_public/pub/speciesCountByYear.jsp
Here's another look at the same data. This graph shows how many species were listed as threatened or endangered each year. That sharp decline around 1995 is due to a moratorium on new listings that was enacted by Congress after the Republican Revolution of 1994.

Source: U.S. Fish and Wildlife Service
URL: http://www.fws.gov/endangered/
     http://www.fws.gov/ecos/ajax/tess_public/pub/speciesCountByYear.jsp
Narrative: This graphic shows how many species each president listed under the ESA, on average, per year in office. Environmentalists had a tough time getting species listed during George W. Bush’s two terms, but the rate under Ken Salazar’s Interior Department is less than half the rate when Bruce Babbitt was in charge of Interior during the Clinton administration.


URL: http://ecos.fws.gov/tess_public/

Notes: Table does not include delistings or the 131 species listed before 1974.
Narrative: Many species that the Fish and Wildlife Service has judged at risk of extinction are not receiving protection from the ESA. Nearly 250 species have been declared as “candidates,” meaning their listing is biologically “warranted but precluded” by budgetary constraints. This list is akin to the queue waiting to board Noah’s Ark and has been the subject of some recent litigation. The Obama administration has made some progress in reducing the number of candidates from about 250 at the start of the first term to 192 in November 2012.

Source: U.S. Fish and Wildlife Service

URL: http://ecos.fws.gov/tess_public/pub/SpeciesReport.do?listingType=C
Narrative: Hawaii, the Pacific Coast, the Southwest, Appalachia, and Florida tend to have the most candidates.

Source: U.S. Fish and Wildlife Service
URL: http://www.fws.gov/ecos/
With threatened and endangered species, Hawaii is also at the top, with nearly 400, followed by California, Alabama, Florida, Texas, and Tennessee. The Dakotas are at the bottom of the list.

Source: U.S. Fish and Wildlife Service
URL: http://www.fws.gov/ecos/
Narrative: This map analyzes endangered species by counties. You can see that there is often considerable variation within single states like California and Nevada, where one county may have more than 10 listed species while an adjoining county has none. Hawaii, the Pacific Coast, the Southwest, Appalachia, and Florida stand out for their large number of listed species, but many U.S. counties, especially in the Midwest, have no threatened or endangered species.


URL: http://www.natureserve.org/publications/preciousHeritage.jsp
Here’s another look at the same data, using equal area hexagons to depict the hotspots, which avoids the problem of large counties overshadowing smaller ones. The same basic pattern exists: hotspots for endangered species include Hawaii, the Pacific Coast, Southwest, Appalachia, and the Southeast.

URL: http://www.natureserve.org/publications/preciousHeritageCharts.jsp
Another biodiversity measure—the rarity-weighted richness index—combines both diversity and rarity of species. Many of the hotspots are in California, though the Southwest also ranks relatively high. Back East, there are hotspots of rarity and richness in Appalachia and Florida.


**URL:** http://www.natureserve.org/publications/preciousHeritageCharts.jsp
Narrative: One other way to look at the geography of endangered species is to examine a map of critical habitat—areas considered especially important for the recovery of listed plants and animals. These areas are designated under the ESA and can face additional regulations, but only some threatened and endangered species have critical habitat mapped. You can see from this map that a handful of species, such as the spotted owls, desert tortoise, greater sage grouse, and Canada lynx, account for much of the critical habitat in the West. Most of the fish critical habitat is for salmon and trout.

Source: Conservation Biology Institute and U.S. Fish and Wildlife Service
URL: GIS layers downloaded from databasin.org
Narrative: On public lands, the greatest number of federally listed and imperiled species are found on national forests. Military lands, many of them located in the West, actually have a greater share of imperiled and endangered species than our national parks or national wildlife refuges.


URL: http://www.natureserve.org/publications/preciousHeritage.jsp

Notes: Graphic shows the percentage of imperiled and federally listed species found in each land category.
More than half of the nation’s threatened and endangered species are plants, which receive less protection under the law. Although insects make up the bulk of species that we know about, very few are protected by the ESA.

Source: U.S. Fish and Wildlife Service
URL: http://ecos.fws.gov/tess_public/pub/Boxscore.do
Narrative: Why are species at risk? This analysis looked at a broader category—species listed under the ESA and those classified as imperiled—and analyzed why they were in jeopardy. Habitat loss and degradation is the biggest threat, followed by alien species. There are some differences depending on the type of species: reptiles, for instance, are subject to overexploitation because of a brisk black market while birds are subject to diseases like avian malaria and West Nile virus.

Narrative: Here’s another look at threats to endangered species. This graphic shows the share of federal endangered, threatened, and proposed species that have been harmed by various types of habitat loss and degradation.


URL: http://www.natureserve.org/publications/preciousHeritage.jsp
We’ve talked about a couple of different classification schemes thus far. How does something like the IUCN Red List match up against the list of species protected by the ESA? This graphic shows that about 80 percent of U.S. endangered species are considered imperiled or worse by the IUCN. For both endangered and threatened species, nearly all are considered vulnerable or worse. But there are some interesting differences across species: the three bars on the right show that about half of listed vertebrates are critically imperiled or worse, but about 70 percent of listed plants and more than 80 percent of listed invertebrates are considered critically imperiled or worse. This suggests that plants and invertebrates have to be in worse shape before they are listed, perhaps because these species tend to be less charismatic.


URL: http://www.natureserve.org/publications/preciousHeritage.jsp
We’ve talked about how species get added to the list, but what about de-listings under the ESA? This hasn’t happened very often since 1973—less than 50 times. In 20 cases, a species was declared recovered and no longer in need of ESA protection. Eighteen times, the government has decided the original listing was in error, often because of taxonomic changes or the discovery of new populations. In nine cases, a species protected by the ESA has been declared extinct. At a high level, this graphic summarizes the performance of the ESA: hardly any species that have received federal protection have gone extinct, but less than 2 percent of listed species have recovered sufficiently so they could be delisted.

Source: U.S. Fish and Wildlife Service
URL: http://ecos.fws.gov/tess_public/pub/delistingReport.jsp
It’s important to remember that plenty of U.S. species went extinct long before the ESA was enacted in 1973. This graphic summarizes what we know about species that have gone extinct or are possibly gone for good. Insects, plants, and snails lead the list, but there are virtually no reptiles, mammals, or amphibians that are classified as presumed or possibly extinct.


URL: hhttp://www.natureserve.org/publications/preciousHeritage.jsp
Narrative: This map shows where extinctions are thought to have taken place. Hawaii, with 249, is off the charts and followed by Alabama, with 96, and California, with 35.


URL: http://www.natureserve.org/publications/preciousHeritageCharts.jsp
Here are some examples of species once found in the West that are now considered extinct. The photos shown here are of closely related subspecies or stuffed animals. Because these species are extinct, obtaining actual images of the plants and animals is no longer possible.

Source: EcoWest.org
URL: ecowest.org
Conclusion

- Ecosystem and species diversity is one of the hallmarks of the American West
- This is due to its extremes in elevation, wide variation in climate, and unique assemblage of ecological communities
- Within this mosaic of ecoregions, the West harbors some of the nation’s hotspots for biological diversity
- Around the world, scientists believe we are losing species at a rate that far exceeds the natural ebb and flow
- Habitat loss and invasive species are among the greatest threats, but overhunting and illegal collecting are less of a problem today
- But we actually know very little about most species, with our attention focused mostly on mammals, birds, and other charismatic life forms
Download more slides and other libraries

ecowest.org

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