Biological Trends in the United States

Louis Iverson, USDA Forest Service Northern Research Station

"Sustaining Forests in a Changing Environment "

A research work unit of the USDA Forest Service Northern Research Station

359 Main Rd
Delaware, OH
43015

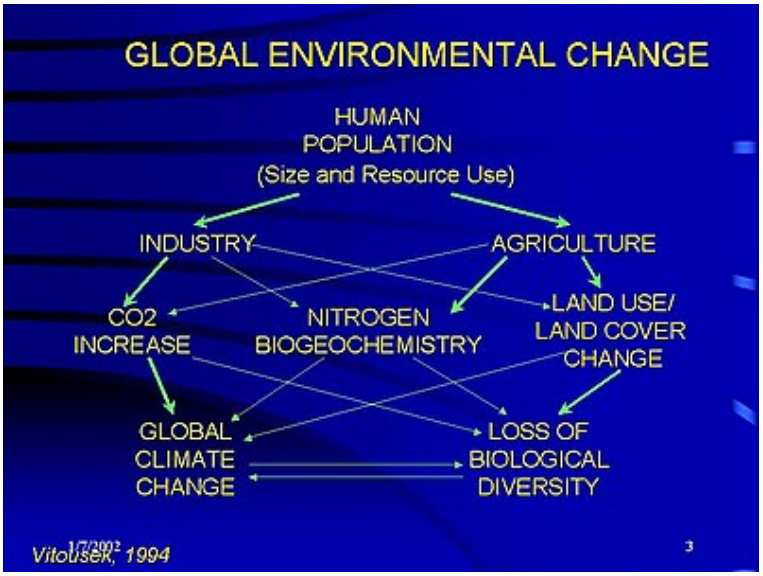
740-368-0097

For more information, contact
Louis Iverson

Past and Potential Future Trends in the Biological Resources of the Midwest

This paper covers trends in biological impacts related to:

- Human population
- Land Use
- Forests
- Water/Wetlands
- Biodiversity and Species Abundance
- Invasive Species
- Environmental Contaminants
- Climate Change



Most of the biological resource issues are related to each other as shown in Vitousek's diagram at left.

Human population (numbers, resources used) is main driver via industry, agriculture, and urbanization.

(Vitousek PM. 1994. Beyond global warming ecology and global change. Ecology 75:1861-1902.)

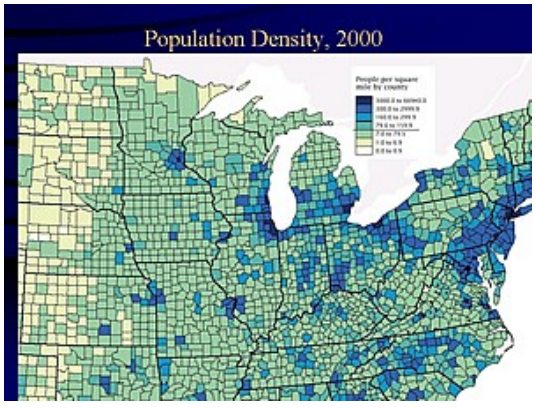
Topics in Human Population Trends

- Population changes since 1990
- Changes in recreational use

High density counties shown in blue colors, low density in light colors.
High population along Eastern seaboard, Lake Michigan.

Low population in the prairie states.

http://www.census.gov/



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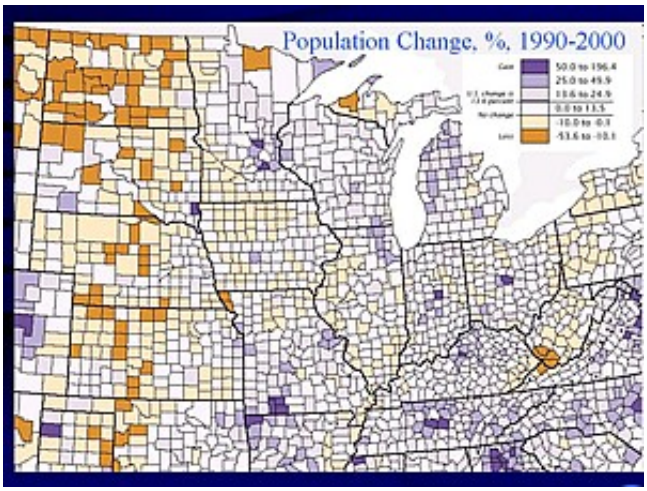
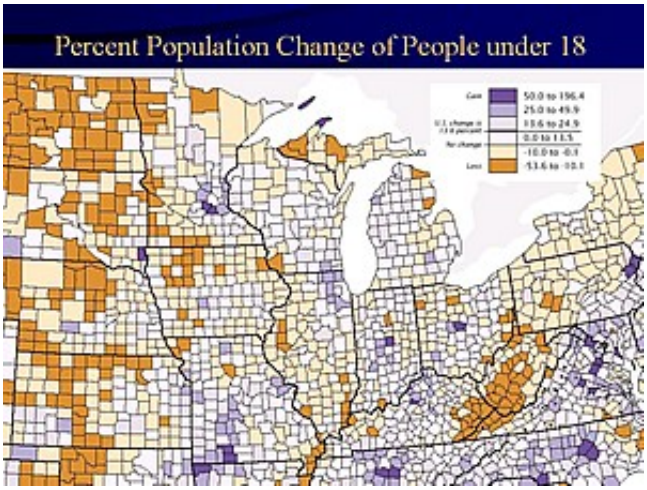


Human Population Trends

Changing populations between 1990 and 2000 show continual decline in prairie states and southern Appalachians.

Some counties gained over 50% in 10 years (including the one Iverson lives in in Ohio).

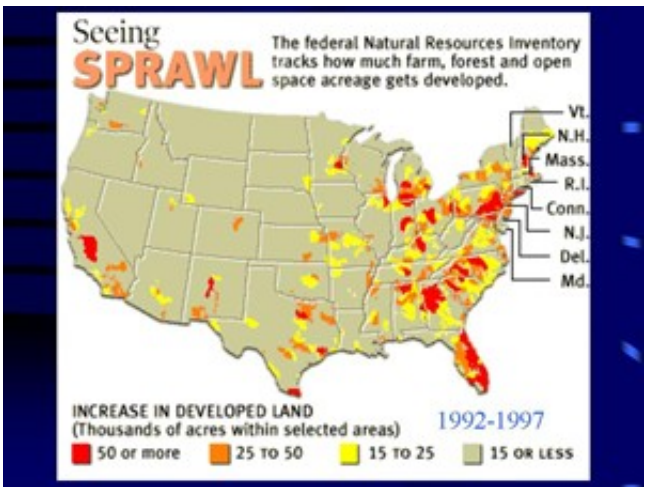
http://www.census.gov/



The population trends of the past decade are accentuated with the percentage change in children.

The 'brown' counties will continually lose population if they don't keep the children.

http://www.census.gov/



Urban sprawl shows dramatic increases in sprawl especially in the East.

Hydrologic regions in red had at least 50,000 acres converted to 'developed' between 1992 and 1997.

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Recreation Use

RECREATION TYPE	1983 (mil)	1995 (mil)	Change, %
Bird Watching	21.2	54.1	+155
Hiking	24.7	47.8	+94
Backpacking	8.8	15.2	+73
Downhill skiing	10.6	16.8	+59
Primitive camping	17.7	28.0	+58
Off-road driving	19.4	27.9	+44
Motorboating	33.6	47.0	+40
Swimming-lake,river	56.5	78.1	+38
Developed camping	30.0	41.5	+38
Snowmobiling	5.3	7.1	+34
Cross-country skiing	5.3	6.5	+23
Picnicking	84.8	98.3	+16
Water skiing	15.9	17.9	+13
Fishing	60.1	57.8	-4
Sailing	10.6	9.6	-9.4
Horseback riding	15.9	14.3	-10.1
Hunting	21.2	18.6	-12.3

No. people active at least 1 day in a year

Mac et al. 1998

9

Recreation use has changed dramatically between 1983 and 1995. The table above shows number of people (in millions) that were active in particular recreation at least 1 day in a year.

Bird watching heads list with 155% increase, followed by 94% increase in hiking. Recreation types showing a decrease are fishing (-4%), sailing (-9%), horseback riding (-10%), and hunting (-12%).

These trends say something to how land managers should be managing their lands.

Cordell, K. 1999. Outdoor recreation in American life a national assessment of demand and supply trends. Sagamore Publishing, Champaign, Il. 449 pp.

Turner MG, Carpenter SR, Gustafson EJ, Naiman RJ, Pearson SM. 1998. Land Use. Pages 37-61 in Mac MJ, Opler PA, Puckett Haecker CE, Doran PD. Status and trends of the nation's biological resources. U.S. Department of the Interior, U.S. Geological Survey, Reston, Va.

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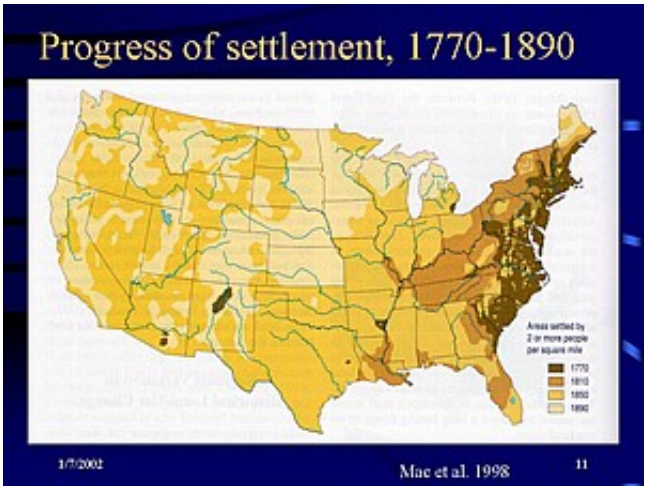
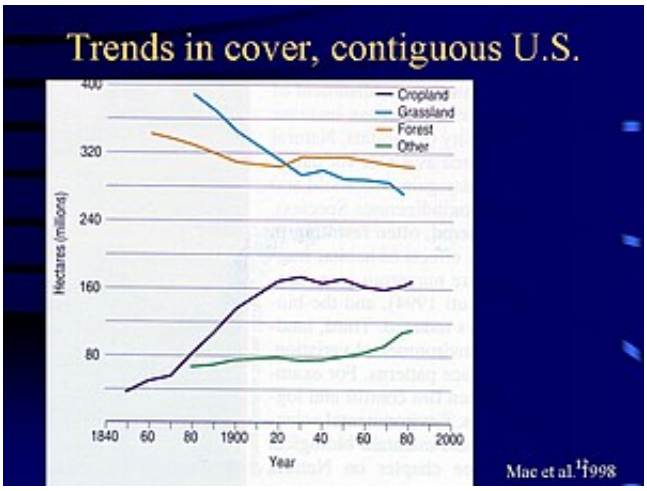


Land Use
Overall Land Conversion
Fragmentation

The pattern of development (at least 2 people per square mile) was confined to the East coast through 1770, then to the Ohio River valley through 1810.
By 1850, most of the forest lands east of the Mississippi were settled, and by 1890, the prairies too.

Some prairie counties now have below 2 people per square mile, with continuing population loss.

Turner MG, Carpenter SR, Gustafson EJ, Naiman RJ, Pearson SM. 1998. Land Use. Pages 37-61 in Mac MJ, Opler PA, Puckett Haecker CE, Doran PD. Status and trends of the nation's biological resources. U.S. Department of the Interior, U.S. Geological Survey, Reston, Va.



The pattern of settlement is also apparent in the changes in land cover since 1840.
Forests were converted to farmland first ("if it can't grow a tree, it probably can't grow crops" was common early impression).
Grasslands very rapidly converted once the moldboard plow was perfected. Urbanization has been major conversion in recent decades.

Turner MG, Carpenter SR, Gustafson EJ, Naiman RJ, Pearson SM. 1998. Land Use. Pages 37-61 in Mac MJ, Opler PA, Puckett Haecker CE, Doran PD. Status and trends of the nation's biological resources. U.S. Department of the Interior, U.S. Geological Survey, Reston, Va.

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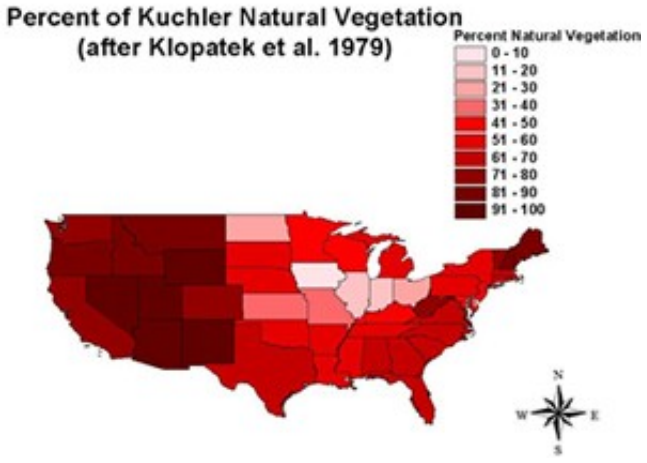
Land Use (continued)



Iowa is 'winner' with respect to the percentage of its natural lands converted to other uses - only 8% is in Kuchler's potential vegetation type.

Illinois next with 11%, Ohio has 25%.

Major conversion occurred in last half of 19th century in the Midwest.

Klopatek JM, Olson RJ, Emerson CJ, Jones JL. 1979. Land-use conflicts with natural vegetation in the United States. Environmental Conservation 6:191-200.

Principles when humans Convert Landscapes

- Principle 1: a safe reliable low-cost (time, energy) system (road, river, rail) to access landscapes is a prerequisite to human conversion of terrestrial habitats.
- Principle 2: barring profound changes to the soil and hydrological properties of a landscape that might occur during human modification, terrestrial habitats are resilient and can revert back to a natural condition if left undisturbed.
- Principle 3: human disturbance reduces the amount and alters the spatial properties (patch size, amount of edge, connectedness) of native habitat.
- Principle 4: Loss of native habitat results in the loss of resident species of plants and animals. Non-native species frequently invade, and can sometimes dominate disturbed landscapes.
- Principle 5: habitat context is a very important characteristic of patches and the biota within a patch are often affected by the habitat(s) surrounding it.

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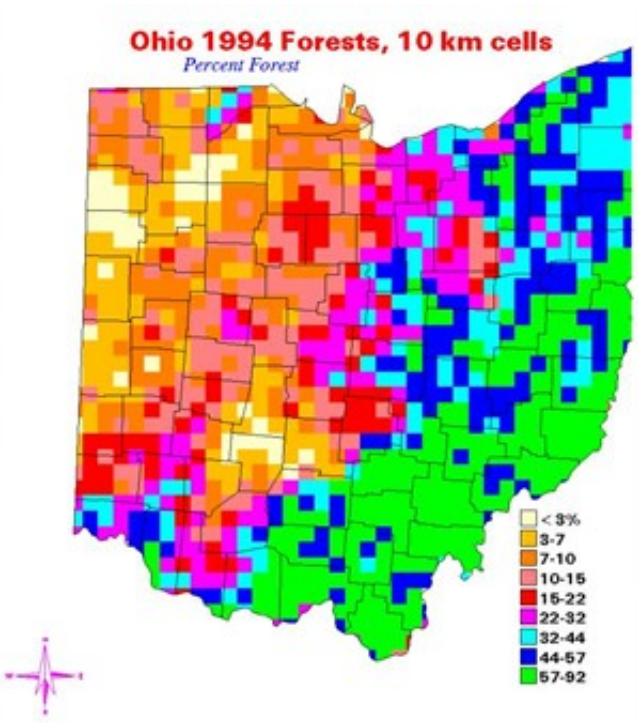

Fragmentation has been studied in many ways. Kurt Riitters and colleagues have done a lot of work assessing global and U.S. fragmentation. I encourage you to go to his site to check out their work. http://www.srs.fs.fed.us/4803/landscapes/

We have done some work in Ohio, assessing forest fragmentation in each 10 x 10 km block across the state.

This shows percent forest is highest in southeast, lowest in northwest.

Iverson, L.R. and A. Prasad. 2001. Assessment of fragmentation in Ohio. unpublished document

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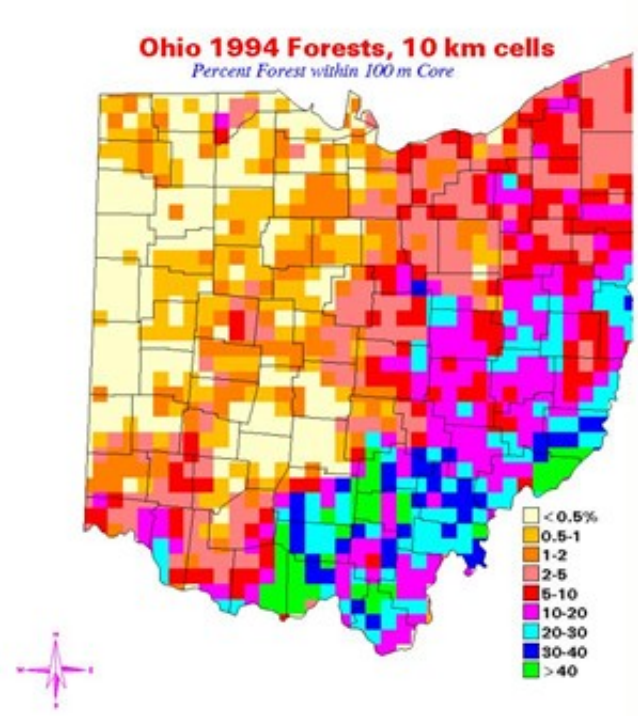

If you remove the outside 100 m from each forest patch, you get 'core' area - which has been linked to e.g. forest interior birds.

Much less of the state qualifies as having a high percentage of its forest as core.

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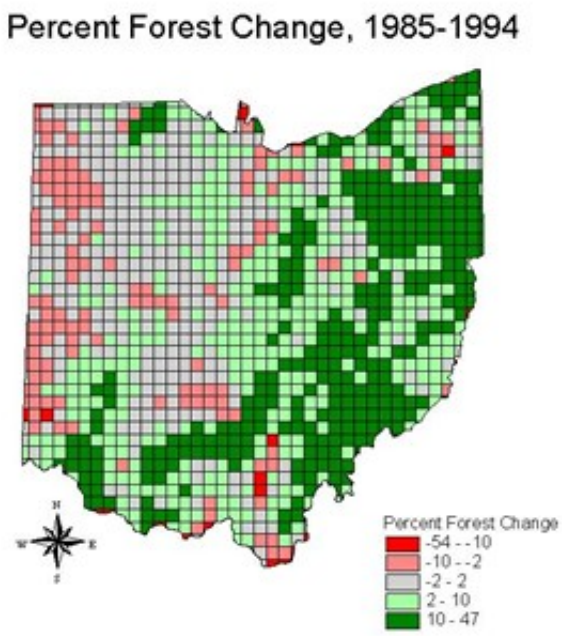
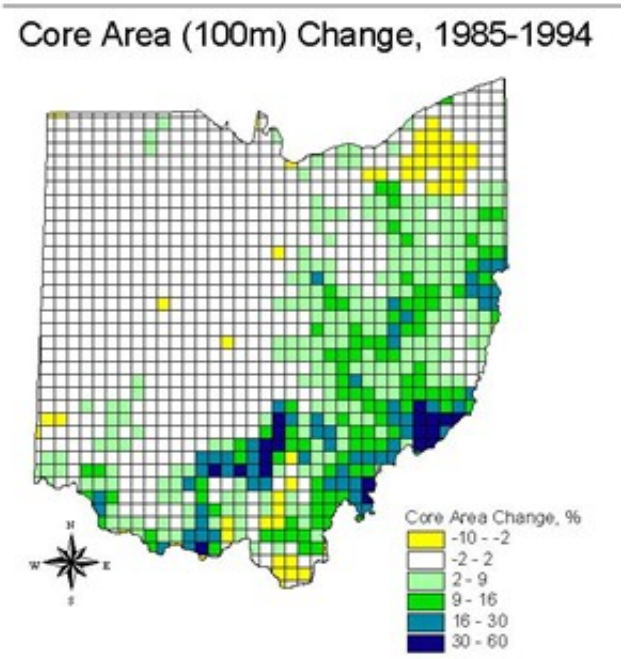
Land Use (continued)



Forest classification was done with Landsat TM (30 m data) in 1985 and 1994, with the percent change shown here.

Keep in mind that there was classification error in each, compounded when overlaying two dates.

Shows general increase in forest along east side, and little change elsewhere.



Changes in core area of forest show significant increases in some southern and southeastern grids.

Some of this could be regrowth of harvested lands (going from shrub type to forest type in the classification).

Some areas around Cleveland show losses of core area.

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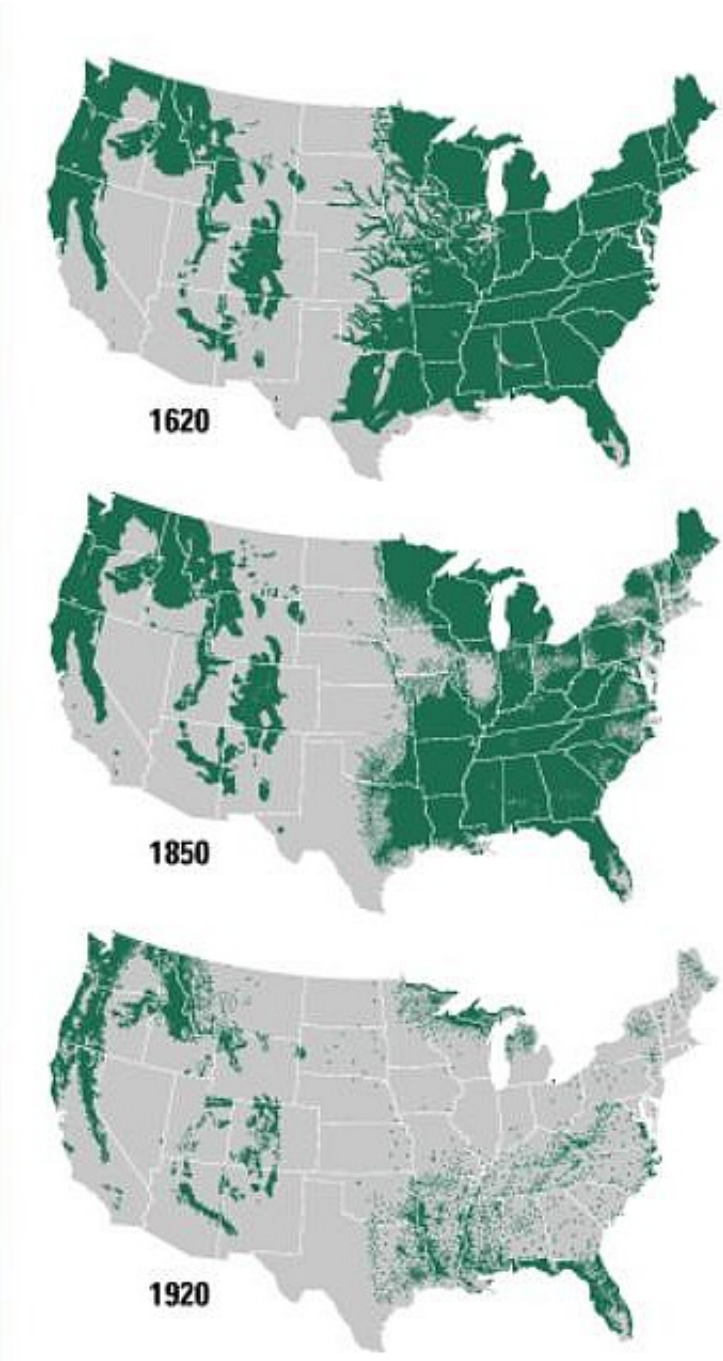
Forest Trends

- Changes in forest area
- Forest cover types
- Changes in volume and growth vs. removals
- "Maple takeover"



Number of forest dependent species in the U.S.

- 865 native woody species
- 419 native species of mammals
- 281 native species of reptiles
- 240 species of amphibians
- 800 freshwater species
- 90% of total bird, amphibian, and fish species and 80% of mammal and reptile species can be found on forest land.

At left, a map showing **Approximate location of virgin forests in 1620, 1850, and 1920.**

Old growth forests were, for the most part, harvested by 1920, especially in the East.

Pacific Northwest forests and UP Michigan forests cut heavily after 1920 until quite recently.

Meyer WB. 1995. Past and present land use and land cover in the USA. Consequences. Spring 1995:25-33.

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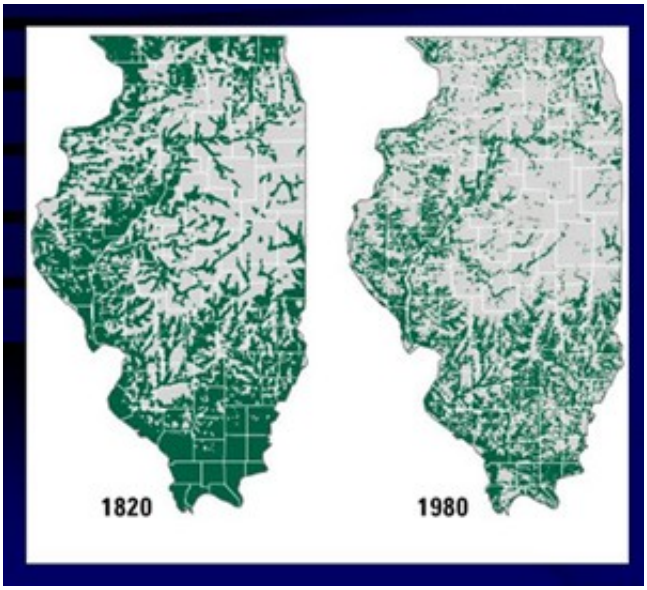

The forest changes (not virgin forests) for Illinois are shown, going from 13.8 million acres in 1820 down to 3.02 million in 1924, and then back up to 4.33 million acres in 1998.

Iverson LR. 1991. Forest resources of Illinois what do we have and what are they doing for us? Pages 361-374 in Symposium Proceedings Our Living Heritage. Illinois Natural History Survey Bulletin 34, Champaign, IL.

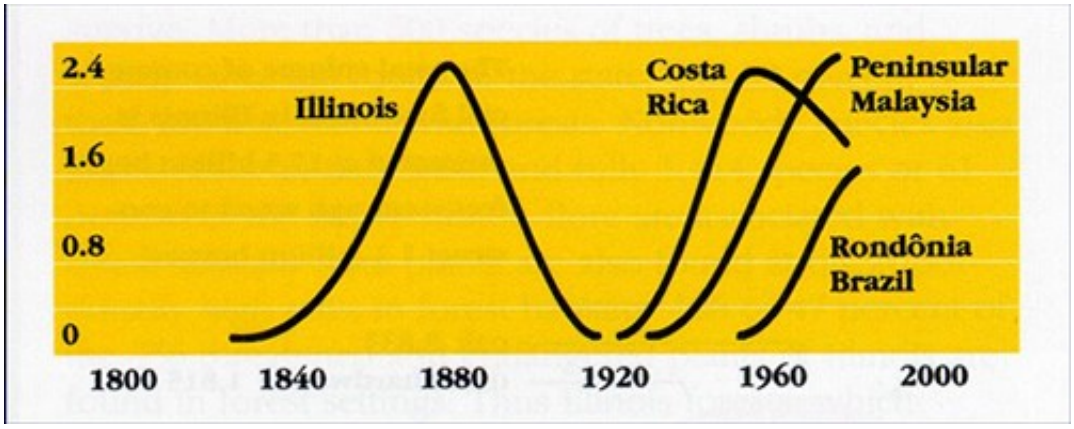

Chart above shows **Deforestation Rates**. History does indeed repeat itself. Deforestation rates in tropics are following same pattern as it did about a century earlier in Illinois

We have to be careful how we deal with tropical countries undergoing deforestation because we did it first!

Iverson, L.R., G.L. Rolfe, T.J. Jacob, A.S. Hodgins, and M.R. Jeffords. 1991. Forests of Illinois. Illinois Council on Forestry Development, Urbana, and Illinois Natural History Survey, Champaign. 24 pp.

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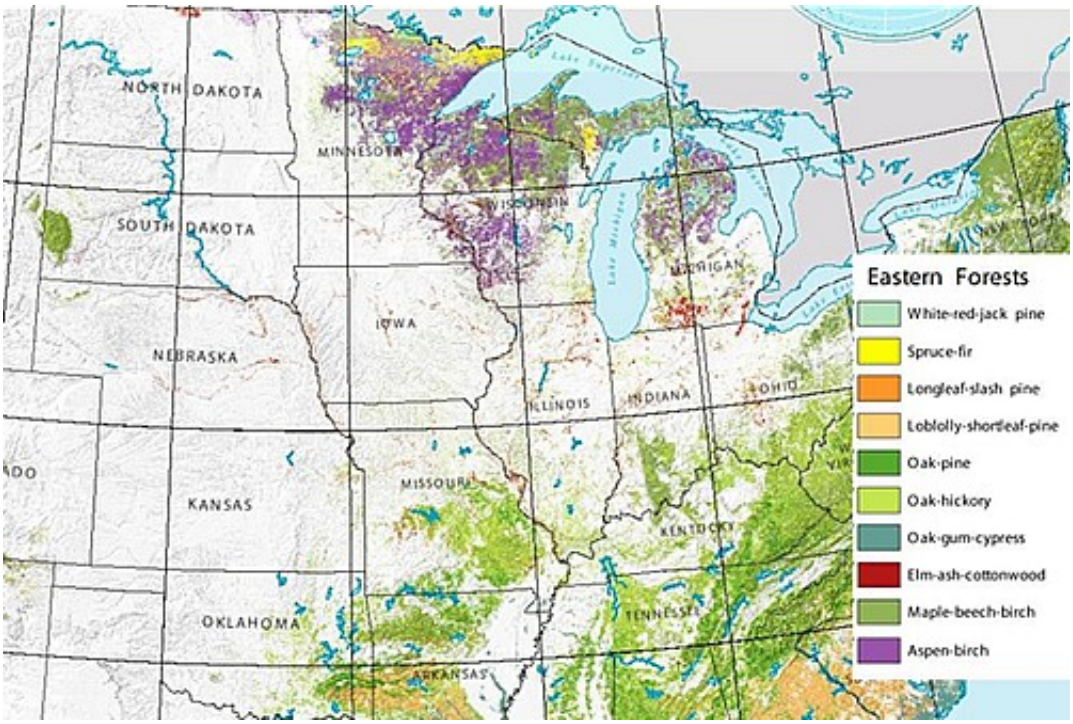
Map at left shows **Percentage of Forests.**

US Forest Service Forest Inventory data shows the amount of forestland in each state.

Prairie states aptly named; highest forest percentages in New England and West Virginia.

Prasad, A. and L.R. Iverson. Unpublished map produced from USDA Forest Service Forest Inventory and Analysis data.



The map above shows the **Distribution of forest types according to classified AVHRR data**.

Lots of aspen-birch in Lake States, mostly oak-hickory elsewhere. But these too are changing and could dramatically change in future.

Zhu Z, Evans DL. 1994. U.S. forest types and predicted percent forest cover from AVHRR data. Photogrammetric Engineering and Remote Sensing 60:525-531.

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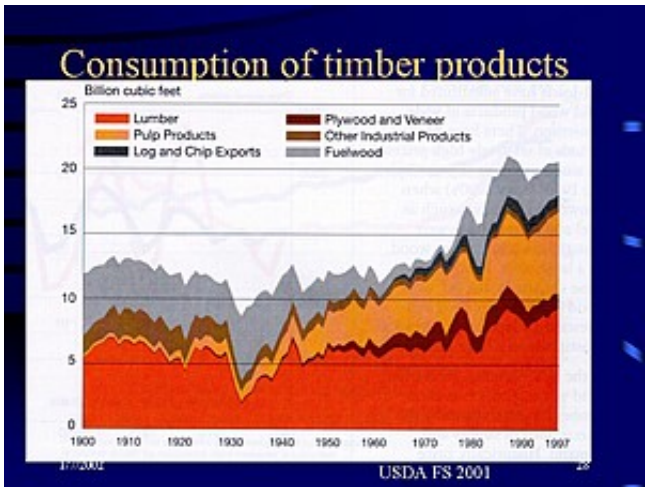
Forest Trends
.Total area of forest land in the US has been stable since early part of 20th century.

Distribution of forest land has been shifting, however.

http://www.fs.fed.us/pl/rpa

USDA Forest Service. 2001. 2000 RPA assessment of forest and range lands. FS-687. USDA Forest Service. Washington, D.C. 78 pp.



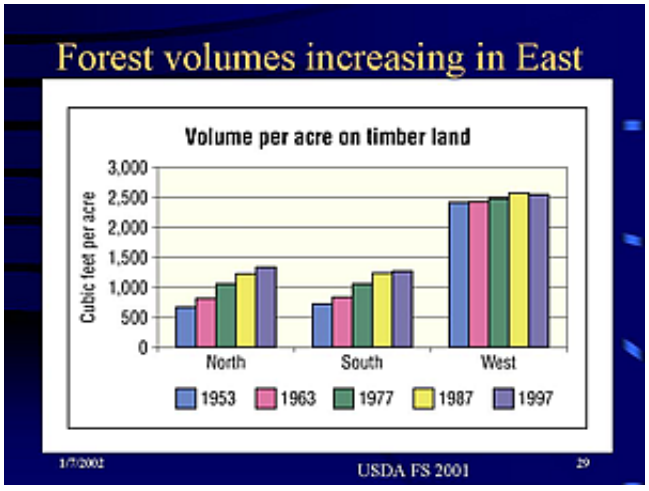
The US demand and consumption of timber products has steadily increased except for 1930s and early 1980s (generally follows economy).

Fuelwood consumption was initially high, then decreased during 1960s and early 1970s until the oil embargo, and has increased again since.

Big rise in pulp products throughout, and more recently with plywood and chip products.

http://www.fs.fed.us/pl/rpa

USDA Forest Service. 2001. 2000 RPA assessment of forest and range lands. FS-687. USDA Forest Service. Washington, D.C. 78 pp.



Volume per acre has increased each decade since 1953 in the north and south (both east); not much change in West.

Secondary forests in East are growing more rapidly than being cut.

http://www.fs.fed.us/pl/rpa

USDA Forest Service. 2001. 2000 RPA assessment of forest and range lands. FS-687. USDA Forest Service. Washington, D.C. 78 pp.

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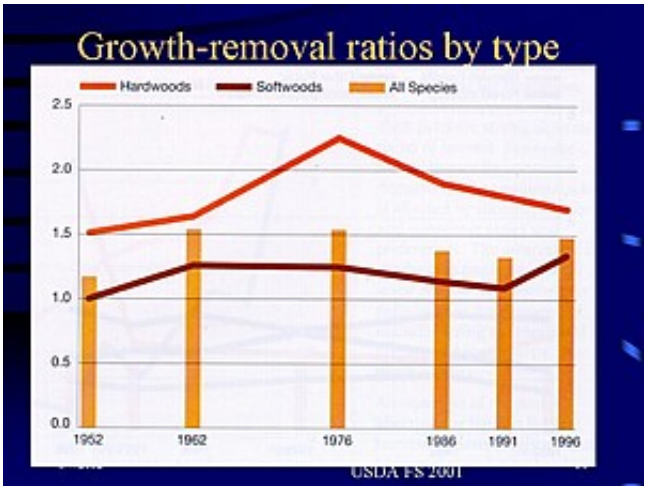
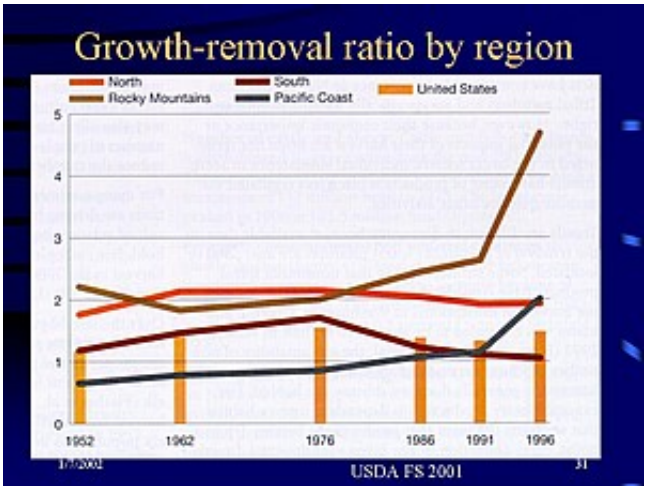


Growth-removal ratios give indication of sustainability of the timber resource: a ratio of 1 means the same amount is growing as is being harvested.

Hardwoods generally have higher ratios than softwoods.

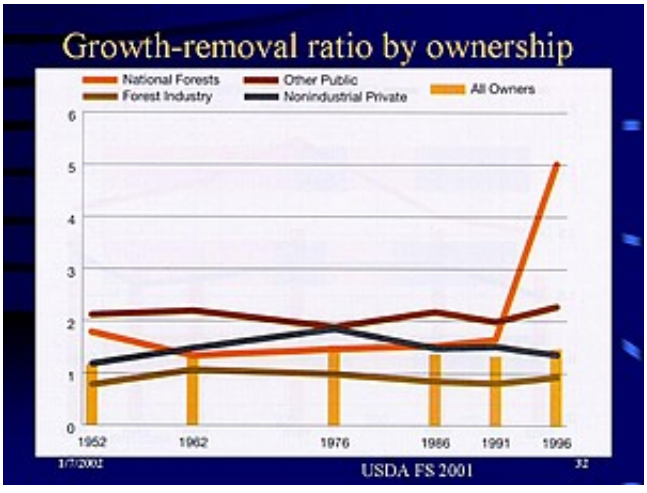
Overall, ratios have been in 1.2 to 1.55 range, and now, nearly 50% more wood is grown than is being removed.



The Rocky Mt. region now has a ratio over 4.5 The south ratio has been declining (heavier harvest partially because of shutdown in Pacific Northwest).

Some project the ratio in the South to go below 1.0 in next couple of decades.

The North is largely secondary growth and has been growing nearly twice that of harvest since the 1950s.



Considered by ownership, the ratio shows a dramatic recent spike, to over 5.0 in national forest lands.

Forest industry lands generally have had ratios below 1.0.

All graphs on this page are from http://www.fs.fed.us/pl/rpa

USDA Forest Service. 2001. 2000 RPA assessment of forest and range lands. FS-687. USDA Forest Service. Washington, D.C. 78 pp.

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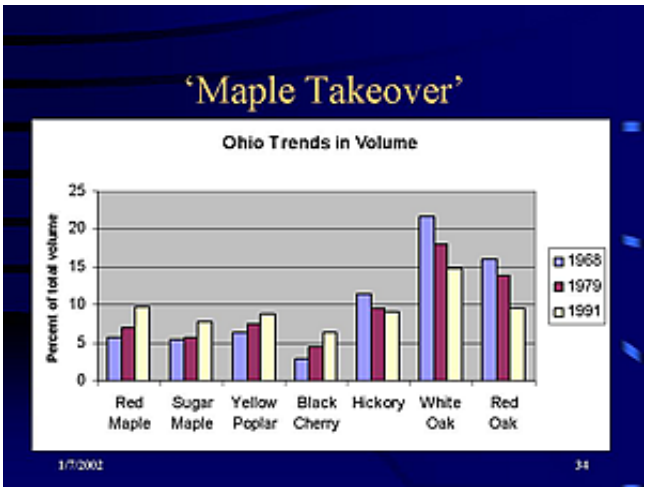

Forest Trends

Trends in wild forest fires show that, although 2000 was the major fire year since the 1950s, there were many more acres burned per year in years preceding Smoky Bear. 50 years of effective suppression has put us in difficult situation now. That, combined with many more humans living in the wildland interface, causes problems.

http://www.fs.fed.us/pl/rpa
USDA Forest Service. 2001. 2000 RPA assessment of forest and range lands. FS-687. USDA Forest Service. Washington, D.C. 78 pp.

Along with the (mostly Western) issue of forest fire danger due to excessive fuel buildup, is the issue of maple takeover in the East. It too is at least partially the result of 50 years of fire suppression.
Trends in Ohio wood volume 1968-1991 show large increases in maples, yellow poplar, and black cherry, with concomitant reductions in oak and hickory.

Iverson LR, Dale ME, Scott CT, Prasad A. 1997. A GIS-derived integrated moisture index to predict forest composition and productivity in Ohio forests. Landscape Ecology 12:331-348.

Another way to show this is the 'oak bottleneck' diagram, where there are plenty of oaks in the seedling size class as well as the canopy trees, but very few in the sapling size class.

As these maple saplings grow and mature, they will replace the oak canopy trees. Regeneration is not presently successful, so management options are needed to help regenerate oaks.
Sutherland E., Sutherland S., Hutchinson T., Yaussy D. Oak bottleneck. Unpublished work of USDA Forest Service Project NE-4153 in Delaware, Ohio.

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We have been studying the role of prescribed fire in the oak-dominated communities of southern Ohio for 7 years.

Though the fires do a good job of topkilling the maple saplings, we are finding that fire alone does not sufficiently open the canopy for oak growth into the canopy.

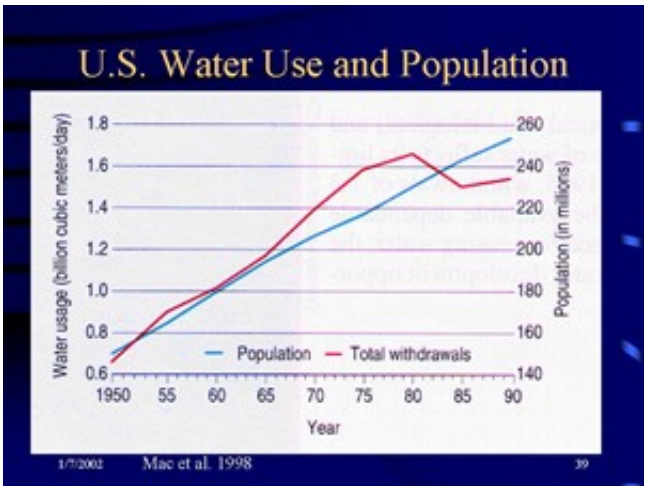
Therefore, in 2001, we began adding thinning to fire to see if we can achieve better oak regeneration.

Stay tuned for results.

Trends in Water/ Wetlands

- Water use trends
- Changes in wetland area

There was a linear relation between the U.S. human population and water use from 1950 to 1980, then a leveling off of water use.



Still, water quantity issues will continue to grow as does the population, especially in the West.

Herrmann R, Stottlemyer R, Scherbarth L. 1998. Water Use. Pages 63-87 in Mac MJ, Opler PA, Puckett Haecker CE, Doran PD. Status and trends of the nation's biological resources. U.S. Department of the Interior, U.S. Geological Survey, Reston, Va.

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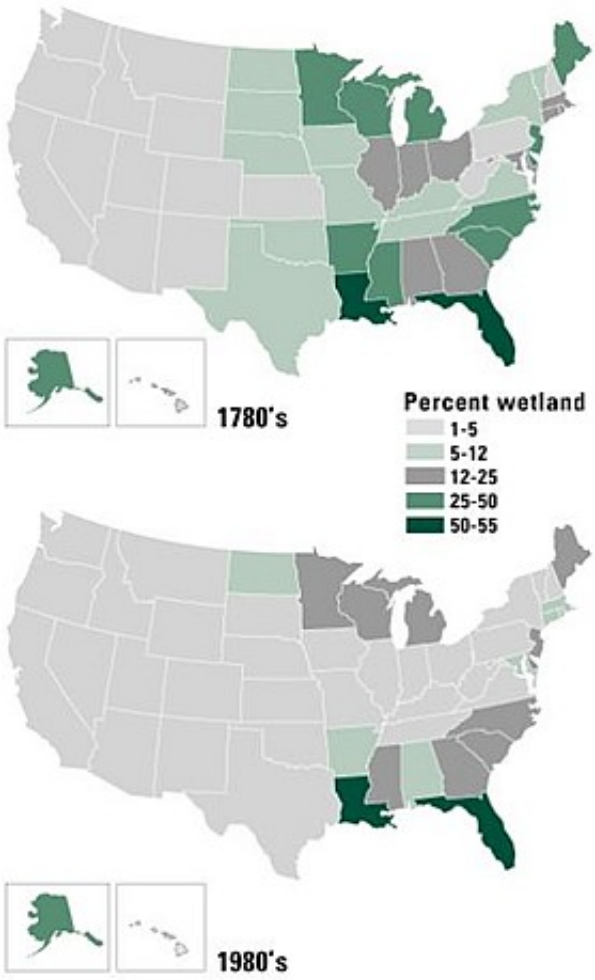
Trends in Water/Wetlands

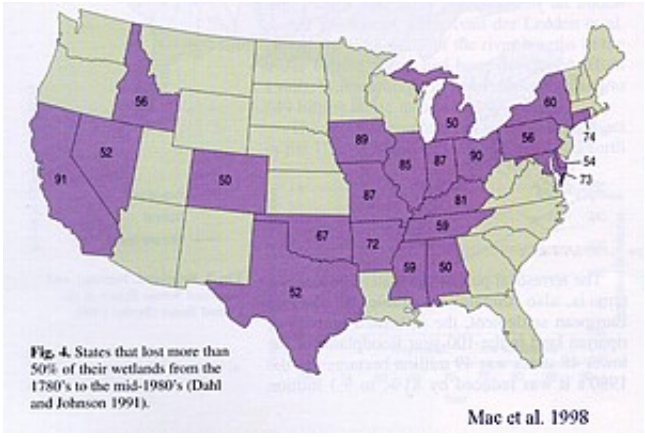


Changes in Wetlands 1780-1980

Wetlands have been drained for over 200 years, and this shows the change in percent wetland over that time period.

Dahl, T.E. 1990. Wetlands losses in the United States, 1780's to 1980's. U.S. Fish and Wildlife Service. Washington, D.C. 13 pp.

Turner MG, Carpenter SR, Gustafson EJ, Naiman RJ, Pearson SM. 1998. Land Use. Pages 37-61 in Mac MJ, Opler PA, Puckett Haecker CE, Doran PD. Status and trends of the nation's biological resources. U.S. Department of the Interior, U.S. Geological Survey, Reston, Va.



States which lost >50% of wetlands since 1780.
The states in purple have lost at least 50% of their wetlands since 1780. 90% in Ohio, second only to CA with 91%.

Dahl, T.E. and C.E. Johnson. 1991. Status and trends of wetlands in the conterminous United States, mid-1970's to mid-1980's. U.S. Department of Interior, Fish and Wildlife Service. Washington, D.C.

Herrmann R, Stottlemyer R, Scherbarth L. 1998. Water Use. Pages 63-87 in Mac MJ, Opler PA, Puckett Haecker CE, Doran PD. Status and trends of the nation's biological resources. U.S. Department of the Interior, U.S. Geological Survey,

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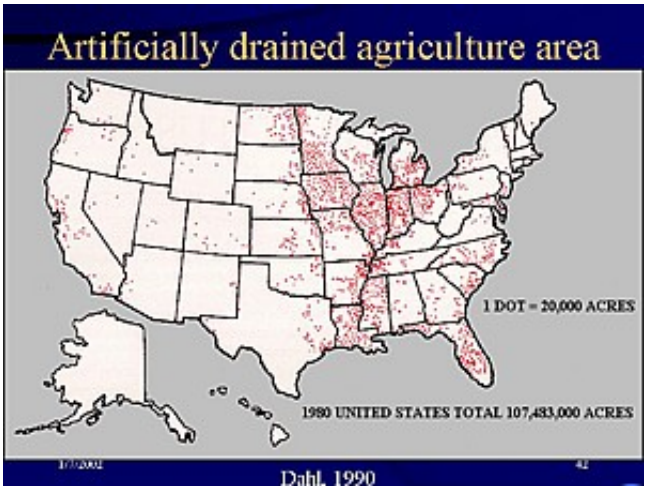
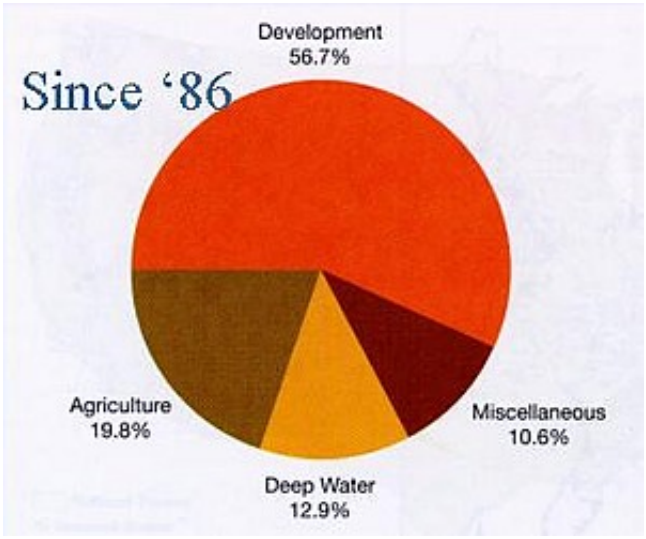
Trends in Water/Wetlands



Most of the wetland loss has been to drainage for agriculture. Each dot on this map corresponds to 20,000 acres of artificially drained agriculture area.

Dahl, T.E. 1990. Wetlands losses in the United States, 1780's to 1980's. U.S. Fish and Wildlife Service. Washington, D.C. 13 pp.



Loss of wetlands in the U.S.
For every hour over a 200 year period, the lower 48 lost over 60 acres of wetlands per hour! The heaviest time of drainage was during the 1950-1975 period, when nearly a half a million acres were drained per year.

Conversion rates have slowed since 1975, due to regulations and less 'suitability' of remaining sites.

Current 'no net loss' policy not working well yet because the mitigation wetlands often do not have functionality of native wetlands.

Most wetlands now are being lost to development rather than agriculture.

http://www.fs.fed.us/pl/rpa

USDA Forest Service. 2001. 2000 RPA assessment of forest and range lands. FS-687. USDA Forest Service. Washington, D.C. 78 pp.

Williams JD Meffe GK. 1998. Nonindigenous species. Pages 117-129 in Mac MJ, Opler PA, Puckett Haecker CE, Doran PD. Status and trends of the nation's biological resources. U.S. Department of the Interior, U.S. Geological Survey, Reston, Va.

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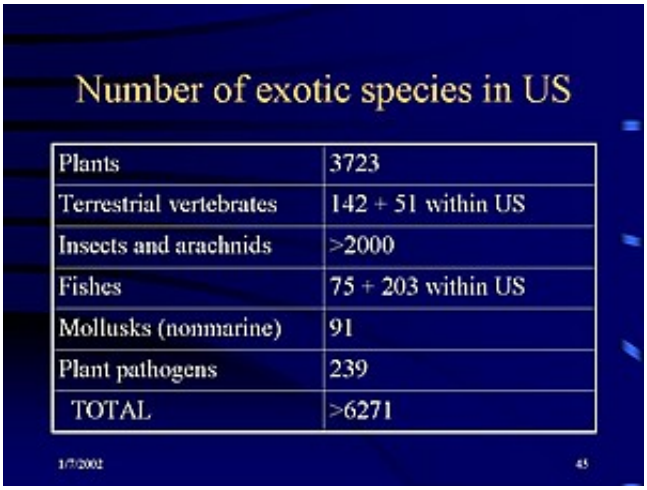
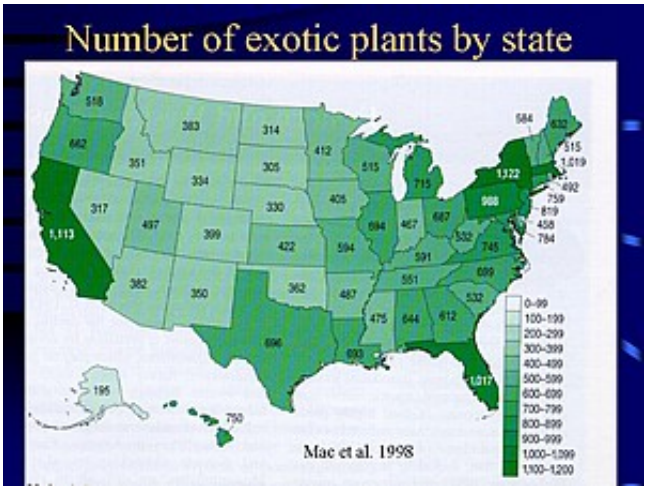
Invasives

- Number of exotics by type and state
- Impacts



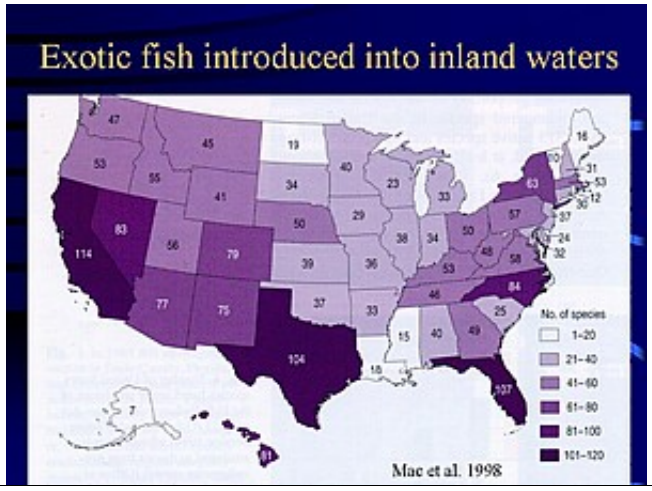
An estimated 6300 exotic species currently reside in this country (though it is a guess on the insects). For vertebrates and especially fishes, many of the exotics are native to some parts of the country, but have invaded other territory where they are not native.

Williams JD Meffe GK. 1998. Nonindigenous species. Pages 117-129 in Mac MJ, Opler PA, Puckett Haecker CE, Doran PD. Status and trends of the nation's biological resources. U.S. Department of the Interior, U.S. Geological Survey, Reston, Va.



This map shows the **Number of exotic plants recorded in each state**.
Highest exotics in CA, NY, and FL - states with a large amount of overseas traffic.

Williams JD Meffe GK. 1998. Nonindigenous species. Pages 117-129 in Mac MJ, Opler PA, Puckett Haecker CE, Doran PD. Status and trends of the nation's biological resources. U.S. Department of the Interior, U.S. Geological Survey, Reston, Va.



Here's the pattern for **Number of exotic fish recorded by state**. Generally higher numbers near the coasts.

Williams JD Meffe GK. 1998. Nonindigenous species. Pages 117-129 in Mac MJ, Opler PA, Puckett Haecker CE, Doran PD. Status and trends of the nation's biological resources. U.S. Department of the Interior, U.S. Geological Survey, Reston, Va.

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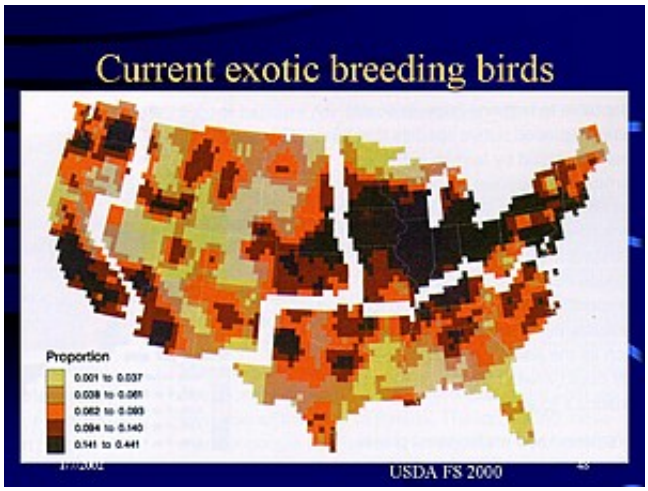


Invasive Species

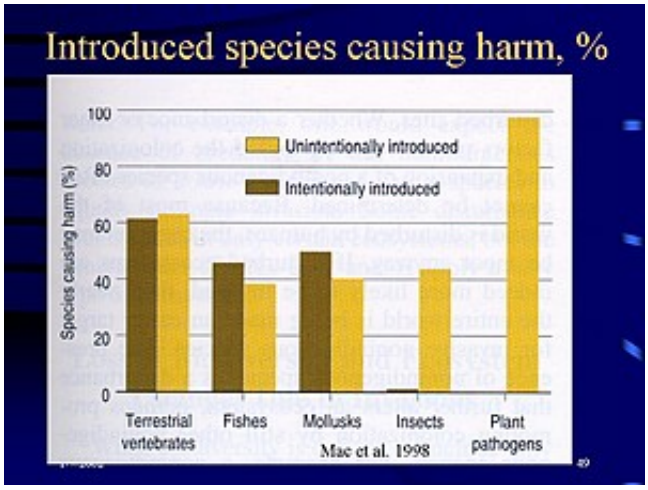
The proportion of bird numbers that are exotic breeding birds is shown here.

The Midwest Corn Belt shows up clearly with up to 44% of the birds being exotic (e.g., starlings and English sparrows).

http://www.fs.fed.us/pl/rpa

Flather, C.H., S.J. Brady, and M.S. Knowles. 1999. Wildlife resource trends in the United States A technical document supporting the 2000 RPA Assessment. Gen. Tech. Rep. RMRS-GTR-33. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. Fort Collins, CO. 79 pp.

USDA Forest Service. 2001. 2000 RPA assessment of forest and range lands. FS-687. USDA Forest Service. Washington, D.C. 78 pp.



Many exotics were intentionally introduced - and for the most part, these are equally as damaging as those unintentially introduced.

60% of the terrestrial vertebrates, 40% of fishes, and 40-50% of mollusks cause harm, especially to other organisms.

Williams JD Meffe GK. 1998. Nonindigenous species. Pages 117-129 in Mac MJ, Opler PA, Puckett Haecker CE, Doran PD. Status and trends of the nation's biological resources. U.S. Department of the Interior, U.S. Geological Survey, Reston, Va.

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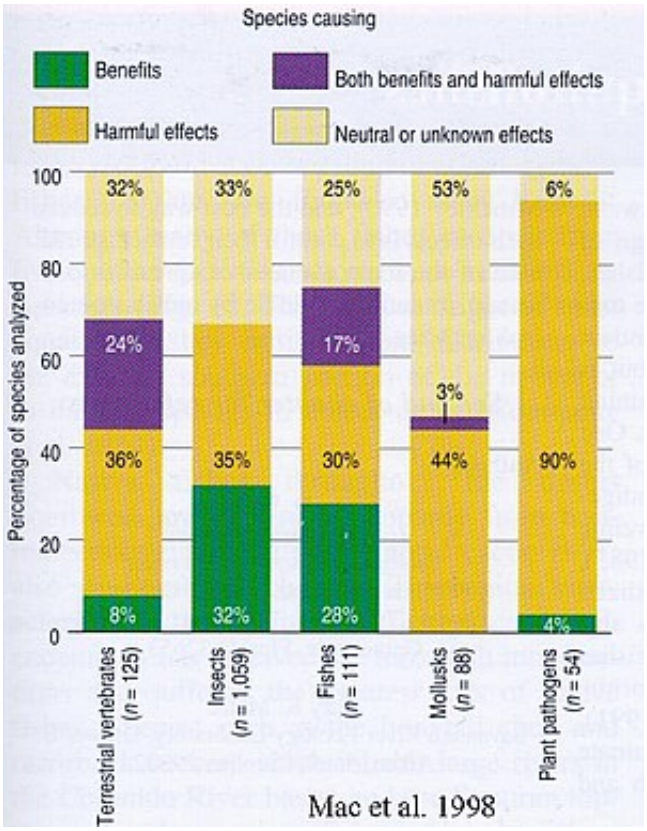
Invasive Species



The impacts of exotic species can be positive (as in the case of the honey bee for example), negative, neutral (or unknown), or both beneficial and harmful.

For example, a third of exotic insects are beneficial, a third harmful, and and third neutral or unknown.

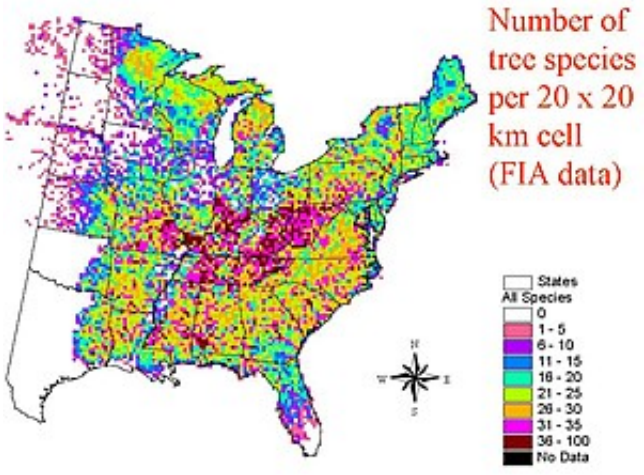
A quarter of exotic terrestrial vertebrates are both beneficial and harmful, depending on spatial and temporal conditions.

Seldom will we see a plant pathogen which is anything but harmful, unless it is only harmful to exotic plants. There are a few of those.

Williams JD Meffe GK. 1998. Nonindigenous species. Pages 117-129 in Mac MJ, Opler PA, Puckett Haecker CE, Doran PD. Status and trends of the nation's biological resources. U.S. Department of the Interior, U.S. Geological Survey, Reston, Va.

Biodiversity/Threatened and Endangered Species/Species Abundance:

- Changes in plant/animal diversity
- Threatened and endangered species
- Changes in species abundance — Deer and Selected birds



The number of tree species per 20 x 20 km cell is shown here, according to forest inventory data of the USDA Forest Service.

Prasad, A.M. and L.R. Iverson. 1999. A Climate Change Atlas for 80 Forest Tree Species of the Eastern United States [database]. www.fs.fed.us/ne/delaware/atlas

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Plant species losses by state

State	Number of native species	Native species extirpated or extinct	
		Number	Percent
Maine	1,500	84	5.6
Massachusetts	1,700	53	3.1
New York	2,000	59	3.0
Pennsylvania	2,100	62	3.0
Illinois	2,000	50	2.5
Indiana	1,900	22	1.2
Iowa	1,350	49	3.6
Ohio	1,800	84	4.7
Wisconsin	1,700–1,800	13	0.7

1/7/2002 Mac et al. 1998 53

State or region	Number of native species having bred in region[a]	Native species extirpated or extinct	
		Number	Percent
Mammals			
New England	70	6	9
Massachusetts	58	8	14
Pennsylvania	70	8	11
Ohio	65	13	20
Indiana	65	13	20
Illinois	67	8	12
Iowa	68	10	15
Missouri	70	3	4
Michigan	66	6	9
Minnesota	78	5	6
Birds			
Massachusetts	186	3	2
Pennsylvania	180[a]	8	4
Ohio	188[a]	8	4
Indiana	180[a]	15	8
Illinois	215[a]	16	7
Iowa	160[a]	15	9
Missouri	184	32	17
Michigan	214[a]	5	2
Minnesota	245[a]	8	3
Wisconsin	220[a]	4	2
Fish			
Connecticut	40	1	2
Massachusetts	41	1	2
Pennsylvania	180	28	15
Ohio	154	9	6
Indiana	168	10	6
Illinois	186	10	6
Iowa	140[a]	12	9
Wisconsin	155	9	6

[a] Approximate number.

Mac et al. 1998

Biodiversity/Threatened and Endangered Species/Species Abundance

A number of native species have been either extirpated from the state, or are considered extinct.

This table shows those estimates for plants - 4.7% of native species in OH and 5.6% in ME have been lost.

Turner MG, Carpenter SR, Gustafson EJ, Naiman RJ, Pearson SM. 1998. Land Use. Pages 37-61 in Mac MJ, Opler PA, Puckett Haecker CE, Doran PD. Status and trends of the nation's biological resources. U.S. Department of the Interior, U.S. Geological Survey, Reston, Va.

The same information for mammals, birds, and fish are shown here.

Up to 20% of mammals, 17% of birds, and 15% of fish are considered extinct or extirpated from various states in the Midwest.

Turner MG, Carpenter SR, Gustafson EJ, Naiman RJ, Pearson SM. 1998. Land Use. Pages 37-61 in Mac MJ, Opler PA, Puckett Haecker CE, Doran PD. Status and trends of the nation's biological resources. U.S. Department of the Interior, U.S. Geological Survey, Reston, Va.

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Endangered Species

- 70% of biologists surveyed agreed that animal and plant life is in 'the midst of a mass extinction'
- World wide, 15-20% of vertebrates could be eliminated by 2100.
- Larger animals are most vulnerable.

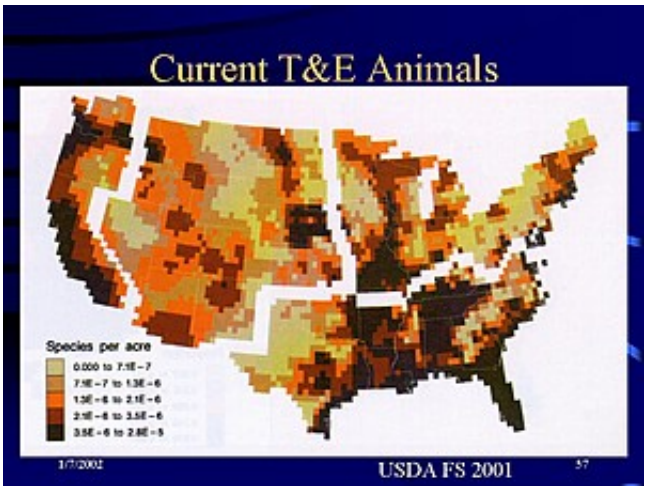
Species	Total species endangered	Aquatic and riparian species endangered	Total species threatened	Aquatic and riparian species threatened
Mammals[a]	53	18	10	4
Birds[b]	30	15	12	7
Reptiles[c]	8	3	18	6
Amphibians	6	6	3	3
Fishes	64	64	36	36
Clams	50	50	6	6
Snails	13	12	7	4
Insects	19	9	9	5
Arachnids	4	4	0	0
Crustaceans	11	11	2	2
Flowering plants[d]	187	55	74	29
Conifers and cycads	2	1	0	0
Ferns and allies	4	3	2	1
Lichens	1	0	0	0
Total	452	251 (56%)	179	103 (58%)

[a]Mammals that occur only in saline or marine environments; 12 endangered and 2 threatened species.
[b]Birds that occur only in saline or marine environments; 6 endangered and 2 threatened species.
[c]Reptiles that occur only in saline or marine environments; 4 endangered and 4 threatened species.
[d]Flowering plants that occur only in saline or marine environments; 2 endangered species.

Mac et al. 1998

.There are 452 endangered and 179 threatened species in the contiguous U.S. Of these, at least half are associated with aquatic or riparian habitats.

Herrmann R, Stottlemyer R, Scherbarth L. 1998. Water Use. Pages 63-87 in Mac MJ, Opler PA, Puckett Haecker CE, Doran PD. Status and trends of the nation's biological resources. U.S. Department of the Interior, U.S. Geological Survey, Reston, Va.



The **Density distribution of T&E animals** is shown here. Highest concentrations tend to be near coasts and Mississippi River valley.

http://www.fs.fed.us/pl/rpa

Hof, J., C. Flather, T. Baltic, and S. Davies. 1999. National projections of forest and rangeland condition indicators a supporting technical document for the1999 RPA assessment. Gen. Tech. Rep. PNW-GTR-442. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Portland, OR. 57 pp.

USDA Forest Service. 2001. 2000 RPA assessment of forest and range lands. FS-687. USDA Forest Service. Washington, D.C. 78 pp.

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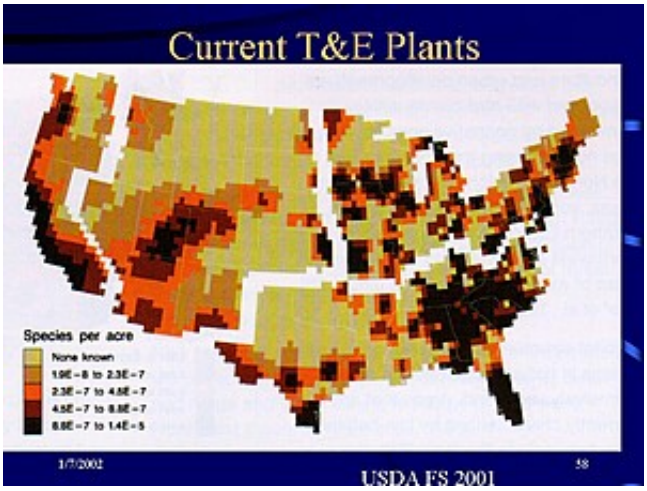
Endangered Species



The **Density distribution of T&E plants**. Highest concentrations along coasts, in southeastern U.S., and nothern Arizona and Utah.

http://www.fs.fed.us/pl/rpa

Hof, J., C. Flather, T. Baltic, and S. Davies. 1999. National projections of forest and rangeland condition indicators a supporting technical document for the1999 RPA assessment. Gen. Tech. Rep. PNW-GTR-442. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Portland, OR. 57 pp.

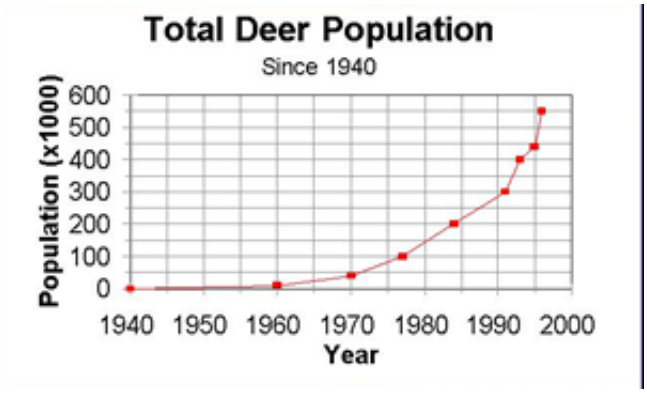
USDA Forest Service. 2001. 2000 RPA assessment of forest and range lands. FS-687. USDA Forest Service. Washington, D.C. 78 pp.

Some trends in wildlife

- Turkey—up 200% from 1975-1993
- Pronghorn—up 56% from 1975-1993
- Species associated with rangeland down: northern bobwhite, hare, western quail
- Deer—up greatly in East, down in West
- Canada Goose—up!

http://www.fs.fed.us/pl/rpa

USDA Forest Service. 2001. 2000 RPA assessment of forest and range lands. FS-687. USDA Forest Service. Washington, D.C. 78 pp.



The trends in Ohio deer show that the population has increased nearly exponentially from near zero in the 1940s.

Iverson AL, Iverson LR. 1999. Spatial and temporal trends of deer harvest and deer-vehicle accidents in Ohio. The Ohio Journal of Science 99(4):84-94.

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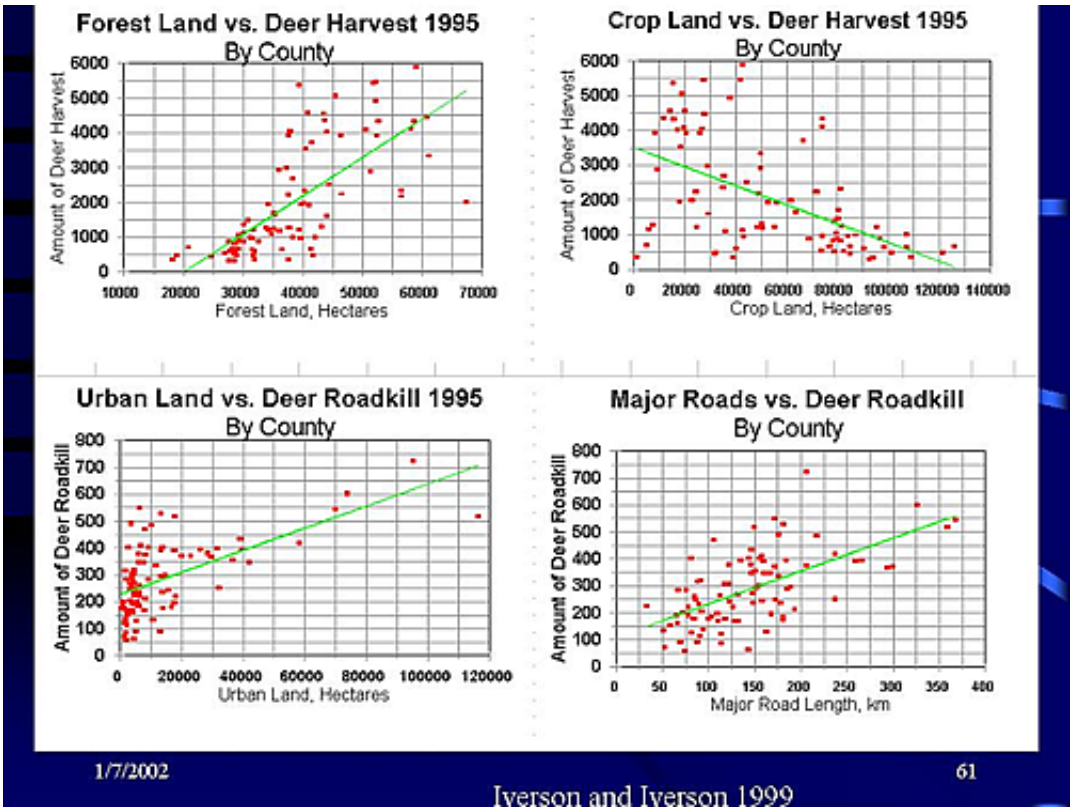
Endangered Species



When analyzed using county data, the deer harvest was positively related to amount of forest in that county, and negatively related to amount of crop land.

Road-vehicle accidents were related to urban land and road lengths in the county.

Iverson AL, Iverson LR. 1999. Spatial and temporal trends of deer harvest and deer-vehicle accidents in Ohio. The Ohio Journal of Science 99(4):84-94.

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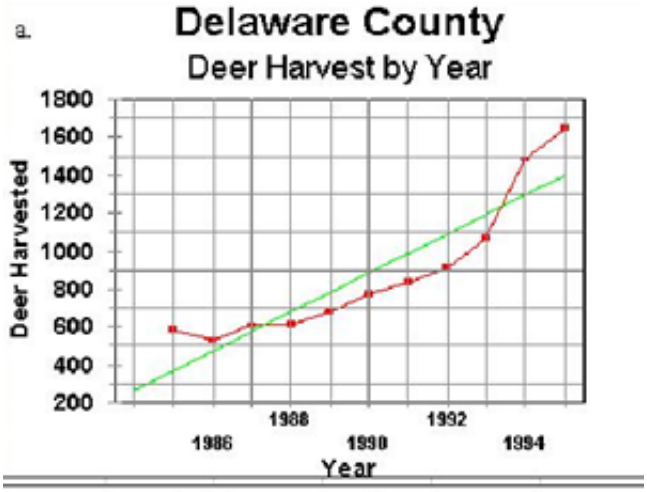
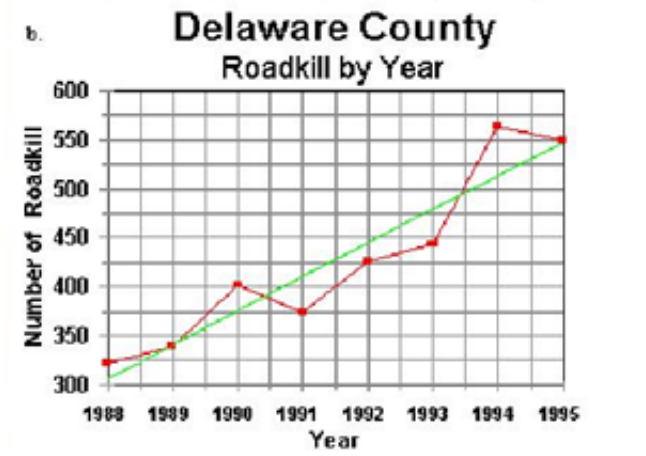


The temporal trend in deer harvest (1985-1995) and roadkill (1988-1995) is steeply up for Delaware County, and the pattern is typical for many Ohio counties.

If this trend continues, it would be better not to drive at dusk in October and November, because you have a very high chance of a deer collision!

Iverson AL, Iverson LR. 1999. Spatial and temporal trends of deer harvest and deer-vehicle accidents in Ohio. The Ohio Journal of Science 99(4):84-94



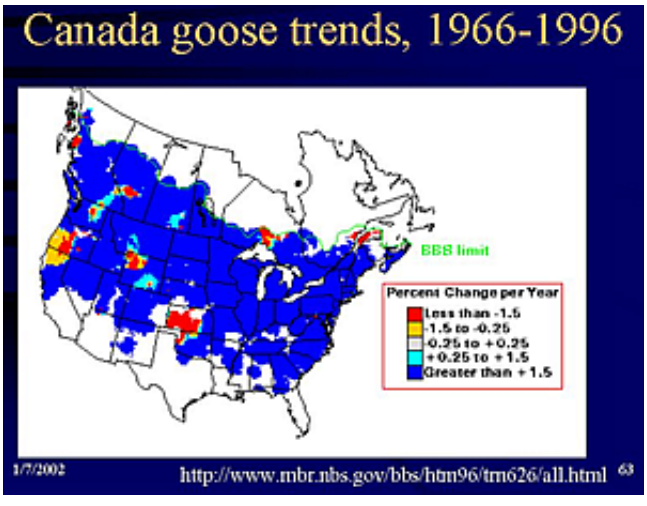
The next several slides are downloaded from the Breeding Bird Survey web site, showing the 30-year trends in bird abundances across the country (and into southern Canada).

If the map is blue, the populations are increasing at least 1.5% per year over the 30 years; if red, a decrease of at least 1.5% per year.

Canada goose populations are way up.

http://www.mbr.nbs.gov/bbs/htm96/trn626/all.html

Sauer, J.R., J.E. Hines, and J. Fallon. 2001. The North American breeding bird survey, results and analysis 1966 -2000. Version 2001.2 USGS Patuxent Wildlife Research Center. Laurel, MD.



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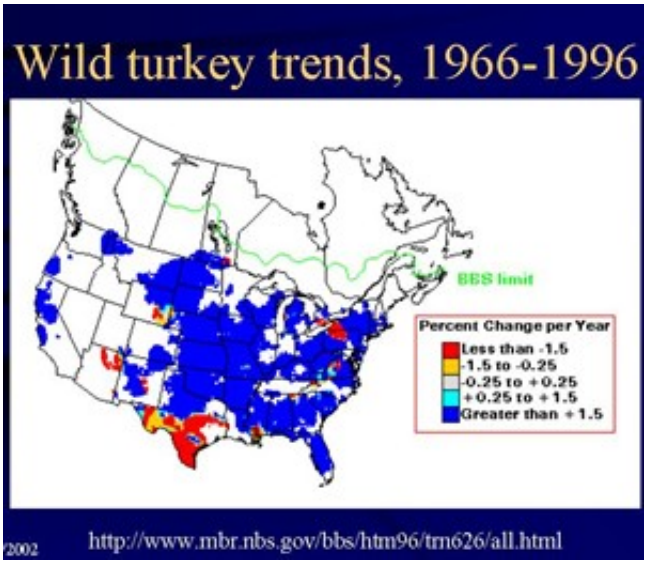
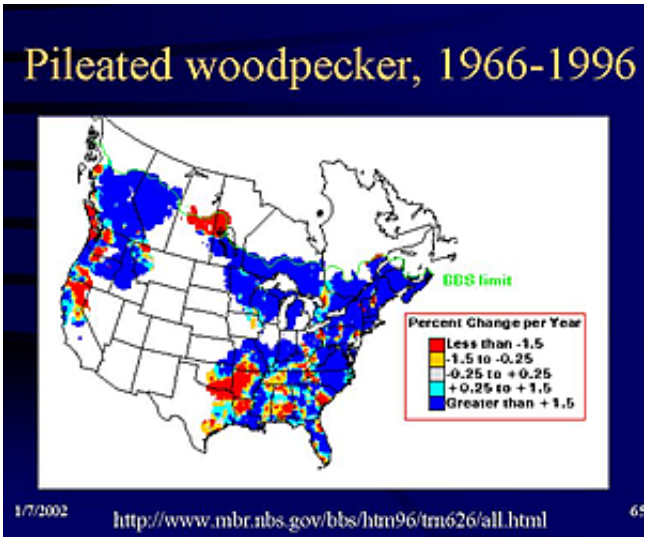


Endangered Species

Wild turkeys are up.

http://www.mbr.nbs.gov/bbs/htm96/trn626/all.html

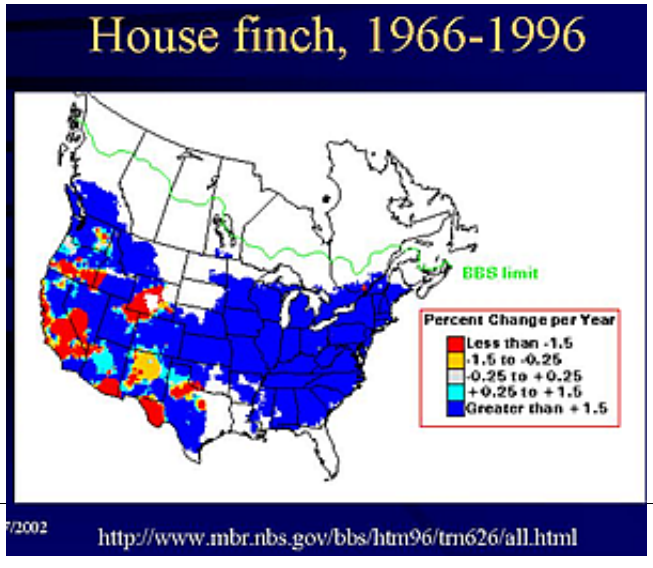
Sauer, J.R., J.E. Hines, and J. Fallon. 2001. The North American breeding bird survey, results and analysis 1966-2000. Version 2001.2 USGS Patuxent Wildlife Research Center. Laurel, MD.



Pileated woodpeckers are up in the north, a mix south.

http://www.mbr.nbs.gov/bbs/htm96/trn626/all.html

Sauer, J.R., J.E. Hines, and J. Fallon. 2001. The North American breeding bird survey, results and analysis 1966-2000. Version 2001.2 USGS Patuxent Wildlife Research Center. Laurel, MD.



House finches are up in the East. It was introduced from the West to the East in 1940, and is now meeting the native populations in the center.

http://www.mbr.nbs.gov/bbs/htm96/trn626/all.html

Sauer, J.R., J.E. Hines, and J. Fallon. 2001. The North American breeding bird survey, results and analysis 1966-2000. Version 2001.2 USGS Patuxent Wildlife Research Center. Laurel, MD.

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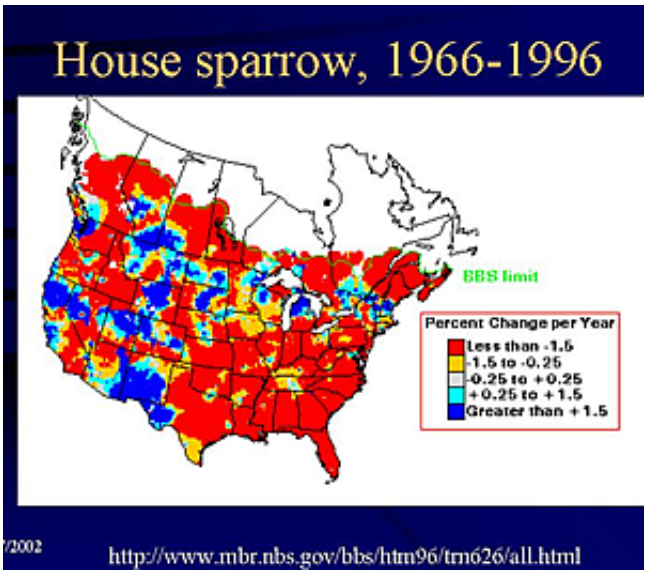

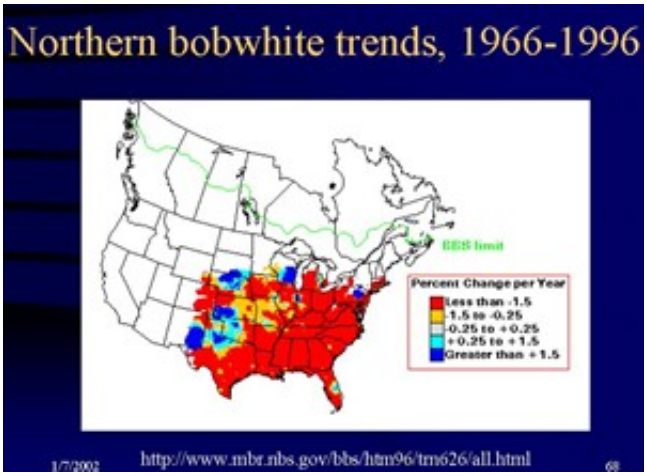

Endangered Species

Some good news: the **house sparrow** is down in the East, maybe because the house finch is up?

http://www.mbr.nbs.gov/bbs/htm96/trn626/all.html

Sauer, J.R., J.E. Hines, and J. Fallon. 2001. The North American breeding bird survey, results and analysis 1966-2000. Version 2001.2 USGS Patuxent Wildlife Research Center. Laurel, MD.

Northern bobwhite is mostly down.

http://www.mbr.nbs.gov/bbs/htm96/trn626/all.html

Sauer, J.R., J.E. Hines, and J. Fallon. 2001. The North American breeding bird survey, results and analysis 1966-2000. Version 2001.2 USGS Patuxent Wildlife Research Center. Laurel, MD.

Loggerhead shrike is mostly down.

http://www.mbr.nbs.gov/bbs/htm96/trn626/all.html

Sauer, J.R., J.E. Hines, and J. Fallon. 2001. The North American breeding bird survey, results and analysis 1966-2000. Version 2001.2 USGS Patuxent Wildlife Research Center. Laurel, MD.

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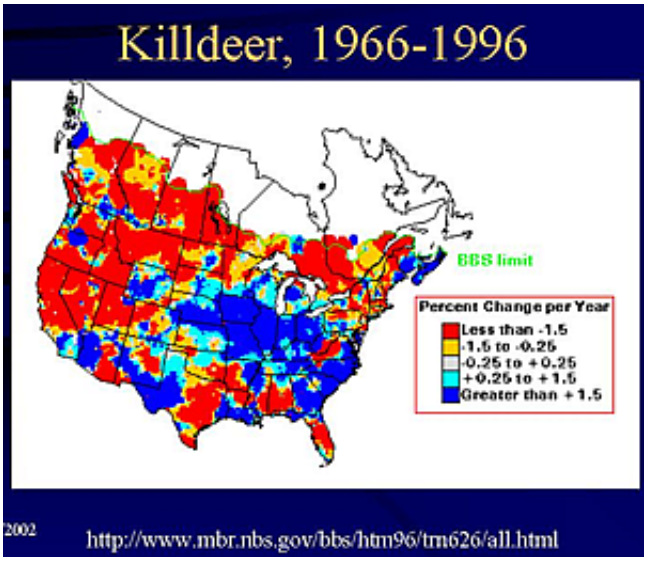
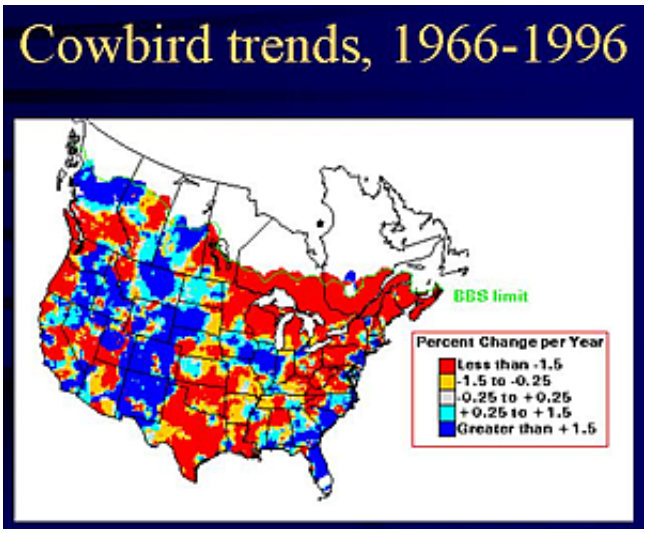


Endangered Species

Killdeer is a mix nationally, but mostly up in the Midwest.

http://www.mbr.nbs.gov/bbs/htm96/trn626/all.html

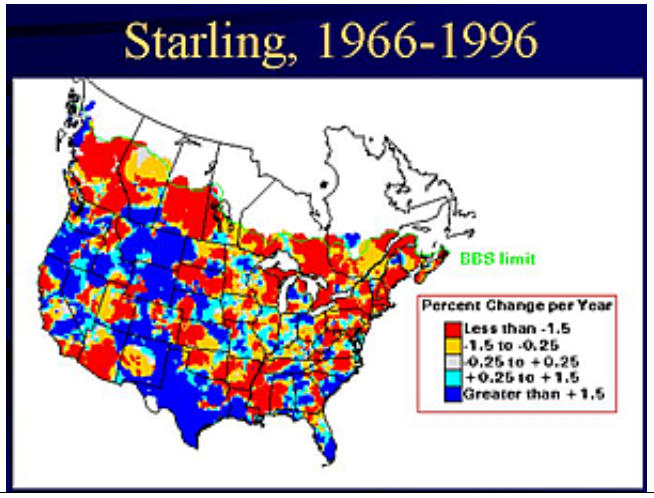
Sauer, J.R., J.E. Hines, and J. Fallon. 2001. The North American breeding bird survey, results and analysis 1966 -2000. Version 2001.2 USGS Patuxent Wildlife Research Center. Laurel, MD.



For brown-headed cowbird, it is mostly down in the East, except for IL, IA and FL.

http://www.mbr.nbs.gov/bbs/htm96/trn626/all.html

Sauer, J.R., J.E. Hines, and J. Fallon. 2001. The North American breeding bird survey, results and analysis 1966 -2000. Version 2001.2 USGS Patuxent Wildlife Research Center. Laurel, MD.



With starling, it is a mix, but overall in the Midwest, slightly down.

http://www.mbr.nbs.gov/bbs/htm96/trn626/all.html

Sauer, J.R., J.E. Hines, and J. Fallon. 2001. The North American breeding bird survey, results and analysis 1966 -2000. Version 2001.2 USGS Patuxent Wildlife Research Center. Laurel, MD.

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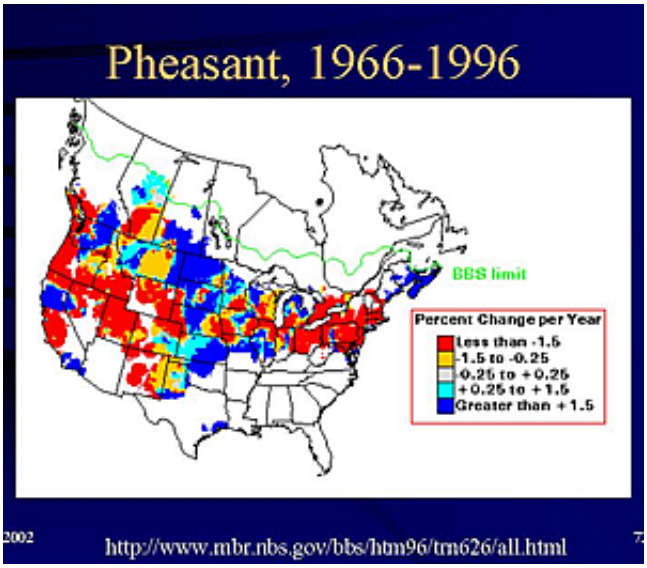


Endangered Species

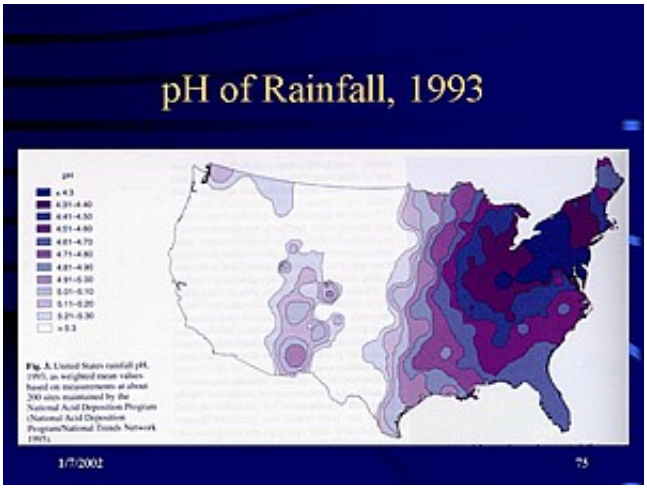
For pheasant, again a mix.

http://www.mbr.nbs.gov/bbs/htm96/trn626/all.html

Sauer, J.R., J.E. Hines, and J. Fallon. 2001. The North American breeding bird survey, results and analysis 1966-2000. Version 2001.2 USGS Patuxent Wildlife Research Center. Laurel, MD.

Trends in Contaminants

- pH
- Nutrients, especially nitrogen
- Pesticides



The pH of rainfall shows a marked increasing trend from the central US eastward.

The acid rain has been shown to cause detrimental effects in some lakes.

Low pH problems are also evident as acid mine drainage, with over 12,000 km of streams with this type of problem.

Schmitt CJ. 1998. Environmental Contaminants. Pages 131-165 in Mac MJ, Opler PA, Puckett Haecker CE, Doran PD. Status and trends of the nation's biological resources. U.S. Department of the Interior, U.S. Geological Survey, Reston, Va.

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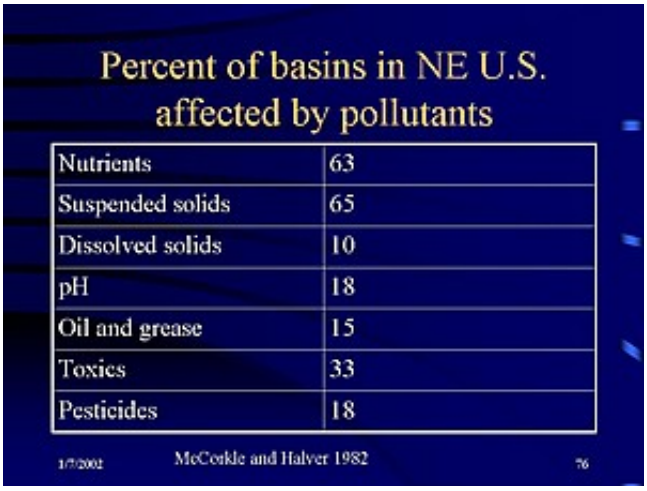

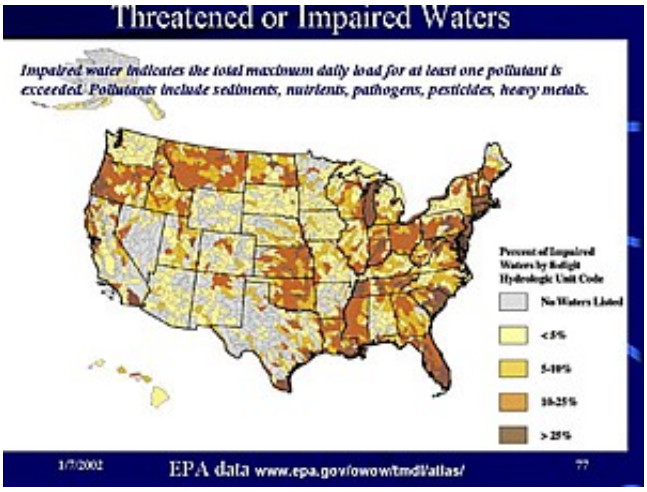

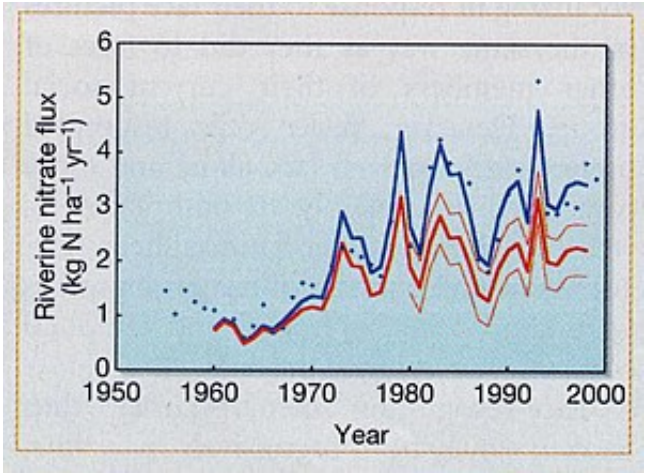

Trends in Contaminants

Overall, however, most basins (over 60% of them in the northeast) suffer more from excessive nutrients and suspended solids.

McCorkle, C.O.Jr. and J.E. Halver, co-chairs. 1982. Impacts of emerging agricultural trends on fish and wildlife habitat. National Research Council. National Academy Press. Washington, D.C. 303 pp.

This map shows the distribution of threatened or impaired waters, according to EPA.

Percentages of impaired land (polluted by sediments, nutrients, pathogens, pesticides, or heavy metals) by hydrologic unit code (large basin) is presented.

http://www.epa.gov/owow/tmdl/atlas/

US EPA. 2000. Total maximum daily load (TDML) program. EPA-840-B-00-002 . US EPA. Washington, D.C.

The large hypoxic zone in the Gulf of Mexico is indicative of excessive nutrients moving down the Mississippi River. The graph shows that the trend in nitrate flux has been generally up since 1960.
McIsaac et al.'s model showed that a 12% reduction in agricultural fertilization would reduce nitrates in the Gulf by 33%.
This 12% cutback should be reasonable since farmers generally are adding >30% more N than necessary.

McIsaac GF, David MB, Gertner GZ, Goolsby DA. 2001. Nitrate flux in the Mississippi River. Nature 414:166-167.

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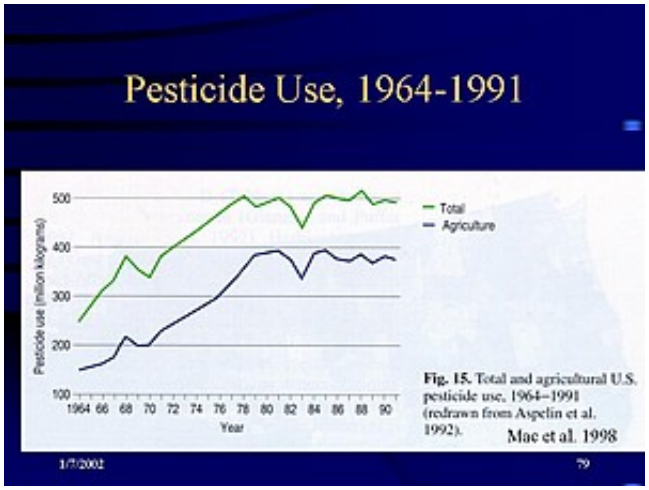
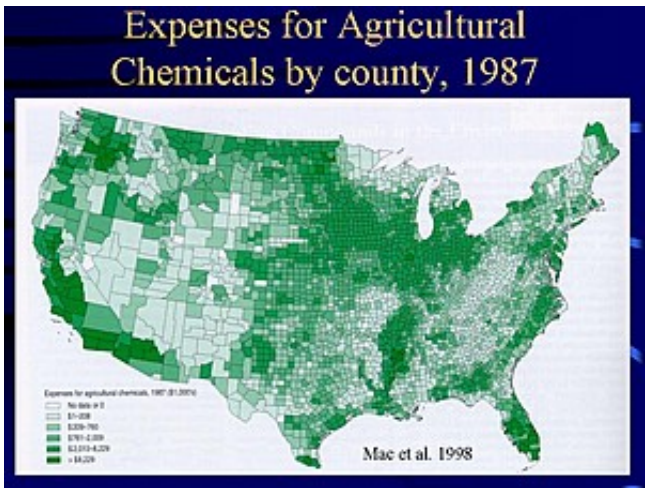
Trends in Contaminants



Overall pesticide use was up dramatically from 1960-1980, then has leveled off.

Schmitt CJ. 1998. Environmental Contaminants. Pages 131-165 in Mac MJ, Opler PA, Puckett Haecker CE, Doran PD. Status and trends of the nation's biological resources. U.S. Department of the Interior, U.S. Geological Survey, Reston, Va.



The Cornbelt and CA are some of largest users of agricultural chemicals. Over 60% of chemicals are used on corn or soybeans.

Schmitt CJ. 1998. Environmental Contaminants. Pages 131-165 in Mac MJ, Opler PA, Puckett Haecker CE, Doran PD. Status and trends of the nation's biological resources. U.S. Department of the Interior, U.S. Geological Survey, Reston, Va.

Climate Change

- Climate trends un the past 100 years
- Climate trends predicted n the next 100 years
- Potential forest species composition changes
- Potential changes in other organisms

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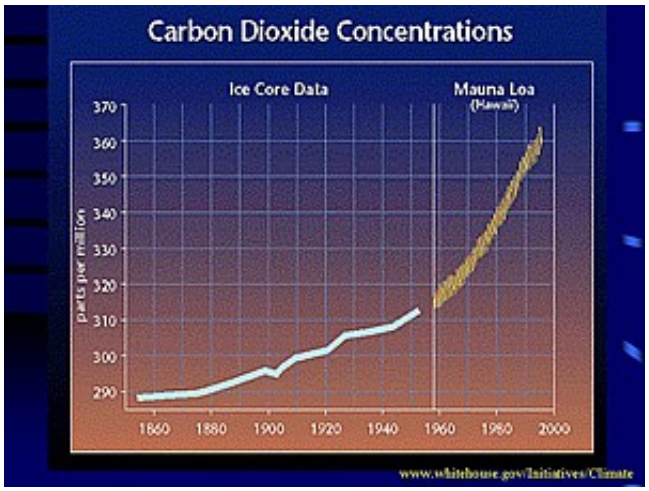
Climate Change

A lot of what I will present is contained within the US National Assessment reports, 3 of which are shown here (and 3 I was involved with).

http://www.usgcrp.gov/usgcrp/Library/nationalassessment/overview.htm

http://www.usgcrp.gov/usgcrp/Library/nationalassessment/foundation.htm

http://www.usgcrp.gov/usgcrp/nacc/midatlantic.htm



Carbon dioxide concentrations are rising, as documented on Mauna Loa since 1959, and before that in ice core data.

www.whitehouse.gov/Initiatives/Climate (Clinton administration)

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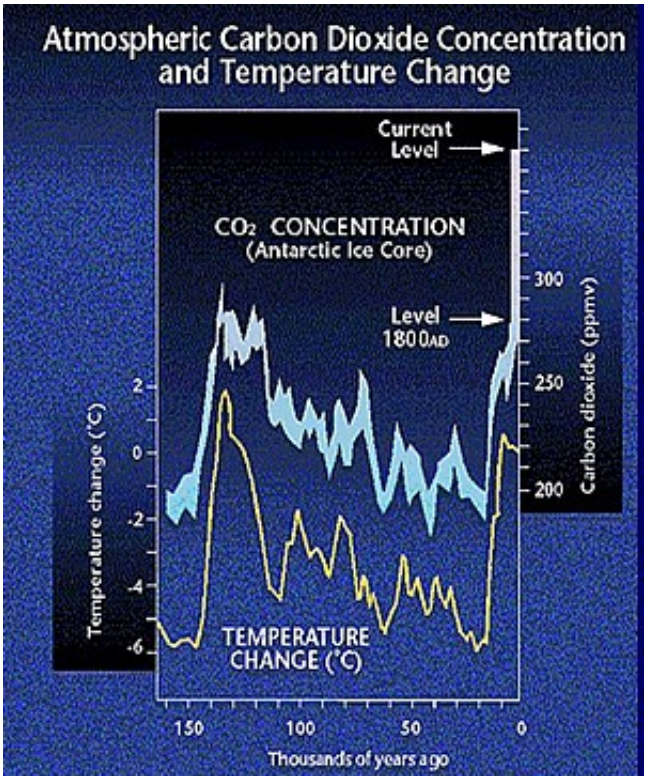
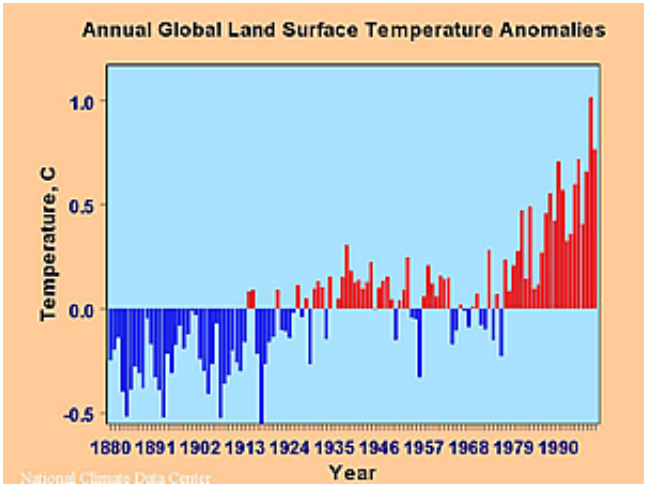
Climate Change



If we go back 150,000 years, the temperature and CO2 concentrations track each other very well, up until a few years ago.

Now we are at unprecidented levels of CO2: what will happen to the temperature?

www.whitehouse.gov/Initiatives/Climate (Clinton administration)



Global land surface temperatures over the past 120 years shows first a cool period, then a warmer one, then cooler, then very warm.

9 of 10 hottest years on record have been since 1990.

http://lwf.ncdc.noaa.gov/oa/climate/research/monitoring.html

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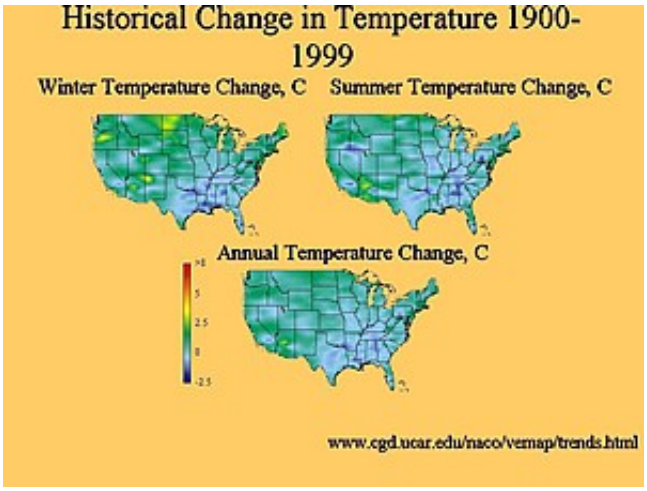
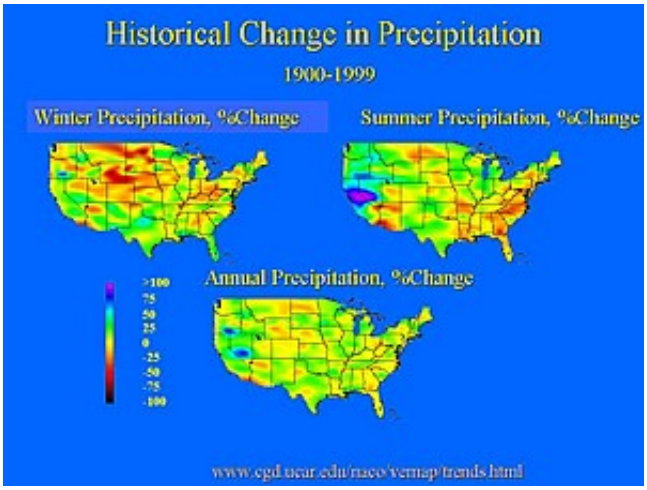


Winter temperatures have been rising in the northern plains, especially over the past 25 years.

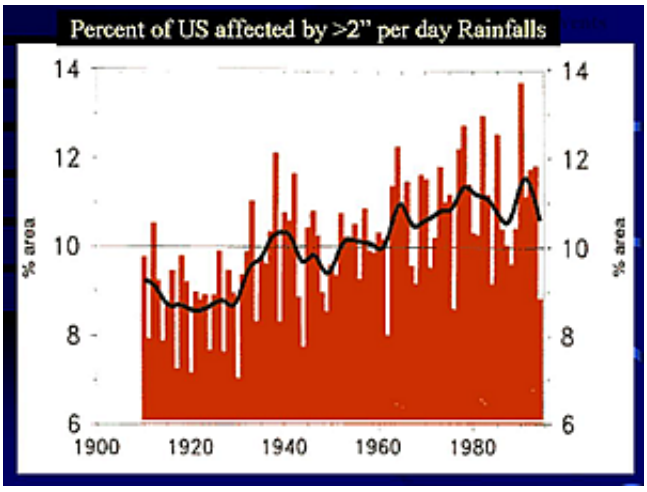
The southeast has been cooling slightly, but that is also expected according to climate models.

http://www.cgd.ucar.edu/vemap/



Precipitation is down in the upper plains in winter, and in the southeast in summer.

http://www.cgd.ucar.edu/vemap/



The percent of US affected by extreme rainfall events (>2 inches of rain in 1 day) has been increasing.

Models predict a more vigorous hydrologic cycle.

http://www.grida.no/climate/ipcc/regional/185.htm

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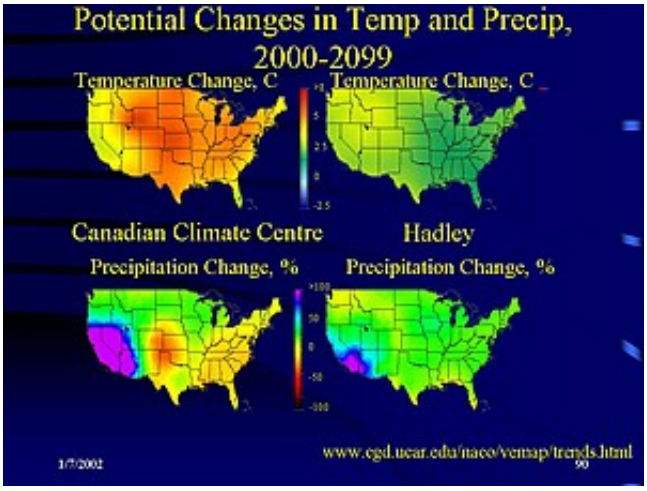
Climate is expected to change in the future

- Maximum warming higher precipitation in high northern latitudes in winter
- Reduction in diurnal range of temperature
- Increase in number of extremely hot days, decrease in extremely cold days
- More 'vigorous' hydrologic cycle: more severe droughts and/or floods in various places



The National Assessment used two future climate scenarios in their analysis: the Canadian Climate Center (CCC) and the Hadley.

Though both show elevated temperatures in this century, the CCC model is warmer, with up to 8 degrees C increase in middle America.

Both models show a wetter West, while the Hadley shows about a 25% increase in precipitation also in the East.

The CCC model shows a decrease of precipitation in the southeast and a severe decrease in the souther plain states.

http://www.usgcrp.gov/usgcrp/Library/nationalassessment/overviewlooking.htm

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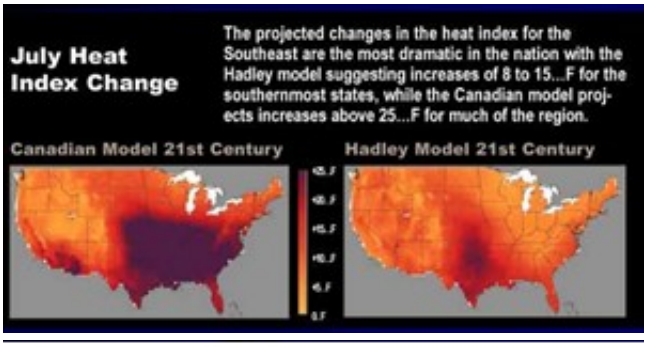

According the the heat index, it will be significantly more uncomfortable in July, especially under the CCC scenario.

http://www.usgcrp.gov/usgcrp/Library/nationalassessment/../HeatIndex.jpg

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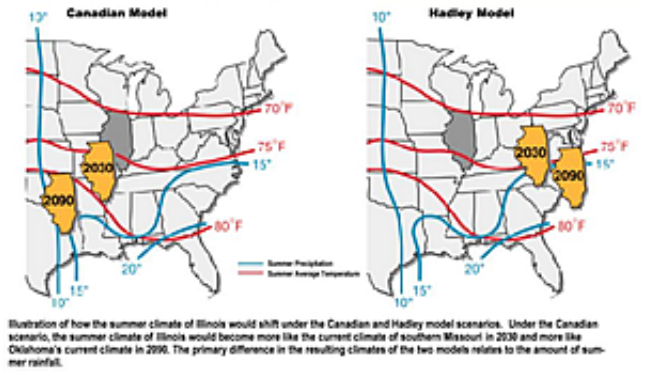

This shows the 'average' summer Illinois weather, and how it might shift by 2030 and 2090.

For the CCC scenario, it shifts south and west, for the Hadley, south and east.

http://www.usgcrp.gov/usgcrp/Library/nationalassessment/../SummerChange.jpg

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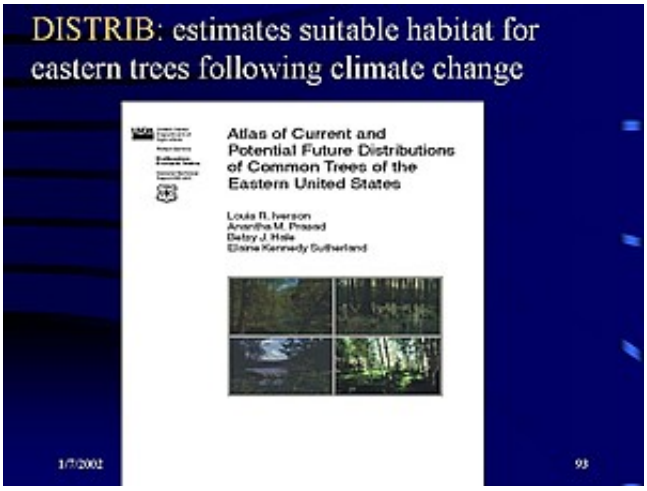

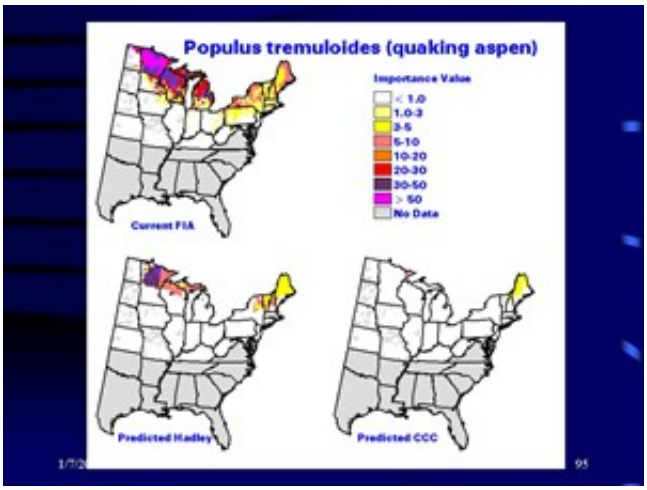

We have been analyzing the potential distribution trends of suitable habitat for 80 eastern tree species.

The model, called DISTRIB, creates maps of potential habitat under a doubled CO2 climate according to 5 climate change scenarios, and has been published in this atlas.

Iverson, L.R., A.M. Prasad, B.J. Hale, and E.K. Sutherland. 1999. An atlas of current and potential future distributions of common trees of the eastern United States. General Technical Report NE-265. Northeastern Research Station, USDA Forest Service. 245 pp.

Iverson LR, Prasad AM. 1998. Predicting abundance of 80 tree species following climate change in the eastern United States. Ecological Monographs 68:465-485.

Prasad, A.M. and L.R. Iverson. 1999. A Climate Change Atlas for 80 Forest Tree Species of the Eastern United States [database].

www.nrs.fs.fed.us/atlas/

Here is the current distribution of quaking aspen, using importance value (current FIA), and the potential future suitable habitat according to the Hadley and CCC models.

There is a northward shift in the suitable habitat, with a more northward shift with the CCC scenario.

Prasad, A.M. and L.R. Iverson. 1999. A Climate Change Atlas for 80 Forest Tree Species of the Eastern United States [database].

www.nrs.fs.fed.us/atlas

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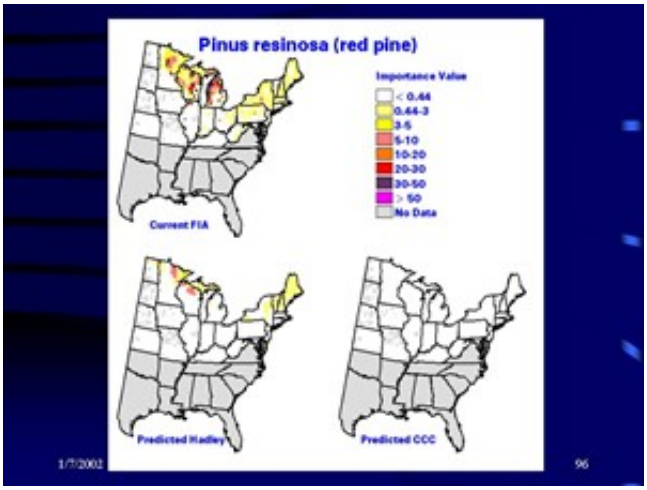
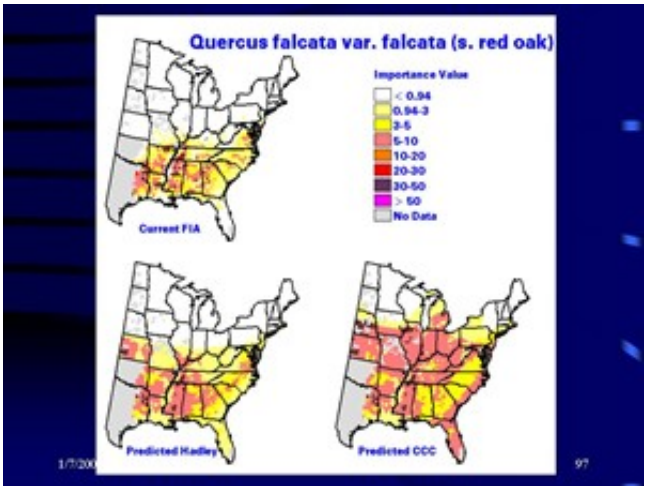


For red pine, the species habitat shows an extirpation from the U.S. under the CCC scenario.

Prasad, A.M. and L.R. Iverson. 1999. A Climate Change Atlas for 80 Forest Tree Species of the Eastern United States [database].

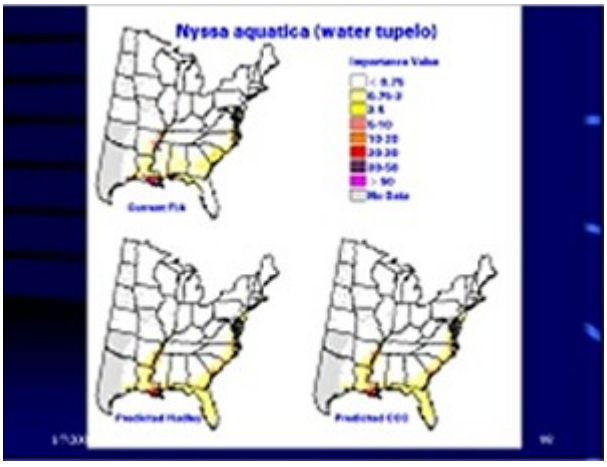
www.nrs.fs.fed.us/atlas



For some southern species, there is a large expansion of suitable habitat, especially with the CCC scenario.

Prasad, A.M. and L.R. Iverson. 1999. A Climate Change Atlas for 80 Forest Tree Species of the Eastern United States [database].

www.nrs.fs.fed.us/atlas



And for some other species, like this water tupelo, the climate drivers are secondary to edaphic drivers.

Prasad, A.M. and L.R. Iverson. 1999. A Climate Change Atlas for 80 Forest Tree Species of the Eastern United States [database]. www.nrs.fs.fed.us/atlas

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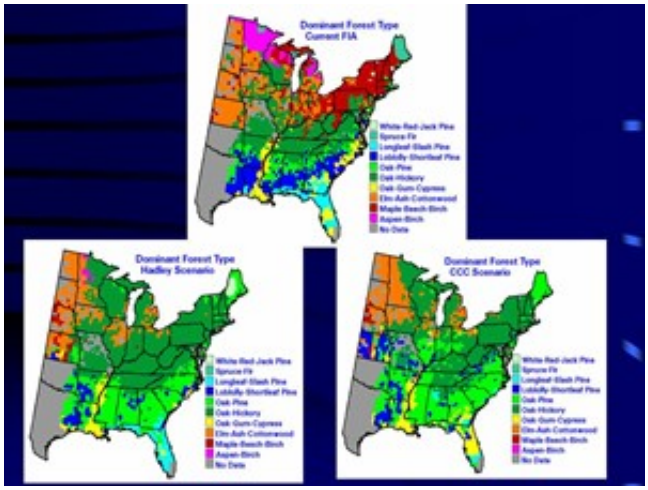


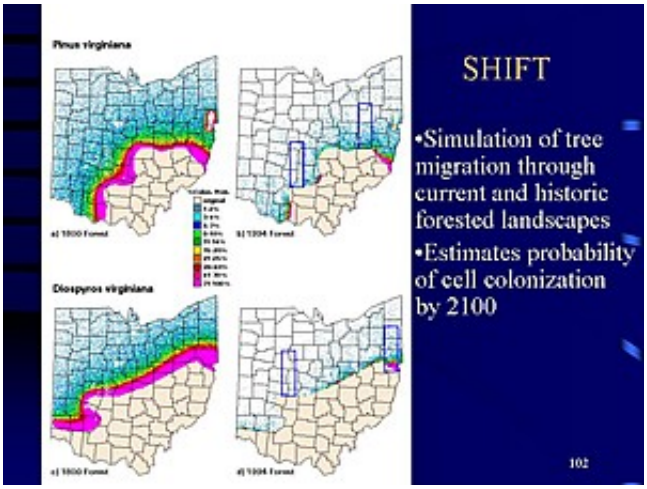
By evaluating the 80 species in combination, we can produce forest type maps of today and potentially of future suitable habitat.

Both the Hadley and CCC scenarios show substantial loss of spuce-fir, maple-beech-birch, and aspen-birch habitat.

Habitat for the oak-hickory and oak-pine types would increase substantially.

Hansen AJ, Dale V, Flather C, Neilson RP, Bartlein P, Iverson L, Currie D. 2001. Global change in forests interactions among biodiversity, climate, and land use. BioScience 51(9)765-779.

Prasad, A.M. and L.R. Iverson. 1999. A Climate Change Atlas for 80 Forest Tree Species of the Eastern United States [database]. www.nrs.fs.fed.us/atlas



The SHIFT model simulates tree migration through current and historic forested landscapes.

It estimates the probability of cell colonization, via a cellular automata model, over the next 100 years.

These maps for Ohio show the 1800, forested landscapes to have a much higher probability of colonization, as compared to current conditions of highly fragmented forests.

Iverson LR, Prasad AM, Schwartz MW. 1999. Modeling potential future individual tree-species distributions in the Eastern United States under a climate change scenario a case study with *Pinus virginiana*. Ecological Modelling 11577-93.

Schwartz MW, Iverson LR, Prasad AM. 2001. Predicting the potential future distribution of four tree species in Ohio using current habitat availability and climatic forcing. Ecosystems. 4: 568-581.

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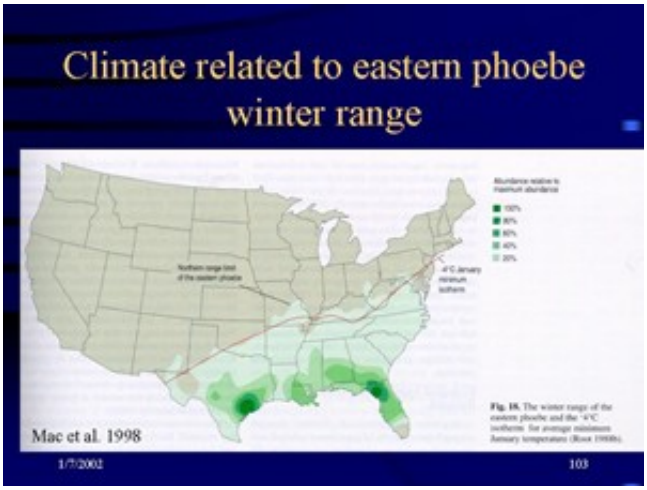
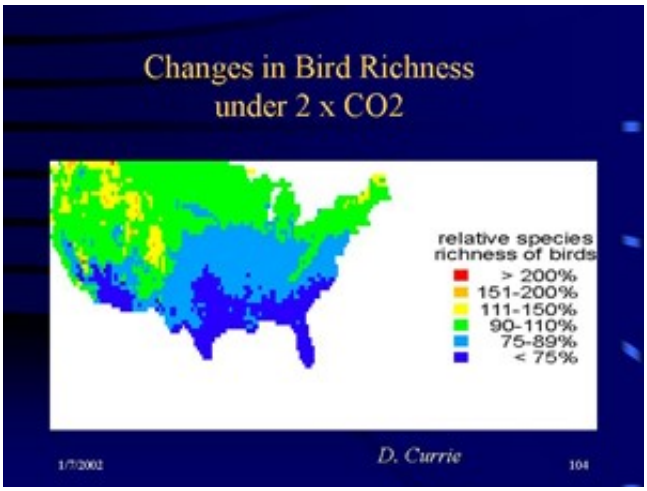


Climate also bears a large influence on various wildlife species.

This is one example showing the match of a January minimum isotherm with the northern limit of the eastern phoebe.

These types of relationships exist for many species.

Schneider SH, Root TL. 1998. Climate Change. Pages 89-116 in Mac MJ, Opler PA, Puckett Haecker CE, Doran PD. Status and trends of the nation's biological resources. U.S. Department of the Interior, U.S. Geological Survey, Reston, Va.



Currie has put together this map showing potential changes in bird species richness under a doubled CO2 climate.

It shows a decrease in richness in the southern part of the country.

Hansen AJ, Dale V, Flather C, Neilson RP, Bartlein P, Iverson L, Currie D. 2001. Global change in forests interactions among biodiversity, climate, and land use. BioScience 51(9):765-779.

Conclusions

- There has been extreme human modification of the biological resources in the Midwest
- Positive changes, or at least a slowing of the problem, and occurring for some trends in the recent past
- Restoration efforts in prairie, wetlands, and mined-lands, plus 33 million acres of CRP land,
    - Forest management including older forests in East and higher growth-removal rates
    - Increases in big game and many waterfowl and furbearers,
    - Increase in some rare wildlife and plant species
    - More awareness and incentives for positive trending
- Negative changes continue for some trends
    - Urbanization and parcelization
    - Invasion of exotics
    - Excessive nitrogen into water and terrestrial ecosystems
    - Reduced water quality and quantity
    - Species composition changes in natural systems (e.g., maple takeover)

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359 Main Rd
Delaware, OH
43015

740-368-0097

For more information, contact
Louis Iverson

Climate is expected to change in the future

- Negative changes continue for some trends (cont.)
    - Climate change (at least potentially)

Many of the graphs come from tow reports

- Mac et.al. 1998. Status and trends of the nation's biological resources. USGS.
- USDA Forest Service. 2001. 2000 RPA assessment of forest and range lands. FS-687.

Web access at www.nrs.fs.fed.us/atlas/