

GIS: Geographic Information Systems

Module 08: Time and temporal data

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But what about time?

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- Adds an additional dimension to the map
 - Makes it even harder to represent
- **Spatial-temporal Visualization:** Techniques for representing time on a map

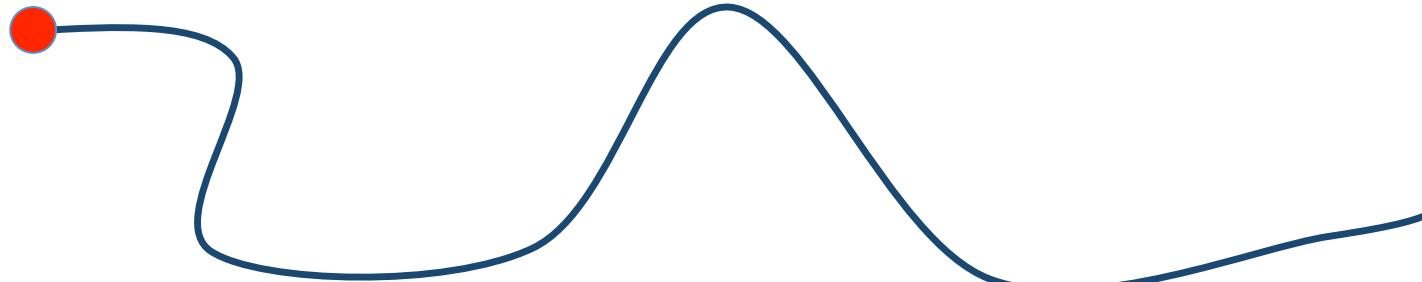
Spatio-Temporal Data

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- What is changing where and how?
 - What?
 - Points, lines, areas
 - Where?
 - Along a path, in 3 dimensional space
 - How?
 - Continuously, new areas

Example

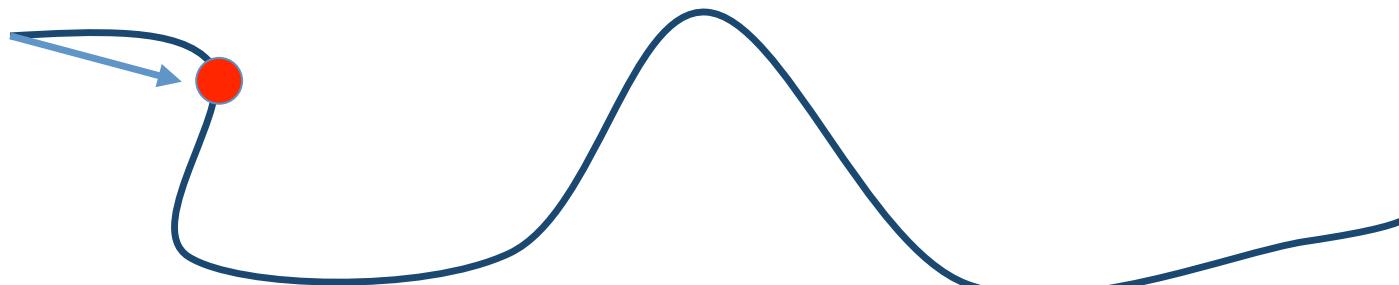
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- Continuous movement of a point along a line
 - Examples: tracking an animal, car or GPS receiver

Example

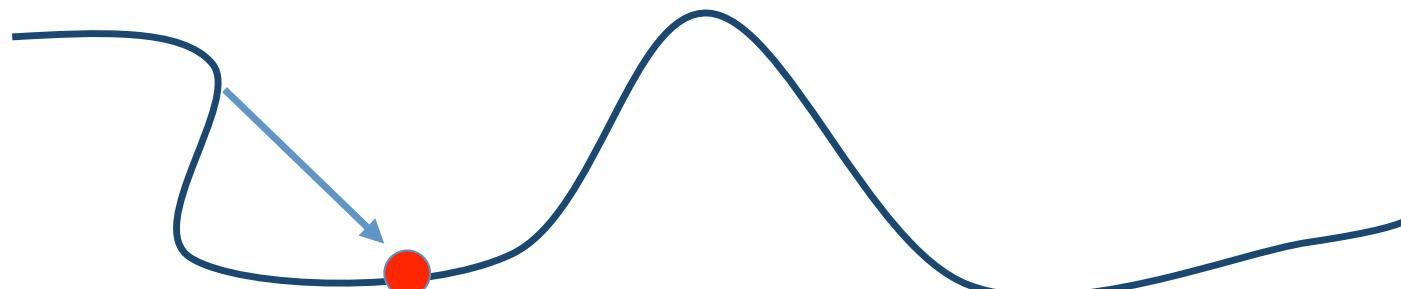
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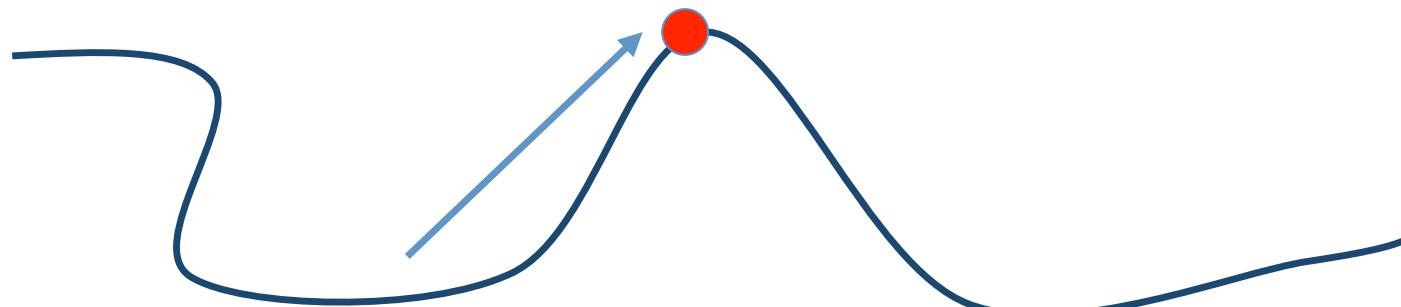
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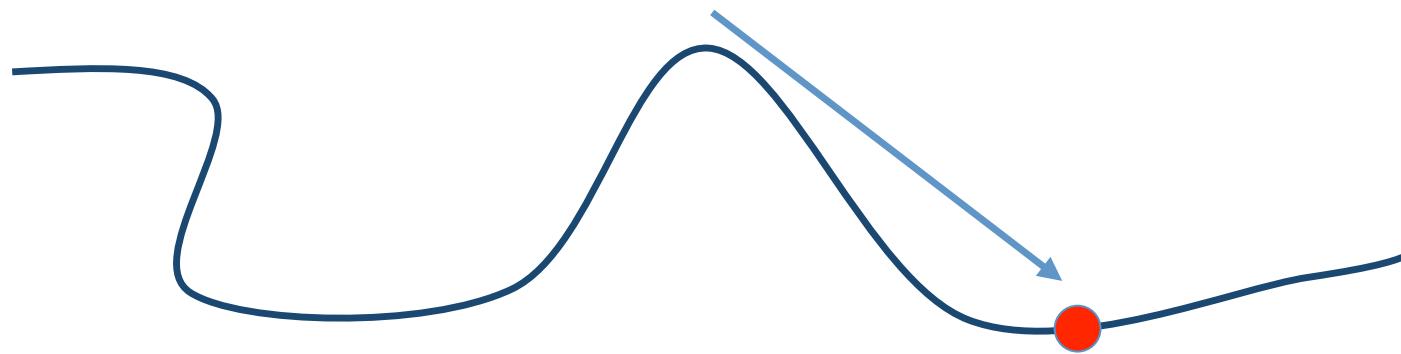
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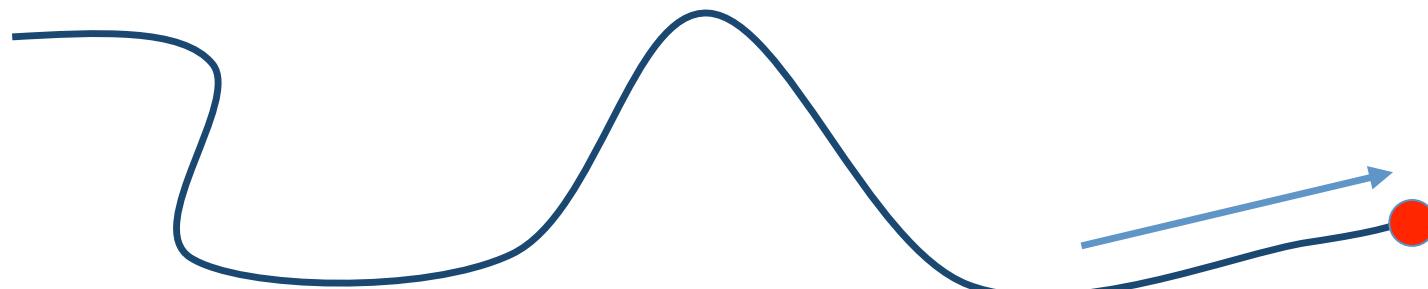
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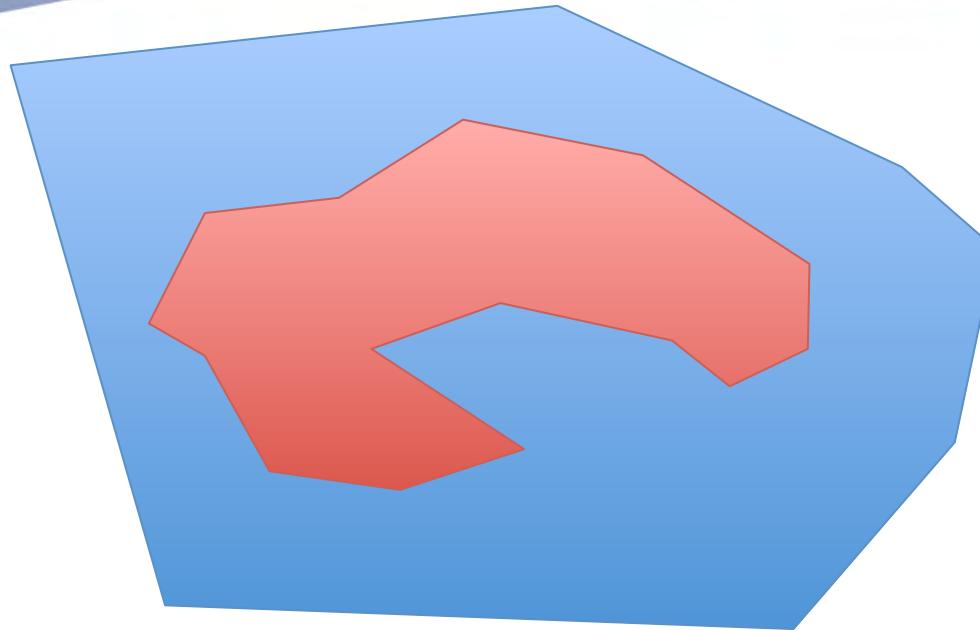
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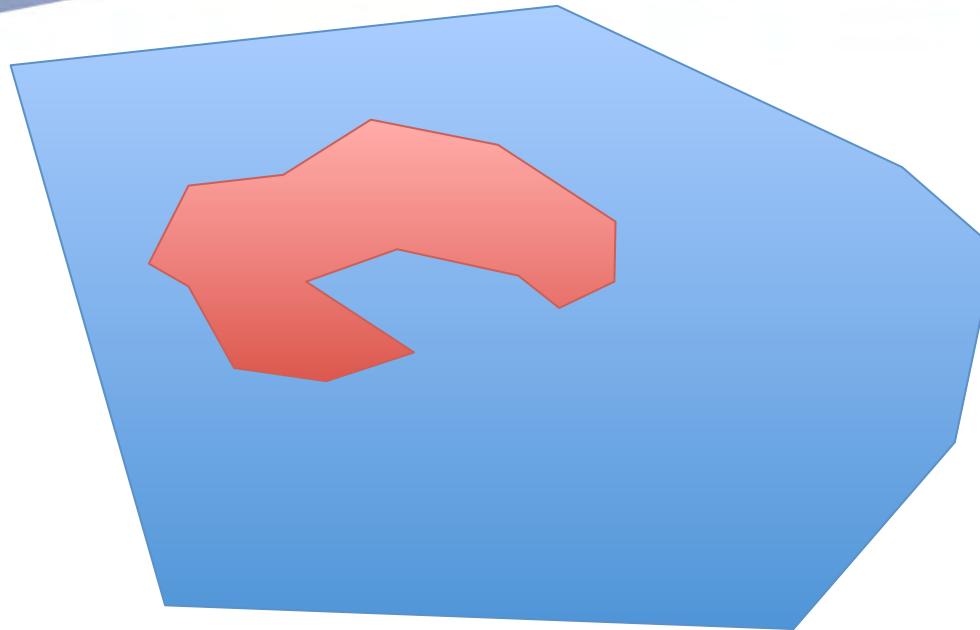
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- Evolution of an area in size or shape
 - Increasing or decreasing the size or shape of a feature
 - Examples: urban sprawl, decreasing forest cover

Example

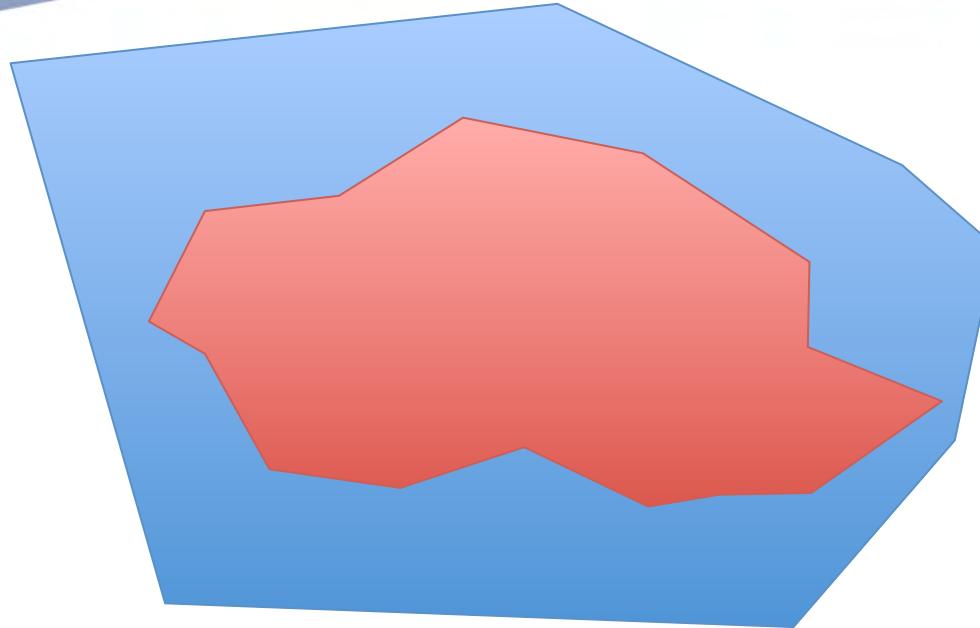
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Example

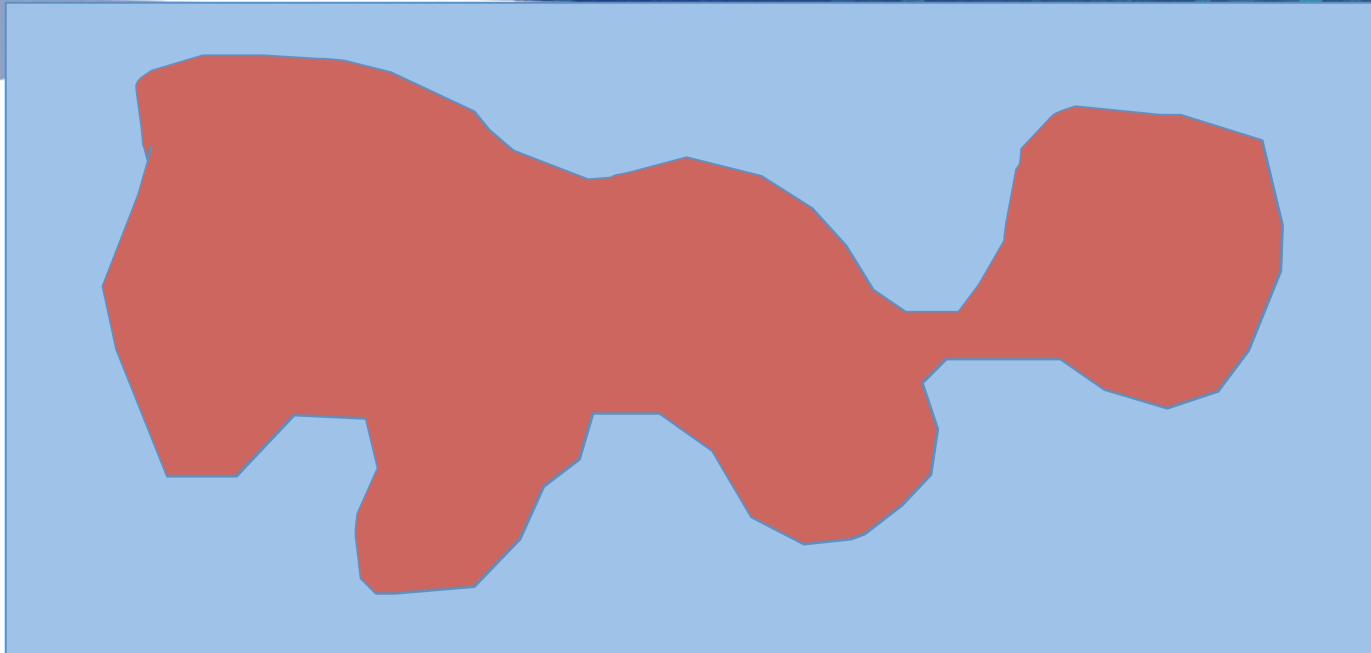
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 - Increasing or decreasing the size or shape of a feature
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Example

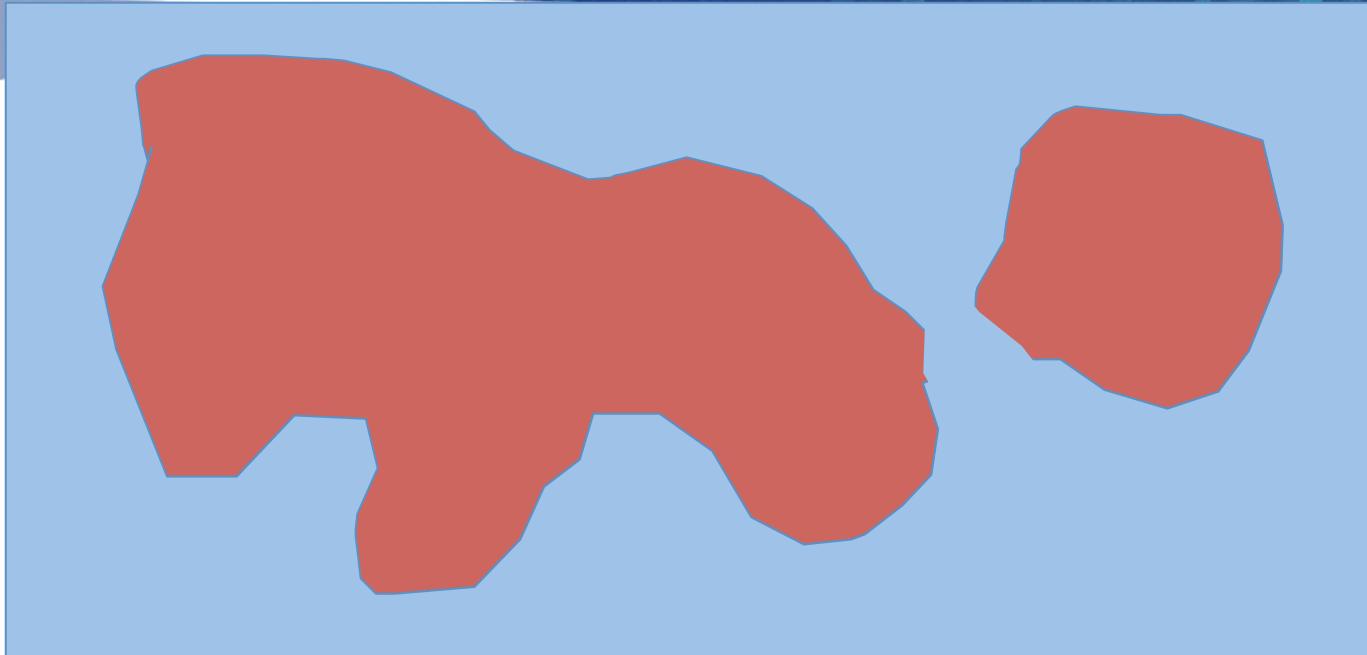
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- Changing the number of occurrences
 - Changing the number of features
 - Usually included with changes in size or shape
- Examples: forest fragmentation, spread of species

Example

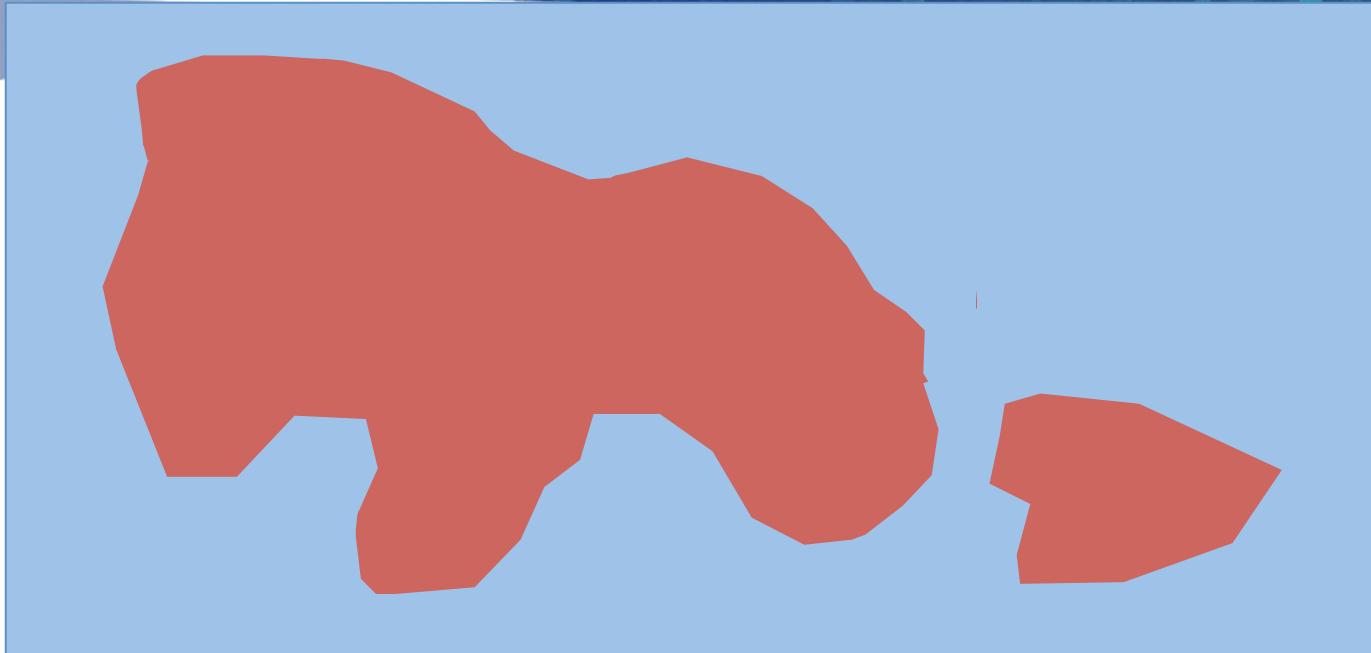
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Example

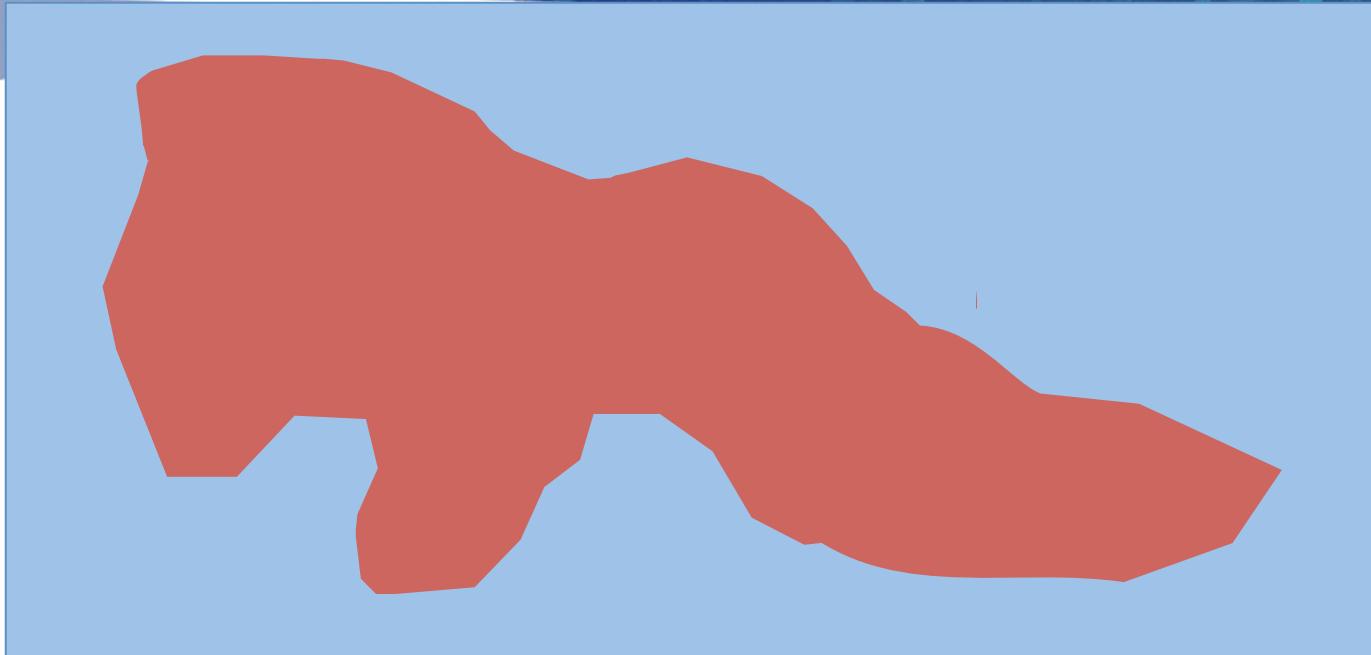
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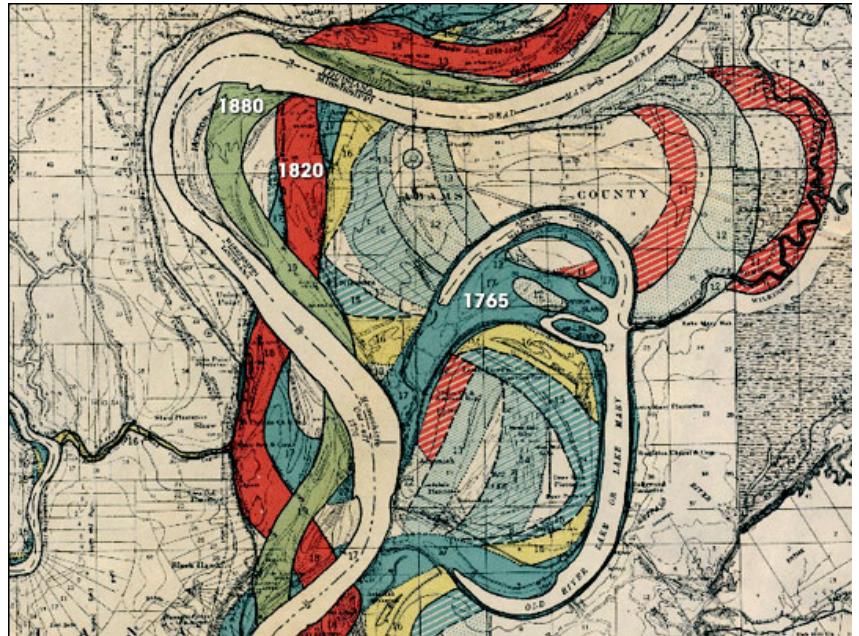
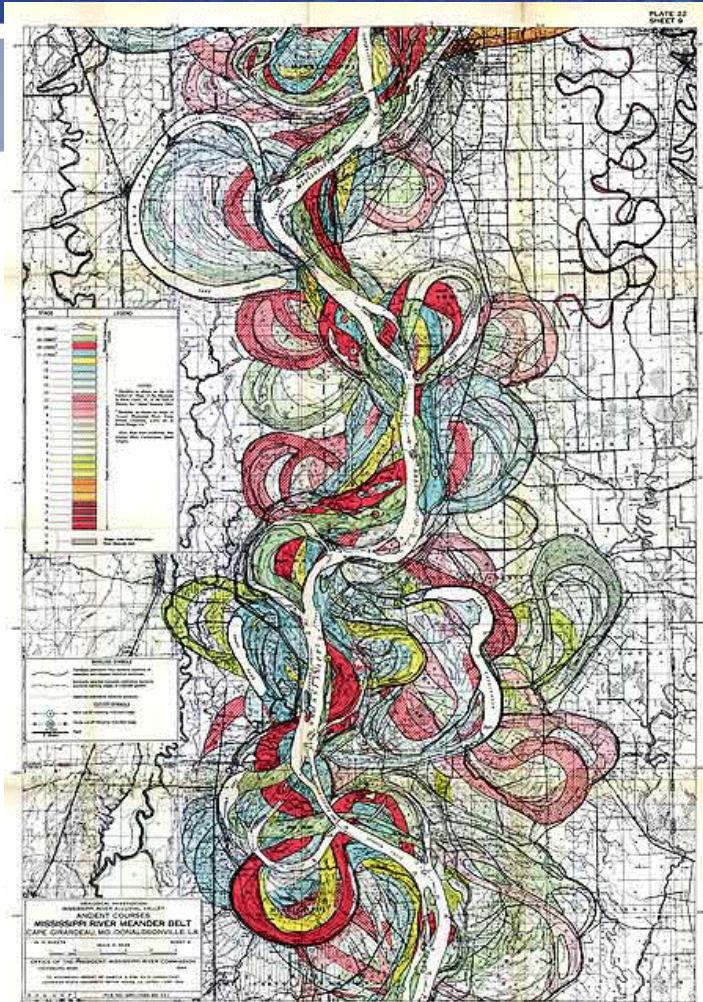
Illustrating time on a map

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- Single static map
- Series of static maps
- Animated map

Single static map

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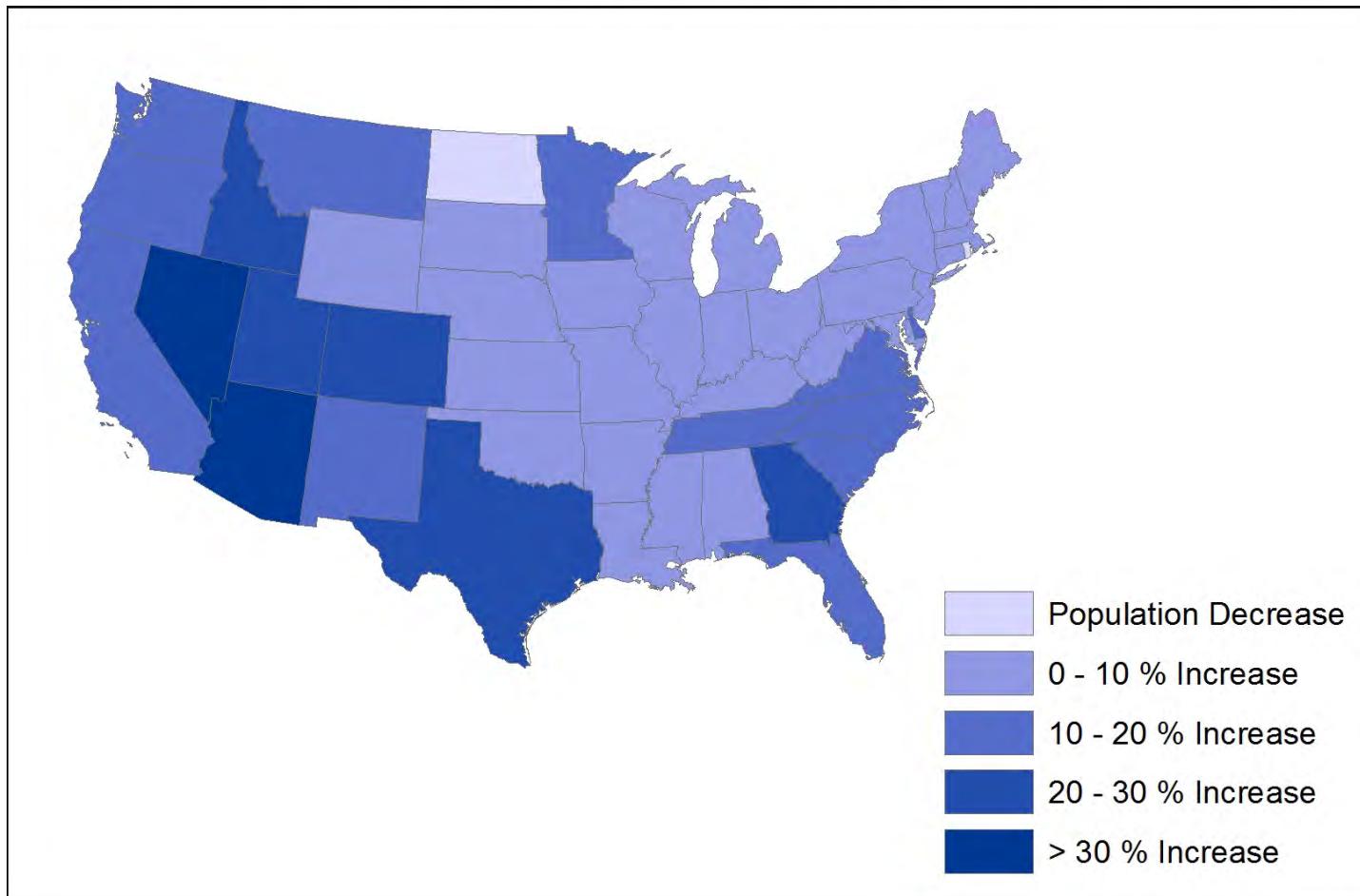


Ancient Courses of the Mississippi Meander Belt, US Army Corps of Engineers, 1944.

Single static map

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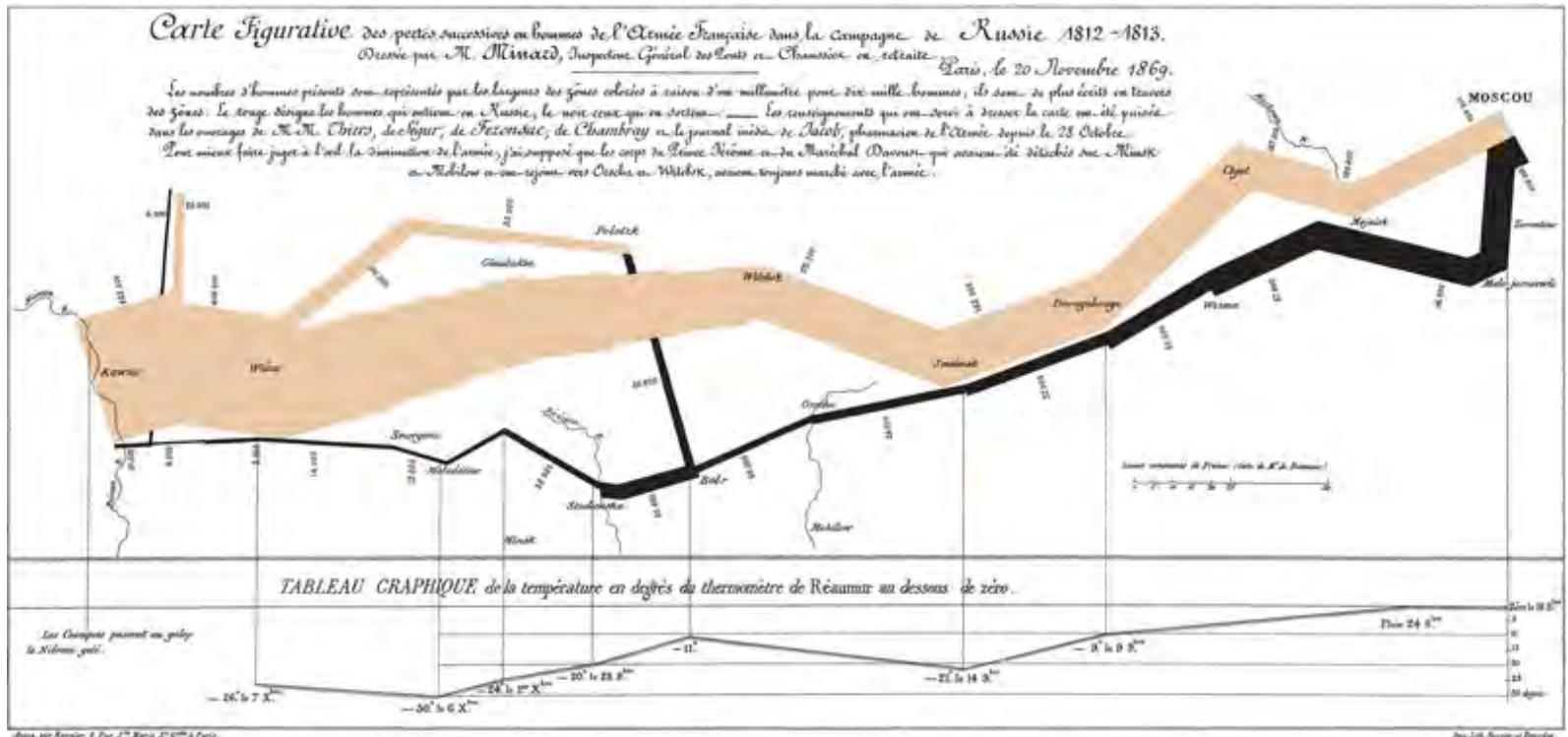
US Population Change between 1990 and 2000



Single static map

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- Charles Minard's flow map shows Napoleon's 1812 winter march to and from Moscow
 - The map shows the path of the army, with the area (pink and black) scaled to the number of soldiers
 - The bottom shows the temperature relative to time



Carte figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812-1813 by Charles Minard, 1861

Static single maps

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- Shows how a given area has changed over the specified period
 - How a country or state's borders have altered over time, or how natural features in an area have changed
- Usually shows differences using varying borders, shading, or arrows

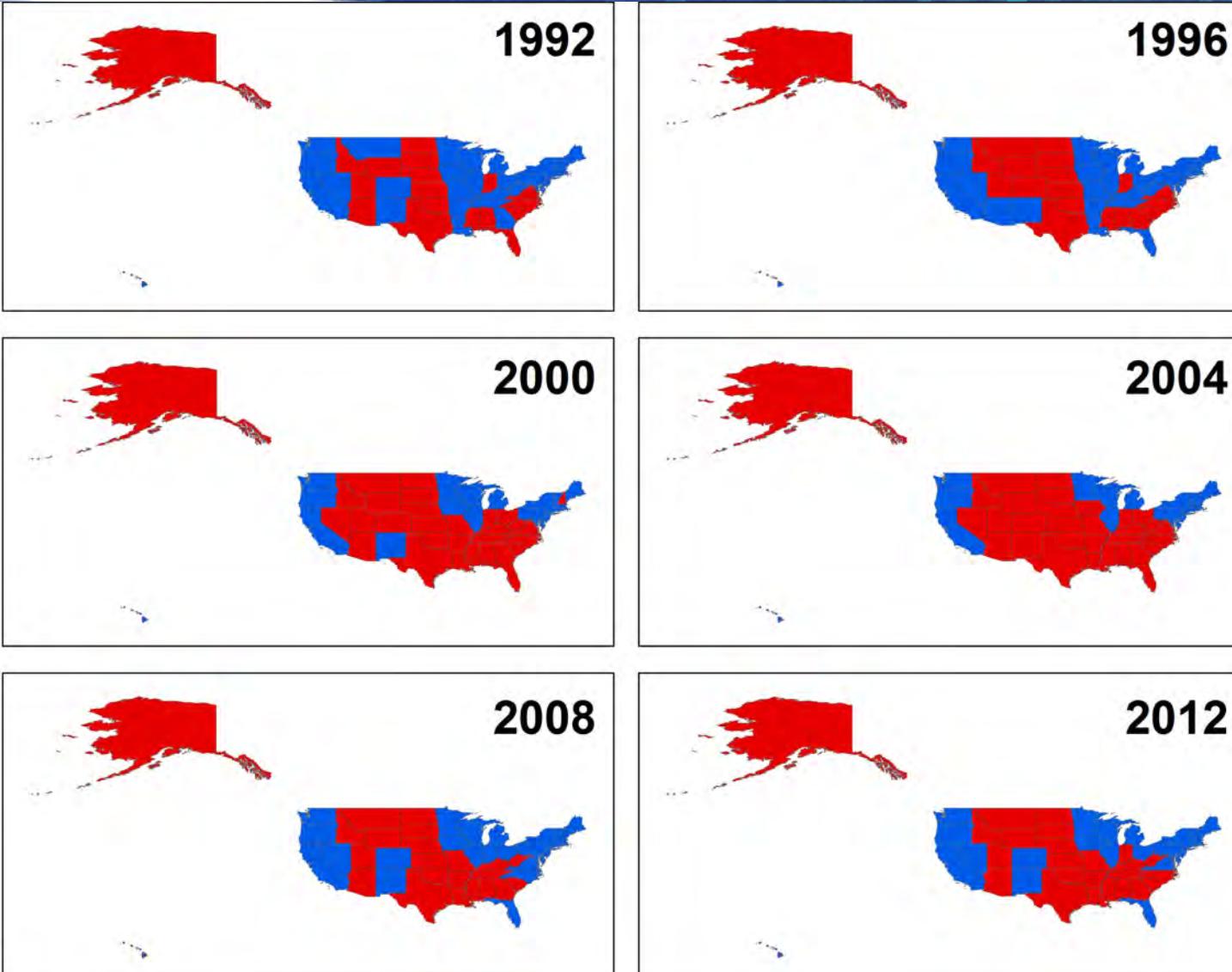
Series of static maps

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- Each map shows a different “slice” of time
 - Allows the viewer to compare among the different times

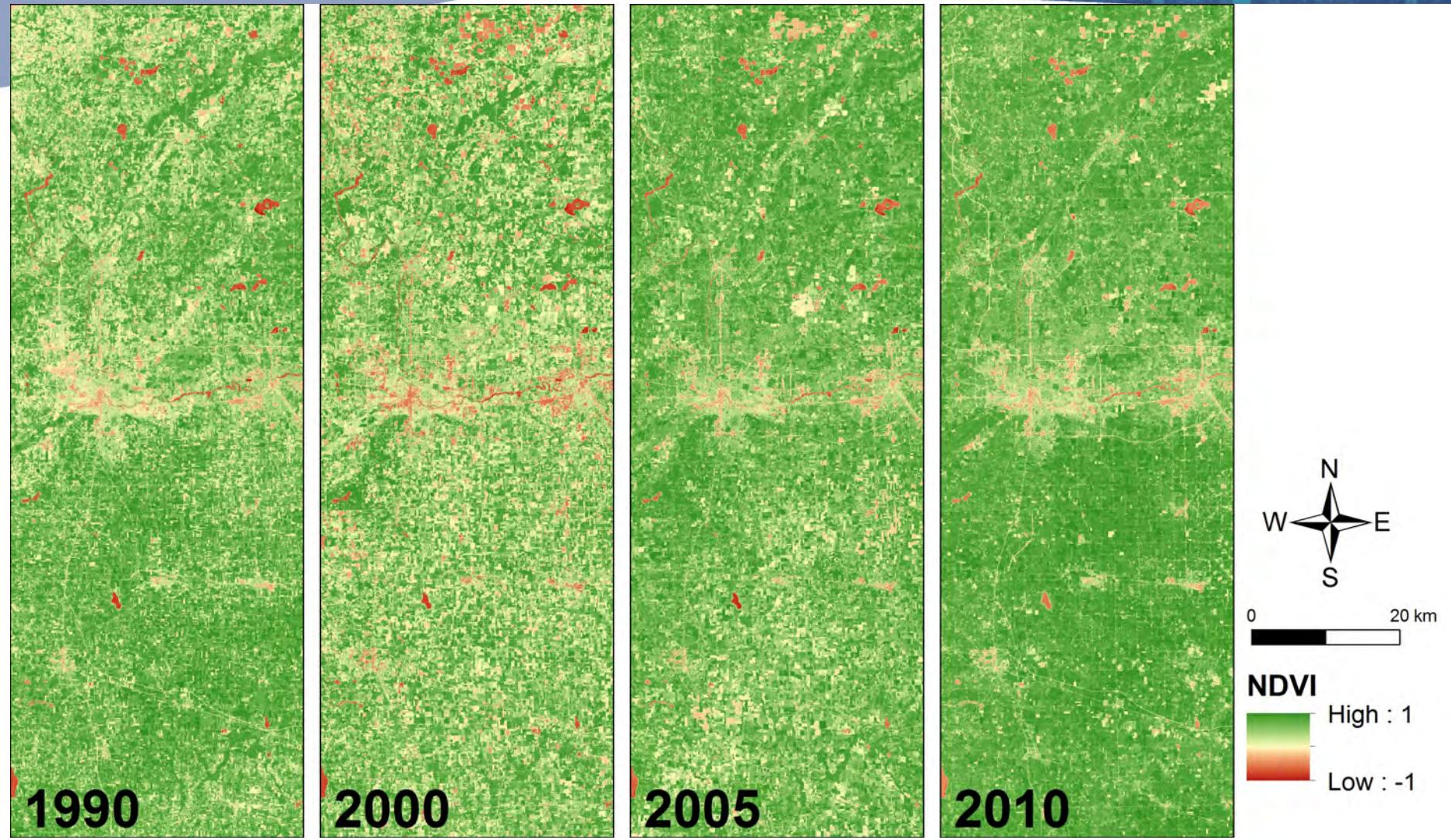
Series of static maps

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Series of static maps

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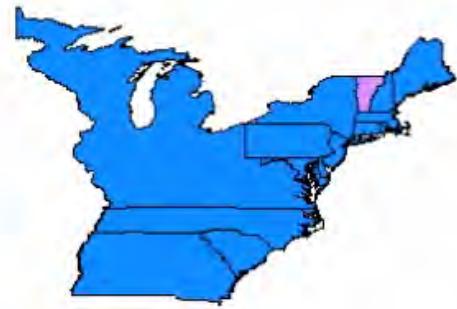
Animated maps

Animated Maps

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- Uses animation to overlay a time series of data
 - Can be difficult to focus on an individual time
 - Works well for digital display
 - Can not (obviously) be used for print documents

1783



Time in ArcGIS

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- Vector: Time tools
 - Need to have repeated features
 - Not repeated fields
- Raster: NetCDF Tools
 - Each time is a different layer
 - Hard to process in ArcGIS
 - Other GIS packages are better
- For both types of data, can create animations or query particular times

Repeated Fields

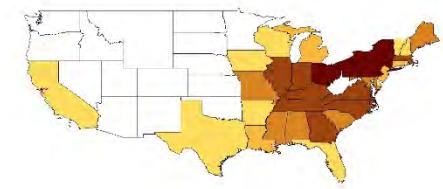
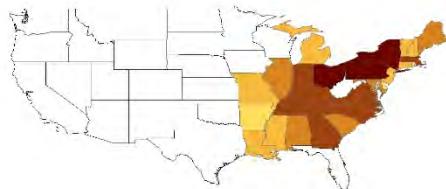
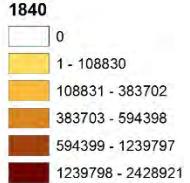
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Table

StatesWithYearlyPop

FID	Shape *	OBJECTID	STATE_NAME	A00AA1790	A00AA1800	A00AA1810	A00AA1820	A00AA1830	A00AA1840	A00AA1850	A00AA1860	A00AA1870	A00AA1880	A00AA1890	A00AA1900	A00AA1910	A00A...	
0	Polygon	1	Hawaii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1	Polygon	2	Washington	0	0	0	0	0	0	0	0	0	0	349390	518103	1141990	1	
2	Polygon	3	Montana	0	0	0	0	0	0	0	0	0	0	132159	243329	376053		
3	Polygon	4	Maine	0	0	0	298335	399455	501793	583169	628279	626915	648936	661086	694466	742371		
4	Polygon	5	North Dakota	0	0	0	0	0	0	0	0	0	0	0	182719	319146	577056	
5	Polygon	6	South Dakota	0	0	0	0	0	0	0	0	0	0	0	328808	401570	583888	
6	Polygon	7	Wyoming	0	0	0	0	0	0	0	0	0	0	0	60705	92531	145965	
7	Polygon	8	Wisconsin	0	0	0	0	0	0	0	305391	775681	1054670	1315497	1686880	2069042	2333860	2
8	Polygon	9	Idaho	0	0	0	0	0	0	0	0	0	0	0	84385	161772	325594	
9	Polygon	10	Vermont	85341	154465	217895	235764	280652	291948	314120	315098	330551	332286	332422	343641	355956		
10	Polygon	11	Minnesota	0	0	0	0	0	0	0	0	172023	439706	780773	1301826	1751394	2075708	2
11	Polygon	12	Oregon	0	0	0	0	0	0	0	0	52465	90923	174768	313767	413536	672765	
12	Polygon	13	New Hampshire	141899	183858	214460	244161	269328	284574	317976	326073	318300	346991	376530	411588	430572		
13	Polygon	14	Iowa	0	0	0	0	0	0	0	192214	674913	1194020	1624615	1911896	2231853	2247471	2
14	Polygon	15	Massachusetts	475199	574564	700745	523287	610408	737699	994514	1231066	1457351	1783085	2238943	2805346	3366416	3	
15	Polygon	16	Nebraska	0	0	0	0	0	0	0	0	0	0	1058910	1066300	1192214	1	
16	Polygon	17	New York	340241	589051	959049	1372812	1916608	2428921	3097394	3880735	4382759	5082871	5997853	7268894	9113614	10	
17	Polygon	18	Pennsylvania	433611	602365	810091	1049458	1348233	1724033	2311786	2906215	3521951	4282891	5258014	6302115	7665111	8	
18	Polygon	19	Connecticut	237655	251002	261942	275248	297675	309978	370792	460147	537454	622700	746258	908420	1114756	1	
19	Polygon	20	Rhode Island	69112	69122	76931	83059	97199	108830	147545	174620	217353	276531	345506	428556	542610		
20	Polygon	21	New Jersey	184139	211149	245562	277575	320823	373306	489555	672035	906096	1131116	1444933	1883669	2537167	3	
21	Polygon	22	Indiana	0	0	0	147178	343031	685866	988416	1350428	1680637	1978301	2192404	2516462	2700876	2	
22	Polygon	23	Nevada	0	0	0	0	0	0	0	42491	62266	45761	42335	81675			
23	Polygon	24	Utah	0	0	0	0	0	0	0	0	0	0	0	276749	373551		
24	Polygon	25	California	0	0	0	0	0	0	0	92597	379994	560247	864694	1208130	1485053	2377549	
25	Polygon	26	Ohio	0	0	230760	581434	937903	1519467	1980329	2339511	2665260	3198062	3672316	4157545	4767121	5	
26	Polygon	27	Illinois	0	0	0	55211	157445	476183	851470	1711951	2539891	3077871	3826351	4821550	5638591	6	
27	Polygon	28	District Of Columbia	0	14093	24023	33039	39834	43712	51687	75080	131700	177624	230392	278718	331069		

US_HistStateTerr [StatesWithYearlyPop]



Repeated Features

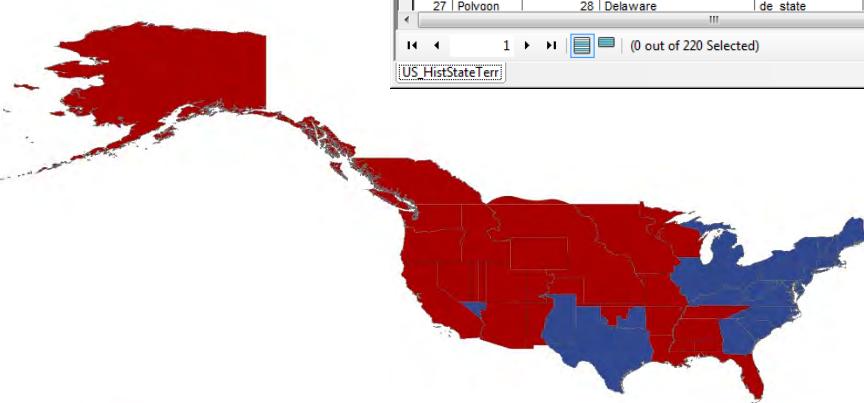
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Table CHAIN

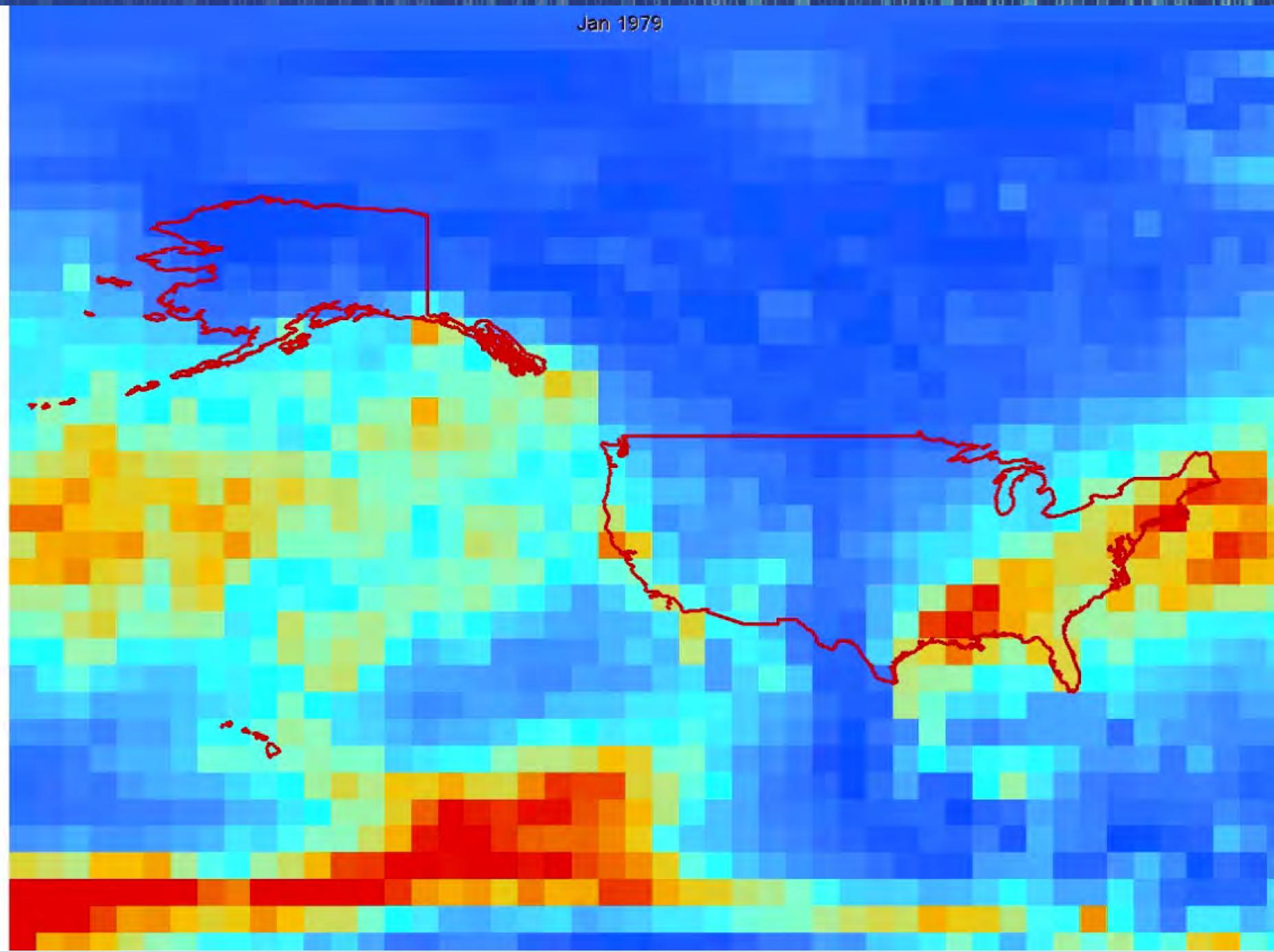
US_HistStateTerr

FID	Shape *	ID_NUM *	NAME	ID	VERSION	START_DATE *	END_DATE *	DESCRIPTION
0	Polygon	1	Alaska Department	ak_dept	1	3/30/1867	5/16/1884	The United States acquired Alaska from Russia. Presidential proclamation issued 20 June 1867. Alaska was considered an "unorganized territory" until 1884.
1	Polygon	2	Alaska District	ak_district	1	5/17/1884	6/23/1912	The United States Congress established a civil government for Alaska. This act was limited and resulted in a partial organization of Alaska as a territory.
2	Polygon	3	Alaska	ak_state	1	1/3/1959	12/31/2000	The state of Alaska was created from Alaska Territory by Presidential proclamation; Alaska Territory eliminated.
3	Polygon	4	Alaska Territory	ak_terr	1	8/24/1912	1/2/1959	Alaska was fully organized as a territory in the United States.
4	Polygon	5	Alabama	al_state	1	12/14/1819	5/28/1820	The state of Alabama was created from Alabama Territory; Alabama Territory eliminated.
5	Polygon	6	Alabama	al_state	2	5/29/1820	12/18/1820	Surveyors demarcated the southern segment of the Alabama-Mississippi line, fixing the end point ten miles east of the mouth of the Pascagoula River.
6	Polygon	7	Alabama	al_state	3	12/19/1820	12/31/2000	MARION's overlap of the state of Mississippi and TUSCALOOSA's overlap of the state of Mississippi ended.
7	Polygon	8	Alabama Territory	al_terr	1	3/3/1817	2/5/1818	The United States created Alabama Territory from the eastern half of Mississippi Territory.
8	Polygon	9	Alabama Territory	al_terr	2	2/6/1818	12/13/1819	TUSCALOOSA created by Alabama Territory from MONTGOMERY and Non-County Area 1; TUSCALOOSA overlapped non-county area in the western half of Mississippi Territory.
9	Polygon	10	Arkansas	ar_state	1	6/15/1836	5/20/1840	The state of Arkansas was created from Arkansas Territory; Arkansas Territory eliminated.
10	Polygon	11	Arkansas	ar_state	2	5/21/1840	12/31/2000	Survey of boundary between the Republic of Texas and the United States began. MILLER (original) officially became extinct and LAFAYETTE (copy) was created.
11	Polygon	12	Arkansas Territory	ar_terr	1	7/4/1819	5/25/1824	The United States created Arkansas Territory from Missouri Territory. Arkansas Territory included all of present Arkansas and part of present Oklahoma.
12	Polygon	13	Arkansas Territory	ar_terr	2	5/26/1824	5/6/1828	Arkansas Territory was reduced in size when the western extent of the territory was moved to a line running forty miles west of the south fork of the Arkansas River.
13	Polygon	14	Arkansas Territory	ar_terr	3	5/6/1828	6/14/1836	CLARK, CRAWFORD, LOVELEY, and MILLER lost to Indian lands when the treaty between the United States and Cherokee Indians established the Cherokee Nation.
14	Polygon	15	Arizona	az_state	1	2/14/1912	12/31/2000	The state of Arizona was created from Arizona Territory; Arizona Territory eliminated.
15	Polygon	16	Arizona Territory	az_terr	1	2/24/1863	5/4/1866	The United States created Arizona Territory from the western portion of New Mexico Territory and a part of present Nevada.
16	Polygon	17	Arizona Territory	az_terr	2	5/5/1866	2/13/1912	State of Nevada gained parts of MOHAVE and PAH-UTE (extinct) when the United States transferred the portion of Arizona Territory lying to the west of the Colorado River.
17	Polygon	18	California	ca_state	1	9/9/1850	12/30/1959	The state of California was admitted to the Union.
18	Polygon	19	California	ca_state	2	12/31/1959	12/31/2000	Between 1949 and 1959 (precise date unknown) SAN FRANCISCO gained a small area of the Alameda Naval Air Station when landfill expanded into the San Francisco Bay.
19	Polygon	20	Colorado	co_state	1	8/1/1876	12/31/2000	The state of Colorado was created from Colorado Territory; Colorado Territory eliminated.
20	Polygon	21	Colorado Territory	co_terr	1	2/28/1861	7/31/1876	The United States created Colorado Territory from Nebraska, New Mexico, and Utah Territories, and from the former Kansas Territory.
21	Polygon	22	Connecticut	ct_state	1	9/3/1783	9/13/1786	Connecticut became an independent state on 4 July 1776. The map depicts state boundaries as of 3 September 1783.
22	Polygon	23	Connecticut	ct_state	2	9/14/1786	4/27/1800	Connecticut ceded to the United States its claim to lands north and west of Pennsylvania and the Ohio River, except for a tract, lying in the northwest corner of the state.
23	Polygon	24	Connecticut	ct_state	3	4/28/1800	12/30/1804	Connecticut ceded the Western Reserve in present Ohio to the United States, and the area was incorporated into the Northwest Territory.
24	Polygon	25	Connecticut	ct_state	4	12/31/1804	12/31/2000	HARTFORD lost part of the town of Southwick (the "Southwick Job") to HAMPSHIRE (Mass.) when the state boundary was adjusted.
25	Polygon	26	District of Columbia	dc	1	3/30/1791	9/6/1846	The United States created an unnamed district from land ceded by Maryland and Virginia to be the seat of national government.
26	Polygon	27	District of Columbia	dc	2	9/7/1846	12/31/2000	The federal government retroceded to Virginia all of the District of Columbia west of the Potomac River, including all of ALEXANDRIA (now part of Virginia).
27	Polygon	28	Delaware	de_state	1	9/3/1783	12/31/2000	The three Lower Counties of KENT, NEW CASTLE, and SUSSEX became an independent state on 4 July 1776. The name Delaware was first used in 1787.

State Population



Jan 1979



Data Links

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- Atlas of Historic County Boundaries
 - <http://publications.newberry.org/ahcbp/>
- National Historic Geographic Information System
 - <https://www.nhgis.org/>
- NOAA's Gridded Climate Datasets
 - <http://www.esrl.noaa.gov/psd/data/gridded/>