Esri International User Conference
San Diego, California

Technical Workshops | July 26 2012

Working with Temporal Data

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Please!
Turn OFF cell phones and paging devices

This technical workshop

- Visualizing temporal data – recurring theme
- Managing temporal data
- Analyzing temporal data
- Building temporal visualizations
- Sharing temporal visualizations

ArcGIS 10.1 Themes

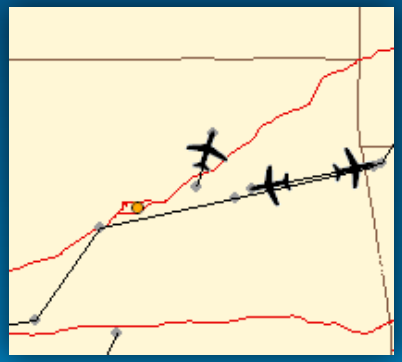
- Online
- Desktop
- Server
- Mobile
- Developer
- Solutions

Demonstration

Zebra Mussels, 1988-2008

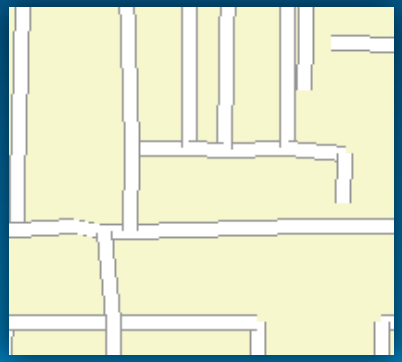
Visualizing temporal data

Dynamic
something that moves



- Planes
- Vehicles
- Animals
- Satellites
- Storms

Discrete
something that "just happens"

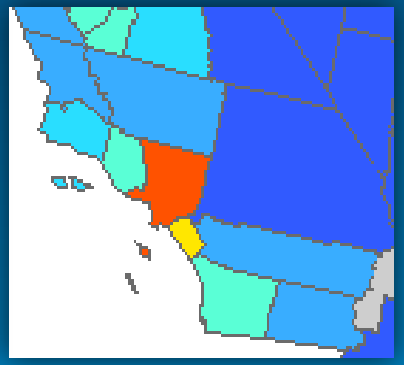


- Crimes
- Lightning
- Accidents

Stationary
stands still but records changes

- Weather stations
- Traffic sensors

Change
change or growth



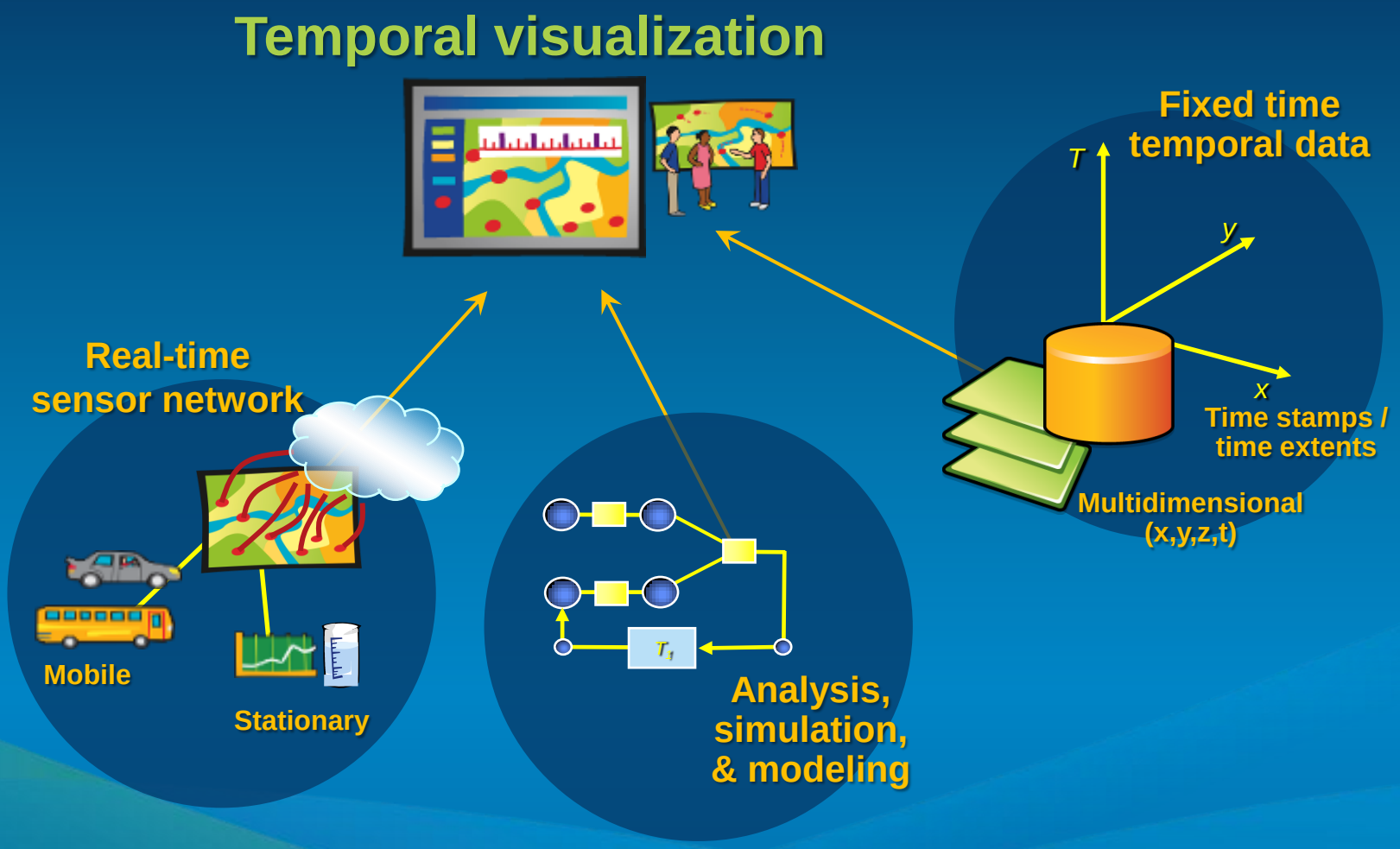
- Demographics
- Fire perimeter

Animated displays intuitively give the impression of change

Properties of time

- Time is linear
  - Wednesday always follows Tuesday
- Unidirectional
  - Events which happen today don’t affect yesterday
- Time can be cyclical
  - June 20th happens every year
- There are calendar and non-calendar based temporal measurement systems

GIS integration of time

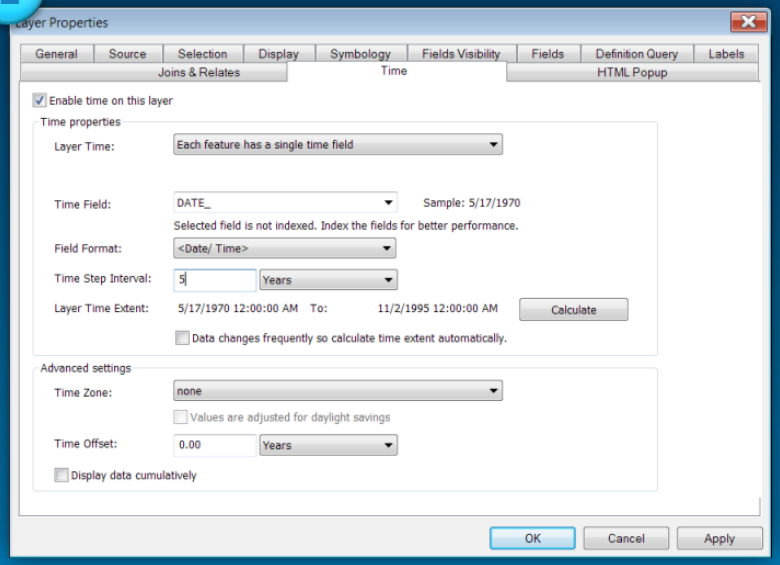


New ways to manage, analyze, and visualize temporal data

ArcGIS built time into GIS

- Time-enabled layers
  1. Configure time properties on the layer
  2. Use Time Slider window to visualize the layer
- Unified experience for time
  - Works the same in ArcMap, ArcGlobe, and ArcScene
  - Part of Desktop, Engine, and Server products

1



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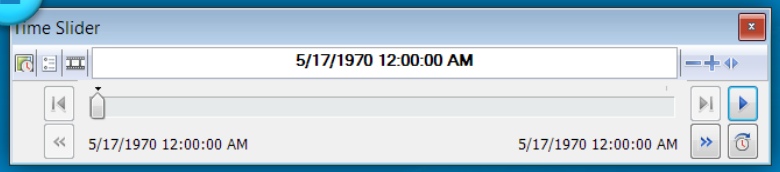


ArcGIS built time into GIS, continued

- Geoprocessing (GP) tools
  - Data management
  - New Time-aware analysis tools

- Ability to share
  - Layer and map packages
  - Map services for the web
  - Temporal map books

Demonstration

100 Largest Cities in the USA, 1790-2000

Managing temporal data

ArcGIS terminology

- Time-enabled layer
  - A layer that has been enabled to display time
- Time stamp
  - Value in the time attribute of the feature class, image, etc…
- Time instant
  - A single point on the timeline
- Time extent
  - Period of time between two points on the timeline

Tips for temporal data management

- Field formats
- Duration
- Time zones
- Daylight Savings Time

Store temporal data using the Date field type

- **Store temporal data in a Date type field when possible**
  - "Date" is a special field type specific to time
  - Only use String or Number field types if importing old data, or when Date won't hold what you have
  - Convert the data, if necessary
- **Index the Date field for faster display and query performance**

Numeric and String formats

- **Numeric**
  - YYYY
  - YYYYMM
  - YYYYMMDD
  - YYYYMMDDhhmmss
- **String**
  - YYYY
  - YYYYMM
  - YYYYMMDD YYYY/MM/DD YYYY-MM-DD
  - YYYYMMDDhhmmss YYYY/MM/DD hh:mm:ss YYYY-MM-DD hh:mm:ss

Numeric and String formats, continued

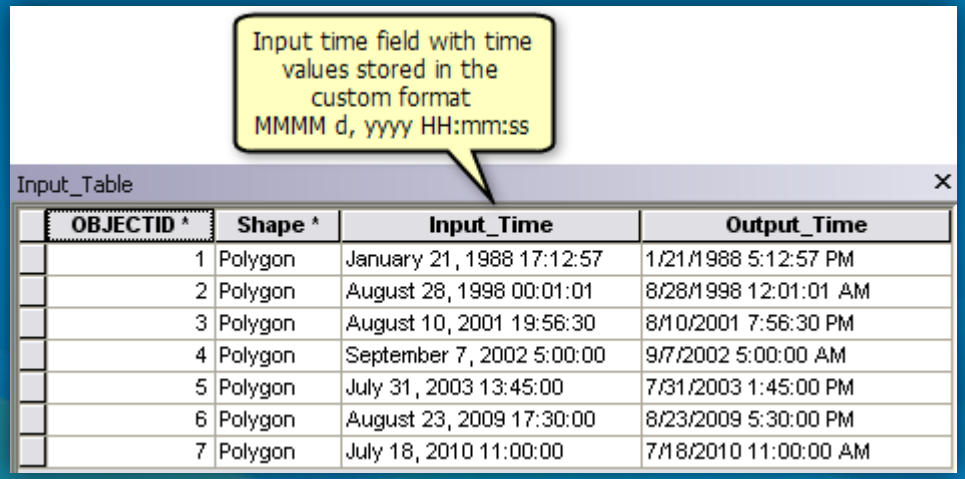
- Only “sortable” formats are supported
  - Numeric:
    - YYYYMMDD 20120730 > 20120830 = TRUE
    - MMDDYYYY 07302012 > 08302012 = FALSE

Named Month strings are sorted alphabetically!

- AUG-30-2012 will come before JUL-30-2012

What if your time is not in one of those formats?

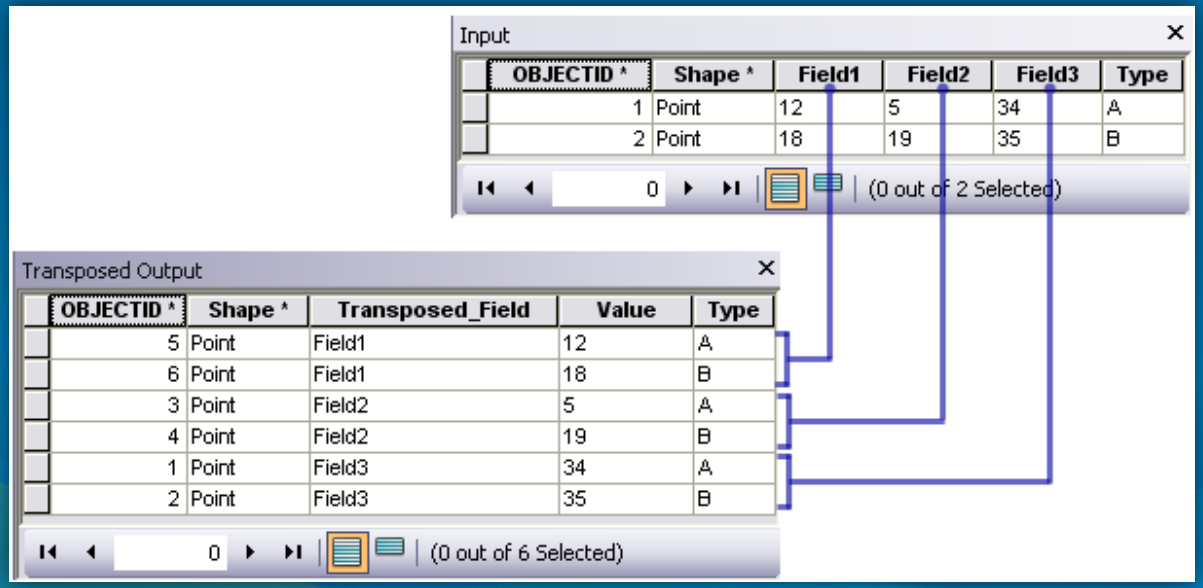
- **Use Data Management GP tools to convert to supported field types**
  - **Convert Time Field** GP tool - converts Numeric and String formats into a new Date field: "20120726" → 07/26/2012
    - Converts custom String formats into a new Date field: "July 26, 2012" → 07/26/2012



OBJECTID *	Shape *	Input_Time	Output_Time
1	Polygon	January 21, 1988 17:12:57	1/21/1988 5:12:57 PM
2	Polygon	August 28, 1998 00:01:01	8/28/1998 12:01:01 AM
3	Polygon	August 10, 2001 19:56:30	8/10/2001 7:56:30 PM
4	Polygon	September 7, 2002 5:00:00	9/7/2002 5:00:00 AM
5	Polygon	July 31, 2003 13:45:00	7/31/2003 1:45:00 PM
6	Polygon	August 23, 2009 17:30:00	8/23/2009 5:30:00 PM
7	Polygon	July 18, 2010 11:00:00	7/18/2010 11:00:00 AM

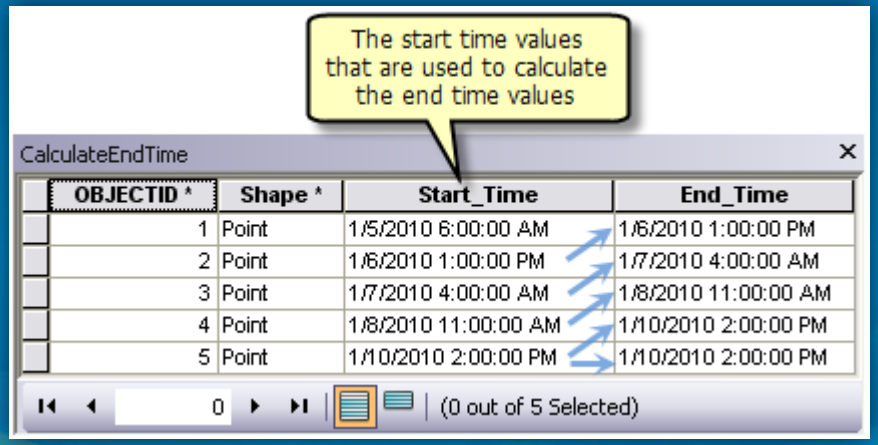
What if time is stored in columns?

- **Use Data Management GP tools to convert to row format**
  - Need to convert data with time in separate columns
  - <u>Transpose Fields</u> GP tool – shifts data entered in fields or columns into rows in a table or feature class

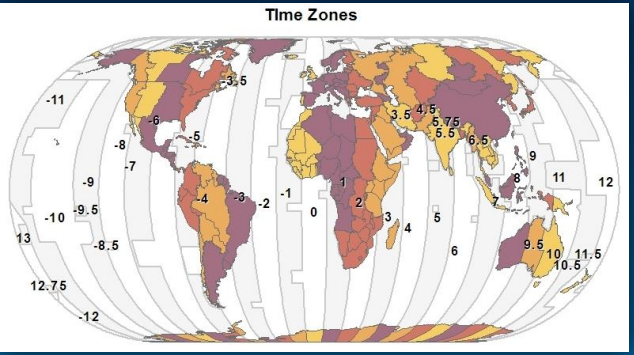


What if you want to imply duration?

- **Use Data Management GP tools to calculate end time**
  - **Calculate End Date GP tool - populates the End Time field with the next successive record's Start Time**
  - **The last instance will not have a duration as the Start and End Time will be the same**



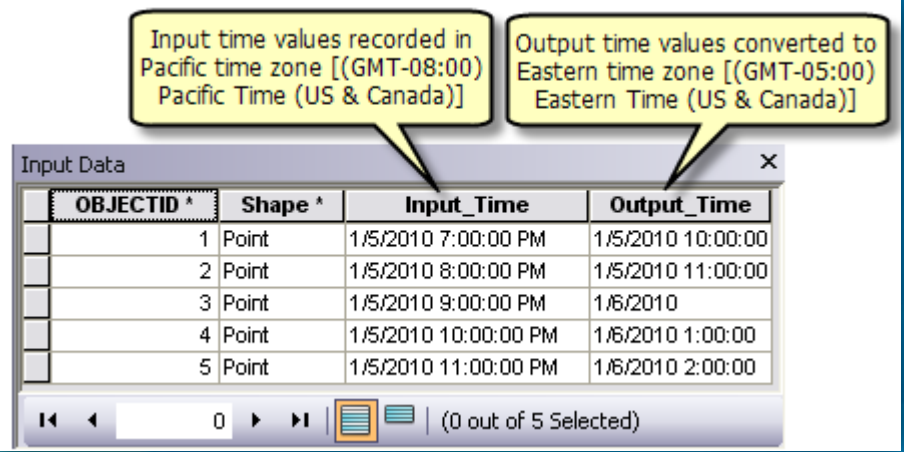
What if your data reflects different time zones?



- **Standardize on UTC* or GMT** data is from multiple time zones**

  ** Coordinated Universal Time, ** Greenwich Mean Time*

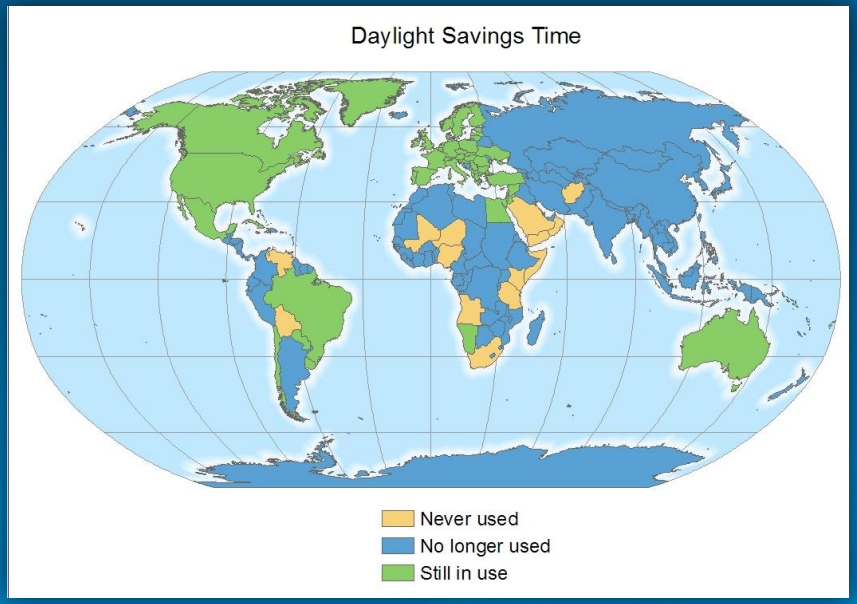
- **ArcGIS integrates data across different time zones**
- **Convert Time Zone GP tool – converts between time zones**



OBJECTID *	Shape *	Input_Time	Output_Time
1	Point	1/5/2010 7:00:00 PM	1/5/2010 10:00:00
2	Point	1/5/2010 8:00:00 PM	1/5/2010 11:00:00
3	Point	1/5/2010 9:00:00 PM	1/6/2010
4	Point	1/5/2010 10:00:00 PM	1/6/2010 1:00:00
5	Point	1/5/2010 11:00:00 PM	1/6/2010 2:00:00

What if you are dealing with Daylight Savings Time?

- **Use Data Management GP tools to store temporal data as Standard Time (not DST)**
  - **Calculate Field GP tool**
  - **Problems with DST**
    - **Regional differences**
    - **Political disagreement**
    - **Rules and boundaries change frequently**
    - **Some DST zones adjust less than an hour**
      - **30 minute DST offset**
      - **45 minute DST offset**



Source: Wikipedia

Supported data

- Feature layers
- Mosaic datasets
- Raster catalog layers
- Tracking dataset layers with traffic data
- NetCDF (raster, feature, table)
- Network layers
- Video layers

Demonstration

Deepwater Horizon Oil Spill, 2010

Feature layers – Separate features

- The shape and location of each feature changes over time or the shape and location does not change
- One table, features repeat for each time stamp
- Row = feature + unique time stamp
- Each row can also have an attribute value
- Commonly used for capture or playback of moving objects (tracking)

OBJECTID *	Shape	Rank	Place	Population	X_coord	Y_coord	Year
870	Point	87	Akron, OH	42728	-81.5178	41.07315	1900
963	Point	81	Akron, OH	69067	-81.5178	41.07315	1910
1014	Point	32	Akron, OH	208435	-81.5178	41.07315	1920
1117	Point	35	Akron, OH	255040	-81.5178	41.07315	1930
1220	Point	38	Akron, OH	244791	-81.5178	41.07315	1940
1321	Point	39	Akron, OH	274605	-81.5178	41.07315	1950
1427	Point	45	Akron, OH	290351	-81.5178	41.07315	1960
1534	Point	52	Akron, OH	275425	-81.5178	41.07315	1970
1641	Point	59	Akron, OH	237177	-81.5178	41.07315	1980
1753	Point	71	Akron, OH	223019	-81.5178	41.07315	1990
1878	Point	97	Akron, OH	217074	-81.5178	41.07315	2000
17	Point	19	Albany, NY	3498	-73.7813	42.65982	1790
37	Point	17	Albany, NY	5289	-73.7813	42.65982	1800

Feature layers – Features joined to a table

- Features with one-to-one or one-to-many join
- The shape and location of each feature is constant but attribute values can change over time
- Commonly used with fixed position samples, such as weather stations and other sensor networks

Stations feature class

OBJECTID*	SHAPE*	StationID
1	Point	43
2	Point	55
3	Point	21
4	Point	15
5	Point	30

Temperature table

OBJECTID*	StationID	Date_1	Temp
1	43	1/1/2000	50
2	43	1/1/2001	53
3	43	1/1/2002	49
4	43	1/1/2003	58
5	43	1/1/2004	55
6	55	1/1/2000	65
7	55	1/1/2001	70

Mosaic datasets and raster catalog layers

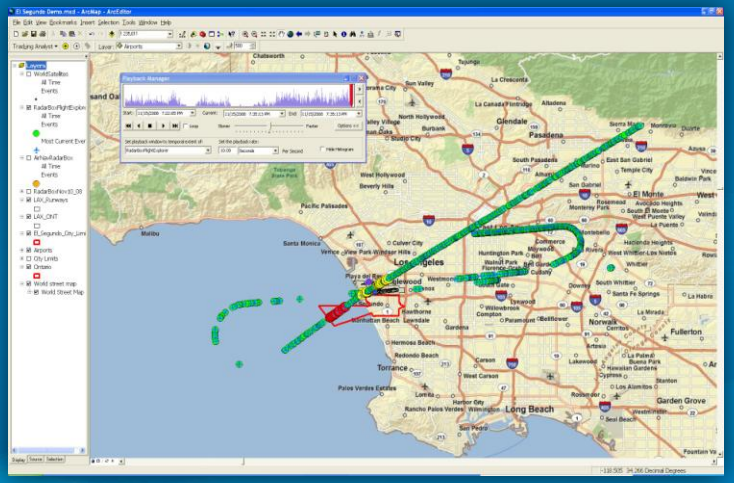
- Use a Date field
- Use an Index field (*i.e.*, ObjectID)

OBJECTID*	NAME	Shape*	Raster	Date_Time	SHAPE_Length	SHAPE_Area
1	Image1.gif	Polygon	Raster	1998-10-14 12:00:00	3068	522753
2	Image2.gif	Polygon	Raster	1998-10-15	3068	522753
3	Image3.gif	Polygon	Raster	1998-10-15 12:00:00	3068	522753
4	Image4.gif	Polygon	Raster	1998-10-16	3068	522753
5	Image5.gif	Polygon	Raster	1998-10-16 12:00:00	3068	522753
6	Image6.gif	Polygon	Raster	1998-10-17	3068	522753
7	Image7.gif	Polygon	Raster	1998-10-17 12:00:00	3068	522753

Raster catalog layers will initially draw as a wire frame if there are more than nine rasters

Tracking datasets – Use Tracking Analyst

- Tracks objects in real time
- Symbolize temporal data using time windows and other specialized options for viewing data that changes through time
- Play back temporal data using TA Playback Manager
- Analyze patterns in temporal data by creating data clocks
- Create and apply actions on temporal data
- Create animations of your data using TA Animation tool

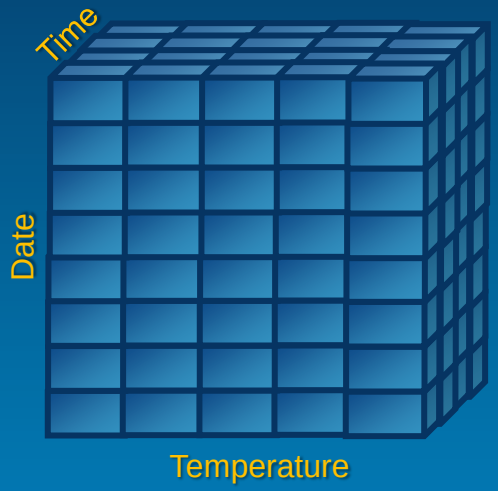


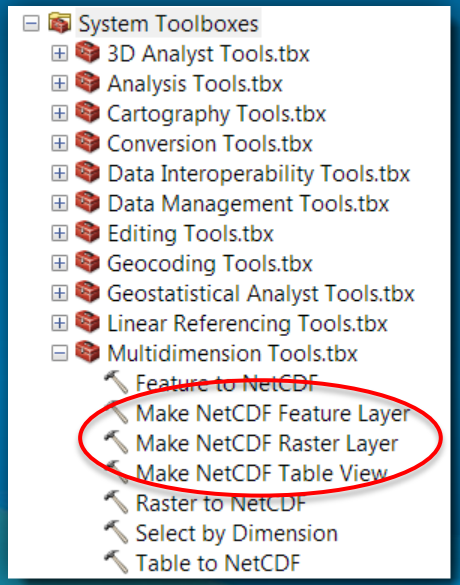
Learn more!

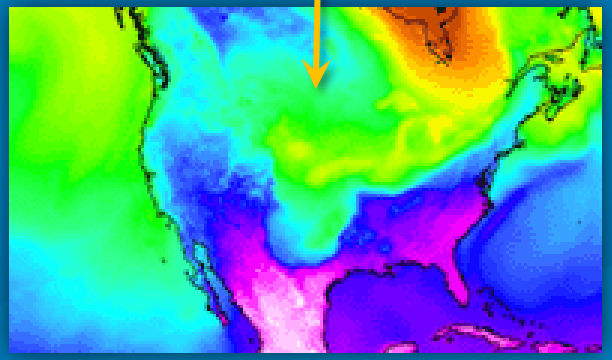
- **Leveraging Temporal Data with ArcGIS Tracking Analyst and Esri Tracking Server**
  - **Wednesday, July 25, 10:15 AM - 11:30 AM, Room 28 C**

NetCDF layers and tables

- NetCDF – a file format for storing spatiotemporal data
  - Multiple dimensions (x, y, z, t)
  - Multiple variables (temperature, pressure, salinity, wind speed)
- Make a layers or tables for visualization and analysis using GP tools

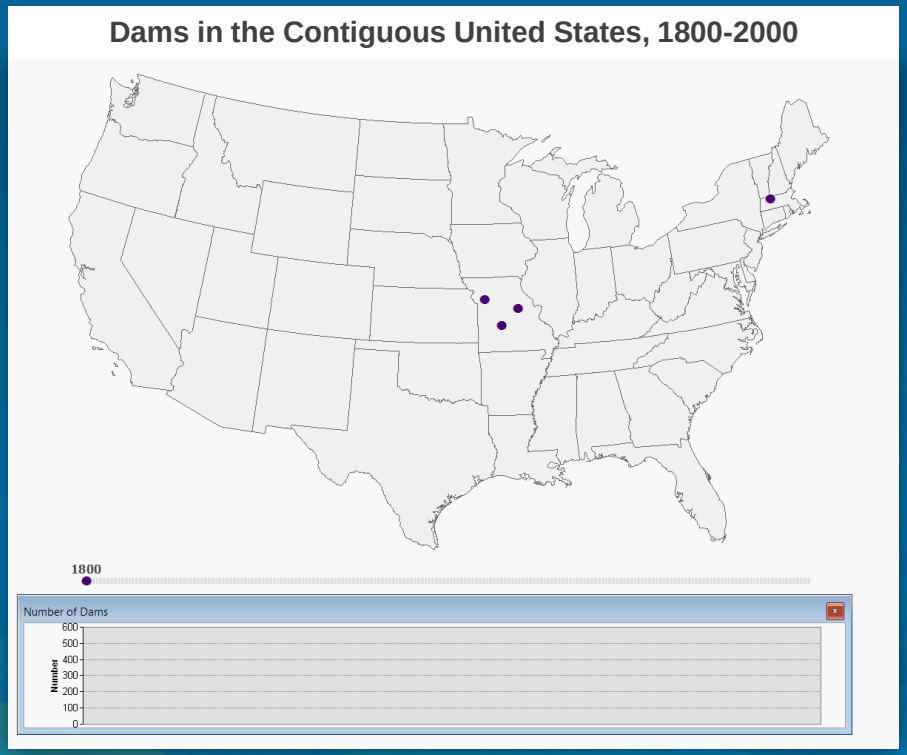






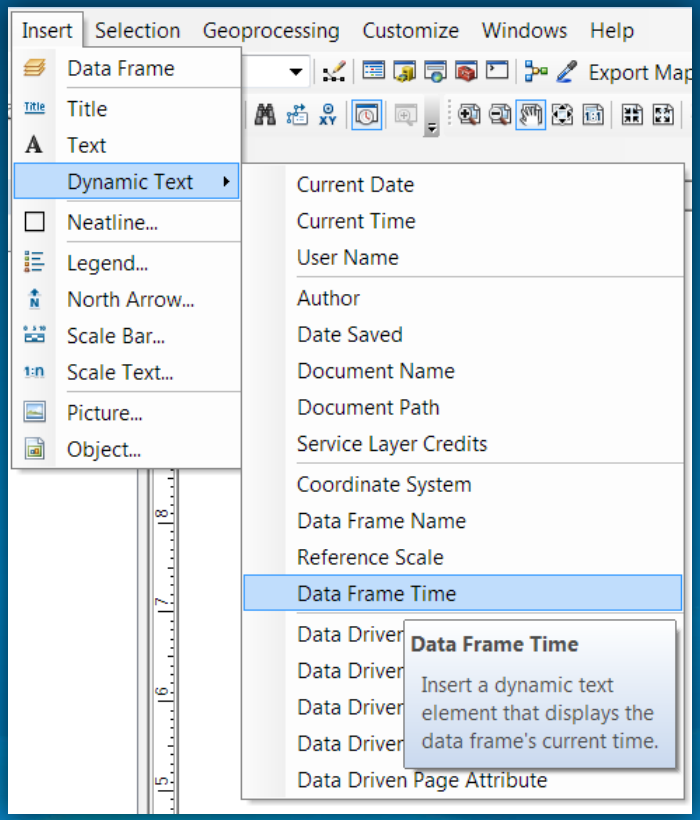
Graphs

- Create a graph using a layer or table
- The graph will animate if the map is time-enabled



Text – Dynamic text

- Insert > Dynamic Text > Data Frame Time
- Layout view only

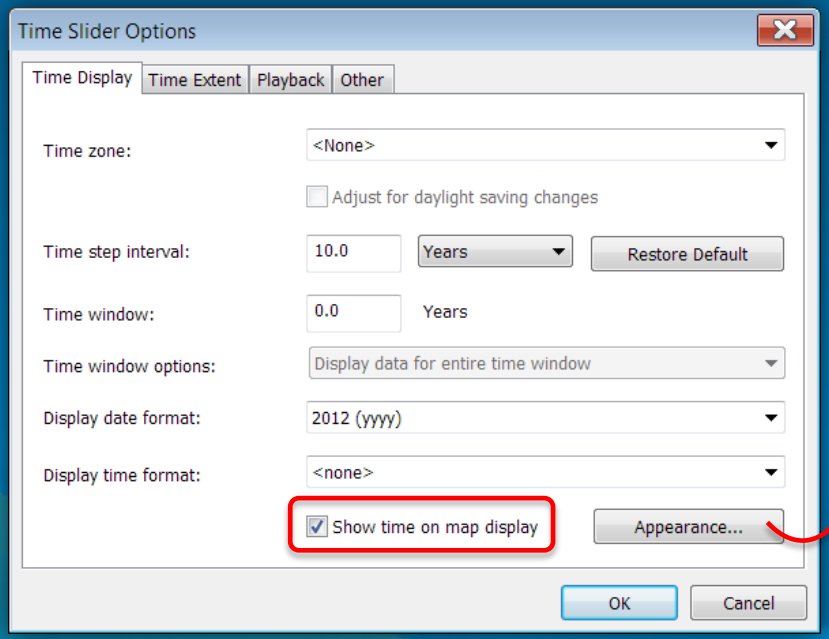


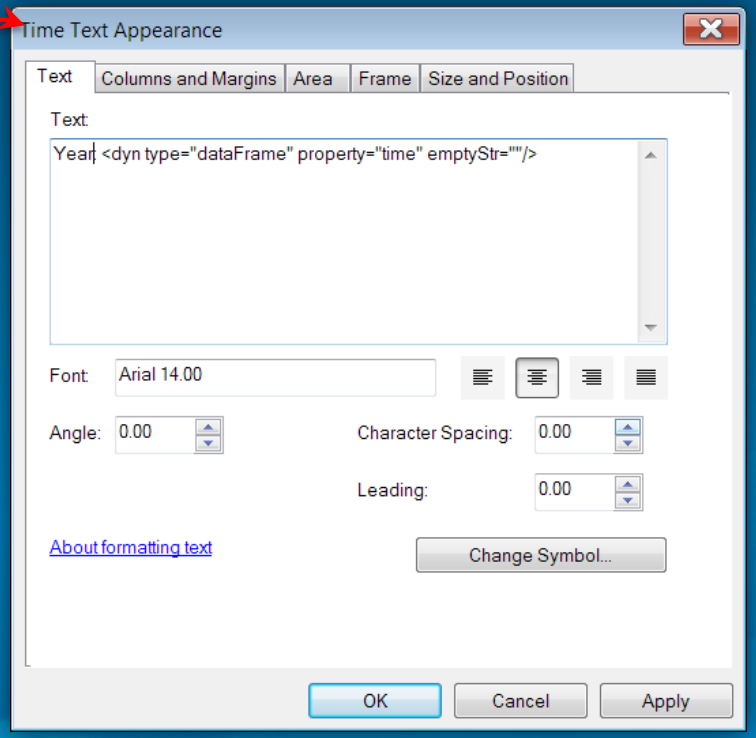
Text – Dynamic text

- **Insert > Dynamic Text > Data Frame Time**

Text – Time text

- New **Time Slider Window > Time Display tab > Show time on map display**
  - **Data view or layout view**





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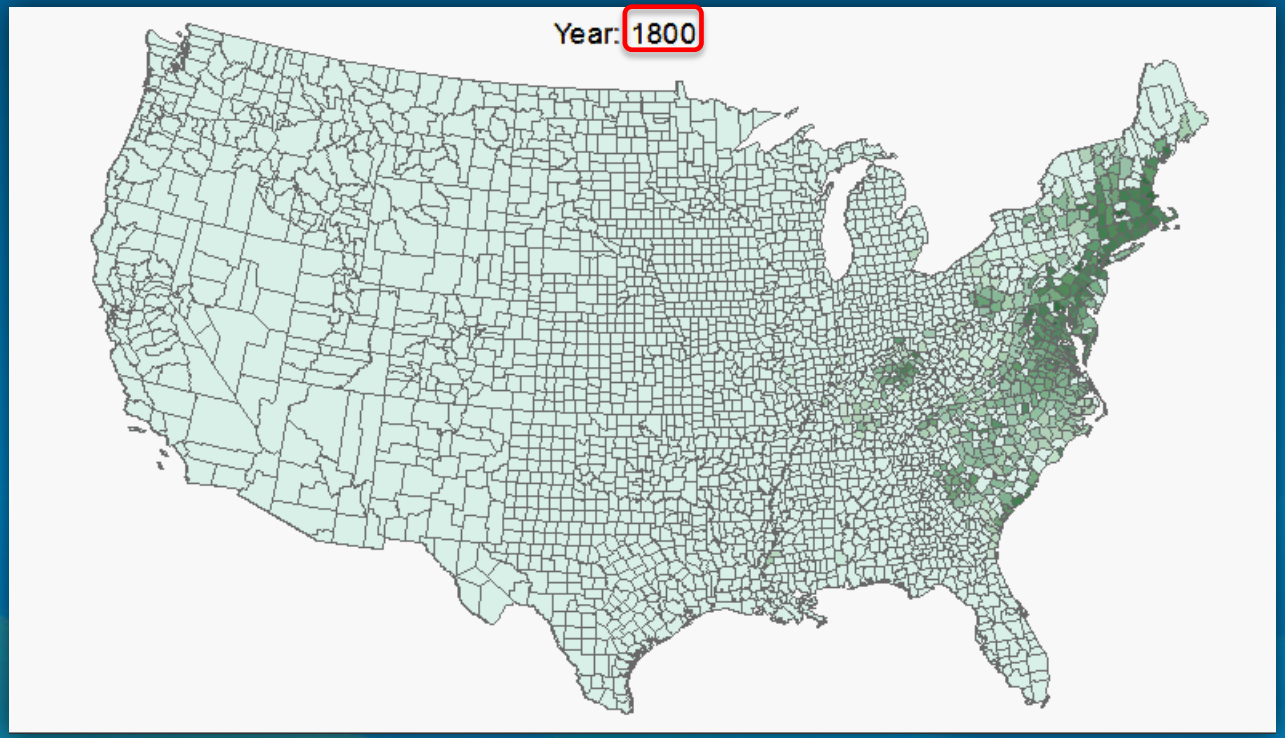


Demonstration

USA County Population, 1800-2000

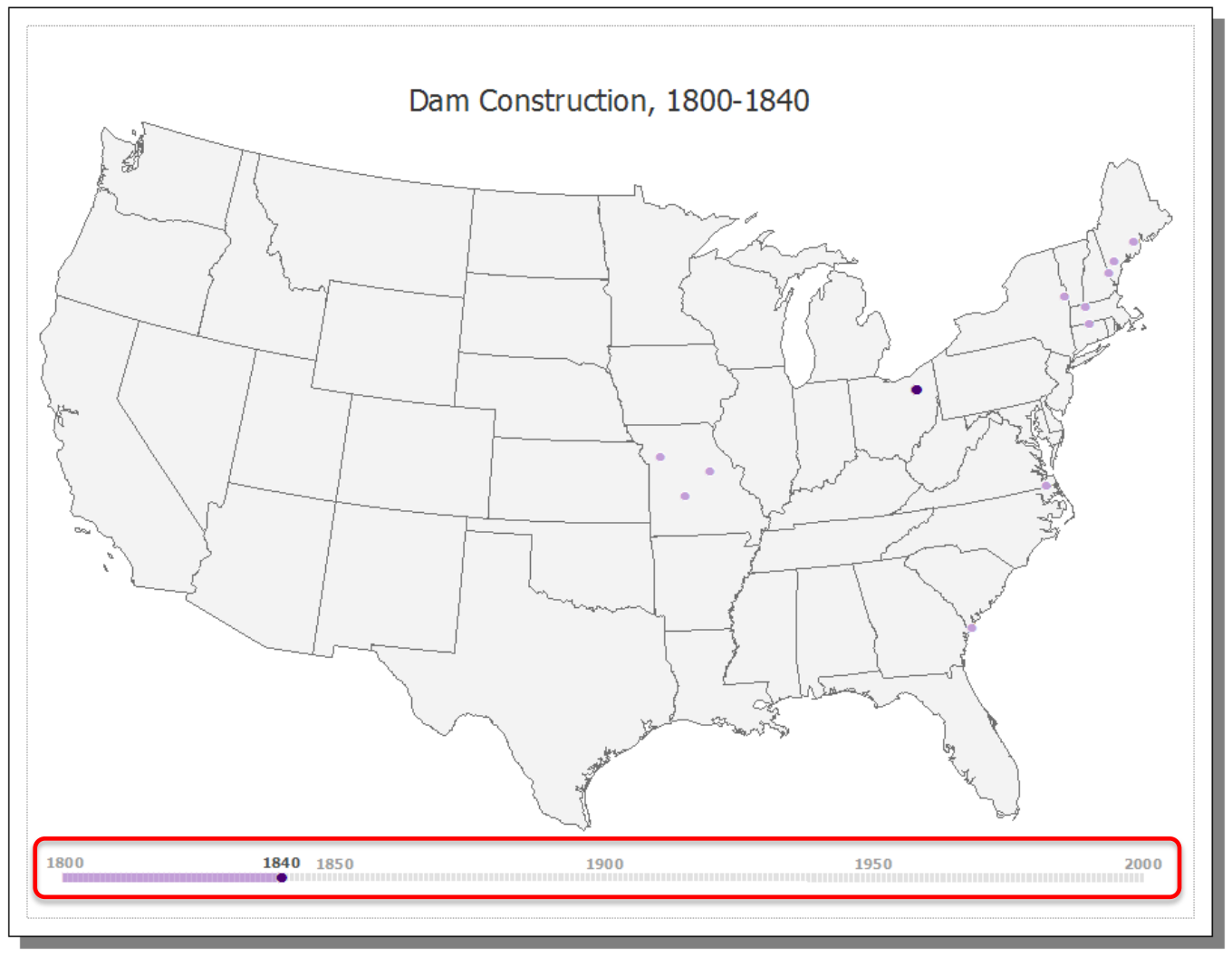
Demonstration

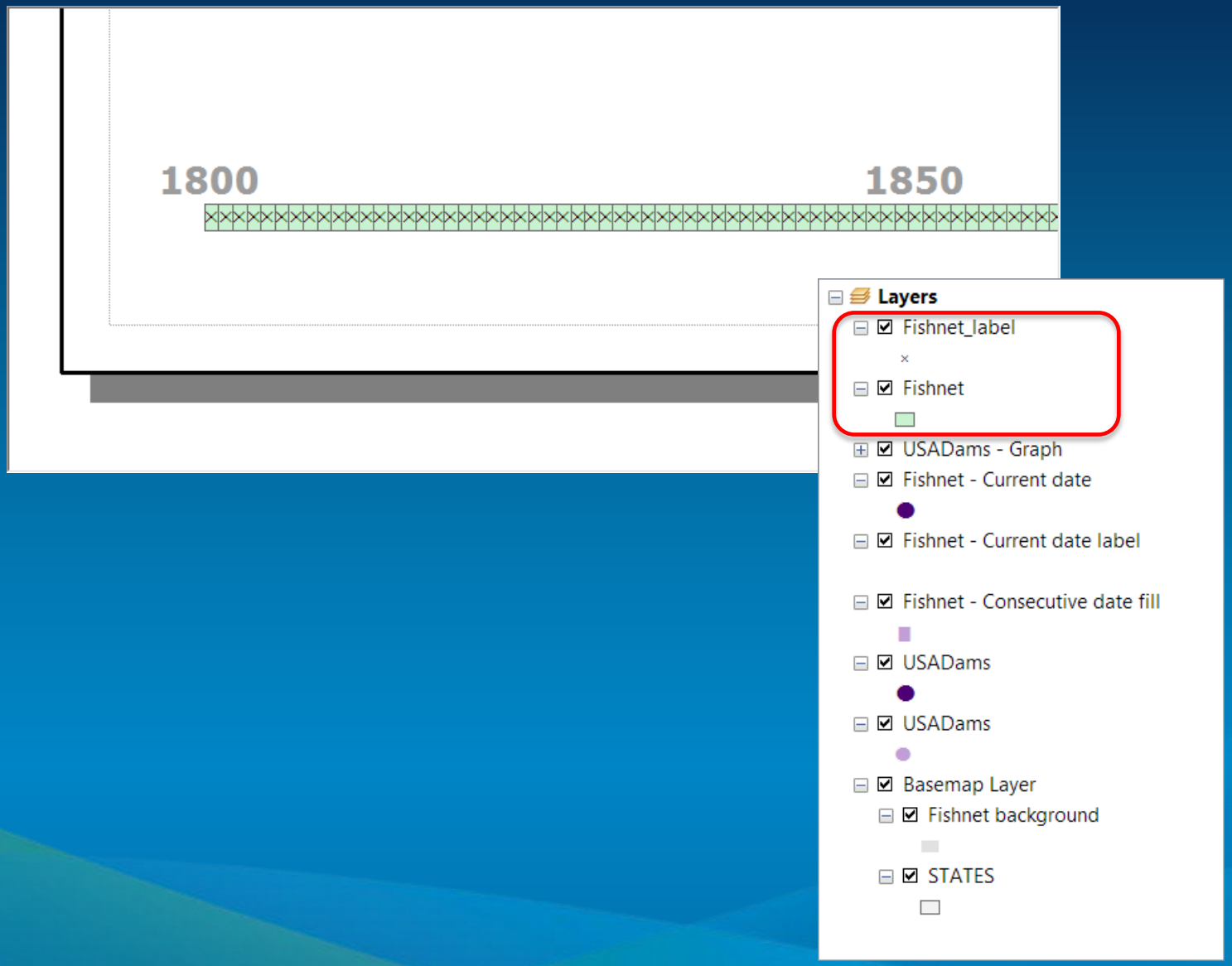
USA Dams, 1800-2000

Dynamic timelines

- Constructed as geographic features
- A Date field is added and calculated
- Time is enabled on the appropriate layers

Example

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1850
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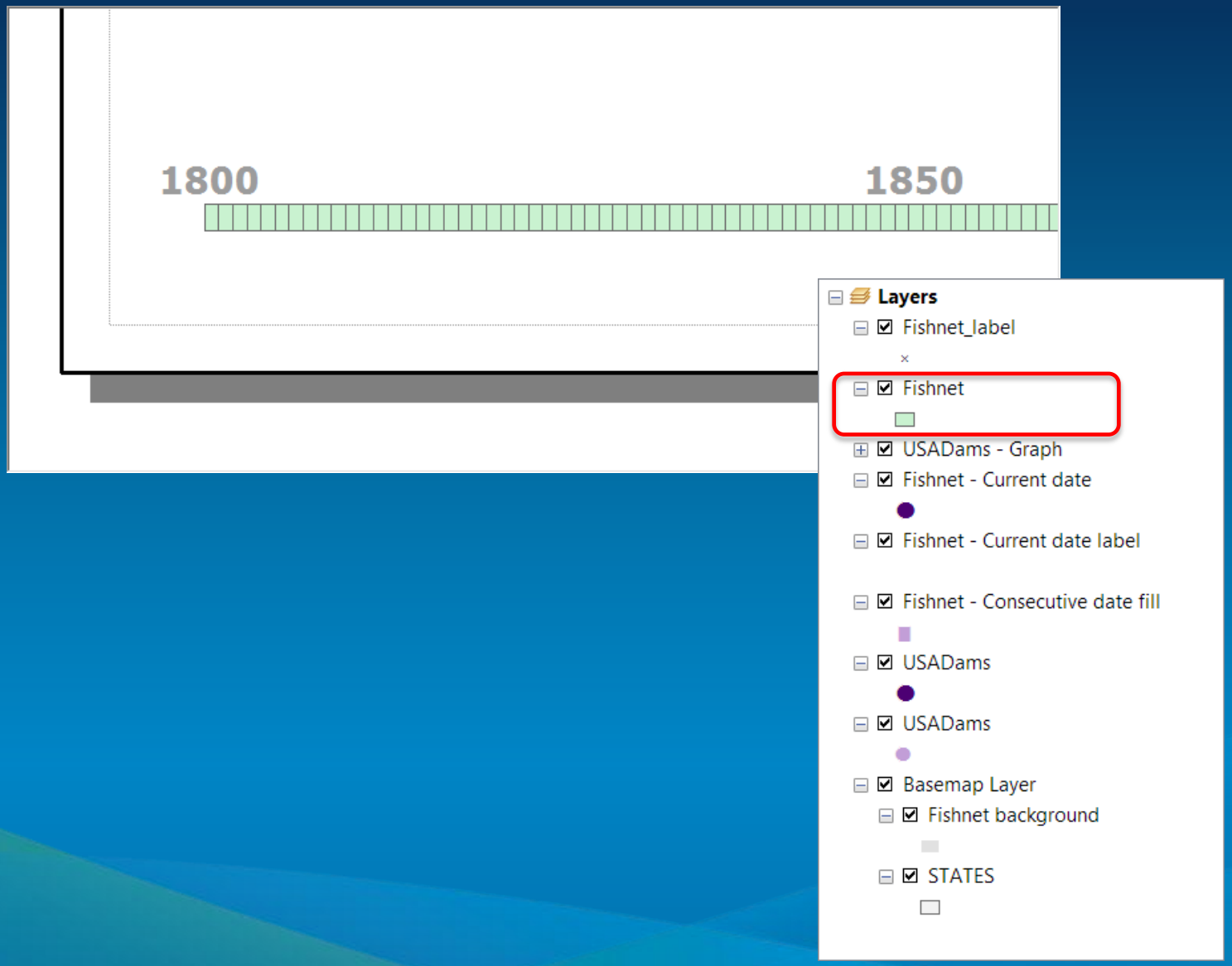
Fishnet_label
Fishnet
USADams - Graph
Fishnet - Current date
Fishnet - Current date label
Fishnet - Consecutive date fill
USADams
USADams
Basemap Layer
Fishnet background
STATES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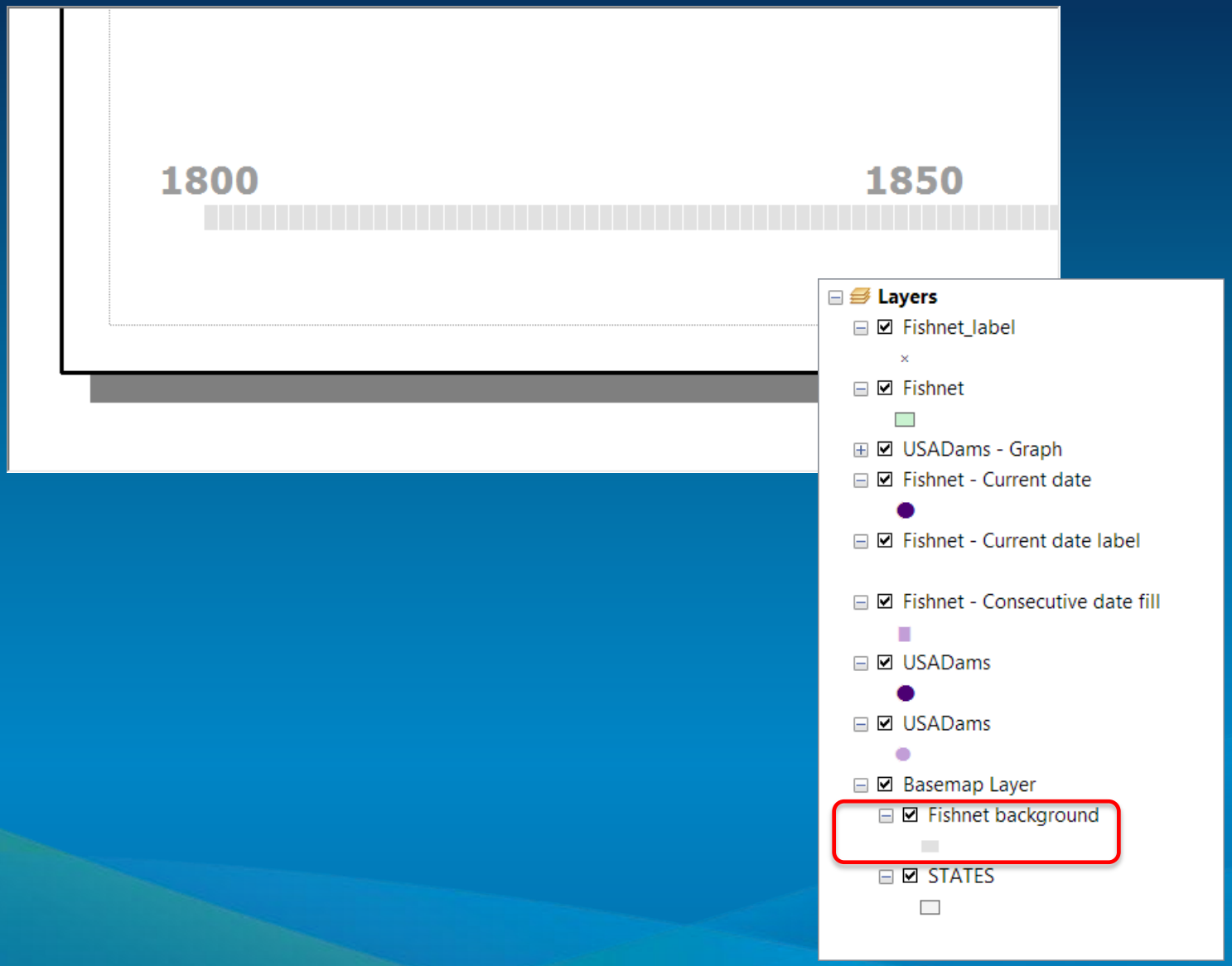
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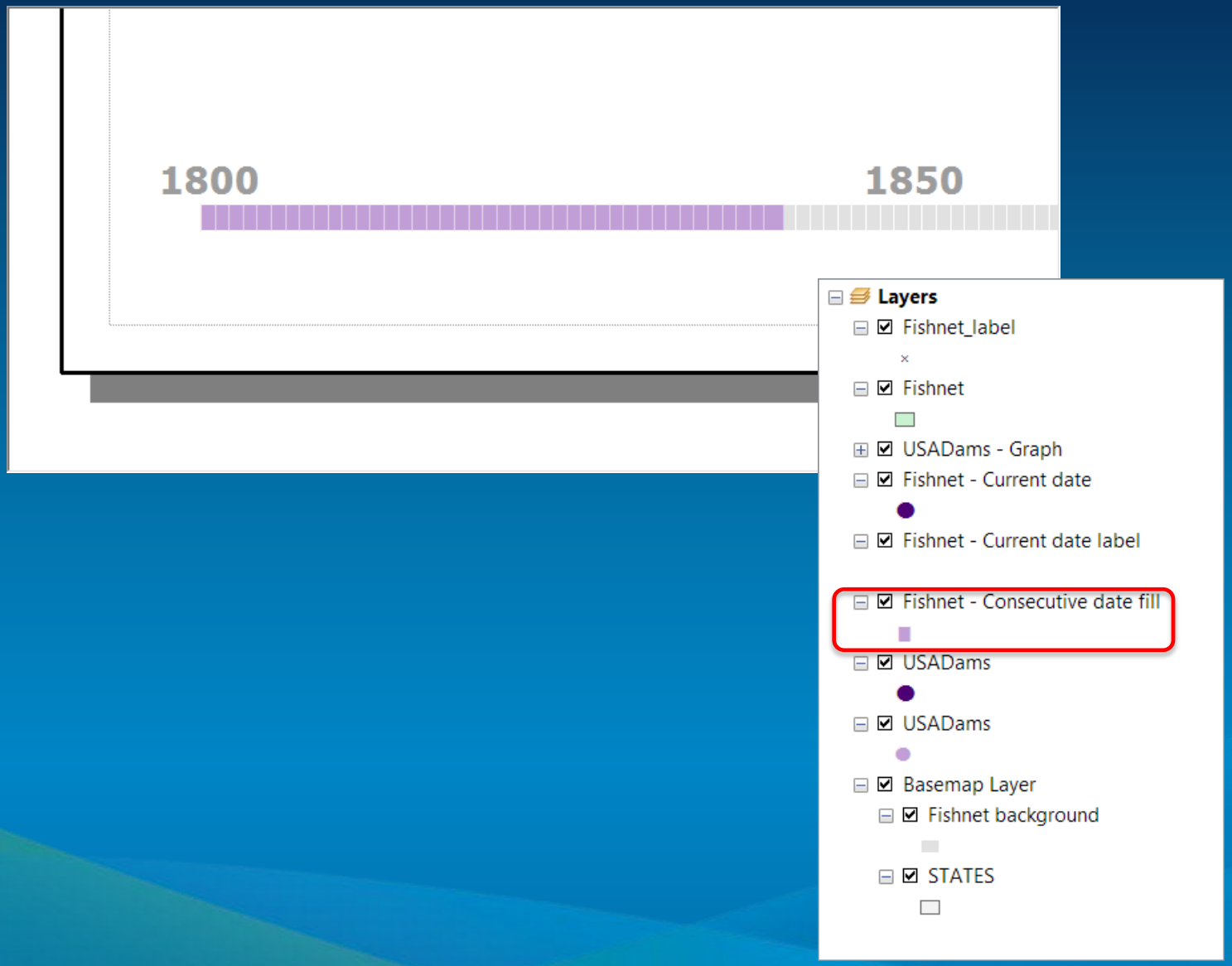
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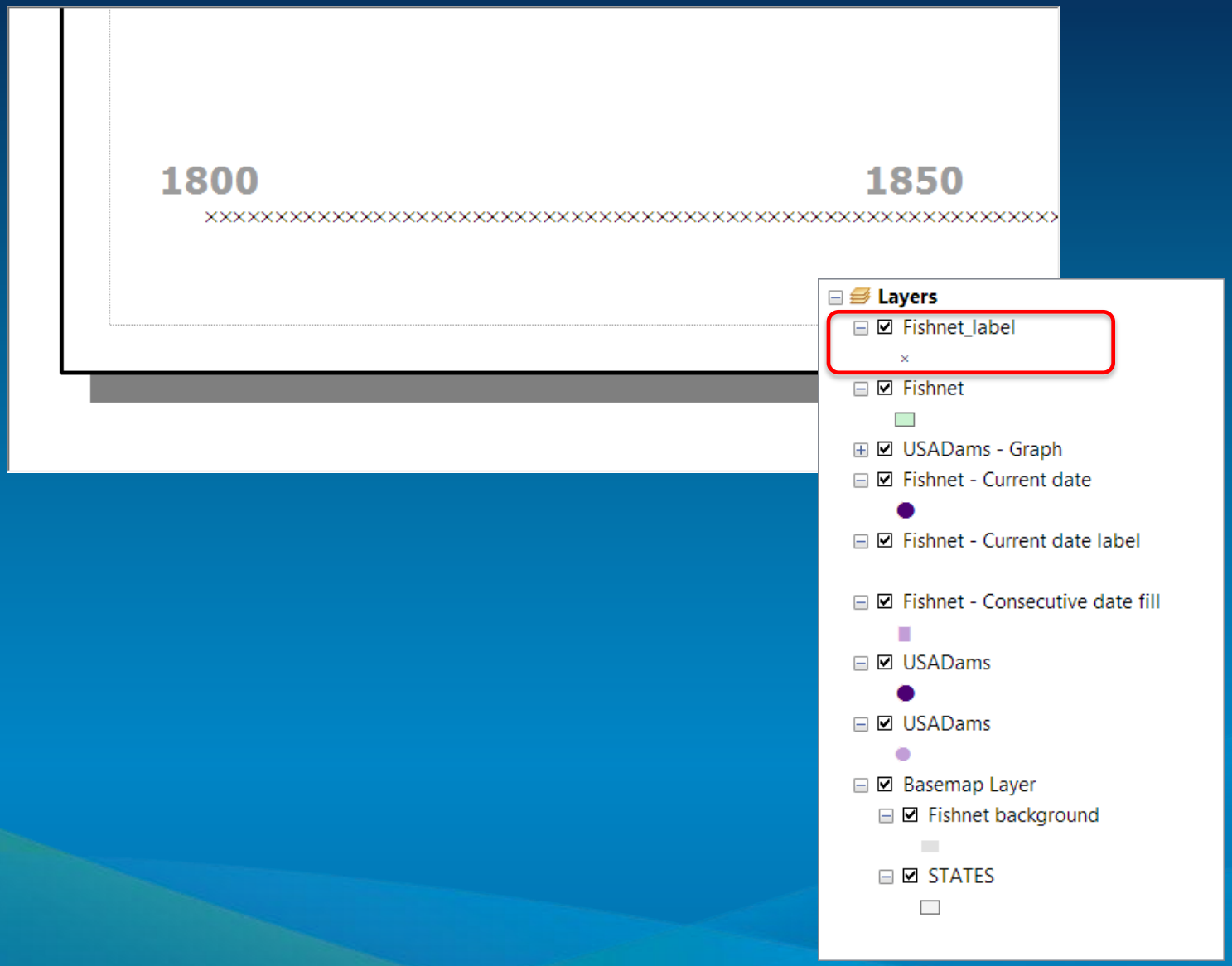
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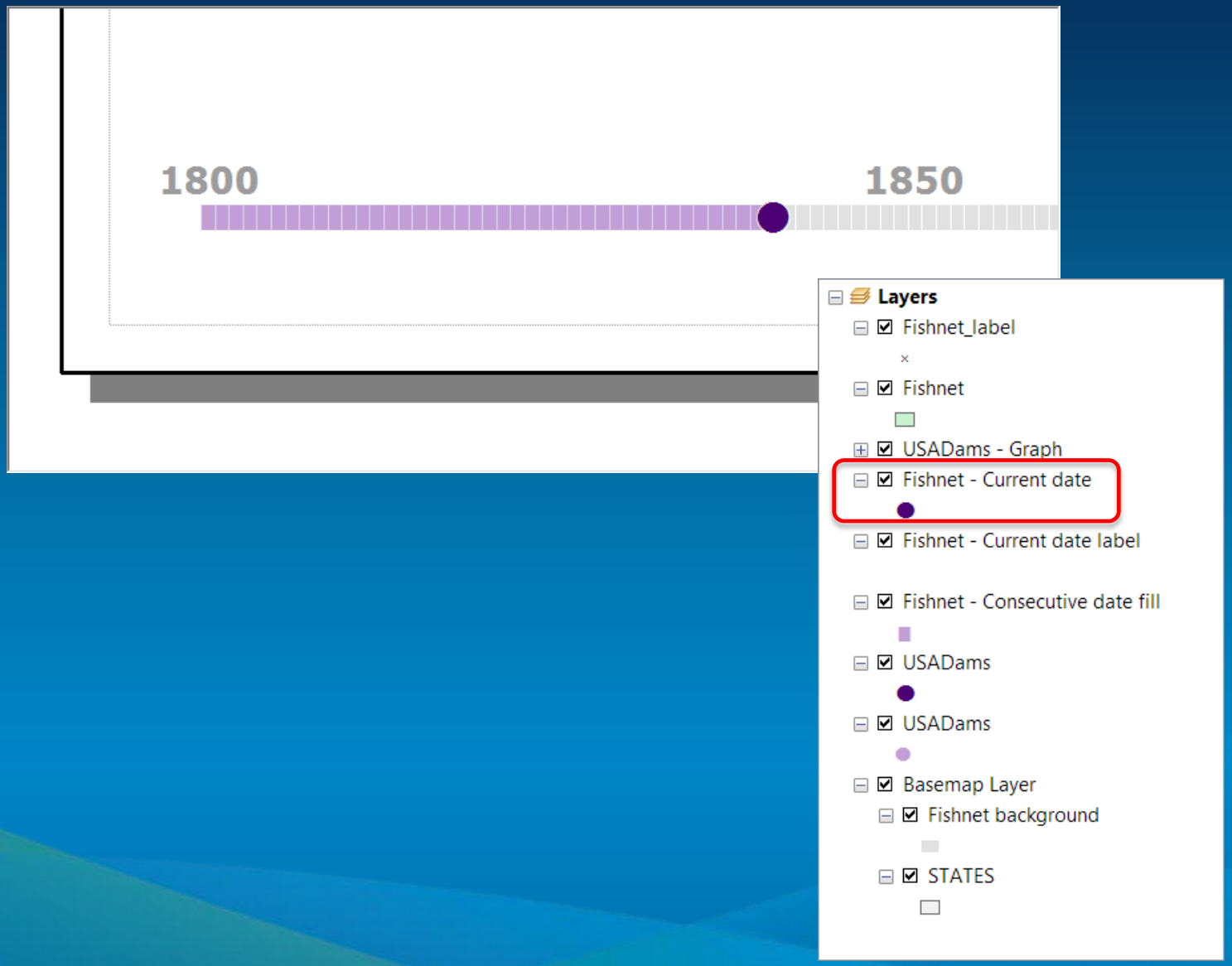
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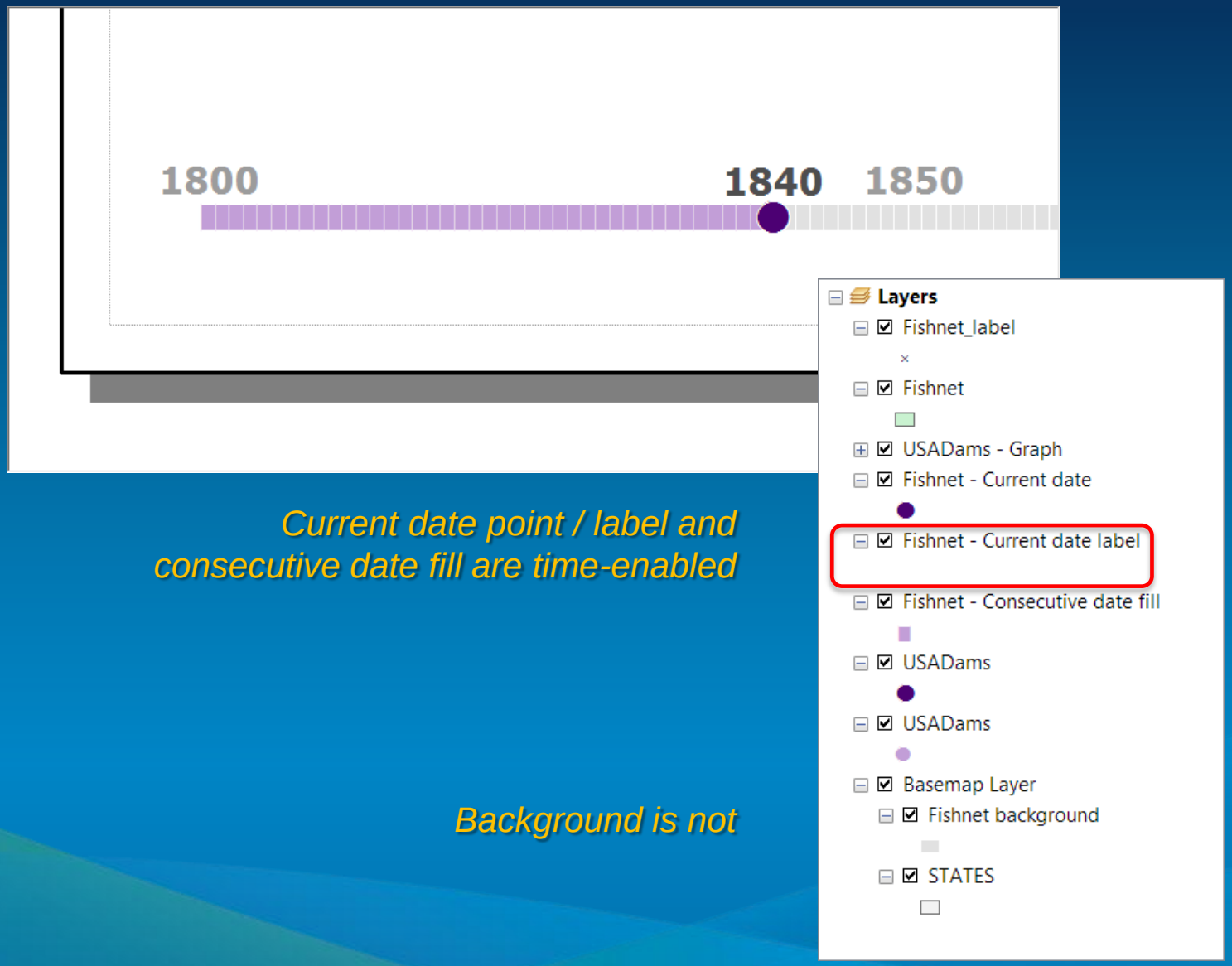
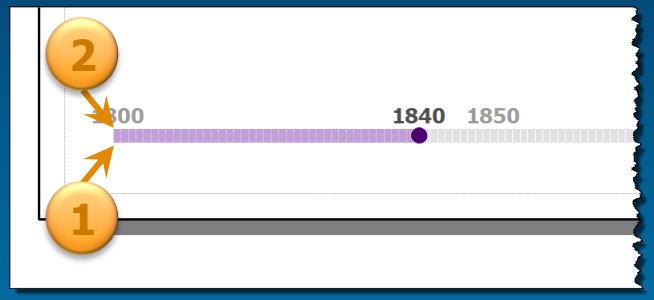
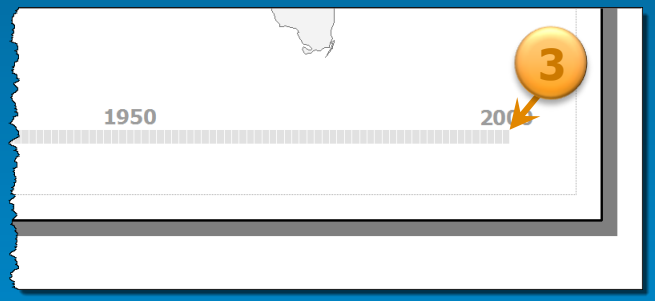


Current date point / label and consecutive date fill are time-enabled

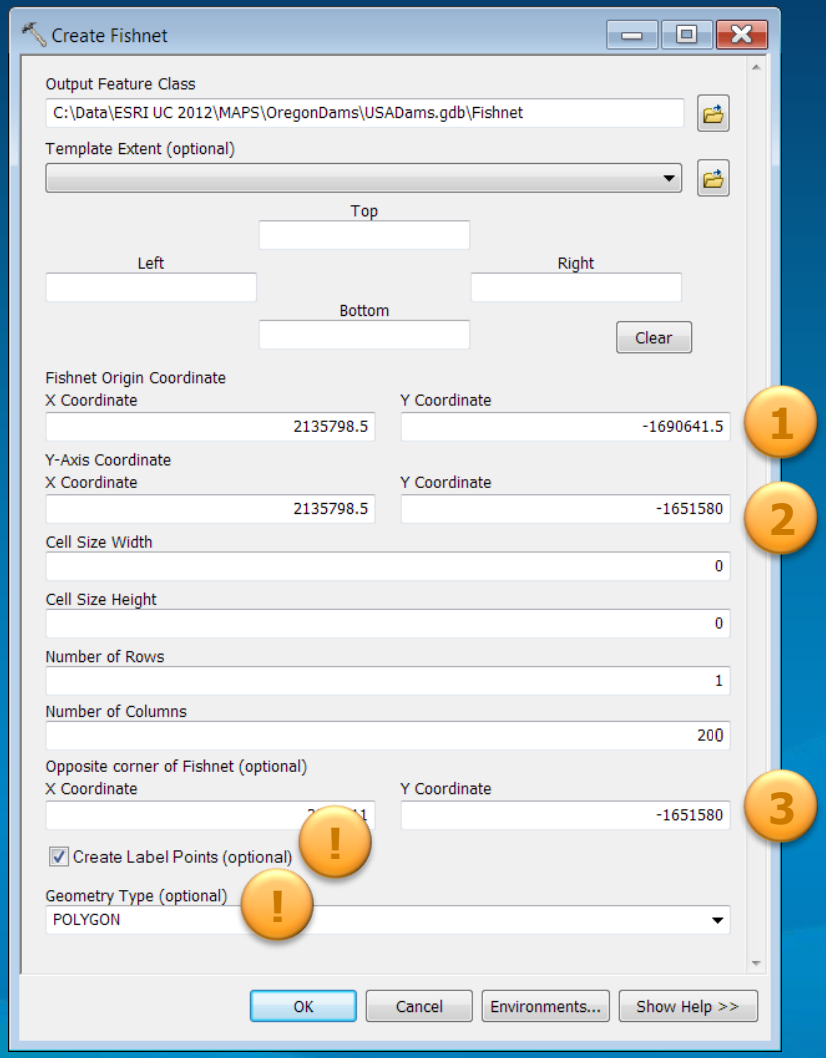
Background is not

Using the Fishnet GP tool





1 row, 200 columns (one for each year)



Analyzing temporal data

ArcGIS spatial statistics GP tools

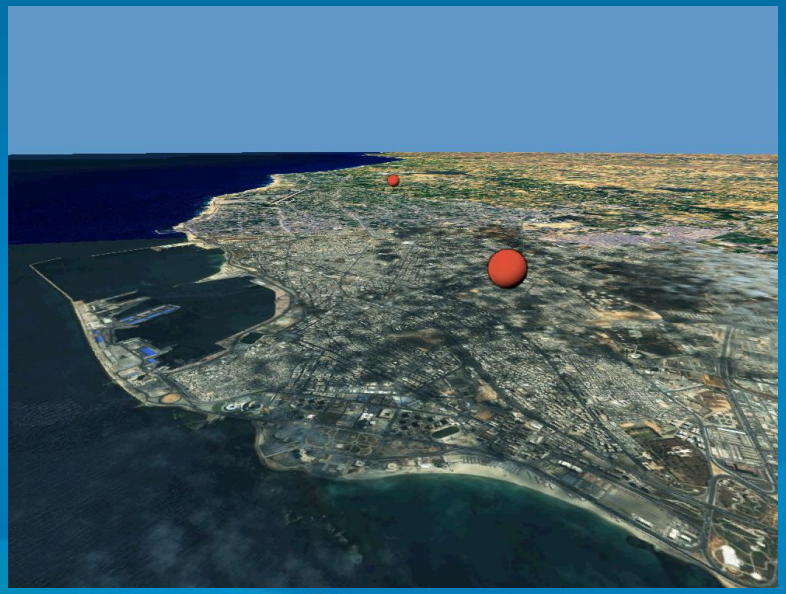
- Existing tools that now incorporate space AND time

New **Hot Spot Analysis** - identify statistically significant hot/cold spots in space and time

New **Cluster and Outlier Analysis** - identify statistically significant spatial outliers in space and time

- New tool that allows space/time constraints

New **Grouping analysis** GP tool



Learn more!

- **What's New in Spatial Statistics (three 20 minute sessions)**
  - Tuesday, July 24, 3:15 PM – 4:25 PM, Room 5 A/B
- **Spatial Pattern Analysis: Mapping Trends and Clusters**
  - Tuesday, July 24, 8:30 AM – 9:45 AM, Room 5 A/B
  - Wednesday, July 25, 1:30 PM – 2:45 PM, Room 5 A/B

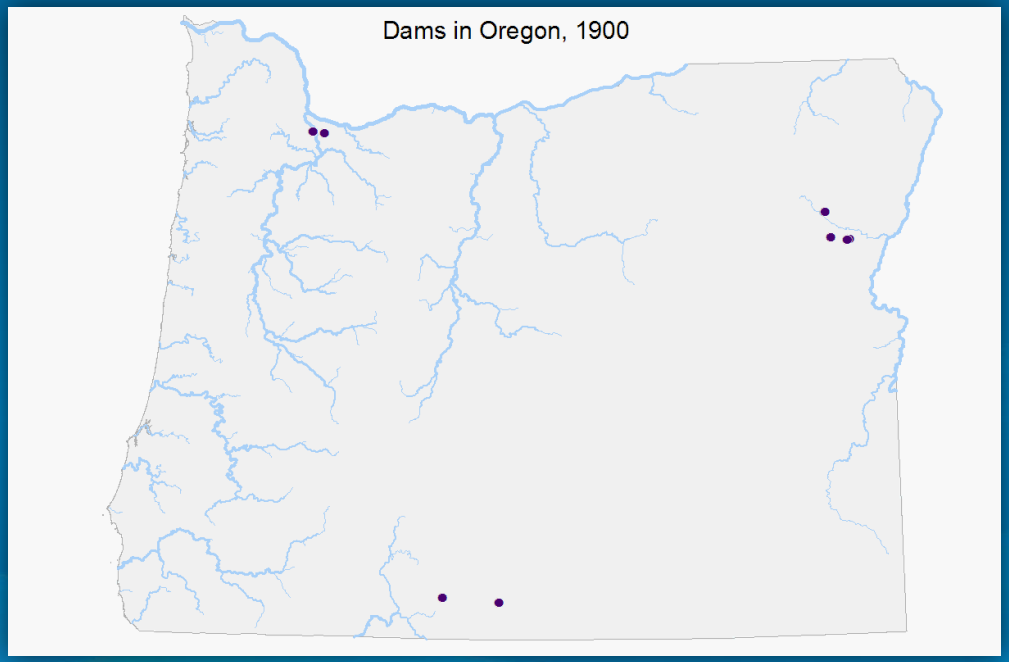
Building temporal visualizations

Tools to build temporal visualizations

- All these work with time-enabled layers
  - Time Slider window
  - Animation tools
  - Timeliner add-in
- Tracking Analyst

Time-enabled layers

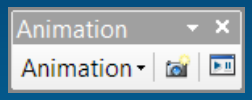
- To visualize data interactively through time
- ArcMap, ArcScene, ArcGlobe
- Special effects with the Time Slider window
  - Time text
  - Time window
  - Time offset
  - Display data cumulatively



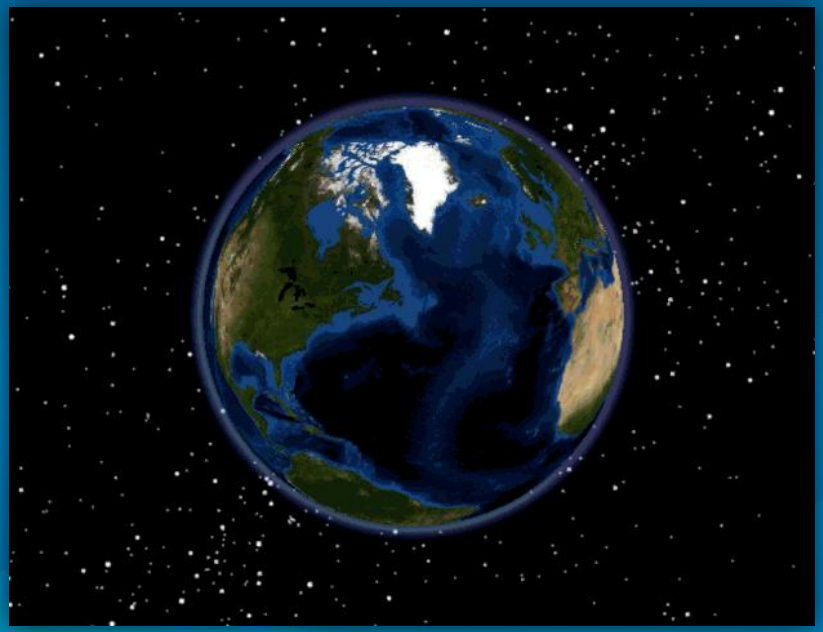
Demonstration

Atlantic Storms, 1995

Animation tools



- Animation toolbar
- ArcMap, ArcScene, ArcGlobe
- Use to create additional visual effects
  - Camera – Move camera along a path (fly-over)
  - Layers – Fade layers in/out with transparency
  - Map view – Pan/zoom
  - Visualize time-enabled data

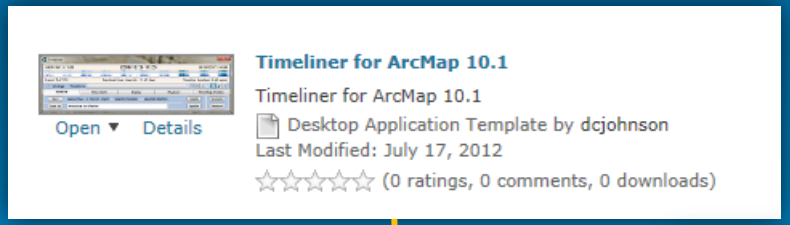


Learn more!

- **Building 2D Animations**
  - Tuesday, July 24, 9:20 AM – 9:40 AM, Room 1 B
  - Thursday, July 26, 4:05 PM – 4:35 PM, Room 3
- **Creating 3D Animations**
  - Tuesday, July 24, 9:30 AM – 10:00 AM, Exhibit Hall B
  - Wednesday, July 25, 1:00 PM – 1:30 PM, Exhibit Hall B

Timeliner add-in

- arcgis.com > search for Timeliner
- http://www.arcgis.com/home/item.html?id=39458d01c4254bc8b34030cbcc2b2415

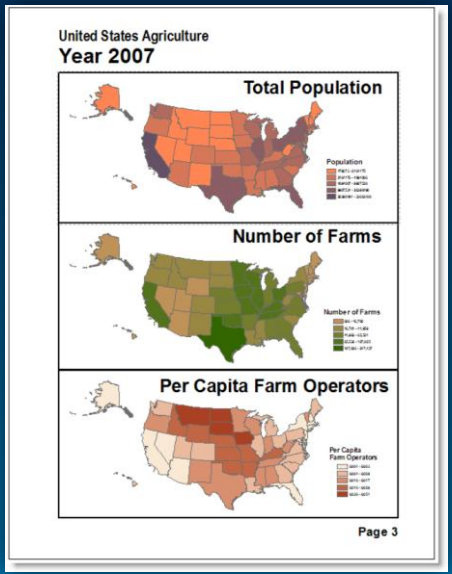


Timeliner

- Differs from Time Slider window
- Navigates from time-stamped data element to time-stamped data element without regard to fixed time period
  - Great for sparse or temporally fragmented data
  - Events can be excluded interactively or based on an attribute
  - Multiple timelines can be named and saved for later use
- Works with feature layers, mosaic datasets, image service layers
- Field type must be Date
- Currently no export option, no support for end time field

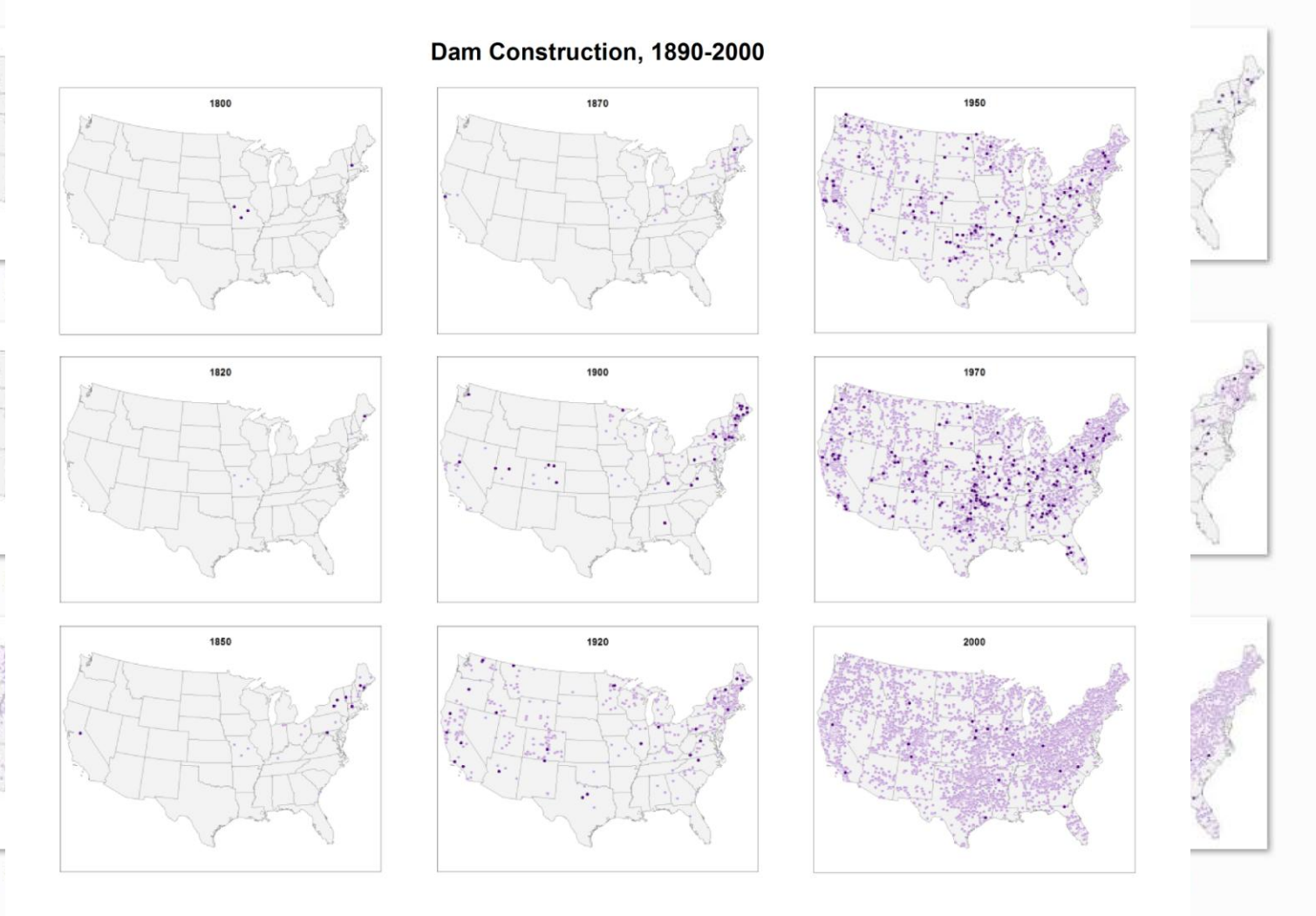
Sharing temporal data

Sharing temporal visualizations



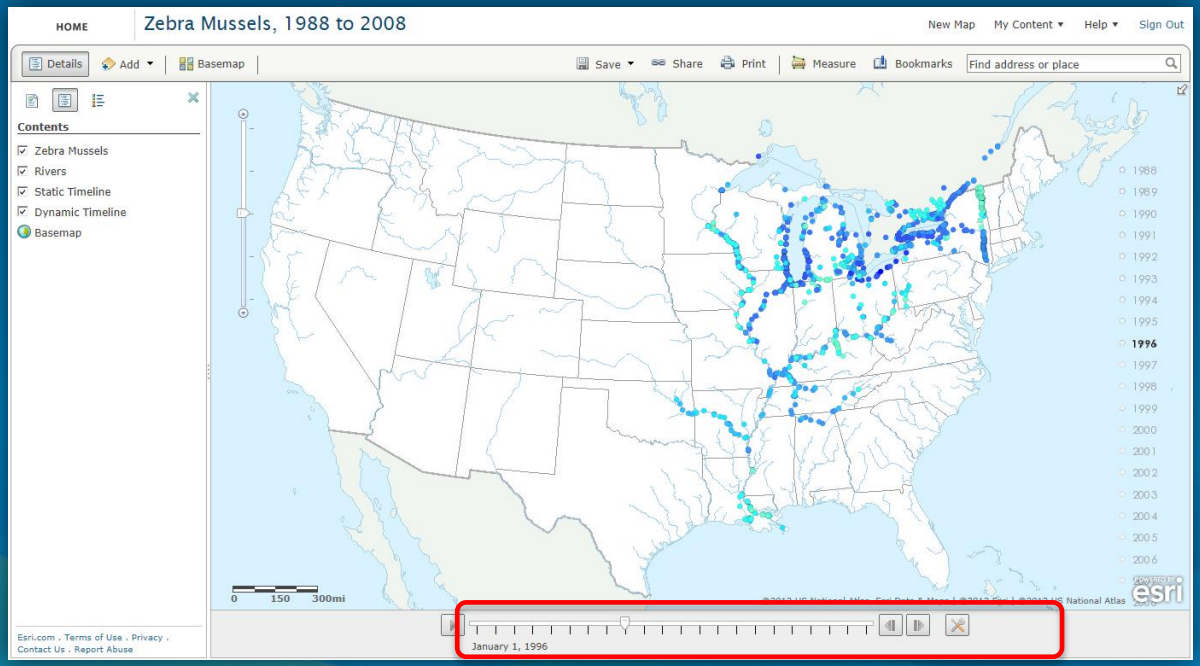
- Time-enabled layer and map packages
- Exports created using Time Slider window or Animation tools
  - Video – AVI
  - Sequential images – BMP or JPG
- Temporal map books created using ArcPy scripting
- Time-enabled web map services

Export sequential images



Time-enabled web map services

- View in ArcGIS Online and Explorer
- Create web maps or embed them in web map apps
- Playback controls added automatically



Review and summary

Review

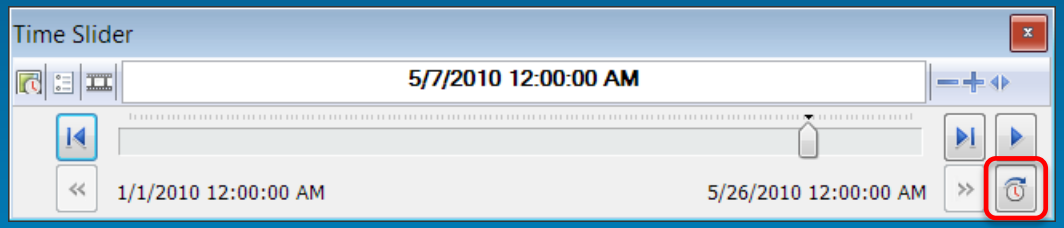
- Visualizing temporal data
- Managing temporal data
- Analyzing temporal data
- Building temporal visualizations
- Sharing temporal visualizations

Summary of best practice recommendations

- Store temporal data in a Date type field when possible
- Index the Date field for faster display and query performance
- Use Data Management GP tools to
  - Convert to supported field types
  - Convert to row format
  - Calculate end time
  - Store temporal data as Standard Time (not DST)

Review - What's new in ArcGIS 10.1? New

- New Visualizing data updates in live mode
  - Allows you to visualize the most recent updates to time-enabled data

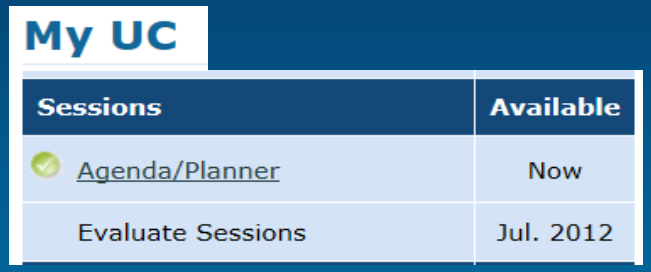


- New Time display improvements (time window, exclude start / end times)
- New Add time text to data view and/or layout view
- New Space-time analysis using GP tools

Please complete an online session evaluation

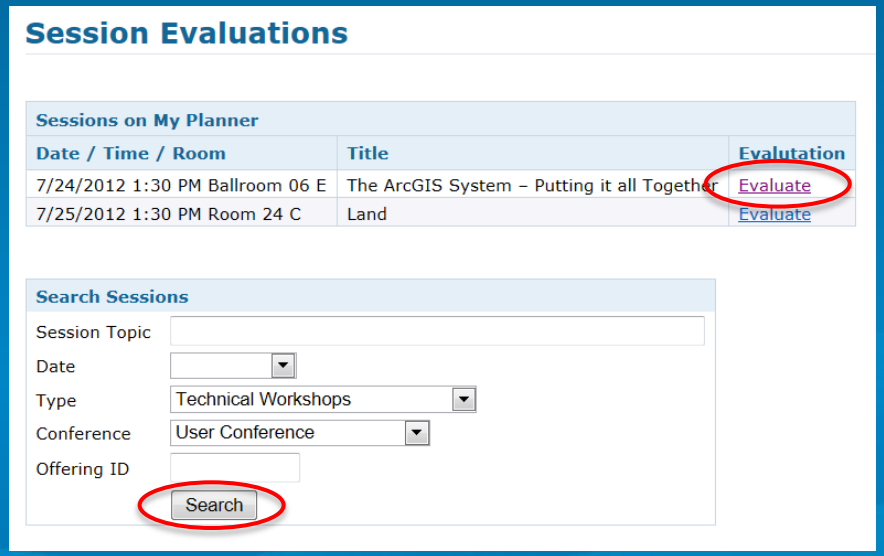
www.esri.com/ucsessionsurveys

1. My UC Homepage > "Evaluate Sessions"



2. Choose session from planner or search for session

ID for this session: 907



Questions?

Online session evaluation:
www.esri.com/ucsessionsurveys

Offering ID: 907

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