Know All About

Environment of the United States

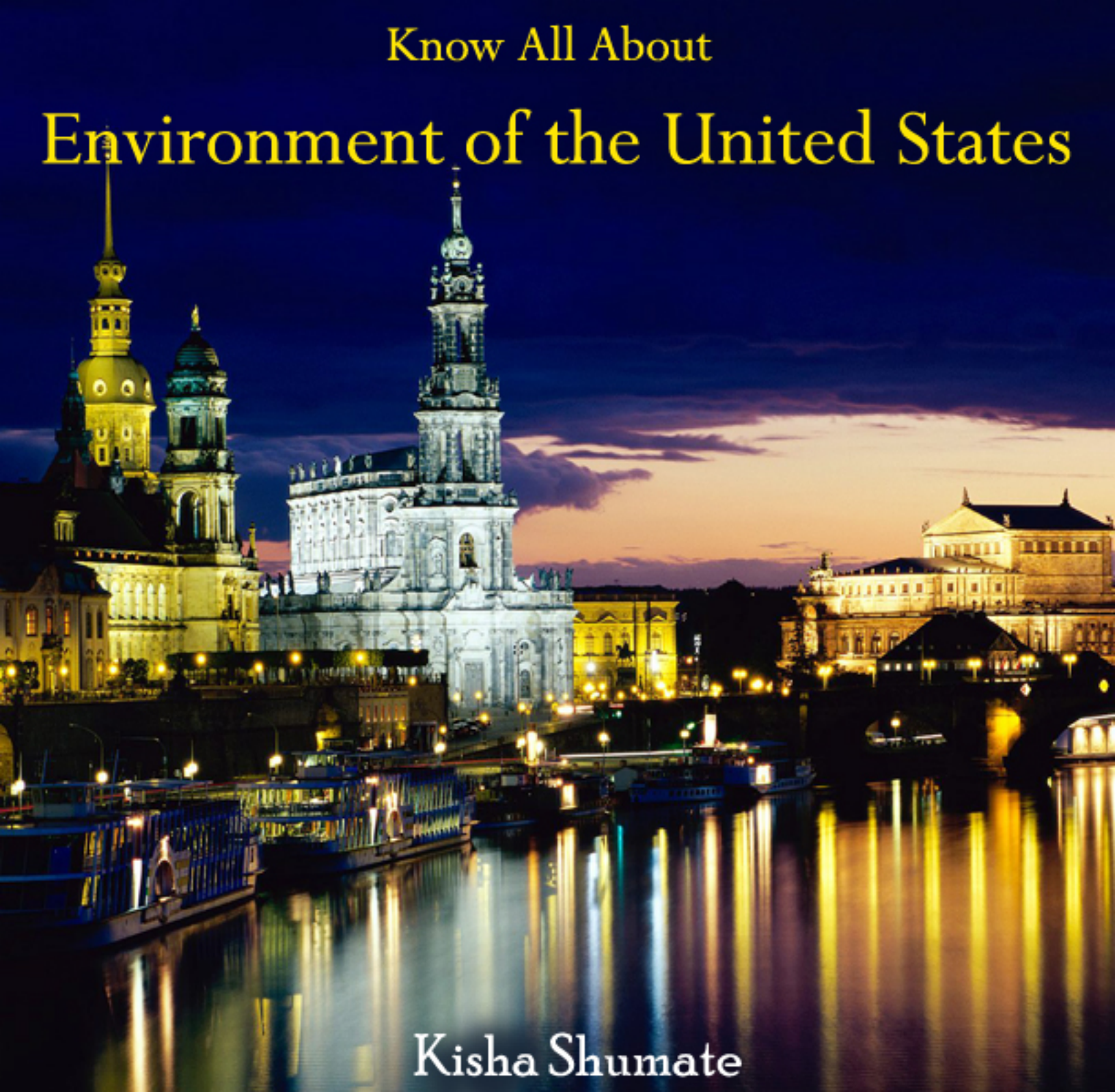

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Table of Contents

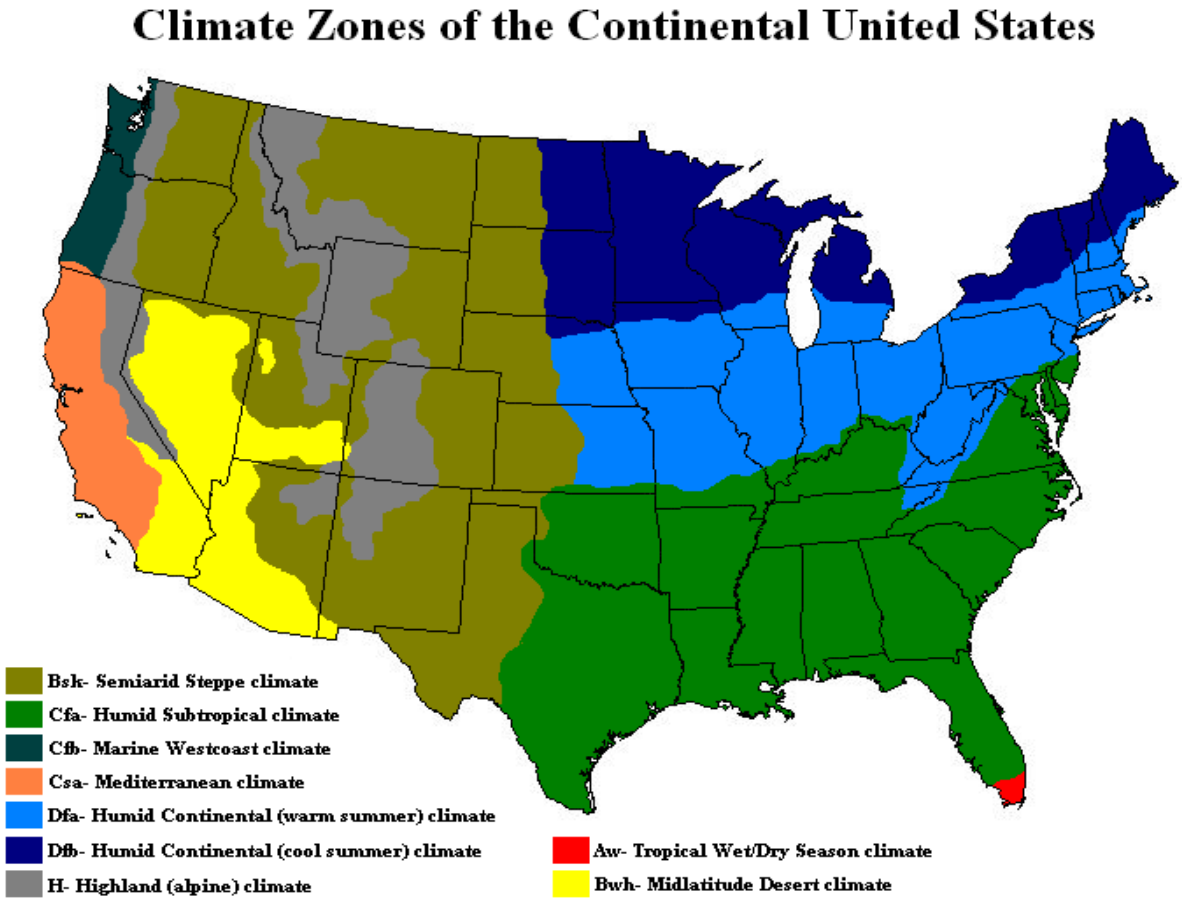
Chapter- 1

Climate of the United States

The United States includes a wide variety of climate types due to its large size, range of geographic features, and non-contiguous arrangement. In the contiguous United States to the east of the 100th meridian, the climate ranges from humid continental in the north to humid subtropical in the south. The southern tip of Florida is tropical. The Great Plains west of the 100th meridian are semi-arid. Much of the Rocky Mountains, the Sierra Nevada, and the Cascade Range are alpine. The climate is arid in the Great Basin, desert in the Southwest, Mediterranean in coastal California, and oceanic in coastal Oregon and Washington. The state of Alaska—on the northwestern corner of the North American continent—is largely subarctic, with an oceanic climate in its southern edge and a polar climate in the north. The archipelago state of Hawaii, in the middle of the Pacific Ocean, is tropical.

Extreme weather is not uncommon—the states bordering the Gulf of Mexico are prone to hurricanes, and tornadoes regularly occur in the area of the Midwest referred to as Tornado Alley. The United States has more tornadoes than the rest of the world combined.

Overview



Climate zones of the Continental United States

Deep snow during the Blizzard of 2006 Nor'easter in Brooklyn, New York City

The main influence on weather in the United States is the polar jet stream, which brings in large low pressure systems from the northern Pacific Ocean. Once a Pacific cyclone moves over the Great Plains, uninterrupted flat land allows it to reorganize and can lead to major clashes of air masses. Sometimes during late winter and spring these storms can combine with another low pressure system as they move up the East Coast and into the Atlantic Ocean, where they intensify rapidly. These storms are known as Nor'easters and often bring widespread, heavy snowfall to the Mid-Atlantic and New England. The uninterrupted flat grasslands of the Great Plains also leads to some of the most extreme climate swings in the world. Temperatures can rise or drop rapidly; winds can be extreme; and the flow of heat waves or Arctic air masses often advance uninterrupted through the plains.

The Great Basin and Columbia Plateau (the Intermontane Plateaus) are arid or semiarid regions that lie in the rain shadow of the Cascades and Sierra Nevada. Precipitation averages less than 15 inches (38 cm). The Southwest is a hot desert, with temperatures exceeding 100°F (38°C) for several weeks at a time in summer. The Southwest and the Great Basin are also affected by the monsoon from the Gulf of California from July-September, which brings localized but often severe thunderstorms to the region.

Precipitation

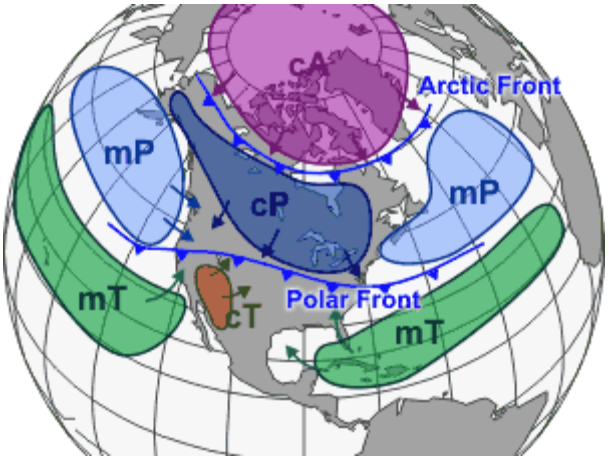
Average precipitation

The characteristics of rainfall across the United States differ significantly across the United States and its possessions. Late summer and fall extratropical cyclones bring a majority of the precipitation which falls across western, southern, and southeast Alaska annually. During the fall, winter, and spring, Pacific storm systems bring most of Hawaii and the western United States much of their precipitation. Nor'easters moving up the East coast bring cold season precipitation to the Mid-Atlantic and New England states. Lake-effect snows add to precipitation potential downwind of the Great Lakes, as well as Great Salt Lake and the Finger Lakes during the cold season. The snow to liquid ratio across the contiguous United States is 13:1, meaning 13 inches (330 mm) of snow melts down to 1 inch (25 mm) of water. The El Niño-Southern Oscillation affects the precipitation distribution, by altering rainfall patterns across the West, Midwest, the Southeast, and throughout the tropics.

During the summer, the Southwest monsoon combined with Gulf of California and Gulf of Mexico moisture moving around the subtropical ridge in the Atlantic ocean bring the promise of afternoon and evening thunderstorms to the southern tier of the country as well as the Great Plains. Equatorward of the subtropical ridge, tropical cyclones enhance precipitation across southern and eastern sections of the country, as well as Puerto Rico, the United States Virgin Islands, the Northern Mariana Islands, Guam, and American Samoa. Over the top of the ridge,

the jet stream brings a summer precipiation maximum to the Great Lakes. Large thunderstorm areas known as mesoscale convective complexes move through the Plains, Midwest, and Great Lakes during the warm season, contributing up to 10% of the annual precipitation to the region.

Extremes



Several different air masses affect the United States

In northern Alaska, tundra and arctic conditions predominate, and the temperature has fallen as low as −80 °F (−62 °C). On the other end of the spectrum, Death Valley, California once reached 134 °F (56.7 °C), the second-highest temperature ever recorded on Earth.

On average, the mountains of the western states receive the highest levels of snowfall on Earth. The greatest annual snowfall level is at Mount Rainier in Washington, at 692 inches (1,758 cm); the record there was 1,122 inches (2,850 cm) in the winter of 1971–72. This record was broken by the Mt. Baker Ski Area in northwestern Washington which reported 1,140 inches (2,896 cm) of snowfall for the 1998-99 snowfall season. Other places with significant snowfall outside the Cascade Range are the Wasatch Mountains, near the Great Salt Lake and the Sierra Nevada, near Lake Tahoe.

Along the coastal mountain ranges in the Pacific Northwest, rainfall is greater than anywhere else in the continental U.S., with Quinault Ranger in Washington having an average of 137 inches (3,480 mm). Hawaii receives even more, with 460 inches (11,684 mm) measured annually, on average, on Mount Waialeale, in Kauai. The Mojave Desert in the southwest is home to the driest locale in the U.S. Yuma, Arizona, has an average of 2.63 inches (67 mm) of precipitation each year.

Natural disasters

Total devastation in Gulfport, Mississippi following Hurricane Katrina in 2005.

The United States is affected by a large variety of weather related natural disasters. Deadly and destructive hurricanes occur almost every year along the Atlantic seaboard and the Gulf of Mexico. Hurricanes can also strike Hawaii in the Pacific Ocean. Particularly at risk are the central and southern Texas coasts, the area from southeastern Louisiana east to the Florida Panhandle, the east coast of Florida, and the Outer Banks of North Carolina. Hurricane season runs from June 1 to November 30, with a peak from mid-August through early October. Some of the more devastating hurricanes have included the Galveston Hurricane of 1900, Hurricane Andrew in 1992, and Hurricane Katrina in 2005. The remnants of tropical cyclones from the Eastern Pacific also occasionally impact the southwestern United States, bringing sometimes heavy rainfall.

A powerful tornado in Texas

The Great Plains and Midwest, because of the contrasting air masses, have frequent severe thunderstorms and tornado outbreaks during spring and summer. In central portions of the U.S., tornadoes are more common than anywhere else on Earth and touch down most commonly in the spring and summer. The strip of land from north Texas north to Nebraska and east into Southern Michigan is known as Tornado Alley, where many houses have tornado shelters and many towns have tornado sirens.

The Appalachian region and the Midwest experience the worst floods. Widespread severe flooding is rare. Some exceptions include the Great Mississippi Flood of 1927, the Great Flood of 1993, and widespread flooding and mudslides caused by the 1982-1983 El Niño event in the western United States. Localized flooding can, however, occur anywhere, and mudslides from heavy rain can cause problems in any mountainous area, particularly the Southwest. The narrow canyons of many mountain areas in the west and severe thunderstorm activity during the monsoon season in summer leads to sometimes devastating flash floods as well, while Nor'easter snowstorms can bring activity to a halt throughout the Northeast (although heavy snowstorms can occur almost anywhere).

The Southwest has the worst droughts; one is thought to have lasted over 500 years and to have decimated the Anasazi people. Large stretches of desert shrub in the west can fuel the spread of wildfires. Although severe drought is rare, it has occasionally caused major problems, such as during the Dust Bowl (1931–1942), which coincided with the Great Depression. Farmland failed

throughout the Plains, entire regions were virtually depopulated, and dust storms ravaged the land. More recently, the western U.S. experienced widespread drought from 1999-2004.

Hurricanes - Sunspot theory

A 2010 report correlates low sunspot activity with high hurricane activity. Analyzing historical data, there was a 25% chance of at least one hurricane striking the continental US during a peak sunspot year; a 64% chance during a low sunspot year. In June 2010, the hurricanes predictors in the US were not using this information.

Statistics for Selected Cities

Anchorage

Climate chart (explanation)

J	F	M	A	M	J	J	A	S	O	N	D
0.7	0.7	0.7	0.5	0.7	1.1	1.7	2.9	2.9	2.1	1.1	1.1
22	26	34	44	55	62	65	63	55	40	28	24
9	12	18	29	39	47	52	49	41	28	16	11

average max. and min. temperatures in °F

precipitation totals in inches

Atlanta

Climate chart (explanation)

J	F	M	A	M	J	J	A	S	O	N	D
5	4.7	5.4	3.6	4	3.6	5.1	3.7	4.1	3.1	4.1	3.8
52	57	65	73	80	87	89	88	82	73	63	55
34	37	44	50	60	67	71	70	64	53	44	36

average max. and min. temperatures in °F

precipitation totals in inches

Chicago

Climate chart (explanation)

J	F	M	A	M	J	J	A	S	O	N	D
2	1.8	2.8	3.8	3.9	4.2	3.8	3.9	3.5	2.8	3.2	2.8
31	36	47	59	71	81	85	82	75	63	48	36
16	21	31	40	51	61	66	65	57	45	34	22

average max. and min. temperatures in °F

precipitation totals in inches

Denver

Climate chart (explanation)

J	F	M	A	M	J	J	A	S	O	N	D
0.5	0.5	1.3	1.9	2.3	1.6	2.2	1.8	1.1	1	1	0.6
43	47	54	61	71	82	88	86	77	66	52	44
15	19	25	34	44	53	59	57	47	36	24	16

average max. and min. temperatures in °F

precipitation totals in inches

New York

Climate chart (explanation)

J	F	M	A	M	J	J	A	S	O	N	D
4.1	3.2	4.4	4.3	4.7	3.8	4.6	4.2	4.2	3.9	4.4	4
38	41	50	61	71	79	84	82	75	64	53	43
26	28	35	44	54	63	69	68	60	50	41	32

average max. and min. temperatures in °F

precipitation totals in inches

Los Angeles (LAX)

Climate chart (explanation)

J	F	M	A	M	J	J	A	S	O	N	D
2.4	2.5	2	0.7	0.1	0	0	0.2	0.3	0.3	1.8	1.7
66	66	66	68	69	72	75	77	77	75	70	66
48	49	51	53	56	60	63	64	63	59	53	48

average max. and min. temperatures in °F

precipitation totals in inches

Miami

Climate chart (explanation)

J	F	M	A	M	J	J	A	S	O	N	D
2	2.1	2.4	2.9	6.2	9.3	5.7	7.6	7.6	5.6	2.7	1.8
75	77	79	82	85	88	89	89	88	85	80	77
59	60	64	68	72	75	76	77	76	72	67	62

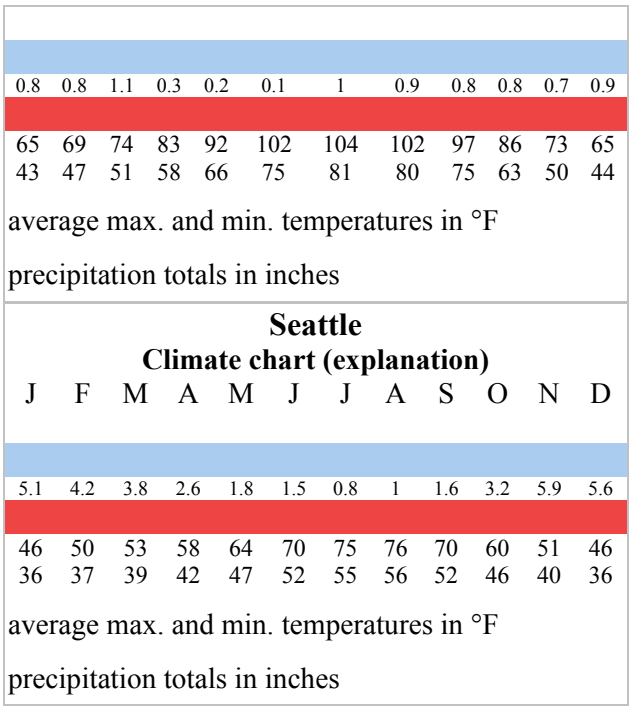
average max. and min. temperatures in °F

precipitation totals in inches

Phoenix

Climate chart (explanation)

J	F	M	A	M	J	J	A	S	O	N	D



Climate data for Anchorage (Anchorage International Airport, 1961-2000)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Record high °F (°C)	56 (13.3)	57 (13.9)	56 (13.3)	72 (22.2)	82 (27.8)	92 (33.3)	84 (28.9)	85 (29.4)	73 (22.8)	64 (17.8)	62 (16.7)	53 (11.7)	92 (33.3)
Average high °F (°C)	22.2 (-5.44)	25.8 (-3.44)	33.6 (0.89)	43.9 (6.61)	54.9 (12.72)	62.3 (16.83)	65.3 (18.5)	63.3 (17.39)	55.0 (12.78)	40.0 (4.44)	27.7 (-2.39)	23.7 (-4.61)	43.1 (6.17)
Average low °F (°C)	9.3 (-12.61)	11.7 (-11.28)	18.2 (-7.67)	28.7 (-1.83)	38.9 (3.83)	47.0 (8.33)	51.5 (10.83)	49.4 (9.67)	41.4 (5.22)	28.3 (-2.06)	15.9 (-8.94)	11.4 (-11.44)	29.3 (-1.5)
Record low °F (°C)	−35 (-37.2)	−38 (-38.9)	−24 (-31.1)	−15 (-26.1)	1 (-17.2)	29 (-1.7)	34 (1.1)	31 (-0.6)	19 (-7.2)	−6 (-21.1)	−21 (-29.4)	−36 (-37.8)	−38 (-38.9)
Precipitation inches (mm)	0.68 (17.3)	0.74 (18.8)	0.65 (16.5)	0.52 (13.2)	0.70 (17.8)	1.06 (26.9)	1.70 (43.2)	2.93 (74.4)	2.87 (72.9)	2.09 (53.1)	1.09 (27.7)	1.05 (26.7)	16.08 (408.4)
Snowfall inches (cm)	7.4 (18.8)	9.8 (24.9)	8.7 (22.1)	3.9 (9.9)	0 (0)	0 (0)	0 (0)	0 (0)	0.2 (0.5)	7.3 (18.5)	9.6 (24.4)	12.6 (32)	59.6 (151.4)
Avg. precipitation days (≥ 0.01 in)	8.1	7.2	6.8	5.5	7.0	8.2	11.3	13.8	14.5	12.3	9.3	11.1	115.1
Avg. snowy days (≥ 0.1 in)	7.0	5.9	5.8	3.4	0.2	0	0	0	0.2	4.3	7.0	8.8	42.6
Sunshine	83.7	121.5	195.3	234.0	288.3	276.0	251.1	204.6	159.0	117.8	81.0	52.7	2,065

Source #1: NOAA

Climate data for Atlanta (Atlanta Airport)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average high °F (°C)	51.9 (11.06)	56.8 (13.78)	65.0 (18.33)	72.9 (22.72)	80.0 (26.67)	86.5 (30.28)	89.4 (31.89)	87.9 (31.06)	82.3 (27.94)	72.9 (22.72)	63.3 (17.39)	54.6 (12.56)	72.0 (22.22)
Average low °F (°C)	33.5 (0.83)	36.7 (2.61)	43.6 (6.44)	50.4 (10.22)	59.5 (15.28)	67.1 (19.5)	70.6 (21.44)	69.9 (21.06)	64.3 (17.94)	52.8 (11.56)	43.5 (6.39)	36.2 (2.33)	52.3 (11.28)
Precipitation inches (mm)	5.03 (127.8)	4.68 (118.9)	5.38 (136.7)	3.62 (91.9)	3.95 (100.3)	3.63 (92.2)	5.12 (130)	3.67 (93.2)	4.09 (103.9)	3.11 (79)	4.10 (104.1)	3.82 (97)	50.2 (1,275)
Snowfall inches (cm)	0.9 (2.3)	0.5 (1.3)	0.4 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.2 (0.5)	2.0 (5.1)
Avg. precipitation days (≥ 0.01 in)	12.1	9.8	10.9	8.4	9.6	9.8	11.5	9.5	8.3	6.4	9.4	10.4	116.1
Avg. snowy days (≥ 0.1 in)	0.6	0.7	0.2	0	0	0	0	0	0	0	0	0.3	1.8
Sunshine hours	164.3	172.3	220.1	261.0	288.3	285.0	272.8	257.3	228.0	283.7	186.0	164.3	2,738.1

Climate data for Chicago (Midway Airport)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Record high °F (°C)	67 (19.4)	75 (23.9)	88 (31.1)	91 (32.8)	98 (36.7)	104 (40)	105 (40.6)	102 (38.9)	101 (38.3)	94 (34.4)	81 (27.2)	71 (21.7)	105 (40.6)
Average high °F (°C)	30.7 (-0.72)	36.1 (2.28)	47.4 (8.56)	59.2 (15.11)	71.3 (21.83)	80.8 (27.11)	84.7 (29.28)	82.3 (27.94)	75.1 (23.94)	63.2 (17.33)	48.0 (8.89)	35.6 (2)	59.5 (15.28)
Average low °F (°C)	16.2 (-8.78)	21.3 (-5.94)	30.6 (-0.78)	40.2 (4.56)	50.9 (10.5)	60.7 (15.94)	66.3 (19.06)	65.0 (18.33)	56.7 (13.72)	44.9 (7.17)	33.6 (0.89)	22.2 (-5.44)	42.4 (5.78)
Record low °F (°C)	−27 (-32.8)	−21 (-29.4)	−12 (-24.4)	7 (-13.9)	27 (-2.8)	35 (1.7)	45 (7.2)	43 (6.1)	29 (-1.7)	14 (-10)	−2 (-18.9)	−25 (-31.7)	−27 (-32.8)
Precipitation inches (mm)	1.95 (49.5)	1.78 (45.2)	2.83 (71.9)	3.82 (97)	3.86 (98)	4.16 (105.7)	3.82 (97)	3.91 (99.3)	3.45 (87.6)	2.79 (70.9)	3.22 (81.8)	2.76 (70.1)	38.35 (974.1)
Snowfall inches (cm)	12.9 (32.8)	10.3 (26.2)	6.0 (15.2)	1.4 (3.6)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.1 (0.3)	2.3 (5.8)	10.1 (25.7)	43.1 (109.5)
Avg.	11.2	8.9	11.7	11.6	11.0	10.3	9.5	9.6	8.9	9.7	11.5	11.3	125.2

precipitation days (≥ 0.01 in)													
Avg. snowy days (≥ 0.1 in)	6.2	6.2	4.5	1.0	0	0	0	0	0	0.2	2.7	7.2	28
Sunshine hours	136.4	138.4	186.0	216.0	282.1	312.0	319.3	282.1	228.0	192.2	114.0	105.4	2,511.9

NOTE - the above data were taken at Stapleton Airport until its closure, at which time Denver International Airport became the replacing station

Climate data for Los Angeles (Downtown - USC campus)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average high °F (°C)	68.1 (20.06)	69.6 (20.89)	69.8 (21)	73.1 (22.83)	74.5 (23.61)	79.5 (26.39)	83.8 (28.78)	84.8 (29.33)	83.3 (28.5)	79.0 (26.11)	73.2 (22.89)	68.7 (20.39)	75.6 (24.22)
Daily mean °F (°C)	58.3 (14.61)	60.0 (15.56)	60.7 (15.94)	63.8 (17.67)	66.2 (19)	70.5 (21.39)	74.2 (23.44)	75.2 (24)	74.0 (23.33)	69.5 (20.83)	62.9 (17.17)	58.5 (14.72)	66.2 (19)
Average low °F (°C)	48.5 (9.17)	50.3 (10.17)	51.6 (10.89)	54.4 (12.44)	57.9 (14.39)	61.4 (16.33)	64.6 (18.11)	65.6 (18.67)	64.6 (18.11)	59.9 (15.5)	52.6 (11.44)	48.3 (9.06)	56.6 (13.67)
Rainfall inches (mm)	3.33 (84.6)	3.68 (93.5)	3.14 (79.8)	0.83 (21.1)	0.31 (7.9)	0.06 (1.5)	0.01 (0.3)	0.13 (3.3)	0.32 (8.1)	0.37 (9.4)	1.05 (26.7)	1.91 (48.5)	15.14 (384.6)
Avg. rainy days (≥ 0.01 inch)	6.5	6.0	6.4	3.0	1.3	0.6	0.3	0.5	1.2	2.0	3.1	4.3	35.2
Sunshine hours	217	232	279	300	279	300	372	341	270	248	210	217	3,265

Climate data for Miami (MIA, 1961-1990)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average high °F (°C)	75.2 (24)	76.5 (24.72)	79.2 (26.22)	82.4 (28)	85.3 (29.61)	87.6 (30.89)	89.1 (31.72)	89.1 (31.72)	87.8 (31)	84.6 (29.22)	80.4 (26.89)	76.6 (24.78)	82.9 (28.28)
Daily mean °F (°C)	67.2 (19.56)	68.5 (20.28)	71.7 (22.06)	75.1 (23.94)	78.7 (25.94)	81.3 (27.39)	82.7 (28.17)	82.9 (28.28)	81.9 (27.72)	78.4 (25.78)	73.6 (23.11)	69.1 (20.61)	75.9 (24.39)
Average low °F (°C)	59.2 (15.11)	60.4 (15.78)	64.2 (17.89)	67.8 (19.89)	72.1 (22.28)	75.0 (23.89)	76.3 (24.61)	76.6 (24.78)	75.9 (24.39)	72.1 (22.28)	66.7 (19.28)	61.5 (16.39)	68.9 (20.5)
Rainfall inches	2.012 (51.1)	2.079 (52.8)	2.39 (60.7)	2.85 (72.4)	6.209 (157.7)	9.331 (237.0)	5.701 (144.8)	7.579 (192.5)	7.63 (193.8)	5.642 (143.3)	2.661 (67.6)	1.831 (46.5)	55.913 (1,420.2)

(mm)													
Avg. rainy days (≥ 1.0 mm)	5.3	4.6	4.9	4.5	9.0	13.8	13.3	15.0	14.2	10.9	7.1	4.5	107.1
Sunshine hours	220.1	217.5	275.9	294.0	300.7	288.0	310.0	288.3	261.0	260.4	222.0	217.0	3,154.9

Climate data for Phoenix, Arizona (Phoenix Int'l, 1971-2000)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Record high °F (°C)	88 (31.1)	92 (33.3)	100 (37.8)	105 (40.6)	114 (45.6)	122 (50)	121 (49.4)	116 (46.7)	116 (46.7)	107 (41.7)	96 (35.6)	87 (30.6)	122 (50)
Average high °F (°C)	67.3 (19.61)	71.4 (21.89)	76.1 (24.5)	84.7 (29.28)	93.9 (34.39)	103.9 (39.94)	106.6 (41.44)	104.5 (40.28)	99.0 (37.22)	87.7 (30.94)	75.0 (23.89)	67.1 (19.5)	86.4 (30.22)
Average low °F (°C)	44.8 (7.11)	48.4 (9.11)	53.0 (11.67)	57.6 (14.22)	67.4 (19.67)	75.6 (24.22)	82.9 (28.28)	81.6 (27.56)	75.6 (24.22)	62.1 (16.72)	50.4 (10.22)	43.9 (6.61)	61.9 (16.61)
Record low °F (°C)	16 (-8.9)	24 (-4.4)	25 (-3.9)	35 (1.7)	39 (3.9)	49 (9.4)	63 (17.2)	58 (14.4)	47 (8.3)	34 (1.1)	27 (-2.8)	22 (-5.6)	16 (-8.9)
Rainfall inches (mm)	0.83 (21.1)	0.77 (19.6)	1.07 (27.2)	0.25 (6.4)	0.16 (4.1)	0.09 (2.3)	0.99 (25.1)	0.94 (23.9)	0.75 (19)	0.79 (20.1)	0.73 (18.5)	0.92 (23.4)	8.29 (210.6)
Avg. rainy days (≥ 0.01 in)	4.2	4.3	4.6	1.7	1.1	.7	4.2	4.5	3.1	2.9	2.7	3.7	37.7
Sunshine hours	257.3	259.9	319.3	354.0	399.9	408.0	378.2	359.6	330.0	310.0	255.0	244.9	3,876.1

NOAA (precipitation normals), HKO (sun)

Chapter- 2

Environmental Policy of the United States

The **environmental policy of the United States** is federal governmental action to regulate activities that have an environmental impact in the United States. The goal of environmental policy is to protect the environment for future generations while interfering as little as possible with the efficiency of commerce or the liberty of the people and to limit inequity in who is burdened with environmental costs. This policy grew mainly out of the environmental movement in the United States in the 1960s and '70's during which several environmental laws were passed, regulating air and water pollution and forming the Environmental Protection Agency (EPA). Partially due to the high costs associated with these regulations, there has been a backlash from business and politically conservative interests, limiting increases to environmental regulatory budgets and slowing efforts to protect the environment. Since the 1970s, despite frequent legislative gridlock, there have been significant achievements in environmental regulation, including increases in air and water quality and to a lesser degree, control of hazardous waste. Due to increasing scientific consensus on global warming and political pressure from environmental groups, modifications to the United States energy policy and limits on greenhouse gas emission have been proposed, but such efforts have made limited progress.

Policy tools

The two major policy tools for protecting the environment are rules and inducements. The United States has chosen to use rules, primarily through regulation. Such regulation can come in the form of **design standards** and **performance standards**. Performance standards specify emission levels and let those covered by the rules decide how those levels will be met. Design standards specify exactly how performance standards will be met.

Alternatively, the government can use inducements, or **market reform**. Inducements are rewards and punishments used to influence people or groups. The two major types of market reforms are charge systems, such as emissions taxes, and **tradable permit systems**. One type of tradable permit system is an **auction of pollution rights** in which the amount of allowed pollution is set and divided into units, which are then auctioned, giving environmental organizations the opportunity to buy the units to create a cleaner environment than originally planned. Such a plan

was implemented for SO_2 emissions in the 1990 Acid Rain Program and has been undertaken for greenhouse gases on a regional scale as a way to mitigate global warming.

Power Delegation and Policy Jurisdiction

Executive Branch

Governmental authority on environmental issues in the United States is highly fragmented. While the EPA is the most comprehensive environmental agency, its authority on these matters is not absolute. Virtually all of the executive branch's departments have some area of environmental authority. This contributes somewhat to the cost and questionable efficacy of the United States' environmental regulation.

Federal Agency	Environmental Responsibilities
White House Office	Overall policy, Agency coordination
Office of Management and Budget	Budget, Agency coordination and management
Council on Environmental Quality	Environmental policy, Agency coordination, Environmental impact statements
Department of Health and Human Services	Health
Environmental Protection Agency	Air and water pollution, Solid waste, Radiation, Pesticides, Noise, Toxic substances
Department of Justice	Environmental litigation
Department of the Interior	Public lands, Energy, Minerals, National parks
Department of Agriculture	Forestry, Soil, Conservation
Department of Defense	Civil works construction, Dredge and fill permits, Pollution control from defense facilities
Nuclear Regulatory Commission	License and regulate nuclear power
Department of State	International environment
Department of Commerce	Oceanic and atmospheric monitoring and research

Department of Labor	Occupational health
Department of Housing and Urban Development	Housing, Urban parks, Urban planning
Department of Transportation	Mass transit, Roads, Aircraft noise, Oil pollution
Department of Energy	Energy policy coordination, Petroleum allocation research and development
Tennessee Valley Authority	Electric power generation

Legislative Branch

Fragmentation within the executive branch is duplicated in Congress and within the states. The EPA is the concern of almost two-thirds of the House of Representatives' standing committees and subcommittees and a similar percentage in the Senate. Some seventy committees and subcommittees control water quality policy, for example. Such fragmentation creates both opportunities and problems. While such a variety of committees provide enormous access for environmentalist and industry groups to lobby, the division of tasks means that no one committee or agency looks at environmental problems as a whole.

Senate and House committee jurisdictions

Senate

Committee on Agriculture, Nutrition and Forestry	Pesticides
Committee on Appropriations	Appropriations
Committee on the Budget	Budget
Committee on Commerce, Science, and Transportation	Oceans, Research and Development, Radiation, Toxics
Committee on Energy and Natural Resources	Synthetic fuels, Conservation oversight, Energy budget, Mines, Oil shale, Outer continental shelf, Strip mining
Committee on Environment and Public Works	Air, Drinking water, Noise, Nuclear energy, Ocean dumping, Outer continental shelf, Research and development, Solid waste, Toxics, Water

Committee on Foreign Relations	International environment
Committee on Homeland Security and Governmental Affairs	Interagency subject area
Committee on Labor and Human Resources	Public health
Committee on Small Business	Impact of environmental regulations on small business
House	
Committee on Agriculture	Pesticides
Committee on Appropriations	Appropriations
Committee on the Budget	Budget
Committee on Oversight and Government Reform	Interagency subject area
Committee on Interior and Insular Affairs	Synthetic fuels, Conservation oversight, Energy budget, Mines, Oil shale, Outer continental shelf, Radiation (Nuclear Regulatory Commission oversight), Strip mining
Committee on Energy and Commerce	Air, Drinking water, Noise, Radiation, Solid waste, Toxics
Committee on Natural Resources	Ocean dumping
Committee on Transportation and Infrastructure	Noise, Water pollution, Water resources
Committee on Science and Technology	Research and Development
Committee on Small Business	Impact of environmental regulations on small business

History

Major Environmental Legislation

Year	Law	Year	Law
1899	Refuse Act	1974	Safe Drinking Water Act
1918	Migratory Bird Treaty Act of 1918	1975	Hazardous Materials Transportation Act
1948	Federal Water Pollution Control Act	1976	Resource Conservation and Recovery Act
1955	Air Pollution Control Act	1976	Solid Waste Disposal Act
1963	Clean Air Act (1963)	1976	Toxic Substances Control Act
1965	Solid Waste Disposal Act	1977	Clean Air Act Amendments
1965	Water Quality Act	1977	Clean Water Act Amendments
1967	Air Quality Act	1980	CERCLA (Superfund)
1969	National Environmental Policy Act	1984	Resource Conservation and Recovery Act Amendments
1970	Clean Air Act (1970)	1986	Safe Drinking Water Act Amendments
1970	Occupational Safety and Health Act	1986	Superfund Reauthorization
1972	Consumer Product Safety Act	1987	Clean Water Act Reauthorization
1972	Federal Insecticide, Fungicide, and Rodenticide Act	1990	Oil Pollution Act
1972	Clean Water Act	1990	Clean Air Act (1990)
1972	Noise Control Act	1993	North American Free Trade Agreement
1973	Endangered Species Act	2003	Healthy Forests Initiative

There are many more environmental laws in the United States, both at the federal and state levels. The common law of property and takings also play an important role in environmental

issues. In addition, the law of standing, relating to who has a right to bring a lawsuit, is an important issue in environmental law in the United States.

Origins of the Environmental Movement

The history of environmental law in the United States can be traced back to early roots in common law doctrines, for example, the law of nuisance and the public trust doctrine. The first statutory environmental law was the Rivers and Harbors Act of 1899, which has been largely superseded by the Clean Water Act. However, most current major environmental statutes, such as the federal statutes listed above, were passed during the modern environmental movement spanning the late 1960s through the early 1980s. Prior to the passage of these statutes, most federal environmental laws were not nearly as comprehensive.

The precursor of the modern environmental movement in the United States was the early twentieth century conservation movement, associated with President Theodore Roosevelt and Gifford Pinchot. During this period, the U.S. Forest Service was formed and public concern for consumer protection began, epitomized by the publication of *The Jungle* by Upton Sinclair. The origins of the modern environmental movement were in the publication of Rachel Carson's controversial *Silent Spring*, which pointed out the perils of pesticide use and rallied concern for the environment in general. Along with critiques of the misuse of technology from figures such as William Ophuls, Barry Commoner and Garrett Hardin, the ineffectiveness and criticism of the 1960s Clean Air and Clean Water acts gave a burgeoning momentum to the environmental movement.

In addition to growing public support, structural changes such as Congressional reform and new access to the courts gave environmentalists new power to enact change. The movement that formed held three key values: ecology, health, and sustainability. These values- that we depend and are interconnected with the environment, that insults to the environment can affect our health, and that we should limit our dependence on non-renewable resources- along with a uniquely sympathetic president and Congress, led to great environmental policy change in the 1970s.

One lawsuit that has been widely recognized as one of the earliest environmental cases is *Scenic Hudson Preservation Conference v. Federal Power Commission,* decided in 1965 by the Second Circuit Court of Appeals, prior to passage of the major federal environmental statutes. The case helped halt the construction of a power plant on Storm King Mountain in New York State. The case has been described as giving birth to environmental litigation and helping create the legal doctrine of standing to bring environmental claims. The Scenic Hudson case also is said to have helped inspire the passage of the National Environmental Policy Act, and the creation of such environmental advocacy groups as the Natural Resources Defense Council.

The Nixon Administration and beginning of the Environmental Decade (1970-1980)

On January 1, 1970, President Richard Nixon signed the National Environmental Policy Act (NEPA), beginning the 1970s as the environmental decade. NEPA created the Council on Environmental Quality which oversaw the environmental impact of federal actions. Later in the

year, Nixon created the Environmental Protection Agency (EPA), which consolidated environmental programs from other agencies into a single entity. The legislation during this period concerned primarily first-generation pollutants in the air, surface water, groundwater, and solid waste disposal. Air pollutants such as particulates, sulfur dioxide, nitrogen dioxide, carbon monoxide, and ozone were put under regulation, and issues such as acid rain, visibility, and global warming were also concerns. In surface water, the contaminants of concern were dissolved oxygen, bacteria, suspended and dissolved solids, nutrients, and toxic substances such as metals. For groundwater, the pollutants included biological contaminants, inorganic and organic substances, and radionuclides. Finally, solid waste contaminants from agriculture, industry, mining, municipalities, and others were put under control.

The Clean Air Act amendments of 1970 and the Federal Water Pollution Control Act amendments of 1972 moved environmental concerns in a new direction. The standards that they put in place were unattainable with existing technology- they were technology forcing. The standards that the EPA put into place called mainly for state implementation. Each state prepared state implementation plans (SIPs), requiring EPA approval, and each state had to request permits from the EPA to emit pollution into any surface water. Congress also provided for a massive public works program to assist in the construction of water and waste treatment plants for municipalities. The 1970 Clean Air Act also enacted deadlines and penalties for automobile emission standards in new cars, resulting in the development and adoption of catalytic converters and greatly reducing automobile pollution.

The Reagan Administration (1980-1989)

Ronald Reagan entered office skeptical of environmental protection laws and campaigned against harsh government regulation with the environmental arena in mind. As Reagan entered office, he was given two transition reports - one called "Mandate for Leadership" from the Heritage Foundation and one called "Avoiding a GOP Economic Dunkirk" from conservative Congressman David Stockman(R-MI) - that called for drastic changes in environmental regulation, primarily through administrative changes. In pursuit of this strategy, Reagan gradually reduced the EPA's budget by 30% through the Omnibus Budget Reconciliation Act of 1981, cut the number of EPA employees, and appointed people at key agency positions who would enthusiastically follow the administration line. Appointees such as Anne Burford at the EPA and James G. Watt at the Department of the Interior were overtly hostile to environmental protection. Through his appointments, Reagan changed the operations of environmental protection from stiff regulation to "cooperative regulation."

Under this administrative strategy of regulatory relief, environmental laws were written and interpreted more favorably for industry interests. The Office of Management and Budget(OMB) was also given new powers to write regulations. During the first Reagan administration, the OMB was given the power to require a favorable cost-benefit analysis of any regulation before it could be implemented. This was used to delay new regulations, and changes that resulted in regulatory relief often had this requirement waived. At the beginning of the second Reagan administration, the OMB was given more power- all regulatory agencies were required to submit proposals each year for all major environmental regulation- allowing it to reduce regulatory efforts before such proposed regulations became public.

The George H. W. Bush Administration (1989-1993)

Environmental policy during the first Bush administration contained a mixture of innovation and restriction. He appointed the first environmentalist, William Reilly, to head the EPA, along with others with strong environmental inclinations. In other departments with environmental responsibilities and in White House offices, however, he appointed people who were more developmentally-oriented, such as John H. Sununu, Richard Darman, and Dan Quayle. While considerable regulation was initially passed, during his last two years in office he severely restricted regulation, and in 1992, a total freeze was put on new regulations.

The private-sector Council on Competitiveness (distinct from the federal Competitiveness Policy Council) was formed in 1989 to play the same role as the previous Task Force on Regulatory Relief that Bush had served on in the Reagan administration, which was to negotiate on behalf of the president for regulatory relief with the heads of federal agencies. This executive branch agency negotiated with EPA director Reilly, leading to industry-favorable rulings such as the redefinition of wetlands and the allowance of untreated toxic chemicals in local landfills (this was later reversed). While previous regulatory-relief efforts, such as Reagan's use of the Office of Budget Management, were subject to congressional oversight, the Council on Competitiveness was independent and wasn't required to keep records of its proceedings.

In 1992, Bush opposed international efforts at the Earth Summit in Rio de Janeiro, Brazil by refusing to sign the biodiversity treaty and lobbying to remove all binding targets from the proposal on limiting global carbon dioxide emissions.

The Clinton Administration (1993-2001)

The Clinton administration promised a change in the direction of environmental policy. Al Gore, the vice president, and appointees such as Carol Browner in EPA and Bruce Babbitt were all encouraging from an environmental standpoint. Clinton eliminated the Council on Competitiveness, returning regulatory authority to agency heads, and Clinton and Gore argued that environmental protection and economic growth were not incompatible.

Clinton's record as the governor of Arkansas however, suggested that Clinton would be willing to make compromises. Through a number of middle-of-the-road positions, on issues such as grazing fees in the West and clean-up of the Everglades, and through his support of the North American Free Trade Agreement in 1993 and the General Agreement on Tariffs and Trade in 1994, Clinton dissatisfied some environmentalists. Specifically, the Green Party and its candidate Ralph Nader were outspoken in their criticism of Clinton's environmental record.

Despite criticism from environmental purists, the Clinton administration had several notable environmental accomplishments. Clinton created the President's Council on Sustainable Development, signed the Kyoto Protocol (although he did not submit the treaty to the Senate), and stood firm against Republican attempts after the 1994 elections to roll back environmental laws and regulations through the appropriations process. During the Clinton administration, the EPA's budget was increased, and much of the country's natural resources were put under greater

protection, such as the restoration of the Everglades and the increase in size of the Everglades National Park.

Issues

Since the environmental movement of the 1970s, the nature of environmental issues has changed. While the initial emphasis was on conventional air and water pollutants, which were the most obvious and easily measurable problems, newer issues are long-term problems that are not easily discernible and can be surrounded by controversy.

Acid Deposition

Acid deposition, in the form of acid rain and dry deposition, is the result of sulfur and nitrogen dioxide being emitted into the air, traveling and landing in a different place, and changing the acidity of the water or land on which the chemicals fall. Acid deposition in the Northeast United States from the burning of coal and in the West United States from utilities and motor vehicles caused a number of problems, and was partially exacerbated by the Clean Air Act, which forced coal power plants to use taller smoke stacks, resulting in farther transmission of sulfur dioxide in the air.

During the Carter administration, the United States undertook a **risk-averse** policy, acting through the EPA and Council on Environmental Quality (CEQ) to research and control the pollutants suspected to cause acid deposition even in the face of scientific uncertainty. The Reagan administration was more **risk tolerant**. It argued that, given the scientific uncertainties about harm and exposure levels, new expenditures should not be undertaken that would curtail energy security and economic growth. During George H. W. Bush's presidential campaign, he called for new Clean Air Act legislation to curtail sulfur- and nitrogen-dioxide emissions. In 1990, after he was elected, amendments to the Clean Air Act were finally passed that cut emissions by over 12 million tons per year, set up a market-like system of emissions trading, and set a cap on emissions for the year 2000. These goals were achieved to some degree by the installation of industrial scrubbers.

While the initial costs in cutting emissions levels were expected to be over $4.6 billion for utilities and a 40% rise in electricity costs, the impact ended up being only about $1 billion and a 2-4% rise in electricity costs. Part of the reason for the relatively-low costs is the availability of low-sulfur coal.

Ozone Depletion

Ozone depletion is the reduced concentration of ozone in the Earth's stratosphere (called the ozone layer), where it serves to block much of the ultraviolet radiation from the sun. Chlorofluorocarbons (CFCs), which were used beginning in the 1930s in a number of important areas, were determined in 1974 to be responsible for much of the depletion of the ozone layer. Four years later, the EPA and FDA to ban CFCs in aerosol cans. As research in the 1980s indicated that the problem was worse than before, and revealed a controversial massive hole in the ozone layer over Antarctica, three international agreements were made to reduce the ozone-

damaging substances- the Vienna Convention, the 1987 Montreal Protocol, and a third agreement in 1990 in London. In the United States, the 1990 Clean Air Act Amendments phased out production of CFCs and required recycling of CFC products.

Although the phase-out of CFCs took almost two decades, the policy is generally seen as a success. While a crisis seems to be averted, due to the longevity of CFC particles in the atmosphere, the ozone layer is only expected to start showing sign of recovery by 2024.

Hazardous Wastes

Hazardous waste regulations began in the United States in 1976 with the Resource Conservation and Recovery Act (RCRA) to govern hazardous waste from its initial generation to final disposition (cradle-to-grave regulation) and the Toxic Substances Control Act (TSCA) to anticipate possible hazards from chemicals. Following the events at Love Canal, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or Superfund) was enacted in 1980 to assist in the cleanup of abandoned hazardous waste disposal sites. In the mid-1980s, the Hazardous and Solid Waste Amendments (1984) and the Superfund Amendments and Reauthorization Act (1986) were passed.

The aim of hazardous waste regulation is to prevent harm from occurring due to hazardous waste and to pass the burdens of cleanup of hazardous waste on to the original producers of the waste. Some of the problems of hazardous waste regulation are that the negative effects of hazardous waste can be difficult to detect and controversial and that, due mainly to the large amount of hazardous waste that is generated (214 million tons in 1995), regulation can be difficult and costly.

Implementation has been difficult, with years sometimes passing between legislation passage and initial regulations. Superfund was passed in December 1980, just before Reagan took office. The first administrator of Superfund was Rita Lavelle who had worked for a major hazardous waste generator. The result was that her implementation of Superfund was designed mainly to delay regulation, and the subsequent controversy resulted in the resignation of Lavelle, EPA administrator Anne Burford, and several other top EPA personnel. In 1986, Congress passed the Superfund Amendments and Reauthorization Act, increasing funding to $9 billion and providing for studies and new technologies. By 1995, Superfund cleanup still took an average of twelve years per site, and costs for each site can range in the billions of dollars. Superfund, while showing improvements, has been probably the most criticized of environmental programs based on costs of remediation, implementation problems, and the questionable seriousness of the problems it addresses.

Risk Control Policy

Underlying the policy decisions made by the United States is the concept of risk control, consisting of two parts: risk assessment and risk management. The science behind risk assessment varies greatly in uncertainty and tends to be the focus of political controversy. For example, animal testing is often used to determine the toxicity of various substances for humans. But assumptions made about expected dosage and exposure to chemicals are often disputed, and

the dosage given to animals is typically much larger than what humans normally consume. While industry groups tend to take a risk-tolerant position, environmentalists take a risk-averse position, following the precautionary principle.

Another issue is the effect that chemicals can have relative to lifestyle choices. Cancer, for example, typically surface decades after first exposure to a carcinogen, and lifestyle choices are frequently more important in causing cancer than exposure to chemicals. While the governmental role in mitigating lifestyle-choice risks can be very controversial, chemical exposure through lifestyle choices can also occur involuntarily if the public is not properly educated.

Finally, the way that threats are presented to the public plays a large role in how those threats are addressed. The threat of nuclear power and the environmental effects of pesticides are overstated, some have claimed, while many high-priority threats go unpublicized. In order to combat this discrepancy, the EPA published a Relative Risk Report in 1987, and a follow-up report published by the Relative Risk Reduction Strategies Committee in 1990 suggested that the EPA should adopt a more pro-active posture, educating the public and assigning budgetary priorities for objectively-assessed high-risk threats.

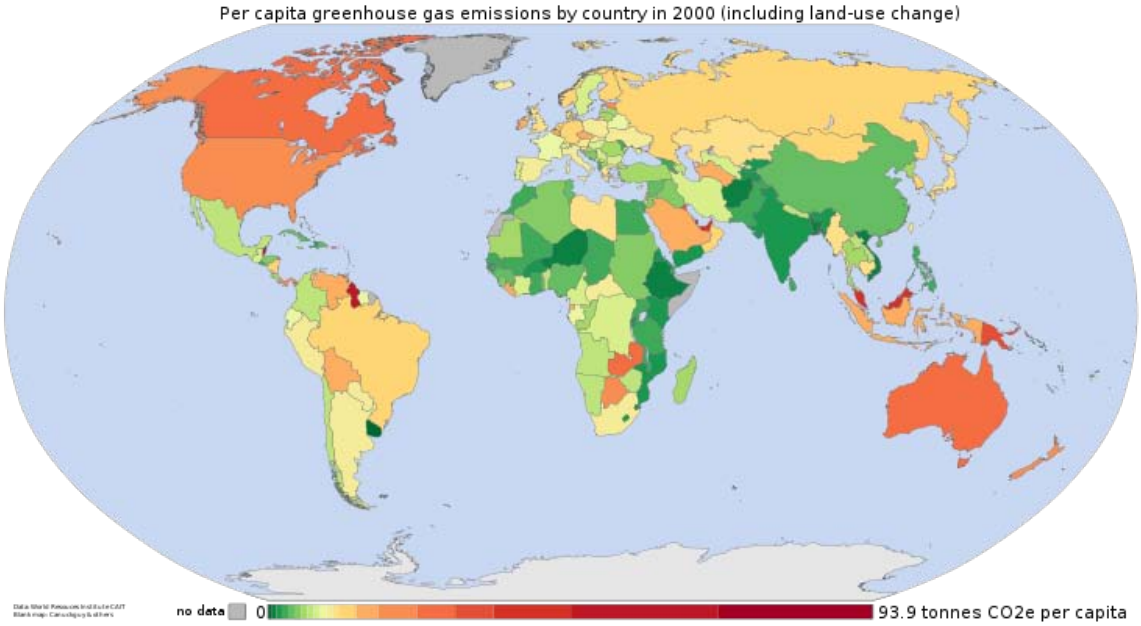
Impact

Since the major environmental legislation of the 1970s was enacted, great progress has been made in some areas, but the environmental protection has come at a high price. Between 1970 and 1996, air pollutants dropped 32% while the population grew by 29%. While air and water standards have been slowly improving, in 1996 70 million people still lived in counties that didn't meet EPA ozone standards. 36% of rivers and 39% of lakes didn't meet minimum standards for all uses (swimming, fishing, drinking, supporting aquatic life). In the same period, the size of the National Park Service grew from 26,000,000 acres (110,000 km^2) to 83,000,000 acres (340,000 km^2), and the U.S. Fish and Wildlife Service expanded by over three times to manage over 92,000,000 acres (370,000 km^2). In 1995, 41% of the 960 endangered species were stable or improving.

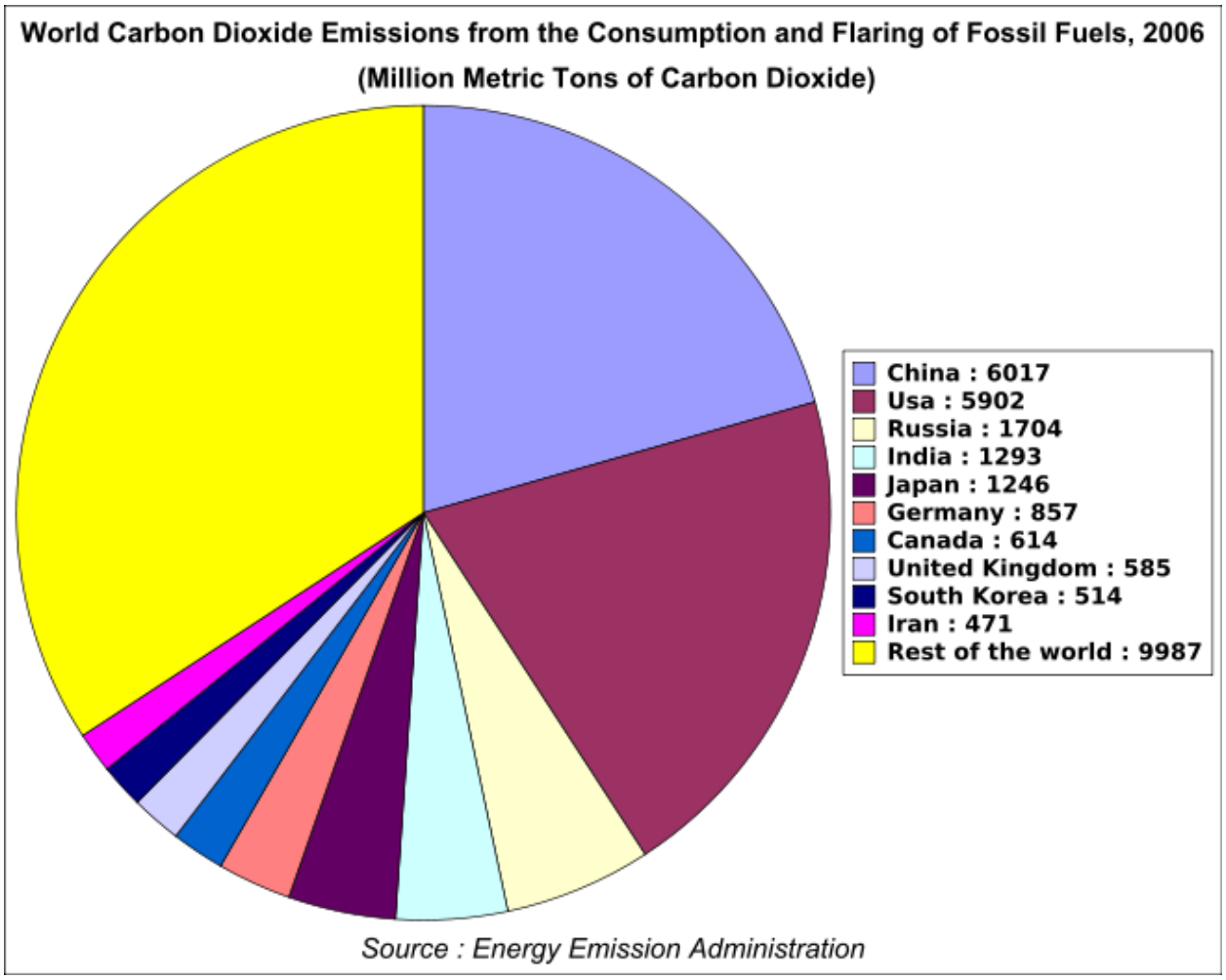
The overall cost of environmental regulation in the United States is estimated to be about 2% of the gross domestic product-similar to many other countries, but calculating the cost is challenging both conceptually (deciding what costs are included) and practically (with data from a broad range of sources). In 1994, almost $122 billion was spent on pollution abatement and control. $35 billion of that has been in direct government spending, $65 billion was spent by business, and $22 billion was spent by individuals. Critics of environmental legislation argue that the gains made in environmental protection come at too great a cost. The cost of meeting OSHA workplace exposure standards, for example, can be as high as $3 million per life-year for benzene protection in coke and coal factories or $51 million per life-year for arsenic protection in glass manufacturing plants. Due to these large costs, non-compliance with environmental rules is rampant in some areas, such as water pollution.

Chapter- 3

Environmental Issues in the United States



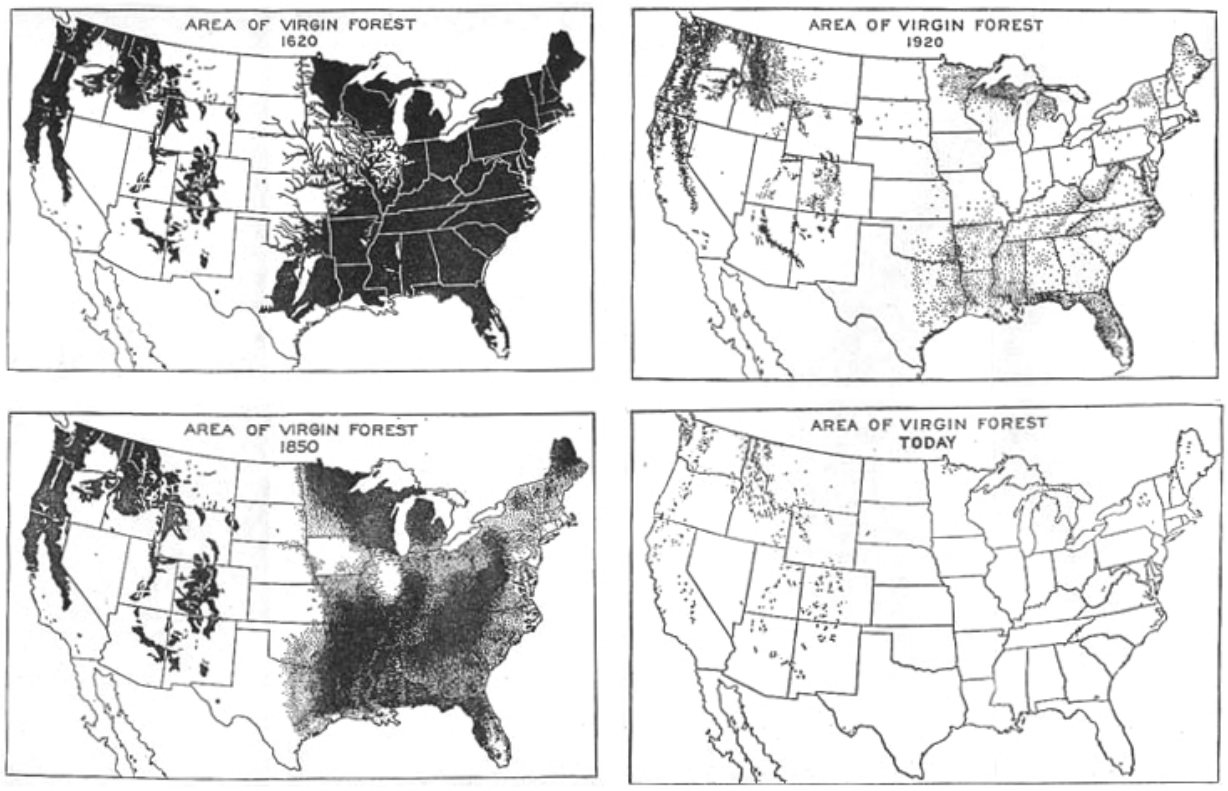
Per capita anthropogenic greenhouse gas emissions by country for the year 2000 including land-use change



As with many other countries there are a number of **environmental issues** in the **United States**.

Environmental Issues:

Deforestation in the United States



Loss of old growth forest in the United States. These maps represent only virgin forest lost. Some regrowth has occurred but not to the age, size or extent of the 1620 level due to population increases and food cultivation.

Deforestation in the **United States** is an ongoing environmental issue that attracts protests from environmentalists. Prior to the arrival of European-Americans about one half of the United States land area was forest, about 4 million square kilometers (1 billion acres) in 1600. Nearly all of this deforestation took place prior to 1910, and the forest resources of the United States have remained relatively constant through the entire 20th century.

The 2005 Food and Agriculture Organization (FAO) *Global Forest Resources Assessment* ranked the United States as seventh highest country losing its old growth forests, a vast majority of which were removed prior to the 20th century.

After European settlement

For the 300 years after the arrival of Europeans land was cleared, mostly for agriculture at a rate that matched the rate of population growth. For every person added to the population, one to two hectares of land was cultivated. This trend continued until the 1920s when the amount of crop land stabilized in spite of continued population growth. As abandoned farm land reverted to forest the amount of forest land increased from 1952 reaching a peak in 1963 of 3,080,000 km² (762 million acres). Since 1963 there has been a steady decrease of forest area with the exception of some gains from 1997. Gains in forest land have resulted from conversions from crop land and pastures at a higher rate than loss of forest to development. Because urban development is expected to continue, an estimated 93,000 km² (23 million acres) of forest land is projected be lost by 2050, a 3% reduction from 1997. Other qualitative issues have been identified such as the continued loss of old-growth forest, the increased fragmentation of forest lands, and the increased urbanization of forest land.

Current issues

The current environmental issue of deforestation in the United States is one that is affected by many different factors. One such factor is the effect, whether positive or negative, that the logging industry has on forests in the country. Logging in the United States is a hotly debated topic as groups who either support or oppose logging argue over its benefits and negative effects. "This industry comprises the establishments primarily engaged in one or more of the following: (1) cutting timber; (2) cutting and transporting timber; (3) producing wood chips in the field," the definition provided by the U.S. Environmental Protection Agency. "The United States is the world's leading producer and consumer of forest products and accounts for about one-fourth of the world's production and consumption. The United States is also the world's largest producer of softwood and hardwood lumber. In 1996, total annual sales for commercial (nonfederal) timber and nontimber forest products was approximately $3.8 billion." The biggest issue facing deforestation in the United States is illegal logging in forests. The U.S. Forest Service states that illegal logging is the biggest problem with deforestation because it is nearly impossible to monitor and stop. It goes on throughout the U.S. and other countries and often happens when companies disregard their permits and go beyond what they are allowed to harvest. The Forest Service and EPA work together to make sure that the permits for logging companies in the United States are granted in such a way that the forests are kept healthy and sustainable, and illegal logging reduces the chances that forests will be kept this way. The United States Forest Service is in favor of logging to a certain extent but there are several groups that oppose logging in the United States. Groups such as NativeForest.org and EarthRoots.org state that logging in the United States and specifically in industrial areas has led to deforestation and near extinction of many animals.

- Logging in the Tongass National Forest in Alaska
- Logging of old growth forests on the West Coast

Species extinctions in the Eastern forests

Forest cover in the Eastern United States reached its lowest point in roughly 1872 with about 48 percent compared to the amount of forest cover in 1620. Of the 28 forest bird species with habitat exclusively in that forest, Pimm claims four become extinct either wholly or mostly because of habitat loss, the passenger pigeon, Carolina parakeet, ivory-billed woodpecker, and Bachman's Warbler.

Energy in the United States

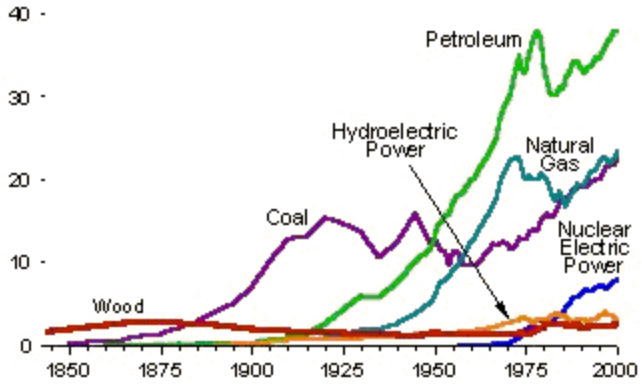
The United States is the largest energy consumer in terms of total use, using 100 quadrillion BTUs (105 exajoules, or 29 PWh) in 2005. This is three times the consumption by the United States in 1950. The U.S. ranks seventh in energy consumption per-capita after Canada and a number of small countries.

The majority of this energy is derived from fossil fuels: in 2005, it was estimated that 40% of the nation's energy came from petroleum, 23% from coal, and 23% from natural gas. Nuclear power supplied 8.4% and renewable energy supplied 7.3%, which was mainly from hydroelectric dams although other renewables are included such as wind power, geothermal and solar energy. Energy consumption has increased at a faster rate than energy production over the last fifty years in the U.S.(when they were roughly equal). This difference is now largely met through imports.

According to the Energy Information Administration's statistics, the per-capita energy consumption in the US has been somewhat consistent from the 1970s to today. The average has been 335.9 million BTUs per person from 1980 to 2006. One explanation suggested for this is that the energy required to produce the increase in US consumption of manufactured equipment, cars, and other goods has been shifted to other countries producing and transporting those goods to the US with a corresponding shift of green house gases and pollution. In comparison, the world average has increased from 63.7 in 1980 to 72.4 million BTU's per person in 2006. On the other hand, US "off-shoring" of manufacturing is sometimes exaggerated: US domestic manufacturing has grown by 50% since 1980.

The development of renewable energy and energy efficiency marks "a new era of energy exploration" in the United States, according to President Barack Obama.

History



US energy consumption, by source, 1850-2000. Vertical axis is in quadrillion BTU

From its founding until the late 18th century, the United States was a largely agrarian country with abundant forests. During this period, energy consumption overwhelmingly focused on readily available firewood. Rapid industrialization of the economy, urbanization, and the growth of railroads led to increased use of coal, and by 1885 it had eclipsed wood as the nation's primary energy source.

Coal remained dominant for the next 7 decades, but by 1950, it was surpassed in turn by both petroleum and natural gas. While coal consumption today is the highest it has ever been, it is now mostly used to generate electricity. Natural gas, which is cleaner-burning and more easily transportable, has replaced coal as the preferred source of heating in homes, businesses and industrial furnaces. Although total energy use increased dramatically during this period, by approximately a factor of 50 between 1850 and 2000, energy use per capita increased only by a factor of 4.

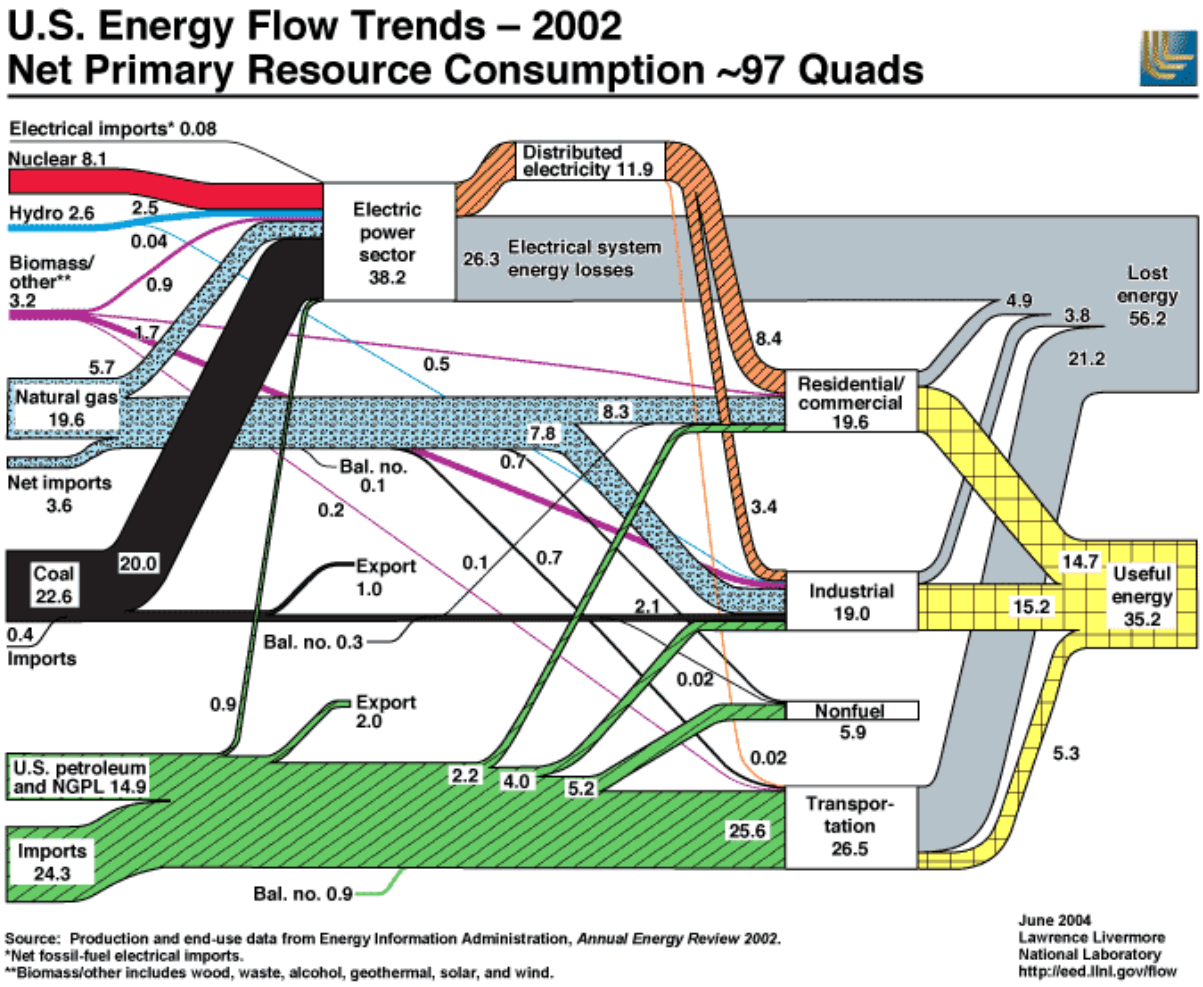
At the beginning of the 20th century, petroleum was a minor resource used to manufacture lubricants and fuel for kerosene and oil lamps. One hundred years later it had become the preeminent energy source for the U.S. and the rest of the world. This rise closely paralleled the emergence of the automobile as a major force in American culture and the economy.

While petroleum is also used as a source for plastics and other chemicals, and powers various industrial processes, today two-thirds of oil consumption in the U.S. is in the form of its derived transportation fuels. Oil's unique qualities for transportation fuels in terms of energy content, cost of production, and speed of refueling have made it difficult to supplant with technological alternatives developed so far.

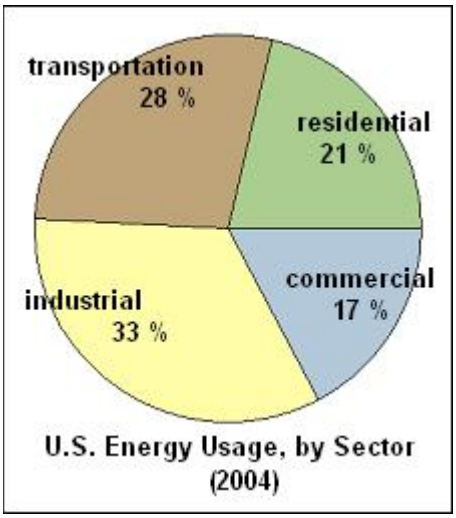
In June 2010, the American Energy Innovation Council, (which includes Bill Gates, Microsoft; Jeffrey R. Immelt, chief executive of General Electric; and John Doerr) has urged the government to more than triple spending on energy research and development, to $16 billion a year. Mr. Gates endorsed the administration’s goal of reducing greenhouse gas emissions by 80 percent by 2050, but said that was not possible with today’s technology or politicism. He said

that the only way to find such disruptive new technology was to pour large sums of money at the problem. The group notes that the federal government spends less than $5 billion a year on energy research and development, not counting one-time stimulus projects. About $30 billion is spent annually on health research and more than $80 billion on military R.& D. They advocate a jump in spending on basic energy research.

Current consumption



U.S. Energy Flow - 2002. A quad is 10^{15} BTU, or 1.055×10^{18} joules. Note that the breakdown of useful and waste energy in each sector (yellow vs. grey) may be misleading because much of the 'lost' energy consists of unavoidable losses arising from the Second Law of thermodynamics: heat engines cannot convert 100% of thermal energy into useful work, and must dump a fraction of waste heat into the environment.



The U.S. Department of Energy tracks national energy consumption in four broad sectors: industrial, transportation, residential, and commercial. The industrial sector has long been the country's largest energy user, currently representing about 33% of the total. Next in importance is the transportation sector, followed by the residential and commercial sectors.

Sector Summary

Sector Name	Description	Major uses
Industrial	Facilities and equipment used for producing and processing goods.	22% chemical production 16% petroleum refining 14% metal smelting/refining
Transportation	Vehicles which transport people/goods on ground, air or water.	61% gasoline fuel 21% diesel fuel 12% aviation
Residential	Living quarters for private households.	32% space heating 13% water heating 12% lighting 11% air conditioning 8% refrigeration 5% electronics 5% wet-clean (mostly clothes dryers)
Commercial	Service-providing facilities and equipment (businesses, government, other institutions).	25% lighting 13% heating 11% cooling

6% refrigeration
6% water heating
6% ventilation
6% electronics

The breakdown of energy consumption by source is given here:

Fuel type	2006 US consumption in PWh	2006 World consumption in PWh
Oil	11.71	50.33
Gas	6.50	31.65
Coal	6.60	37.38
Hydroelectric	0.84	8.71
Nuclear	2.41	8.14
Geothermal, wind, solar, wood, waste	0.95	1.38
Total	**29.26**	**138.41**

U.S, Primary Energy Consumption by Source and Sector in 2008 is tabled as following:

Consumption Summary'

Supply Sources	Percent of Source	Demand Sectors	Percent of Sector
Petroleum 37.1%	71% Transportation 23% Industrial 5% Residential and Commercial 1% Electric Power	**Transportation 27.8%**	95% Petroleum 2% Natural Gas 3% Renewable Energy
Natural Gas 23.8%	3% Transportation 34% Industrial 34% Residential and Commercial 29% Electric Power	**Industrial 20.6%**	42% Petroleum 40% Natural Gas 9% Coal 10% Renewable Energy

Coal 22.5%	8% Industrial <1% Residential and Commercial 91% Electric Power	**Residential and Commercial 10.8%**	16% Petroleum 76% Natural Gas 1% Coal 1% Renewable Energy
Renewable Energy 7.3%	11% Transportation 28% Industrial 10% Residential and Commercial 51% Electric Power	**Electric Power 40.1%**	1% Petroleum 17% Natural Gas 51% Coal 9% Renewable Energy 21% Nuclear Electric Power
Nuclear Electric Power 8.5%	100% Electric Power		

Note: Sum of components may not equal 100 percent due to independent rounding.

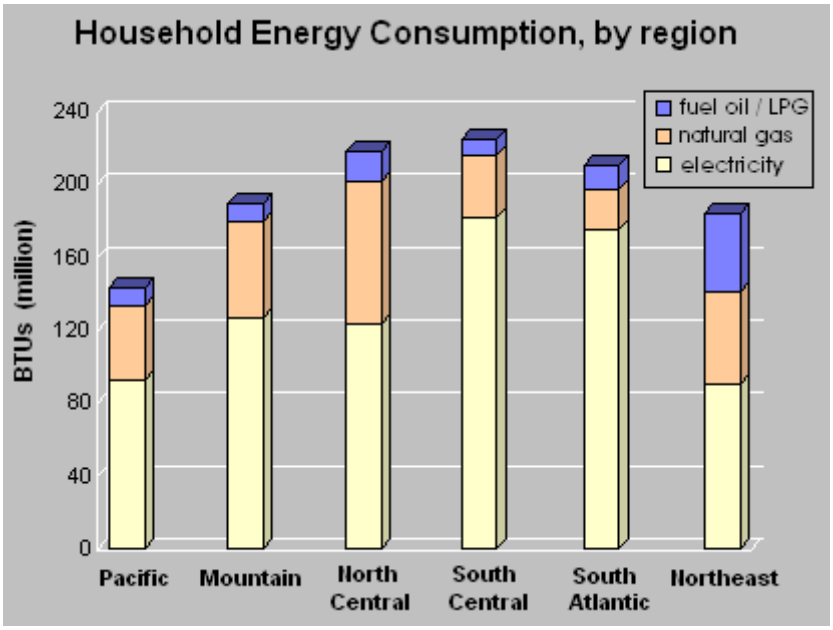
Total Primary Consumption Historical Evolution in U.S until 2009.

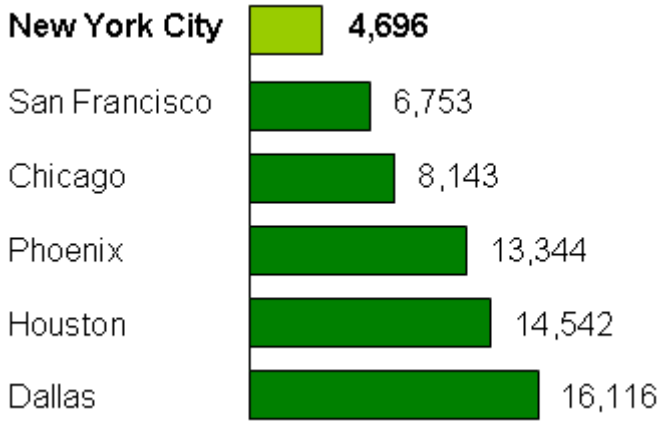
Total Consumption until 2009 in Mtoe:

1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2008-2009**	**CAGR 2000-09**
1914	1929,6	1967,5	2000,9	2041,3	2067,3	2118,4	2140,7	2167,2	2215,9	2279,6	2235,8	2270,6	2265,2	2311	2324,6	2304,5	2340,4	2301,4	2201,4	-4,3%	0,4%

CAGR = Compound Annual Growth Rate Note: Total energy includes coal, gas, oil, electricity, heat and biomass.

Regional variation





Average annual residential electricity usage by city, 2000-2005. Measured in Kilowatt hours per customer.

Household energy use varies significantly across the United States. An average home in the Pacific region (consisting of California, Oregon, and Washington) consumes 35% less energy than a home in the South Central region. Most of the regional differences can be explained by climate. The heavily populated coastal areas of the Pacific states experience generally mild winters and summers, reducing the need for both home heating and air conditioning. The warm, humid climates of the South Central and South Atlantic regions lead to higher electricity usage, while the cold winters experienced in the Northeast and North Central regions result in much higher consumption of natural gas and heating oil.

Another reason for regional differences is the variety of building codes and environmental regulations found at the local and state level. California has some of the strictest environmental laws and building codes in the country, which may contribute to the fact that its per-household energy consumption is lower than all other states except Hawaii.

Major U.S. cities also show significant variation in per capita energy consumption. In addition to differences in regional climates and variations in building code standards, factors affecting energy use in cities include population density and building design. Townhouses are more energy efficient than single-family homes because less heat, for example, is wasted per person.

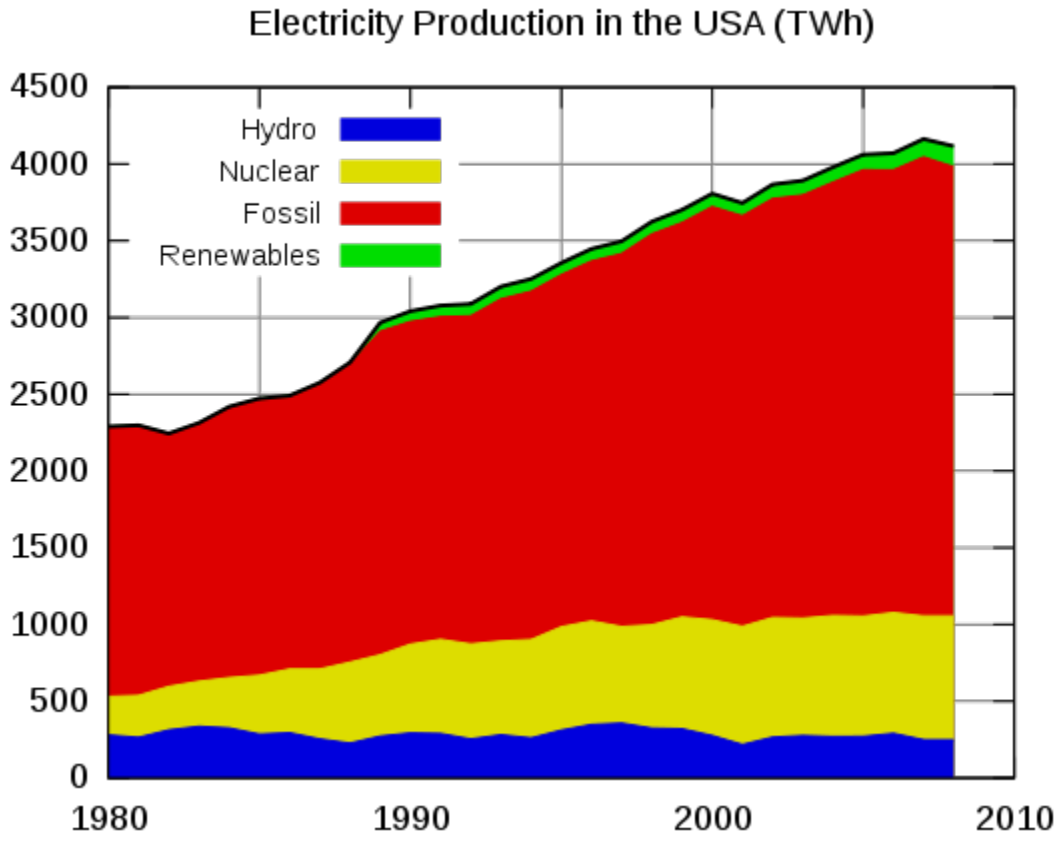
Oil consumption

U.S. oil consumption is approximately 21 million barrels/day, yet domestic production is only 6 million barrels per day (950,000 m^3/d). Hence the majority of oil consumed in the United States must be imported. The cost to import oil is approximately $410 billion dollars a year (at $75/barrel).

During the Carter administration, in response to an energy crisis and hostile Iranian and Soviet Union relations, President Jimmy Carter announced the Carter Doctrine which declared that any interference with U. S. interests in the Persian Gulf would be considered an attack on U.S. vital interests. This doctrine was expanded by Ronald Reagan.

Today, many scholars and politicians call for the immediate incubation of long term energy solutions prior to a 'peak oil' scenario which would force the economy to grinding halt. Although additional drilling in areas such as continental shelf, the Gulf of Mexico, off the U.S. West Coast, Alaska, and the Great Lakes may stave off the inevitability of the problem, it would be only a temporary solution.

Electricity production



Electricity production by source. coal, oil, natural gas hydroelectric nuclear Other renewables

That United States has and continues to get most of its electrical production from conventional thermal power plants. Most of these are coal; however, the 1990s and 2000s have seen a disproportionate increase in natural gas and other kinds of gas powered plants.

From 1992 to 2005 some 270,000 MWe (Megawatt electric) of new gas-fired plant were built, but only 14,000 MWe of new nuclear and coal-fired capacity came on line, mostly coal, with 2,315 MWe of that being nuclear. Nuclear and coal are considerably more capital intensive when compared to gas, and the great shift to gas plant construction is often attributed to deregulation and other political and economic factors.

As of January 2008 the American Wind Energy Association estimated that U.S. wind power, capacity as 16,818 MW, sufficient to power 4.5 million homes. The largest wind facility in the U.S. and the world is in Roscoe Texas, costing more than $1 billion and providing 781.5 MW of power (enough for 230,000 homes throughout Texas, which has more wind power generation capacity than any other state and all but four countries.). Several solar thermal power stations,

including the new 64 MW Nevada Solar One, have also been built. The largest of these solar thermal power stations is the SEGS group of plants in the Mojave Desert with a total generating capacity of 354 MW, making the system the largest solar plant of any kind in the world.

In 2007, summer demand for electricity was 783 GW and 640 GW for winter. By 2017, North American Electric Reliability Corporation (NERC) projects summer consumption to be 925GW for summer and 756 GW for winter.

Electrical Production in the United States for 2006

Power Source	Units in Operation	Total Nameplate Capacity (MW)	% of total Capacity	Annual Production (billion kWh)	% of annual production
Petroleum Coke Fueled Boiler	31	1,754	0.16%	46.4	1.1%
Oil Fired Boiler	327	34,975	3.25%	7.8	0.2%
Nuclear Power	104	105,584	9.82%	787	19.4%
Natural Gas Fueled Boiler	776	97,632	9.08%	159	3.9%
Diesel Generators	4,514	8,563	0.8%	13.8	0.3%
Incinerators	96	2,671	0.25%	12.3	0.3%
Hydroelectric	4,138	96,988	9.02%	282	7.0%
Geothermal	215	3,170	0.29%	13.5	0.3%
Fuel Oil	13	956	0.09%	8.5	0.2%
Combustion Turbine Generators	2,882	155,227	14.4%	147	3.6%
Combined Cycle Natural Gas	1,686	216,269	20.1%	505	12.4%
Coal Fired Boilers	1,460	333,115	30.9%	1,995	49.1%
Biomass	270	6,256	0.58%	53.5	1.3%
Wind Power	341	11,603	1.08%	30.3	0.7%

Solar Energy	31	411	0.04%	2.1	0.1%

Nameplate Capacity Range by Generator Type

Generator Type	0-50MW	50-100MW	100-250MW	250-500MW	500-750MW	750-1,000MW	1000-1250MW	1250MW +
Petroleum Coke Fueled Boiler	24	1	4	2	0	0	0	0
Oil Fired Boiler	232	25	28	22	10	10	0	0
Nuclear Power	0	0	0	0	11	38	41	13
Natural Gas Fueled Boiler	411	99	146	75	30	14	1	0
Diesel Generators	4,513	1	0	0	0	0	0	0
Incinerators	80	16	0	0	0	0	0	0
Hydroelectric	3,559	342	204	27	3	3	0	0
Geothermal	190	17	8	0	0	0	0	0
Fuel Oil	10	1	0	2	0	0	0	0
Combustion Turbine Generators	1,659	839	384	0	0	0	0	0
Combined Cycle Natural Gas	451	290	796	149	0	0	0	0
Coal Fired Boilers	465	184	361	186	193	59	3	9
Biomass	234	19	2	0	1	0	0	0
Wind Power	267	55	23	6	5	0	0	0
Solar Energy	29	2	0	1	0	0	0	0

Energy consumption of computers in the USA

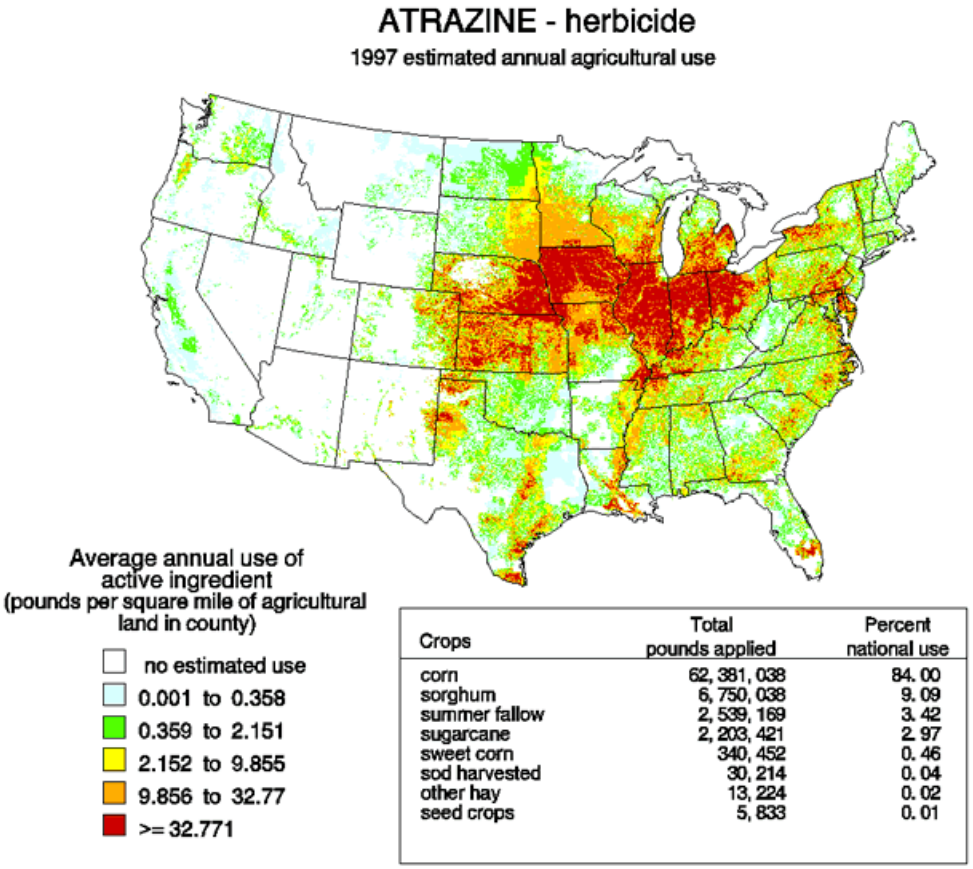
Visible or embedded (i. e. hidden) computers are found everywhere: in all sectors listed in the above chapter, as well as in all subsectors listed in the column entitled **Major uses** in the above tables. In 1999, a study by Mark. P. Mills of the Green Earth Society reported that computers consumed 13% of the entire US supply. Numerous researchers questioned Mills' methodology and it was later demonstrated that he was off by an order of magnitude; for example, Lawrence Berkeley Labs concluded that the figure was nearer three percent of US electricity use. Although the Mills study was inaccurate, it helped drive the debate to the national level, and in 2006 the US Senate started a study of the energy consumption of Server farms.

International Cooperation

President Barack Obama and China's President Hu Jintao announced on 2009-11-17 a far-reaching package of measures to strengthen cooperation between the United States and China on clean energy. The presidents began by establishing a U.S.-China Clean Energy Research Center to facilitate joint research and development of renewable energy technologies by scientists from both countries. The center will be supported by $150 million in public and private funds over the next five years, split evenly between the partners. Initial research priorities will be building energy efficiency and electric vehicles.

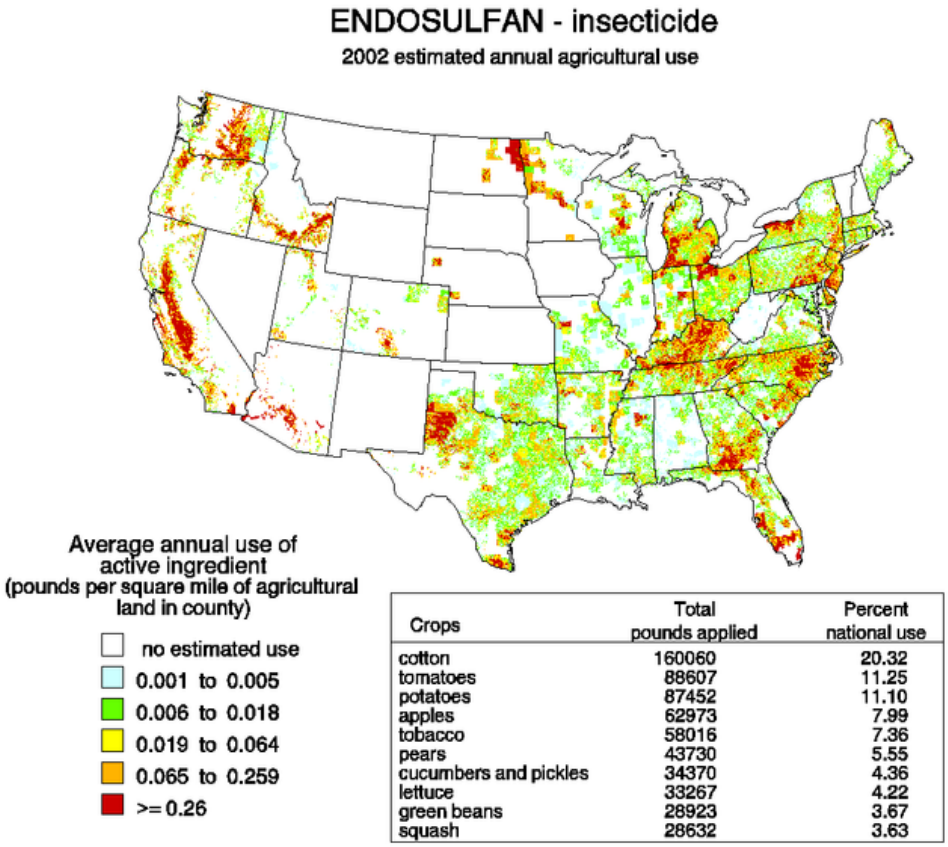
The two countries will also leverage private sector resources to develop clean energy projects in China through the U.S.-China Energy Cooperation Program (ECP). More than 22 companies are founding members of the program. The ECP will include collaborative projects involving renewable energy, smart grids, electric vehicles, green buildings, combined heat and power and energy efficiency.

Pesticides in the United States



Crops	Total pounds applied	Percent national use
corn	62, 381, 038	84. 00
sorghum	6, 750, 038	9. 09
summer fallow	2, 539, 169	3. 42
sugarcane	2, 203, 421	2. 97
sweet corn	340, 452	0. 46
sod harvested	30, 214	0. 04
other hay	13, 224	0. 02
seed crops	5, 833	0. 01

Atrazine use in pounds per square mile by county. Atrazine is one of the most commonly used herbicides in the United States. (From USGS Pesticide Use Maps)



Crops	Total pounds applied	Percent national use
cotton	160060	20.32
tomatoes	88607	11.25
potatoes	87452	11.10
apples	62973	7.99
tobacco	58016	7.36
pears	43730	5.55
cucumbers and pickles	34370	4.36
lettuce	33267	4.22
green beans	28923	3.67
squash	28632	3.63

Endosulfan use in the US in pounds per square mile by county in 2002. (From USGS Pesticide Use Maps)

Pesticide use in the United States is predominantly by the agricultural sector. and about a quarter of pesticides used are used in houses, yards, parks, golf courses, and swimming pools.

Regulation

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) was first passed in 1947, giving the United States Department of Agriculture responsibility for regulating pesticides. In 1972, FIFRA underwent a major revision and transferred responsibility of pesticide regulation to the Environmental Protection Agency and shifted emphasis to protection of the environment and public health.

Issues

Pesticides were found to pollute every stream and over 90% of wells sampled in a study by the US Geological Survey. Pesticide residues have also been found in rain and groundwater.

The National Academy of Sciences estimates that between 4,000 and 20,000 cases of cancer are caused per year by pesticide residues in food in allowable amounts.

The United States Department of Agriculture and the United States Fish and Wildlife Service estimate that between 6 and 14 million fish are killed by pesticides each year in the US.

Effects on biota

Birds

The USDA and USFWS estimate that over 67 million birds are killed by pesticides each year in the US.

Amphibians

US scientists have found that some pesticides used in farming disrupt the nervous systems of frogs, and that use of these pesticides is correlated with a decline in the population of frogs in the Sierra Nevada.

Some scientists believe that certain common pesticides already exist at levels capable of killing amphibians in California. They warn that the breakdown products of these pesticides can be 10 to 100 times more toxic to amphibians than the original pesticides. Direct contact of sprays of some pesticides (either by drift from nearby applications or accidental or deliberate sprays) can be highly lethal to amphibians.

Being downwind from agricultural land on which pesticides are used has been linked to the decline in population of threatened frog species in California.

In Minnesota, pesticide use has been causally linked to congenital deformities in frogs such as eye, mouth, and limb malformations. Researchers in California found that similar deformities in frogs in the US and Canada may have been caused by breakdown products from pesticides which themselves did not pose a threat.

Pesticide residue in food

The Pesticide Data Program, a program started by the United States Department of Agriculture is the largest tester of pesticide residues on food sold in the United States. It began in 1991, and has since tested over 60 different types of food for over 400 different types of pesticides - with samples collected close to the point of consumption. Their most recent summary results are from the year 2005:

For example, on page 30 is comprehensive data on pesticides on fruits. Some example data:

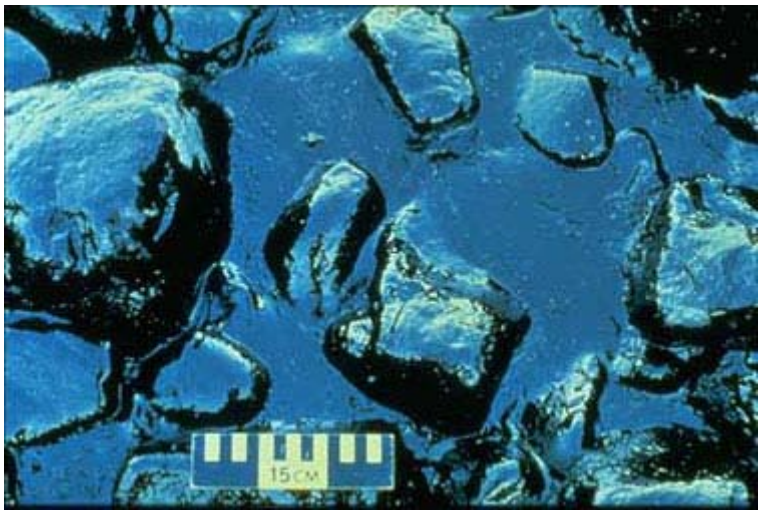
Fresh Fruit and Vegetables	Number of Samples Analyzed	Samples with Residues Detected	Percent of Samples with Detections	Different Pesticides Detected	Different Residues Detected	Total Residue Detections
Apples	774	727	98	33	41	2,619
Lettuce	743	657	88	47	57	1,985
Pears	741	643	87	31	35	1,309
Orange Juice	186	93	50	3	3	94

They were also able to test for multiple pesticides within a single sample and found that:

These data indicate that 29.5 percent of all samples tested contained no detectable pesticides [parent compound and metabolite(s) combined], 30 percent contained 1 pesticide, and slightly over 40 percent contained more than 1 pesticide. - page 34.

The Environmental Working Group used the results of nearly 43,000 tests for pesticides on produce collected by the United States Department of Agriculture (USDA) and the U.S. Food and Drug Administration (FDA) between 2000 and 2004, to produce a ranking of 43 commonly eaten fruits & vegetables.

Pollution in the United States



Pollution from the Exxon Valdez oil spill

As with many countries **pollution in the United States** is a concern for environmental organizations, government agencies and individuals.

Pollution

Land

Land is where most pollution happens. Land pollution can be oil spills caused by oil changes in cars, trucks, and MILFS. Examples of land pollution include:

- Love Canal
- Greenpoint oil spill
- Murphy Oil Spill (Chalmette, Louisiana)
- Prudhoe Bay oil spill

Air

Air pollution is caused predominantly from burning fossil fuels.

Water

Freshwater

In a report published in the November 12, 2008 online issue of Environmental Science and Technology, researchers found that freshwater pollution by phosphorus and nitrogen costs U.S. government agencies, drinking water facilities and individual Americans at least $4.3 billion

annually. Of that, they calculated that $44 million a year is spent just protecting aquatic species from nutrient pollution.

Oceans

Oil spills

- 1969 Santa Barbara oil spill
- 2007 San Francisco Bay oil spill
- 2008 New Orleans oil spill
- 1989 Exxon Valdez oil spill
- 2010 Deepwater Horizon oil spill

Pesticides

The use of DDT and its consequences as a pollutant is attributed as sparking the environmental movement in the United States.

Radioactivity

- Three Mile Island

Waste

Polystyrene

Worldwide there are numerous environmental organizations attempting to ban the use of polystyrene. One such organization in the U.S. is Californians Against Waste. The city of Berkeley, California, was one of the first cities in the world to ban polystyrene food packaging (called Styrofoam in the media announcements). It was also banned in Portland, Oregon and Suffolk County, New York in 1990. Now, over 20 US cities have banned polystyrene food packaging, including Oakland, California, on Jan 1, 2007. San Francisco introduced a ban on the packaging on June 1, 2007: Board of Supervisors President Aaron Peskin noted:

"This is a long time coming. Polystyrene foam products rely on nonrenewable sources for production, are nearly indestructible and leave a legacy of pollution on our urban and natural environments. If McDonald's could see the light and phase out polystyrene foam more than a decade ago, it's about time San Francisco got with the program."

The overall benefits of the ban in Portland, Oregon have been questioned, as have the general environmental concepts of the use of paper versus polystyrene. The California and New York state legislatures are currently considering bills which would effectively ban expanded polystyrene in all takeout food packaging state-wide.

Policy

The United States Environmental Protection Agency (EPA) is an agency of the federal government of the United States charged with protecting human health and with safeguarding the natural environment: air, water, and land. The EPA was proposed by President Richard Nixon and began operation on 2 December 1970, when it was passed by Congress, and signed into law by President Nixon, and has since been chiefly responsible for the environmental policy of the United States.

Cruise ship pollution in the United States

The **cruise ship** industry is a significant and growing contributor to the United States economy, providing more than $32 billion in benefits annually and generating more than 330,000 U.S. jobs, but also making the environmental impacts of its activities an issue to many. Although cruise ships represent a small fraction of the entire shipping industry worldwide, public attention to their environmental impacts comes in part from the fact that cruise ships are highly visible and in part because of the industry's desire to promote a positive image.

Cruise ships carrying several thousand passengers and crew have been compared to "floating cities," and the volume of wastes that they produce is comparably large, consisting of sewage; wastewater from sinks, showers, and galleys (graywater); hazardous wastes; solid waste; oily bilge water; ballast water; and air pollution. The waste streams generated by cruise ships are governed by a number of international protocols (especially MARPOL) and U.S. domestic laws (including the Clean Water Act and the Act to Prevent Pollution from Ships), regulations, and standards, but there is no single law or rule. Some cruise ship waste streams appear to be well regulated, such as solid wastes (garbage and plastics) and bilge water. But there is overlap of some areas, and there are gaps in others. Some, such as graywater and ballast water, are not regulated (except in the Great Lakes), and concern is increasing about the impacts of these discharges on public health and the environment. In other areas, regulations apply, but critics argue that they are not stringent enough to address the problem — for example, with respect to standards for sewage discharges. Environmental advocates have raised concerns about the adequacy of existing laws for managing these wastes, and they contend that enforcement is weak.

In 2000, the U.S. Congress enacted legislation restricting cruise ship discharges in U.S. navigable waters within the state of Alaska. California, Alaska, and Maine have enacted state-specific laws concerning cruise ship pollution, and a few other states have entered into voluntary agreements with industry to address management of cruise ship discharges. Meanwhile, the cruise industry has voluntarily undertaken initiatives to improve pollution prevention, by adopting waste management guidelines and procedures and researching new technologies. Concerns about cruise ship pollution raise issues for Congress in three broad areas: adequacy of laws and regulations, research needs, and oversight and enforcement of existing requirements. Legislation to regulate cruise ship discharges of sewage, graywater, and bilge water nationally was introduced in the 109th Congress, but there was no further congressional action.

We describes the several types of waste streams that cruise ships may discharge and emit. It identifies the complex body of international and domestic laws that address pollution from cruise ships. It then describes federal and state legislative activity concerning cruise ships in Alaskan waters and activities in a few other states, as well as current industry initiatives to manage cruise ship pollution.

Background

More than 46,000 commercial vessels — tankers, bulk carriers, container ships, barges, and passenger ships — travel the oceans and other waters of the world, carrying cargo and passengers for commerce, transport, and recreation. Their activities are regulated and scrutinized in a number of respects by international protocols and U.S. domestic laws, including those designed to protect against discharges of pollutants that could harm marine resources, other parts of the ambient environment, and human health. However, there are overlaps of some requirements, gaps in other areas, geographic differences in jurisdiction based on differing definitions, and questions about the adequacy of enforcement.

Public attention to the environmental impacts of the maritime industry has been especially focused on the cruise industry, in part because its ships are highly visible and in part because of the industry's desire to promote a positive image. It represents a relatively small fraction of the entire shipping industry worldwide. As of January 2008, passenger ships (which include cruise ships and ferries) composed about 12% of the world shipping fleet. The cruise industry is a significant and growing contributor to the U.S. economy, providing more than $32 billion in total benefits annually and generating more than 330,000 U.S. jobs, but also making the environmental impacts of its activities an issue to many. Since 1980, the average annual growth rate in the number of cruise passengers worldwide has been 8.4%, and in 2005, cruises hosted an estimated 11.5 million passengers. Cruises are especially popular in the United States. In 2005, U.S. ports handled 8.6 million cruise embarcations (75% of global passengers), 6.3% more than in 2004. The worldwide cruise ship fleet consists of more than 230 ships, and the majority are foreign-flagged, with Liberia and Panama being the most popular flag countries. Foreign-flag cruise vessels owned by six companies account for nearly 95% of passenger ships operating in U.S. waters. Each year, the industry adds new ships to the total fleet, vessels that are bigger, more elaborate and luxurious, and that carry larger numbers of passengers and crew. Over the past two decades, the average ship size has been increasing at the rate of roughly 90 feet (27 m) every five years. The average ship entering the market from 2008 to 2011 will be more than 1,050 feet (320 m) long and will weigh more than 130,000 tons.

To the cruise ship industry, a key issue is demonstrating to the public that cruising is safe and healthy for passengers and the tourist communities that are visited by their ships. Cruise ships carrying several thousand passengers and crew have been compared to "floating cities," in part because the volume of wastes produced and requiring disposal is greater than that of many small cities on land. During a typical one-week voyage, a large cruise ship (with 3,000 passengers and crew) is estimated to generate 210,000 gallons of sewage; 1 million gallons of graywater

(wastewater from sinks, showers, and laundries); more than 130 gallons of hazardous wastes; 8 tons of solid waste; and 25,000 gallons of oily bilge water. Those wastes, if not properly treated and disposed of, can pose risks to human health, welfare, and the environment. Environmental advocates have raised concerns about the adequacy of existing laws for managing these wastes, and suggest that enforcement of existing laws is weak.

A 2000 General Accounting Office (GAO) report focused attention on problems of cruise vessel compliance with environmental requirements. GAO found that between 1993 and 1998, foreign-flag cruise ships were involved in 87 confirmed illegal discharge cases in U.S. waters. A few of the cases included multiple illegal discharge incidents occurring over the six-year period. GAO reviewed three major waste streams (solids, hazardous chemicals, and oily bilge water) and concluded that 83% of the cases involved discharges of oil or oil-based products, the volumes of which ranged from a few drops to hundreds of gallons. The balance of the cases involved discharges of plastic or garbage. GAO judged that 72% of the illegal discharges were accidental, 15% were intentional, and 13% could not be determined. The 87 cruise ship cases represented 4% of the 2,400 illegal discharge cases by foreign-flag ships (including tankers, cargo ships and other commercial vessels, as well as cruise ships) confirmed during the six years studied by GAO. Although cruise ships operating in U.S. waters have been involved in a relatively small number of pollution cases, GAO said, several have been widely publicized and have led to criminal prosecutions and multimillion-dollar fines.

In 2000, a coalition of 53 environmental advocacy groups petitioned the Environmental Protection Agency (EPA) to take regulatory action to address pollution by cruise ships. The petition called for an investigation of wastewater, oil, and solid waste discharges from cruise ships. In response, EPA agreed to study cruise ship discharges and waste management approaches. As part of that effort, in 2000 EPA issued a background document with preliminary information and recommendations for further assessment through data collection and public information hearings.<refname=epawhitepaper/> Subsequently, in December 2007, the agency released a draft cruise ship discharge assessment report as part of its response to the petition. This report summarized findings of recent data collection activities (especially from cruise ships operating in Alaskan waters). The report was finalized and issued 29-Dec-2008 and published in the FR in 2009

Cruise ship waste streams

Cruise ships generate a number of waste streams that can result in discharges to the marine environment, including sewage, graywater, hazardous wastes, oily bilge water, ballast water, and solid waste. They also emit air pollutants to the air and water. These wastes, if not properly treated and disposed of, can be a significant source of pathogens, nutrients, and toxic substances with the potential to threaten human health and damage aquatic life. It is important, however, to keep these discharges in some perspective, because cruise ships represent a small — although highly visible — portion of the entire international shipping industry, and the waste streams described here are not unique to cruise ships. However, particular types of wastes, such as sewage, graywater, and solid waste, may be of greater concern for cruise ships relative to other seagoing vessels, because of the large numbers of passengers and crew that cruise ships carry and the large volumes of wastes that they produce. Further, because cruise ships tend to

concentrate their activities in specific coastal areas and visit the same ports repeatedly (especially Florida, California, New York, Galveston, Seattle, and the waters of Alaska), their cumulative impact on a local scale could be significant, as can impacts of individual large-volume releases (either accidental or intentional).

International laws and regulations

MARPOL 73/78 is one of the most important treaties regulating pollution from ships. Six Annexes of the Convention cover the various sources of pollution from ships and provide an overarching framework for international objectives. In the U.S., the Convention is implemented through the Act to Prevent Pollution from Ships. Under the provisions of the Convention, the United States can take direct enforcement action under U.S. laws against foreign-flagged ships when pollution discharge incidents occur within U.S. jurisdiction. When incidents occur outside U.S. jurisdiction or jurisdiction cannot be determined, the United States refers cases to flag states, in accordance with MARPOL. These procedures require substantial coordination between the Coast Guard, the State Department, and other flag states, and the response rate from flag states has been poor.

Federal laws and regulations

In the United States, several federal agencies have some jurisdiction over cruise ships in U.S. waters, but no one agency is responsible for or coordinates all of the relevant government functions. The U.S. Coast Guard and EPA have principal regulatory and standard-setting responsibilities, and the Department of Justice prosecutes violations of federal laws. In addition, the Department of State represents the United States at meetings of the IMO and in international treaty negotiations and is responsible for pursuing foreign-flag violations. Other federal agencies have limited roles and responsibilities. For example, the National Oceanic and Atmospheric Administration (NOAA, Department of Commerce) works with the Coast Guard and EPA to report on the effects of marine debris. The Animal and Plant Health Inspection Service (APHIS) is responsible for ensuring quarantine inspection and disposal of food-contaminated garbage (these APHIS responsibilities are part of the Department of Homeland Security). In some cases, states and localities have responsibilities as well.

Sewage

The Federal Water Pollution Control Act, or Clean Water Act (CWA), is the principal U.S. law concerned with limiting polluting activity in the nation's streams, lakes, estuaries, and coastal waters. Under the act, pollutant discharges from point sources — a term that includes vessels — are prohibited unless a permit has been obtained. Sewage from cruise ships and other vessels is exempt from the requirement to obtain an NPDES permit.

Section 312 of the Clean Water Act seeks to address this gap by prohibiting the dumping of untreated or inadequately treated sewage from vessels into the navigable waters of the United States (defined in the act as within 3 miles (4.8 km) of shore). Cruise ships are subject to this prohibition. Under Section 312, commercial and recreational vessels with installed toilets are

required to have marine sanitation devices, which are designed to prevent the discharge of untreated sewage. Beyond 3 miles (4.8 km), raw sewage can be discharged. On some cruise ships, especially many of those that travel in Alaskan waters, sewage is treated using Advanced Wastewater Treatment systems that generally provide improved screening, treatment, disinfection, and sludge processing as compared with traditional MSDs. AWTs are believed to be very effective in removing pathogens, oxygen-demanding substances, suspended solids, oil and grease, and particulate metals from sewage, but only moderately effective in removing dissolved metals and nutrients (ammonia, nitrogen and phosphorus).

Section 312 has another means of addressing sewage discharges, through establishment of no-discharge zones (NDZs) for vessel sewage. A state may completely prohibit the discharge of both treated and untreated sewage from all vessels with installed toilets into some or all waters over which it has jurisdiction (up to 3 miles (4.8 km) from land).

Graywater

Under current federal law, graywater is not defined as a pollutant, nor is it generally considered to be sewage. The Clean Water Act only includes graywater in its definition of sewage for the express purpose of regulating commercial vessels in the Great Lakes, under the Section 312 MSD requirements. Thus, currently graywater can be discharged by cruise ships anywhere — except in the Great Lakes. Pursuant to a state law in Alaska, graywater must be treated prior to discharge into that state's waters.

Solid waste

Cruise ship discharges of solid waste are governed by two laws. Title I of the Marine Protection, Research and Sanctuaries Act makes it illegal to transport garbage from the United States for the purpose of dumping it into ocean waters without a permit or to dump material from outside the U.S. into U.S. waters. Beyond U.S. waters, no MPRSA permit is required for a cruise ship to discharge solid waste. The routine discharge of effluent incidental to the propulsion of vessels is explicitly exempted from the definition of dumping in the MPRSA.28

The Act to Prevent Pollution from Ships prohibits the discharge of all garbage within 3 nautical miles (5.6 km) of shore, certain types of garbage within 12 nautical miles (22 km) offshore, and plastic anywhere. It applies to all vessels operating in U.S. navigable waters and the Exclusive Economic Zone (EEZ).

Hazardous waste

The Resource Conservation and Recovery Act is the primary federal law that governs hazardous waste management. The owner or operator of a cruise ship may be a generator and/or a transporter of hazardous waste, and thus subject to RCRA rules. Issues that the cruise ship industry may face relating to RCRA include ensuring that hazardous waste is identified at the point at which it is considered generated; ensuring that parties are properly identified as generators, storers, treaters, or disposers; and determining the applicability of RCRA

requirements to each. Hazardous waste generated onboard cruise ships are stored onboard until the wastes can be offloaded for recycling or disposal in accordance with RCRA.29.

A range of activities on board cruise ships generate hazardous wastes and toxic substances that would ordinarily be presumed to be subject to RCRA. Cruise ships are potentially subject to RCRA requirements to the extent that chemicals used for operations such as ship maintenance and passenger services result in the generation of hazardous wastes. However, it is not entirely clear what regulations apply to the management and disposal of these wastes. 30 RCRA rules that cover small-quantity generators (those that generate more than 100 kilograms but less than 1,000 kilograms of hazardous waste per month) are less stringent than those for large-quantity generators (generating more than 1,000 kilograms per month), and it is unclear whether cruise ships are classified as large or small generators of hazardous waste. Moreover, some cruise companies argue that they generate less than 100 kilograms per month and therefore should be classified in a third category, as "conditionally exempt small-quantity generators," a categorization that allows for less rigorous requirements for notification, recordkeeping, and the like.31

A release of hazardous substances by a cruise ship or other vessel could also theoretically trigger the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or Superfund, 42 U.S.C. 9601-9675), but it does not appear to have been used in response to cruise ship releases.

In addition to RCRA, hazardous waste discharges from cruise ships are subject to Section 311 of the Clean Water Act, which prohibits the discharge of hazardous substances in harmful quantities into or upon the navigable waters of the United States, adjoining shorelines, or into or upon the waters of the contiguous zone.

Bilge water

Bilge Water. Section 311 of the Clean Water Act, as amended by the Oil Pollution Act of 1990 (33 U.S.C. 2701-2720), applies to cruise ships and prohibits discharge of oil or hazardous substances in harmful quantities into or upon U.S. navigable waters, or into or upon the waters of the contiguous zone, or which may affect natural resources in the U.S. EEZ (extending 200 miles (320 km) offshore). Coast Guard regulations (33 CFR §151.10) prohibit discharge of oil within 12 miles (19 km) from shore, unless passed through a 15-ppm oil water separator, and unless the discharge does not cause a visible sheen. Beyond 12 miles (19 km), oil or oily mixtures can be discharged while a vessel is proceeding en route and if the oil content without dilution is less than 100 ppm. Vessels are required to maintain an Oil Record Book to record disposal of oily residues and discharges overboard or disposal of bilge water.

In addition to Section 311 requirements, the Act to Prevent Pollution from Ships (APPS) implements MARPOL Annex I concerning oil pollution. APPS applies to all U.S. flagged ships anywhere in the world and to all foreign flagged vessels operating in the navigable waters of the United States, or while at a port under U.S. jurisdiction. To implement APPS, the Coast Guard has promulgated regulations prohibiting the discharge of oil or oily mixtures into the sea within 12 nautical miles (22 km) of the nearest land, except under limited conditions. However, because

most cruise lines are foreign registered and because APPS only applies to foreign ships within U.S. navigable waters, the APPS regulations have limited applicability to cruise ship operations. In addition, most cruise lines have adopted policies that restrict discharges of machinery space waste within three miles (5 km) from shore.

Regulation of ship pollution in the United States

International laws and regulations

MARPOL 73/78 is one of the most important treaties regulating pollution from ships. Six Annexes of the Convention cover the various sources of pollution from ships and provide an overarching framework for international objectives. In the U.S., the Convention is implemented through the Act to Prevent Pollution from Ships. Under the provisions of the Convention, the United States can take direct enforcement action under U.S. laws against foreign-flagged ships when pollution discharge incidents occur within U.S. jurisdiction. When incidents occur outside U.S. jurisdiction or jurisdiction cannot be determined, the United States refers cases to flag states, in accordance with MARPOL. These procedures require substantial coordination between the Coast Guard, the State Department, and other flag states, and the response rate from flag states has been poor.

Federal laws and regulations

In the United States, several federal agencies have some jurisdiction over ships in U.S. waters, but no one agency is responsible for or coordinates all of the relevant government functions. The U.S. Coast Guard and EPA have principal regulatory and standard-setting responsibilities, and the Department of Justice prosecutes violations of federal laws. In addition, the Department of State represents the United States at meetings of the IMO and in international treaty negotiations and is responsible for pursuing foreign-flag violations. Other federal agencies have limited roles and responsibilities. For example, the National Oceanic and Atmospheric Administration (NOAA, Department of Commerce) works with the Coast Guard and EPA to report on the effects of marine debris. The Animal and Plant Health Inspection Service (APHIS) is responsible for ensuring quarantine inspection and disposal of food-contaminated garbage (these APHIS responsibilities are part of the Department of Homeland Security). In some cases, states and localities have responsibilities as well.

Sewage

The Federal Water Pollution Control Act, or Clean Water Act (CWA), is the principal U.S. law concerned with limiting polluting activity in the nation's streams, lakes, estuaries, and coastal waters. The act's primary mechanism for controlling pollutant discharges is the National Pollutant Discharge Elimination System (NPDES) program, authorized in Section 402. In accordance with the NPDES program, pollutant discharges from point sources — a term that includes vessels — are prohibited unless a permit has been obtained. While sewage is defined as a pollutant under the act, sewage from vessels is exempt from this statutory definition and is

therefore exempt from the requirement to obtain an NPDES permit. Further, EPA regulations implementing the NPDES permit program provide that "discharges incidental to the normal operation of vessels" are excluded from regulation and thus from permit requirements (40 CFR §122.3(a)). However, a 2006 federal court ruling could result in changes to these regulations that would remove the current permitting exemption.

Marine sanitation devices

Section 312 of the Clean Water Act seeks to address this gap by prohibiting the dumping of untreated or inadequately treated sewage from vessels into the navigable waters of the United States (defined in the act as within 3 miles (4.8 km) of shore). It is implemented jointly by EPA and the Coast Guard. Under Section 312, commercial and recreational vessels with installed toilets are required to have marine sanitation devices (MSDs), which are designed to prevent the discharge of untreated sewage. EPA is responsible for developing performance standards for MSDs, and the Coast Guard is responsible for MSD design and operation regulations and for certifying MSD compliance with the EPA rules. MSDs are designed either to hold sewage for shore-based disposal or to treat sewage prior to discharge.

The Coast Guard regulations cover three types of MSDs (33 CFR Part 159). Large vessels use either Type II or Type III MSDs. In Type II MSDs, the waste is either chemically or biologically treated prior to discharge and must meet limits of no more than 200 fecal coliforms per 100 milliliters and no more than 150 milligrams per liter of suspended solids. Type III MSDs store wastes and do not treat them; the waste is pumped out later and treated in an onshore system or discharged outside U.S. waters. Type I MSDs use chemicals to disinfect the raw sewage prior to discharge and must meet a performance standard for fecal coliform bacteria of not greater than 1,000 per 100 milliliters and no visible floating solids. Type I MSDs are generally only found on recreational vessels or others under 65 feet (20 m) in length. The regulations, which have not been revised since 1976, do not require ship operators to sample, monitor, or report on their effluent discharges.

Critics point out a number of deficiencies with this regulatory structure as it affects large vessels. First, the MSD regulations only cover discharges of bacterial contaminants and suspended solids, while the NPDES permit program for other point sources typically regulates many more pollutants such as chemicals, pesticides, heavy metals, oil, and grease that may be released by large vessels as well as land-based sources. Second, sources subject to NPDES permits must comply with sampling, monitoring, recordkeeping, and reporting requirements, which do not exist in the MSD rules.

In addition, the Coast Guard, responsible for inspecting vessels for compliance with the MSD rules, has been heavily criticized for poor enforcement of Section 312 requirements. In its 2000 report, the GAO said that Coast Guard inspectors "rarely have time during scheduled ship examinations to inspect sewage treatment equipment or filter systems to see if they are working properly and filtering out potentially harmful contaminants." GAO reported that a number of factors limit the ability of Coast Guard inspectors to detect violations of environmental law and rules, including the inspectors' focus on safety, the large size some ships, limited time and staff for inspections, and the lack of an element of surprise concerning inspections.25 The Coast

Guard carries out a wide range of responsibilities that encompass both homeland security (ports, waterways, and coastal security, defense readiness, drug and migrant interdiction) and non-homeland security (search and rescue, marine environmental protection, fisheries enforcement, aids to navigation). Since the September 11 terrorist attacks on the United States, the Coast Guard has focused more of its resources on homeland security activities.26 One likely result is that less of the Coast Guard's time and attention are available for vessel inspections for MSD or other environmental compliance.

Annex IV of MARPOL was drafted to regulate sewage discharges from vessels. It has entered into force internationally and would apply to ships that are flagged in ratifying countries, but because the United States has not ratified Annex IV, it is not mandatory that ships follow it when in U.S. waters. However, its requirements are minimal, even compared with U.S. rules for MSDs. Annex IV requires that vessels be equipped with a certified sewage treatment system or holding tank, but it prescribes no specific performance standards. Within three miles (5 km) of shore, Annex IV requires that sewage discharges be treated by a certified MSD prior to discharge. Between three and 12 miles (19 km) from shore, sewage discharges must be treated by no less than maceration or chlorination; sewage discharges beyond 12 miles (19 km) from shore are unrestricted. Vessels are permitted to meet alternative, less stringent requirements when they are in the jurisdiction of countries where less stringent requirements apply. In U.S. waters, vessels must comply with the regulations implementing Section 312 of the Clean Water Act.

On some ships, especially many of those that travel in Alaskan waters, sewage is treated using Advanced Wastewater Treatment (AWT) systems that generally provide improved screening, treatment, disinfection, and sludge processing as compared with traditional Type II MSDs. AWTs are believed to be very effective in removing pathogens, oxygen demanding substances, suspended solids, oil and grease, and particulate metals from sewage, but only moderately effective in removing dissolved metals and nutrients (ammonia, nitrogen and phosphorus).

No-discharge zones

Section 312 has another means of addressing sewage discharges, through establishment of no-discharge zones (NDZs) for vessel sewage. A state may completely prohibit the discharge of both treated and untreated sewage from all vessels with installed toilets into some or all waters over which it has jurisdiction (up to 3 miles (4.8 km) from land). To create a no-discharge zone to protect waters from sewage discharges by vessels, the state must apply to EPA under one of three categories.

1. NDZ based on the need for greater environmental protection, and the state demonstrates that adequate pumpout facilities for safe and sanitary removal and treatment of sewage from all vessels are reasonably available. As of 2008, this category of designation has been used for 61 areas representing part or all of the waters of 26 states, including a number of inland states.
2. NDZ for special waters found to have a particular environmental importance (e.g., to protect environmentally sensitive areas such as shellfish beds or coral reefs); it is not necessary for the state to show pumpout availability. This category of designation has been used twice (state waters within the Florida Keys National Marine Sanctuary and the Boundary Waters Canoe area of Minnesota).

3. NDZ to prohibit the discharge of sewage into waters that are drinking water intake zones; it is not necessary for the state to show pumpout availability. This category of designation has been used to protect part of the Hudson River in New York.

Graywater

Under current federal law, graywater is not defined as a pollutant, nor is it generally considered to be sewage. By regulation, EPA exempts discharges incidental to the normal operation of a vessel, including graywater, from NPDES permit requirements (40 CFR § 122.3); however, a federal court has ordered EPA to set aside this rule. There are no separate federal effluent standards for graywater discharges. The Clean Water Act only includes graywater in its definition of sewage for the express purpose of regulating commercial vessels in the Great Lakes, under the Section 312 MSD requirements. Thus, currently graywater can be discharged by vessels anywhere — except in the Great Lakes, where the Section 312 MSD rules apply, but those rules prescribe limits only for bacterial contaminant content and total suspended solids in graywater. Pursuant to a state law in Alaska, graywater must be treated prior to discharge into that state's waters.

Solid waste

Ship discharges of solid waste are governed by two laws. Title I of the Marine Protection, Research, and Sanctuaries Act (MPRSA, 33 U.S.C. 1402-1421) applies to cruise ships and other vessels and makes it illegal to transport garbage from the United States for the purpose of dumping it into ocean waters without a permit or to dump any material transported from a location outside the United States into U.S. territorial seas or the contiguous zone (within 12 nautical miles (22 km) from shore) or ocean waters. EPA is responsible for issuing permits that regulate the disposal of materials at sea (except for dredged material disposal, for which the U.S. Army Corps of Engineers is responsible). Beyond waters that are under U.S. jurisdiction, no MPRSA permit is required for a ship to discharge solid waste. The routine discharge of effluent incidental to the propulsion of vessels is explicitly exempted from the definition of dumping in the MPRSA.28

The Act to Prevent Pollution from Ships (APPS, 33 U.S.C. 1901-1915) and its regulations, which implement U.S.-ratified provisions of MARPOL, also apply to ships. APPS prohibits the discharge of all garbage within 3 nautical miles (5.6 km) of shore, certain types of garbage within 12 nautical miles (22 km) offshore, and plastic anywhere. It applies to all vessels, whether seagoing or not, regardless of flag, operating in U.S. navigable waters and the Exclusive Economic Zone (EEZ). It is administered by the Coast Guard which carries out inspection programs to insure the adequacy of port facilities to receive offloaded solid waste.

Hazardous waste

The Resource Conservation and Recovery Act (RCRA, 42 U.S.C. 6901-6991k) is the primary federal law that governs hazardous waste management through a "cradle-to-grave" program that controls hazardous waste from the point of generation until ultimate disposal. The act imposes management requirements on generators, transporters, and persons who treat or dispose of

hazardous waste. Under this act, a waste is hazardous if it is ignitable, corrosive, reactive, or toxic, or appears on a list of about 100 industrial process waste streams and more than 500 discarded commercial products and chemicals. Treatment, storage, and disposal facilities are required to have permits and comply with operating standards and other EPA regulations.

The owner or operator of a ship may be a generator and/or a transporter of hazardous waste, and thus subject to RCRA rules. Issues that the ship industry may face relating to RCRA include ensuring that hazardous waste is identified at the point at which it is considered generated; ensuring that parties are properly identified as generators, storers, treaters, or disposers; and determining the applicability of RCRA requirements to each. Hazardous waste generated onboard ships is stored onboard until the wastes can be offloaded for recycling or disposal in accordance with RCRA.29

A range of activities on board cruise generate hazardous wastes and toxic substances that would ordinarily be presumed to be subject to RCRA. Ships are potentially subject to RCRA requirements to the extent that chemicals used for operations such as ship maintenance and passenger services result in the generation of hazardous wastes. However, it is not entirely clear what regulations apply to the management and disposal of these wastes.30 RCRA rules that cover small-quantity generators (those that generate more than 100 kilograms but less than 1,000 kilograms of hazardous waste per month) are less stringent than those for large-quantity generators (generating more than 1,000 kilograms per month), and it is unclear whether ships are classified as large or small generators of hazardous waste. Moreover, some ship companies argue that they generate less than 100 kilograms per month and therefore should be classified in a third category, as "conditionally exempt small-quantity generators," a categorization that allows for less rigorous requirements for notification, recordkeeping, and the like.31

A release of hazardous substances by a vessel could also theoretically trigger the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or Superfund, 42 U.S.C. 9601-9675).

In addition to RCRA, hazardous waste discharges from ships are subject to Section 311 of the Clean Water Act, which prohibits the discharge of hazardous substances in harmful quantities into or upon the navigable waters of the United States, adjoining shorelines, or into or upon the waters of the contiguous zone.

Bilge water

Section 311 of the Clean Water Act, as amended by the Oil Pollution Act of 1990 (33 U.S.C. 2701-2720), applies to ships and prohibits discharge of oil or hazardous substances in harmful quantities into or upon U.S. navigable waters, or into or upon the waters of the contiguous zone, or which may affect natural resources in the U.S. EEZ (extending 200 miles (320 km) offshore). Coast Guard regulations (33 CFR §151.10) prohibit discharge of oil within 12 miles (19 km) from shore, unless passed through a 15-ppm oil water separator, and unless the discharge does not cause a visible sheen. Beyond 12 miles (19 km), oil or oily mixtures can be discharged while a vessel is proceeding en route and if the oil content without dilution is less than 100 ppm.

Vessels are required to maintain an Oil Record Book to record disposal of oily residues and discharges overboard or disposal of bilge water.

In addition to Section 311 requirements, the Act to Prevent Pollution from Ships (APPS) implements MARPOL Annex I concerning oil pollution. APPS applies to all U.S. flagged ships anywhere in the world and to all foreign flagged vessels operating in the navigable waters of the United States, or while at a port under U.S. jurisdiction. To implement APPS, the Coast Guard has promulgated regulations prohibiting the discharge of oil or oily mixtures into the sea within 12 nautical miles (22 km) of the nearest land, except under limited conditions. However, because many ships are foreign registered and because APPS only applies to foreign ships within U.S. navigable waters, the APPS regulations have limited applicability to ship operations.

Ballast water

Clean Water Act regulations currently exempt ballast water discharges incidental to the normal operation of cruise ships and other vessels from NPDES permit requirements. Because of the growing problem of introduction of invasive species into U.S. waters via ballast water, in January 1999, a number of conservation organizations, fishing groups, native American tribes, and water agencies petitioned EPA to repeal its 1973 regulation exempting ballast water discharge, arguing that ballast water should be regulated as the "discharge of a pollutant" under the Clean Water Act's Section 402 permit program. EPA rejected the petition in September 2003, saying that the "normal operation" exclusion is long-standing agency policy, to which Congress has acquiesced twice (in 1979 and 1996) when it considered the issue of aquatic nuisance species in ballast water and did not alter EPA's CWA interpretation.32 Further, EPA said that other ongoing federal activities related to control of invasive species in ballast water are likely to be more effective than changing the NPDES rules.33 Until recently, these efforts to limit ballast water discharges by cruise ships and other vessels were primarily voluntary, except in the Great Lakes. Since 2004, all vessels equipped with ballast water tanks must have a ballast water management plan.34

After the denial of their administrative petition, the environmental groups filed a lawsuit seeking to force EPA to rescind the regulation that exempts ballast water discharges from CWA permitting. In March 2005, a federal district court ruled in favor of the groups, and in September 2006, the court remanded the matter to EPA with an order that the challenged regulation be set aside by September 30, 2008 (Northwest Environmental Advocates v. EPA, No. C 03-05760 SI (N.D.Cal, September 18, 2006)). The district court rejected EPA's contention that Congress had previously acquiesced in exempting the "normal operation" of vessels from CWA permitting and disagreed with EPA's argument that the court's two-year deadline creates practical difficulties for the agency and the affected industry. Significantly, while the focus of the environmental groups' challenge was principally to EPA's permitting exemption for ballast water discharges, the court's ruling — and its mandate to EPA to rescind the exemption in 40 CFR §122.3(a) — applies fully to other types of vessel discharges that are covered by the regulatory exemption, including graywater and bilge water.

The government has appealed the district court's ruling, and the parties are waiting for a ruling from the appeals court. However, in June 2007, EPA also initiated steps seeking public comment

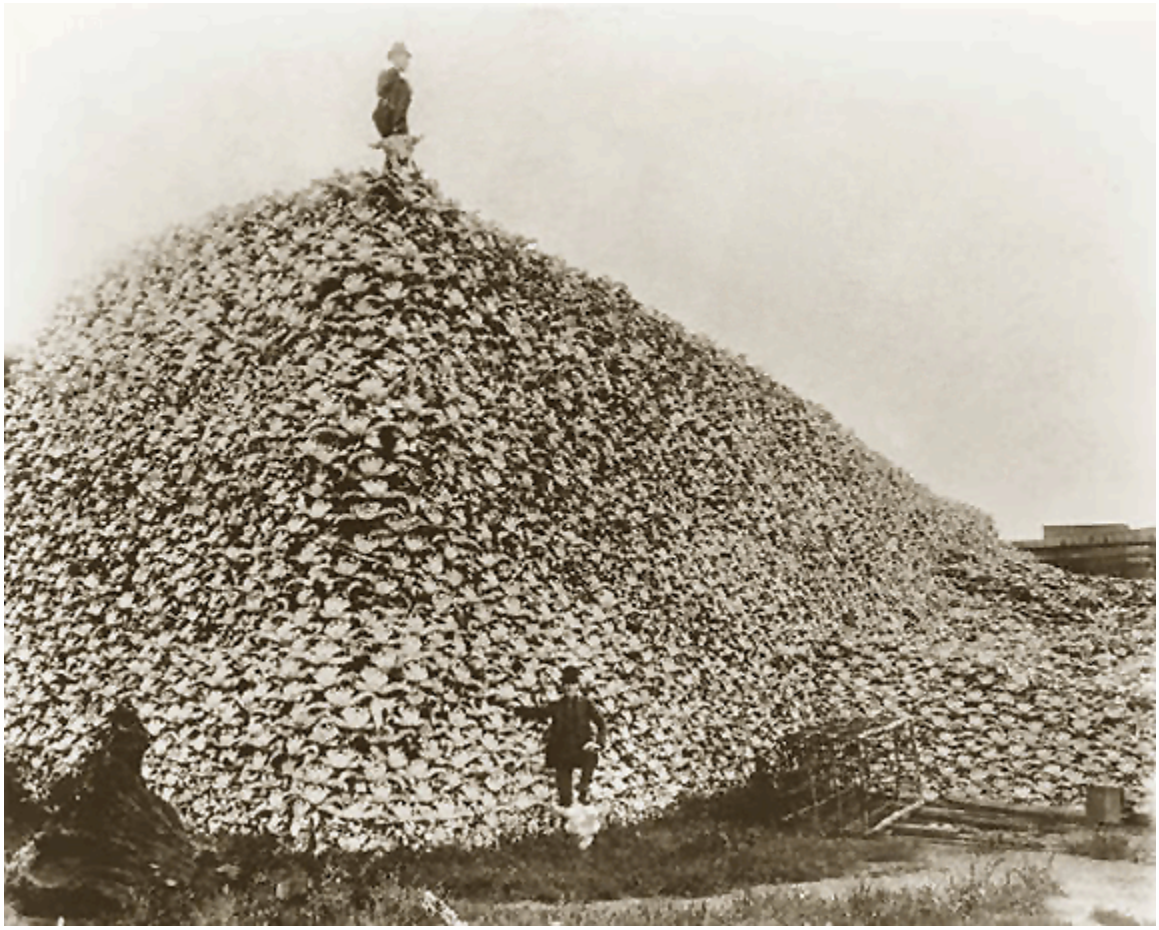
on regulating ballast water discharges from ships, an information-gathering prelude to a potential rulemaking in response to the district court's order.

The 110th Congress has been considering ballast water discharge issues, specifically legislation to provide a uniform national approach for addressing aquatic nuisance species from ballast water under a program administered by the Coast Guard (S. 1578, ordered reported by the Senate Commerce Committee on September 27, 2007, and H.R. 2830 (H.Rept. 110-338)). Some groups oppose S. 1578 and H.R. 2830, because the legislation would preempt states from enacting ballast water management programs more stringent than Coast Guard requirements, while the CWA does allow states to adopt requirements more stringent than in federal rules. Also, while the CWA permits citizen suits to enforce the law, the pending legislation includes no citizen suit provisions.

Chapter- 4

Conservation and Protected Areas of the United States

Conservation in the United States



A pile of Bison skulls circa 1870

Conservation in the United States can be traced back to the 19th century with the formation of the first ever National Park.

History

Philosophy of early American conservation movement

During the nineteenth century, Americans developed a deep and abiding passion for nature. The early evolution of the conservation movement began through both public and private recognition of the relationship between man and nature often reflected in the great literary and artistic works of the nineteenth century. Artists, such as Albert Bierstadt, painted powerful landscapes of the American West during the mid nineteenth century, which were incredibly popular ages representative of the unique natural wonders of the American frontier. Likewise, in 1860, Frederic Edwin Church painted "Twilight in the Wilderness", which was an artistic masterpiece of the era that explored the growing importance of the American wilderness.

Many American writers also romanticized and focused upon nature as a subject matter. However, the most notable literary figure upon the early conservation movement proved to be Henry David Thoreau. Throughout his work, *Walden*, Thoreau detailed his experiences at the natural setting of Walden Pond and his deep appreciation for nature. In one instance, he described a deep grief for a tree that was cut down. Thoreau went on to bemoan the lack of reverence for the natural world: "I would that our farmers when they cut down a forest felt some of that awe which the old Romans did when they came to thin, or let in the light to, a consecrated grove". As he states in *Walden*, Thoreau "was interested in the preservation" of nature. In 1860, Henry David Thoreau delivered a speech to the Middlesex Agricultural Society in Massachusetts; the speech, entitled "The Succession of Forest Trees", explored forest ecology and encouraged the agricultural community to plant trees. This speech became one of Thoreau's "most influential ecological contributions to conservationist thought".

The early conservation movement in the United States was also successful due to the hard work of John Muir. Muir was a former carriage worker who was nearly blinded by an accident at work. After almost losing his sight, Muir decided to see "America's natural wonders". Based upon his travels throughout Yosemite and the Sierra Nevada Mountains, Muir wrote a collection of articles for *Century* magazine, entitled "Studies in the Sierra". In 1892, John Muir joined forces with the editor of "Century" Magazine, Robert Underwood Johnson, to establish the Sierra Club, an organization designed to protect America's natural resources and public parks. Early Americans recognized the importance of natural resources and the necessity of wilderness preservation for sustained yield harvesting of natural resources. In essence, the preservation of wilderness and landscapes were recognized as critical for future generations and their continued subsistence in a healthy environment. The foundation of the conservation movement is grounded during this period between 1850 and 1920. Ultimately, historical trends and cultural mind-sets were united, which influenced ideas and policy towards the early history of the conservation movement in the United States.

Early American conservation movement

The conservation of natural resources is the fundamental problem. Unless we solve that problem, it will avail us little to solve all others.

America had its own conservation movement in the 19th century, most often characterized by George Perkins Marsh, author of *Man and Nature*. The expedition into northwest Wyoming in 1871 led by F. V. Hayden and accompanied by photographer William Henry Jackson provided the imagery needed to substantiate rumors about the grandeur of the Yellowstone region, and resulted in the creation of Yellowstone National Park, the world's first, in 1872. Travels by later U.S. President Theodore Roosevelt through the region around Yellowstone provided the impetus for the creation of the Yellowstone Timberland Reserve in 1891. The largest section of the reserve was later renamed Shoshone National Forest, and it is the oldest National Forest in the U.S. But it was not until 1898 when German forester Dr. Carl A. Schenck, on the Biltmore Estate, and Cornell University founded the first two forestry schools, both run by Germans. Bernard Fernow, founder of the forestry schools at Cornell and the University of Toronto, was originally from Prussia (Germany), and he honed his knowledge from Germans who pioneered forestry in India. He introduced Gifford Pinchot, the "father of American forestry", to Brandis and Ribbentrop in Europe. From these men, Pinchot learned the skills and legislative patterns he would later apply to America. Pinchot, in his memoir history Breaking New Ground, credited Brandis especially with helping to form America's conservation laws.

> “ Conservation means the greatest good to the greatest number for the longest time.—Pinchot ”

Pinchot wrote that the principles of conservation were:

1. *Development*: "the use of the natural resources now existing on this continent for the benefit of the people who live here now. There may be just as much waste in neglecting the development and use of certain natural resources as there is in their destruction. … The development of our natural resources and the fullest use of them for the present generation is the first duty of this generation."
2. *Conservation*: "…the prevention of waste in all other directions is a simple matter of good business. The first duty of the human race is to control the earth it lives upon."
3. *Protection of the public interests*: "The natural resources must be developed and preserved for the benefit of the many, and not merely for the profit of a few."

In 1891, Congress passed the Forest Reserve Act, which allowed the President of the United States to set aside forest lands on public domain. A decade after the Forest Reserve Act, presidents Harrison, Cleveland, and McKinley had transferred approximately 50,000,000 acres (200,000 km^2) into the forest reserve system. However, President Theodore Roosevelt is credited with the institutionalization of the conservation movement in the United States.

For President Roosevelt, the conservation movement was not about the preservation of nature simply for nature itself. After his experiences traveling as an enthusiastic, zealous hunter, Roosevelt became convinced of "the need for measures to protect the game species from further destruction and eventual extinction". President Roosevelt recognized the necessity of carefully managing America's natural resources. According to Roosevelt, "We are prone to speak of the resources of this country as inexhaustible; this is not so". Nonetheless, Roosevelt believed that

conservation of America's natural resources was for the successful management and continued sustain yield harvesting of these resources in the future for the benefit and enjoyment of the American people. Roosevelt took several major steps to further his conservation goals.In 1902, Roosevelt signed the National Reclamation Act, which allowed for the management and settlement of a large tract of barren land. Then, in 1905, President Roosevelt helped to create the United States Forest Service and then appointed respected forester, Gifford Pinchot, as the first head of the agency. By the end of his presidency, Theodore Roosevelt, in partnership with Gifford Pinchot, had successfully increased the number of national parks as well as added area to existing forest reserves.

Despite these advancements, the American conservation movement did have difficulties. In the early 1900s the conservation movement in America was split into two main groups: conservationists, like Pinchot and Roosevelt, who were utilitarian foresters and natural rights advocates who wanted to protect forests "for the greater good for the greatest length", and preservationists, such as John Muir, the founder of the Sierra Club. Important differences separated conservationists like Roosevelt and Pinchot from preservationists like Muir. As a preservationist, Muir envisioned the maintenance of pristine natural environments where any development was banned. Whereas conservationists wanted regulated use of forest lands for both public activities and commercial endeavors, preservationists wanted forest to be preserved for natural beauty, scientific study and recreation. The differences continue to the modern era, with sustainable harvest and multiple-use the major focus of the U.S. Forest Service and recreation emphasized by the National Park Service.

Modern American conservation movement

Ultimately, the modern conservation movement in the United States continues to strive for the delicate balance between the successful management of society's industrial progress while still preserving the integrity of the natural environment that sustains humanity. In a large part, today's conservation movement in the United States is a joint effort of individuals, grassroots organizations, nongovernmental organizations, learning institutions, and various government agencies, such as the United States Forest Service.

For the modern era, the U.S. Forest Service has noted three important aspects of the conservation movement: the climate change, water issues, and the education of the public on conservation of the natural environment, especially among children. In regards to climate change, the U.S. Forest Service has undertaken a twenty year research project to develop ways to counteract issues surrounding climate change. However, some small steps have been taken regarding climate change. As rising greenhouse gases contribute to global warming, reforestation projects are seeking to counteract rising carbon emissions. In Oregon, the Department of Forestry has developed such a small reforestation program in which landowners can lease their land for one hundred years to grow trees. In turn, these trees offset carbon emissions from power companies. Moreover, reforestation projects have other benefits: reforested areas serve as a natural filter of agricultural fertilizers even as new wildlife habitats are created. Reforested land can also contribute to the local economy as rural landowners also distribute hunting leases during the years between harvests.

In essence, projects, such as reforestation, create a viable market of eco-friendly services mutually beneficial to landowners, businesses and society, and most importantly, the environment. Nonetheless, such creative plans will be necessary in the near future as the United States struggles to maintain a positive balance between society and the finite natural resources of the nation. Ultimately, through dedicated research, eco-friendly practices of land management, and efforts to educate the public regarding the necessity of conservation, those individuals dedicated to American conservation seek to preserve the nation's natural resources.

Conservation issues

Historic

- Extinction of the Passenger pigeon
- Wholesale hunting of American Bison

Current

- Logging of old growth forests
- Mountaintop mining
- Draining and development of the Everglades

Enforcement

Game wardens or conservation officers are employed to protect wildlife and natural areas.

- Louisiana Department of Wildlife & Fisheries - Enforcement Division
- Maryland Department of Natural Resources Police
- Michigan Conservation Officers
- New York State Department of Environmental Conservation Police
- Virginia Department of Game and Inland Fisheries

Conservation projects

- Restoration of the Everglades

Conservationists

Some of the more notable American conservationists include:

- Ansel Adams, best known for his black and white photographs of Yosemite National Park
- Aldo Leopold, influential in the development of modern environmental ethics and in the movement for wilderness preservation
- George Perkins Marsh
- John Muir, founder of the Sierra Club a major conservation organization

Protected areas of the United States

The **protected areas of the United States** are managed by an array of different federal, state, tribal and local level authorities and receive widely varying levels of protection. Some areas are managed as wilderness, while others are operated with acceptable commercial exploitation. As of 31 January 2008, according to the United Nations Environment Programme, the U.S. had a total of 6,770 terrestrial nationally designated (federal) protected areas. These protected areas cover 2,607,131 km^2 (1,006,619 sq mi), or 27.08 percent of the land area of the United States. This is also one-tenth of the protected land area of the world. The U.S. also had a total of 787 National Marine Protected Areas, covering an additional 627,830 km^2 (242,410 sq mi), or 67 percent of the total marine area of the United States. In addition, the World Commission on Protected Areas' 2009 database has over 10,480 protected areas listed for the U.S., including the state level protected areas.

Some areas are managed in concert between levels of government. The Father Marquette National Memorial is an example of a federal park operated by a state park system, while Kal-Haven Trail is an example of a state park operated by county-level government.

Federal level protected areas

Federal level protected areas are managed by a variety of agencies, most of which are a part of the National Park Service, a bureau of the United States Department of the Interior. They are often considered the crown jewels of the protected areas. Other areas are managed by the United States Forest Service, the Bureau of Land Management and the United States Fish and Wildlife Service. The United States Army Corps of Engineers is claimed to provide 30 percent of the recreational opportunities on federal lands, mainly through lakes and waterways that they manage.

The highest levels of protection, as described by the International Union for Conservation of Nature (IUCN), are Level I (Strict Nature Reserves & Wilderness Areas) and Level II (National Parks). The United States maintains 12 percent of the Level I and II lands in the world. These lands had a total area of 210,000 sq mi (540,000 km^2).

A confusing system for naming protected areas results in some types being used by more than one agency. For instance, both the National Park Service and the U.S. Forest Service operate areas designated National Preserves and National Recreation Areas. The National Park Service, the U.S. Forest Service, and the Bureau of Land Management operate areas called National Monuments. National Wilderness Areas are designated within other protected areas, managed by various agencies and sometimes wilderness areas span areas managed by multiple agencies.

There are existing Federal designations of historic or landmark status that may support preservation via tax incentives, but that do not necessarily convey any protection, including a listing on the National Register of Historic Places or a designation as a National Historic Landmark. States and local zoning bodies may or may not choose to protect these. The state of

Colorado, for example, is very clear that it does not set any limits on owners of NRHP properties.

State level protected areas

Every state has a system of state parks. State parks vary widely from urban parks to very large parks that are on a par with national parks. Some state parks, like Adirondack Park, are similar to the National parks of England and Wales, with numerous towns inside the borders of the park. About half the area of the park, some 3,000,000 acres (1,200,000 ha), is state-owned and preserved as "forever wild" by the Forest Preserve of New York. Wood-Tikchik State Park in Alaska claims to be the largest state park by the amount of contiguous protected land; it is larger than many U.S. National Parks, with some 1,600,000 acres (650,000 ha). Many states also operate game and recreation areas.

- State parks in the United States include: Alabama, Alaska, Arizona, Arkansas, California, Colorado, Connecticut, Delaware, Florida, Georgia, Hawaii, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, North Carolina, North Dakota, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, Washington, West Virginia, Wisconsin and Wyoming
- List of U.S. state and tribal wilderness areas

Local level protected areas

Various counties, cities, metropolitan authorities, regional parks, townships, soil conservation districts and other units manage a variety of local level parks. Some of these are little more than picnic areas or playgrounds; however, others are extensive nature reserves. South Mountain Park in Phoenix, Arizona, for example, is called the largest city park in the United States; it spans 25 sq mi (65 km^2) and contains 58 mi (93 km) of trails.

MyEnvironment

MyEnvironment is an application built by the United States Environmental Protection Agency to help the public get a sense of environmental indicators in their neighborhood. By keying in a geography, the application comes back with information about the local land, air and water. It mines mostly EPA but also other federal Agency databases. The latest enhancement was the addition of environmental shout outs. Within the context of MyEnvironment - shout outs are a means of crowdsourcing inspirational environmental activities that are happening at the neighborhood-level. The intention is that as people are learning about air and water quality in their neighborhood, they can simultaneously learn about what their neighbors are up with regard to river cleanups, e-cycling efforts and other good-for-the-environment activities.

MyEnvironment receives over one million hits a month and over 100,000 pageviews are downloaded in that same time. The predecessor tool to MyEnvironment is Window to My Environment.

Environmental Information in MyEnvironment

- Radon

Radon can be found all over the US. Inhaling high levels of radon can lead to lung cancer. MyEnvironment features county-level maps of radon levels so that citizens can be proactive about protecting themselves from this naturally occurring hazard.

- Air Quality

There are geographic patterns to air quality problems and MyEnvironment provides a map so that citizens can see what their relative exposure may be especially as they live near major traffic areas, near regulated facilities, or in proximity to confined animal feeding operations. The Clean Air Act is the law that defines EPA's responsibilities for protecting and improving the nationa's air quality.

- Water Quality

Good water quality is a key concern of the EPA. The Clean Water Act is the cornerstone of surface water quality protection in the United States. Understanding the complexities of what can be found in your local stream and how that may impact your health or quality of life is an area of extensive research. MyEnvironment offers the basics of drilling into STORET (one of the EPA's main water monitoring databases) to reveal some of the parameters that may have been sampled for in your local area waters and whether it was found to be present. After that, you'll need to read about that "indicator" to understand whether it is a cause for concern to your immediate health and how you may protect yourself.

- Ecological Indicators

EPA and others rely on the study of ecological indicators as a means of understanding when our environmental health or that of our surroundings may be in jeopardy. MyEnvironment links to only a small subset of these research documents that describe the findings about indicators across the country.

- Regulated Facilities (Facility Registry System from Envirofacts)

EPA collects information from each state about all facilities that either store, handle or emit pollutants to land, air or water. EPA stores the locational information about these regulated facilities in a database called the Facility Registry System. MyEnvironment features these facility locations in its central mapper. As for more in-depth information about which chemicals these facilities are permitted to store/handle/release or other data, MyEnvironment relies on another EPA core database called Envirofacts. Envirofacts is a system that was developed to

support many of the Agency's public access applications that support public inquery about chemical release, permitting and other facility-specific information beyond the simple location of those facilities.

- Ultraviolet Index (UV Index)

Knowing the daily UV index forecasted for your area can help you protect yourself from the sun by bringing a hat, wearing sunscreen or staying indoors. MyEnvironment provides the results of this popular web service.

- Cancer Risk to Air Toxics

EPA, as part of the NATA study, calculates the potential cancer risk to air toxics (cancer from exposure over a lifetime to air pollutants) for each census tract (and finer). MyEnvironment delivers visuals of these risks in the MyHealth accordion.

- Infant Mortality

Infant mortality is often used as an indicator of the health and well-being of a nation. MyEnvironment drills into a Department of Health and Human Services HRSA web service to provide infant mortality statistics at the county-level.

- Low Birth Weight

Low birth weight rates by county are also available via MyEnvironment thanks to another Department of Health and Human Services web service.

- Environmental Shout outs
- Streamflow
- Permit Information for Facilities that Discharge to Water

Watershed Central

Watershed Central is an Environmental Protection Agency (EPA) website developed to organize information and tools relevant to watershed management from across the country.

Watershed Central allows local watershed managers and the public find tools to assess and manage watersheds across the United States. The intention at inception was to present decision support tools, models, data, and other resources in a coordinated, integrated manner for watershed management.

History

Officially unveiled in 2009, Watershed Central was developed by a multidisciplinary team within the EPA in response to an apparent gap in terms of a one-stop shop for watershed tools and data. Over 100 people across state, local, federal, and tribal governments contributed to an online vision for Watershed Central. A key element of the vision was to help managers discover the correct tools to use to support the various steps of developing a watershed management plan, and secondly, to create an environment that would foster the exchange of lessons learned and best management practices across the nation. The Watershed Central website was designed to embody this vision.

Uses

- Provides an integrated water quality assessment and management context for EPA's watershed tools and science to expedite remediation of American waters.
- Provides a mechanism to document analyses, decisions, and watershed plan effectiveness.
- Builds capacity of local watershed organizations to develop and implement comprehensive watershed management programs to protect and restore water resources.
- Provides a means for improving the consistency and compatibility of various data elements provided by public agencies across the country.
- Supports decreased time-frames for development of scientifically credible and defensible watershed plans.
- Informs the Agency and collaborative agencies regarding research gaps and impact of products.
- Integrates good science with regulatory drivers and social and economic incentives.
- Leverages knowledge and capability across Federal, State, local agencies, tribes, etc.

What is a Watershed?

A watershed or drainage basin is the area of land where all of the water that is under it or drains off of it goes into the same place. John Wesley Powell, scientist geographer, put it best when he said that a watershed is:

"That area of land, a bounded hydrologic system, within which all living things are inextricably linked by their common water course and where, as humans settled, simple logic demanded that they become part of a community."

Watersheds come in all shapes and sizes. They cross county, state, and national boundaries. In the continental US, there are 2,110 watersheds; including Hawaii, Alaska, and Puerto Rico, there are 2,267 watersheds.

Chapter- 5

Geology of North America

Sedimentary, volcanic, plutonic, metamorphic rock types of North America

The geology of North America, like most topics of scientific study, is undergoing progressive investigation by numerous public- and private-sector earth scientists, academicians, and students. In that regard, the detailed picture is subject to revision and change as knowledge advances.

Geologic provinces

The lower 48 U.S. states can be divided into roughly five physiographic provinces:

1. The American cordillera.
2. The Canadian Shield.
3. The stable platform.
4. The coastal plain.
5. The Appalachian orogenic belt.

The geology of Alaska is typical of that of the cordillera, while the major islands of Hawaii consist of Neogene volcanics erupted over a hot spot.

Cedar Breaks National Monument, Utah

The American cordillera extends roughly from the Great Plains westward to the Pacific Ocean, narrowing somewhat from north to south. It includes the Cascades, Sierra Nevada, and Basin and Range province; the Rocky Mountains are sometimes excluded from the cordillera proper, in spite of their tectonic history. The geology of this region is complex, having gone through

numerous orogenies, with their associated deformation, faulting, volcanic activity, and periods of uplift separated by intervals of erosion. Much of the cordillera consists of terranes, ancient microcontinents and island arcs that were "welded" onto the North American craton during the Paleozoic and Mesozoic eras. Such a convoluted history is typical of convergent plate boundaries, as has characterized the cordillera through most of the Phanerozoic. Although the Colorado Plateau is near the cordillera, it has remained tectonically stable, with little deformation.

The Canadian Shield consists of surficial, deeply eroded Precambrian rocks, exhumed by past glaciations. Consisting of a variety of rocks from igneous to ancient sedimentary, it is well-exposed only in the Great Lakes region.

A large part of the center of the lower 48 consists of the stable (or continental) platform. Here, the Precambrian rocks of the Shield are buried beneath sedimentary Phanerozoic strata. Tectonic activity is minor to nonexistent, with occasional broad domes and basins that reveal mild epeirogenic deformation. The coastal plain extends from the southern tip of Texas across the northern Gulf of Mexico and into the Mississippi embayment, and northeast through the Mid-Atlantic states. A classic passive continental margin, it consists of a deep clastic wedge of sediment eroded from the platform and mountain belts; it first formed during the opening of the Atlantic Ocean and Gulf of Mexico during the Jurassic and Cretaceous periods.

The Appalachian orogenic belt extends from well into New England south into Mississippi and Alabama. The Ouachita Mountains of Arkansas, and even the Marathon Uplift of Texas are also part of the same province, having all formed in the Alleghenian orogeny that took place when Pangea assembled during the late Paleozoic. Once lofty, they have been heavily weathered since the opening of the Atlantic Ocean. The Appalachians proper consist of deformed sedimentary rocks, cut through by numerous thrust faults; as in the western cordillera, the Appalachians experienced several orogenies over the course of the Paleozoic, making their geologic history difficult to interpret.

Geology of the Rocky Mountains

- Burgess Shale
- Cloverly Formation
- Columbia Icefield
- Dakota Hogback
- Dakota Sandstone
- Denver Basin
- Geology of the Grand Teton area
- Gold mining in Colorado
- Grand Mesa
- Great Divide Basin
- Green River Formation
- La Garita Caldera
- Lance Formation
- Laramide orogeny
- Morrison Formation
- Pikes Peak granite
- Powder River Basin
- Raton Basin
- Rocky Mountain Association of Geologists
- Rocky Mountain Trench
- Silver mining in Colorado
- Sundance Sea
- Triple Divide Peak
- Uranium mining in Colorado
- Uranium mining in Wyoming
- Western Interior Seaway

View from the North Rim of the Grand Canyon

Seismic faults

- Basin and Range Province
- Clarendon-Linden fault system
- Humboldt fault
- Moab Fault
- New Madrid Seismic Zone
- Seattle Fault
- Wasatch Fault

Faults in California

Map of the San Andreas Fault, showing relative motion

- Calaveras Fault
- Clayton-Marsh Creek-Greenville Fault
- Elsinore Fault Zone
- Garlock Fault
- Hayward Fault Zone
- Healdsburg Fault
- Mendocino Fracture Zone
- Monta Vista Fault
- Newport-Inglewood Fault
- Raymond Fault
- San Andreas Fault
- San Gabriel Fault
- San Jacinto Fault Zone
- Sierra Nevada Fault
- Silver Creek Fault
- Tesla Fault
- White Wolf Fault
- Whittier Fault