



Working with Temporal Data

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Technical Workshop

What is temporal data and why is it important?

Moving features

Feature that move over space



- Planes
- Vehicles
- Animals
- Satellites
- Storms

Discrete events

Events that happens at various locations



- Crimes
- Lightning
- Accidents

Stationary recorders

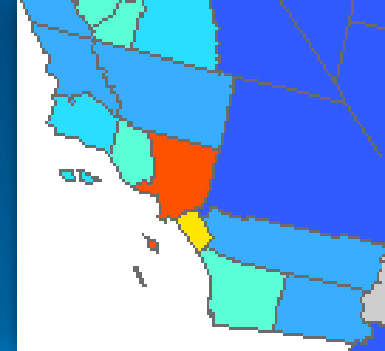
Features stay in one place and record changes



- Weather stations
- Traffic sensors

Change / growth

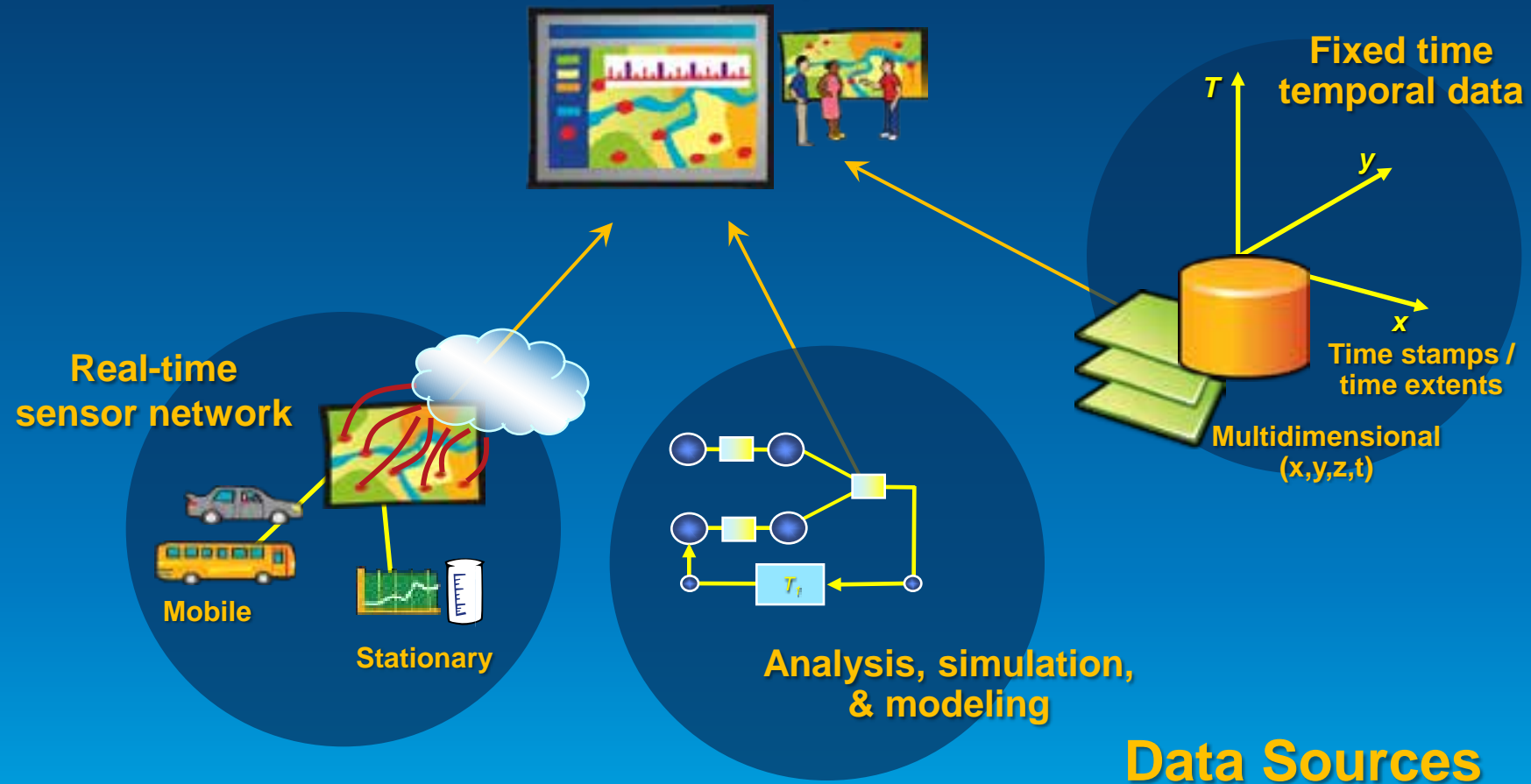
Change or growth over an area



- Demographics
- Fire perimeter

GIS integrates temporal data

Temporal maps

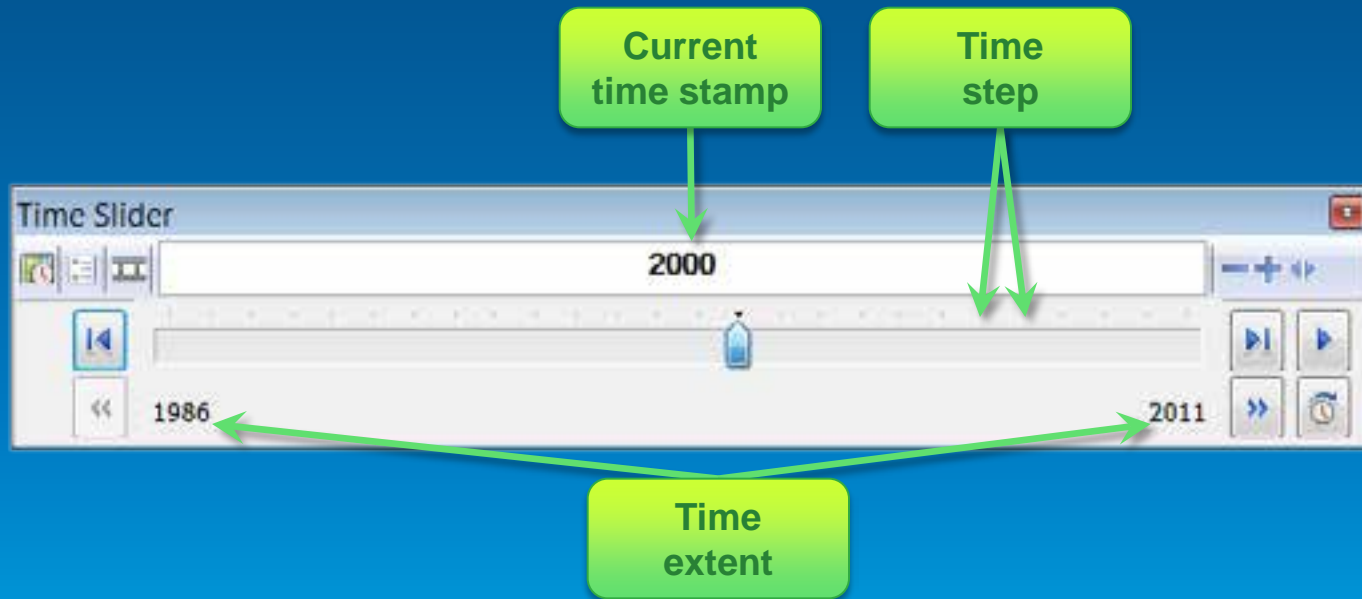


ArcGIS built time into GIS

- **Unified experience for time**
 - **Part of Desktop, Engine, and Server products**
- **Geoprocessing (GP) tools**
 - **Data management tools**
 - **Time-aware analysis tools**
- **Ability to share temporal data/maps**
 - **Packages, videos, images, temporal map books, map services, web maps, web map apps**

ArcGIS terms

- **Time-enabled layer** – layer enabled to display time
- **Time Slider window** – tool to work with those layers



Time-stamps

Single time field

OBJECTID	Shape *	Rank	Place	Population	X_coord	Y_coord	Year *
870	Point	87	Akron, OH	42728	-81.517899	41.073156	1900
963	Point	81	Akron, OH	69067	-81.517899	41.073156	1910
1014	Point	32	Akron, OH	208435	-81.517899	41.073156	1920
1117	Point	35	Akron, OH	255040	-81.517899	41.073156	1930
1220	Point	38	Akron, OH	244791	-81.517899	41.073156	1940
1321	Point	39	Akron, OH	274605	-81.517899	41.073156	1950
1427	Point	45	Akron, OH	290351	-81.517899	41.073156	1960
1534	Point	52	Akron, OH	275425	-81.517899	41.073156	1970
1641	Point	59	Akron, OH	237177	-81.517899	41.073156	1980
1753	Point	71	Akron, OH	223019	-81.517899	41.073156	1990
1878	Point	97	Akron, OH	217074	-81.517899	41.073156	2000

Start and end time fields

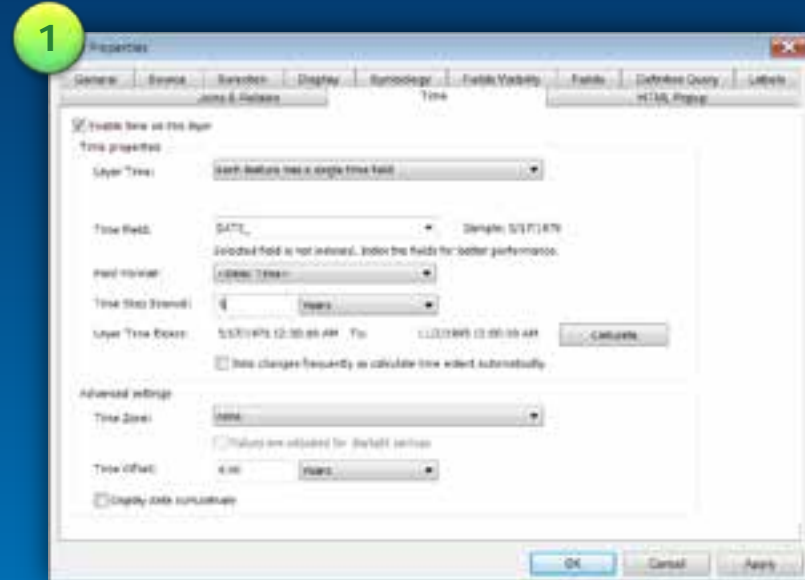
OBJECTID *	Raster	Name	Start_Year	End_Year
1	<Raster>	CA_Redlands_101880_1996_24000_1996	1996	1996
2	<Raster>	CA_Redlands_294582_1967_24000_1980	1980	1988
3	<Raster>	CA_Redlands_294584_1967_24000_1988	1988	1996
4	<Raster>	CA_Redlands_294587_1954_24000_1954	1954	1967
5	<Raster>	CA_Redlands_294588_1967_24000_1967	1967	1973
6	<Raster>	CA_Redlands_294589_1967_24000_1973	1973	1980

Working with time-enabled layers

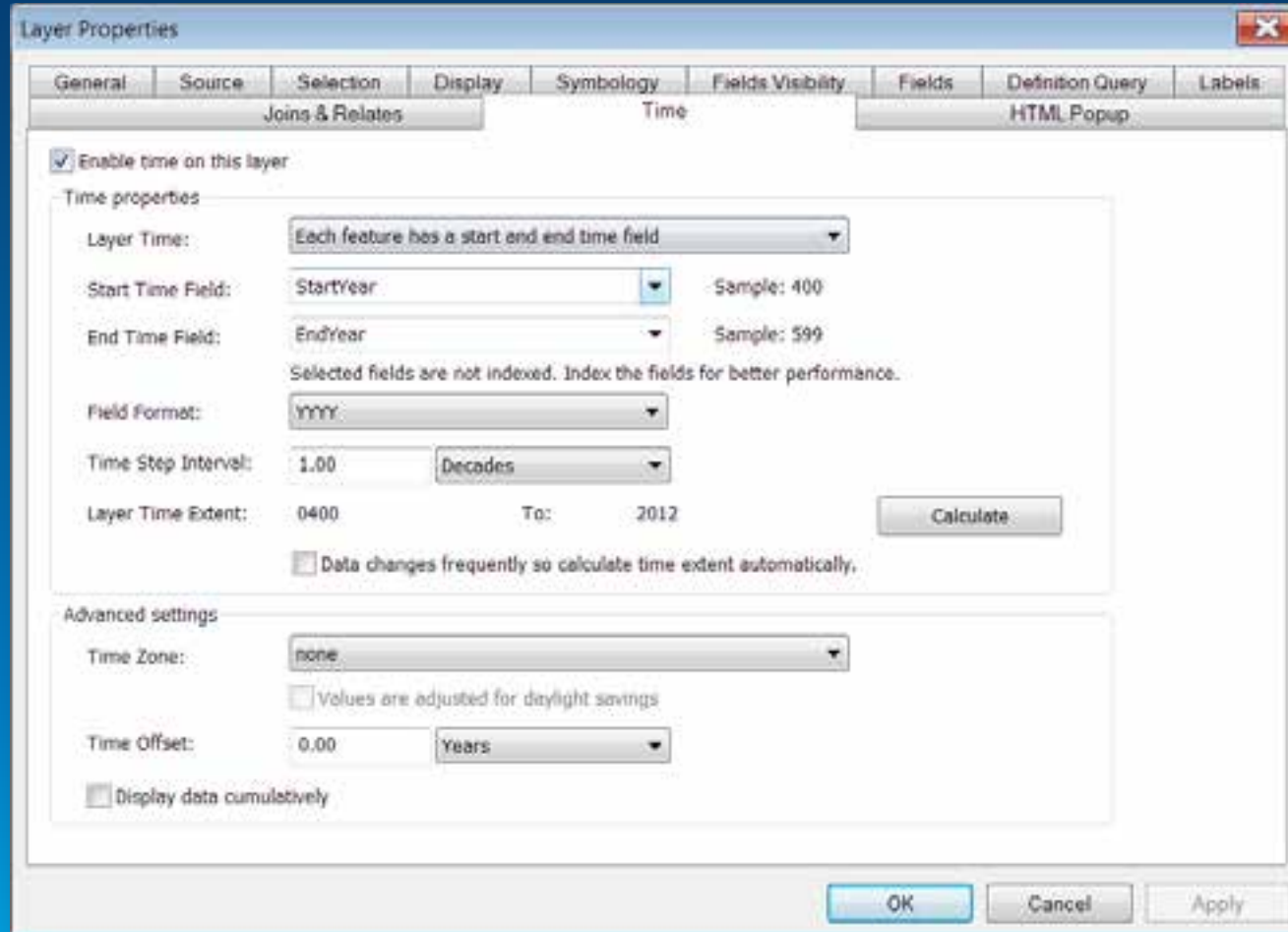
- Two-step process

1 Configure time properties on the layer

2 Use Time Slider window to work with the layer



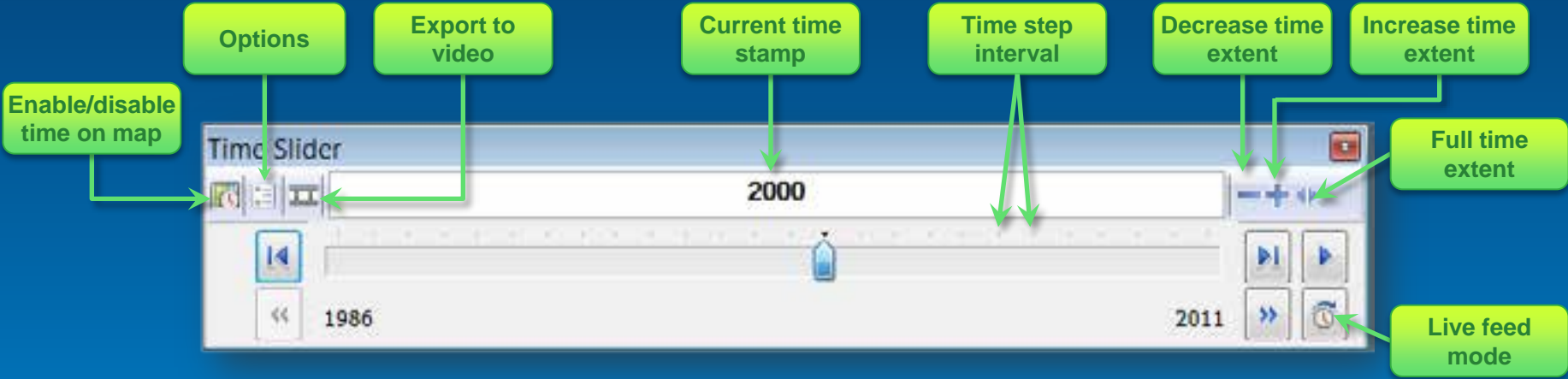
Time Properties on a layer



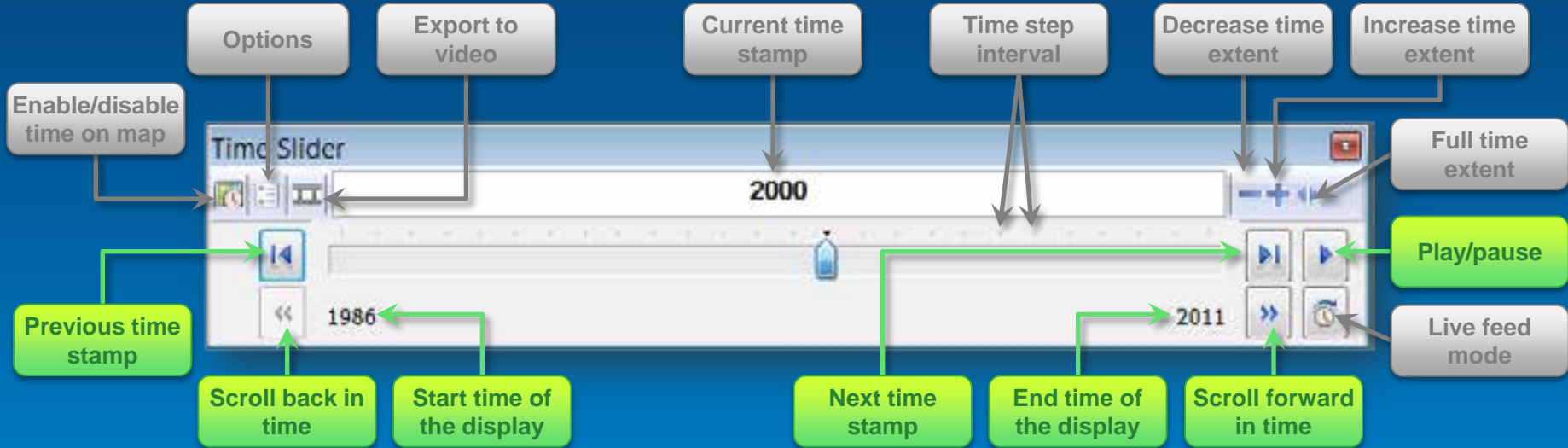
Working with time-enabled layers

- **Set additional display properties**
 - Display data cumulatively
 - Time offset
 - Time window
 - Time text
 - Dynamic text

Time Slider window



Time Slider window – Playback controls



Dynamic nature of the data and display

- The temporal nature of the data is intuitively expressed in a dynamic map
- But it is more complex!



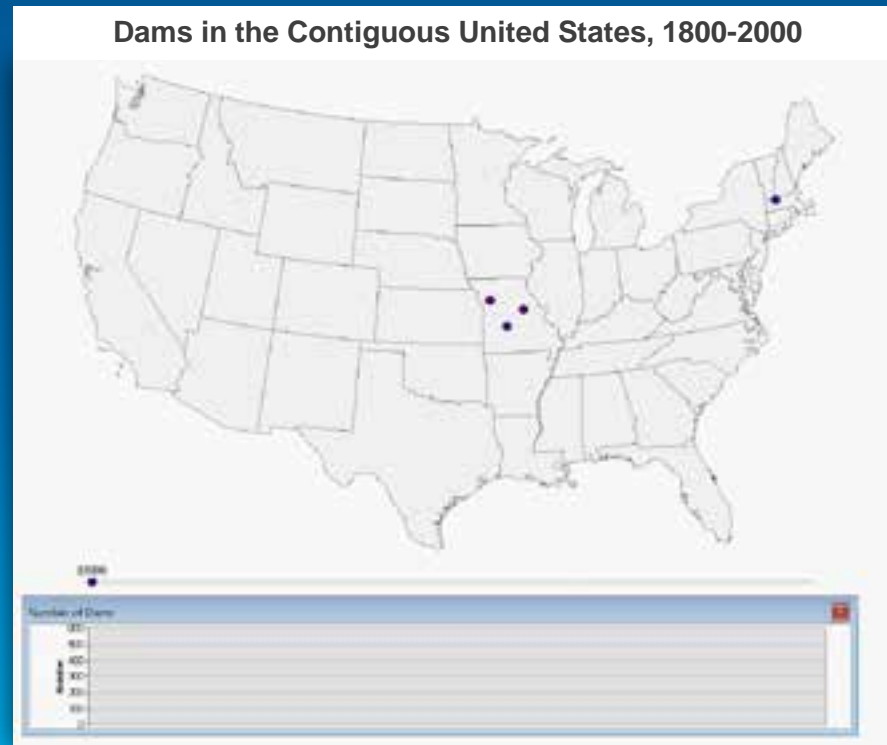
Dynamic versus animated maps

- **Dynamic maps** – show changes in feature shape/position and/or attributes over time
- **Animated maps** – a type of dynamic map but there are others
 - Change in perspective, like a fly-through
- Use Animation tools

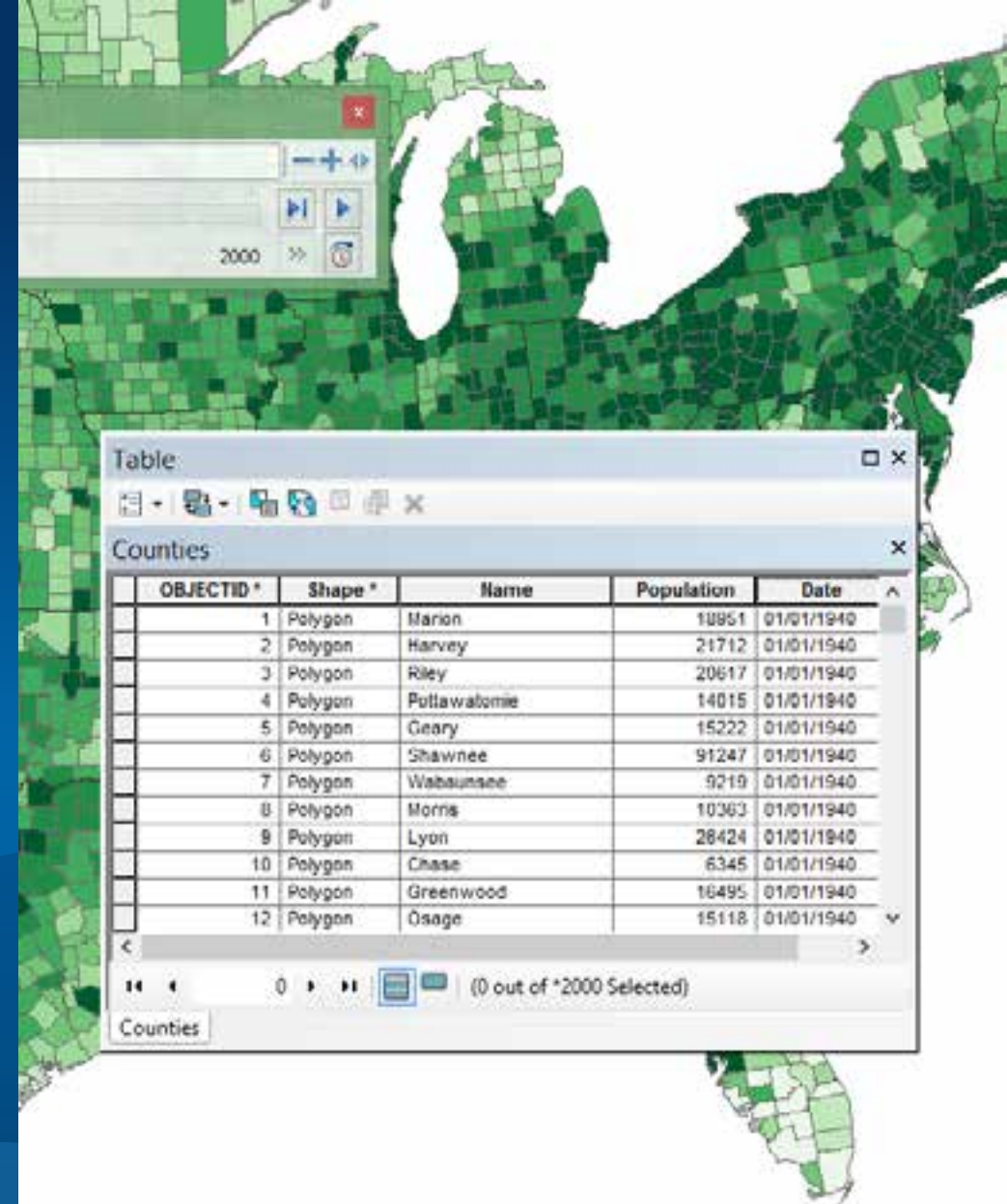


Temporal graphs

- Create a graph that relates to a table or a layer
- The graph will animate if the table or layer it is created from is time-enabled



Managing temporal data



Supported data types

- **Let's look at each of these in detail in the next few slides:**
 - **Feature layers**
 - **Mosaic datasets**
 - **Raster catalogs**
 - **Tables**
 - **NetCDF layers**
 - **Tracking layers**
 - **Network dataset layers with traffic data**
 - **Video layers**

Managing temporal data

- **Supported data types**
- **Storing time stamps**
- **Tools to migrate and convert data**

Feature layers – Separate features

- Feature shape/position change over time
- A new feature for each time stamp
- Attribute values can change over time

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
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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

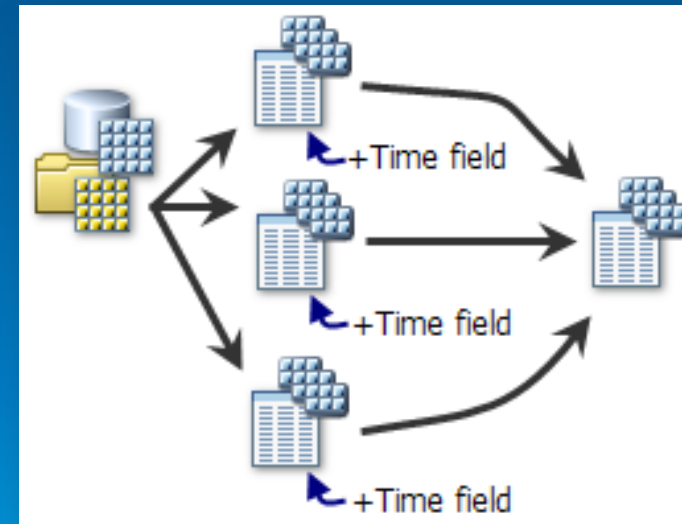
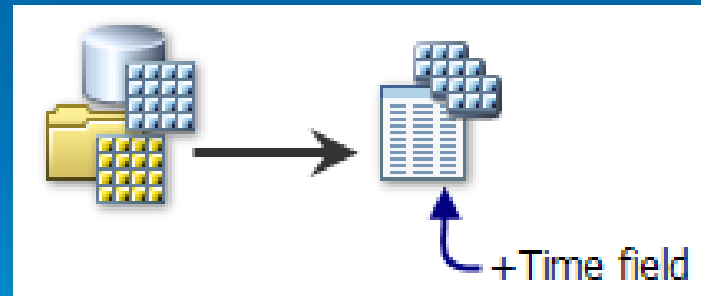
- Feature layers with one-to-one or one-to-many join
- Feature shape/position is constant
- Attribute values change over time

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

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

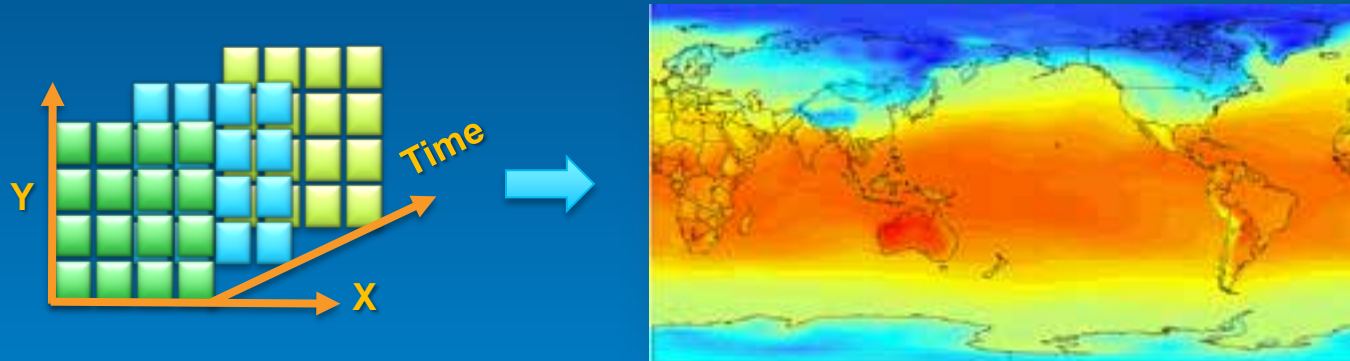
Mosaic datasets and raster catalogs

- Field containing time information
- Two primary ways to organize the data:
 - A single mosaic dataset for all imagery
 - Multiple mosaic datasets in a master mosaic dataset



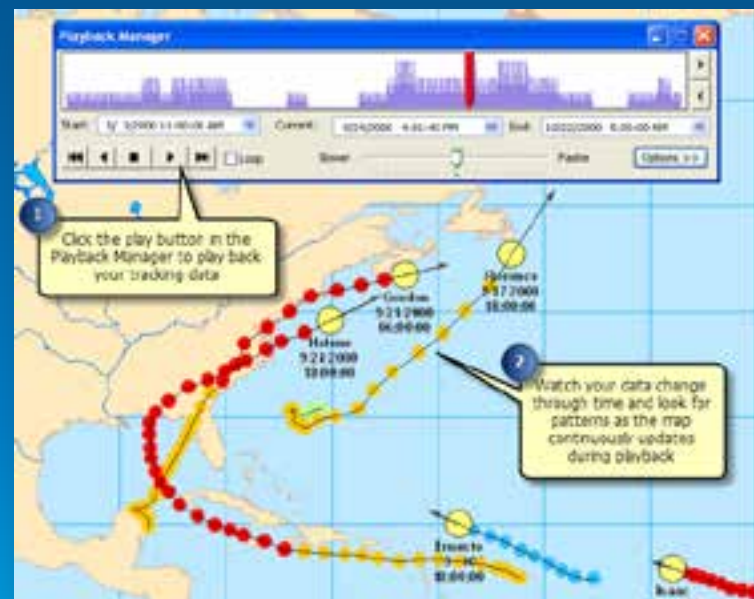
NetCDF layers

- A file format for storing multidimensional data
 - X, Y, Z, T, temperature, pressure, salinity, wind speed,...



Tracking layers

- Tracking Analyst extension
 - View objects that move or change through time
- Track objects in real time
- Temporal symbology



Managing temporal data

- **Supported data types**
- **Storing time stamps**
- **Tools to migrate and convert data**

Date field type

- A field type that stores dates, times, or dates and times
- Most efficient format for query and display performance
 - Supports more sophisticated database queries
- Easiest to configure on the layer

 **Index the field for faster display and query performance**

Number and Text field types

- Only “sortable” formats are supported
 - YYYYMMDD 20140709 > 20130709 = TRUE
 - MMDDYYYY 07092014 > 08092013 = FALSE
- Named month is not supported
 - AUG-09-2013 would come before JUL-09-2013

 Index the field for faster display and query performance

Converting between time formats

- **Convert Time Field** GP tool
 - Converts custom Text/Number formats into a new Date field
 - “**July 09, 2013**” → **07/09/2013**

Input time field with
custom format
MMMM d, yyyy HH:mm:ss

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

Setting duration

- **Calculate End Time** GP tool
 - Populates an end time field with the next record's start time
- **The last record will not have a duration**
 - The end time is calculated to be the same as the start time of the feature

Start_Time	End_Time
1/5/2010 6:00:00 AM	1/6/2010 1:00:00 PM
1/6/2010 1:00:00 PM	1/7/2010 4:00:00 PM
1/7/2010 4:00:00 PM	1/8/2010 11:00:00 AM
1/8/2010 11:00:00 AM	1/10/2010 2:00:00 PM
1/10/2010 2:00:00 PM	1/10/2010 2:00:00 PM

Temporal data stored in multiple columns

- **Transpose Fields** GP tool
 - Shifts data entered in columns into rows

STATE_NAME	Y1980	Y1981	Y1982
Alabama	539	706	707
Alaska	180	215	274
Arizona	109	115	117
Arkansas	101	113	136
California	20	22	25
Colorado	0	0	0
Connecticut	106	105	115



STATE_NAME	DateField	Expense
Alabama	Y1980	539
Alaska	Y1980	180
Arizona	Y1980	109
Arkansas	Y1980	101
California	Y1980	20
Colorado	Y1980	0
Connecticut	Y1980	106
Alabama	Y1981	706
Alaska	Y1981	215
Arizona	Y1981	115
Arkansas	Y1981	113

Working with time zones

- ArcGIS integrates data across different time zones
 - Layers in map can be in different time zones
- Data for same layer needs to be in the same time zone
- **Convert Time Zone** GP tool
 - Converts time values recorded in a date field from one time zone to another time zone
- Standardize on UTC¹ or GMT²



¹ Coordinated Universal Time, ² Greenwich Mean Time

Daylight savings time

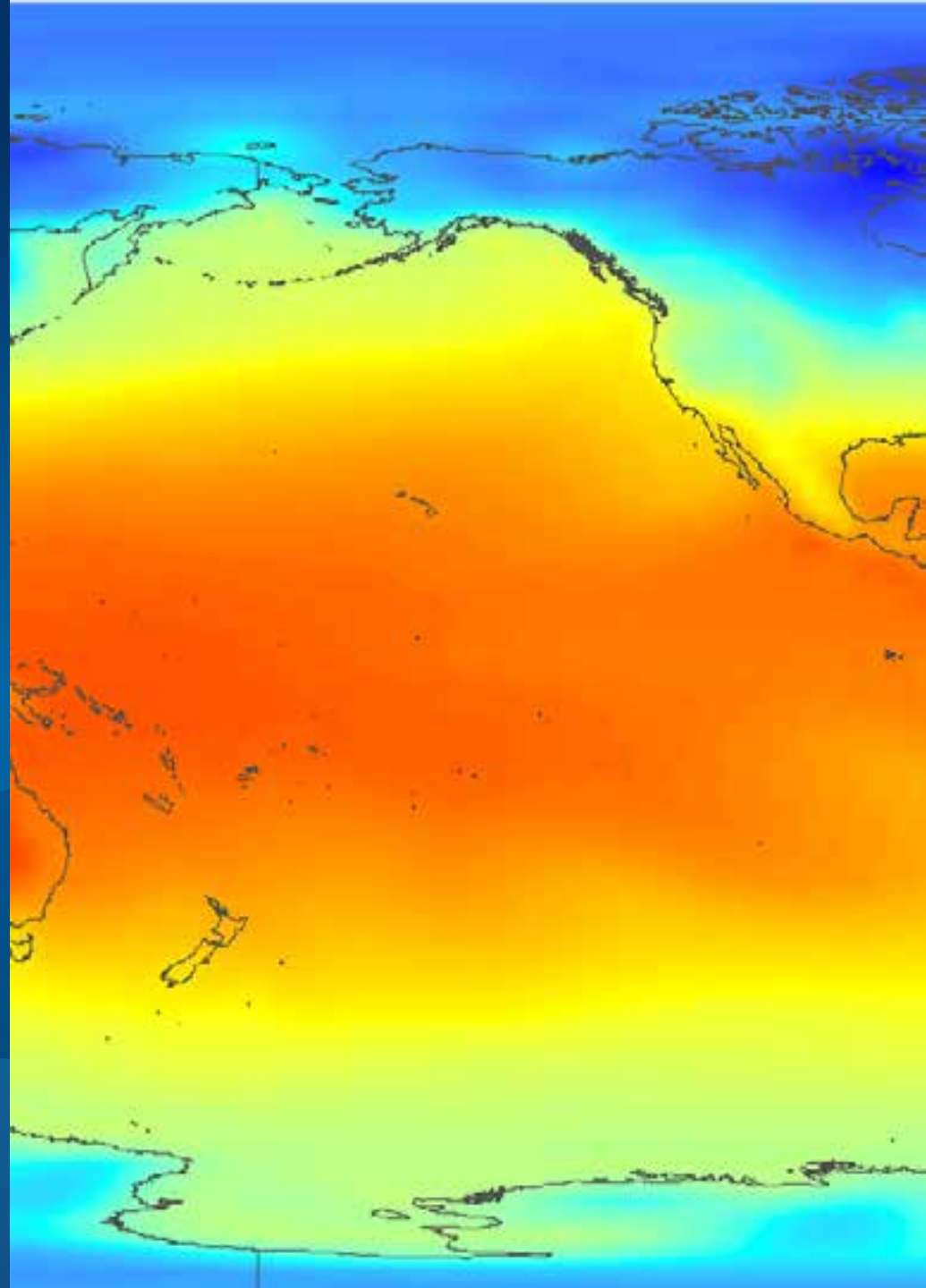
- **Problems with DST**
 - **Regional differences**
 - **Rules and boundaries change frequently**
 - **Some DST zones adjust less than an hour**
 - 30 minute DST offset
 - 45 minute DST offset



Source: Wikipedia

 **Store temporal data as Standard Time (not DST)**

Analyzing temporal data

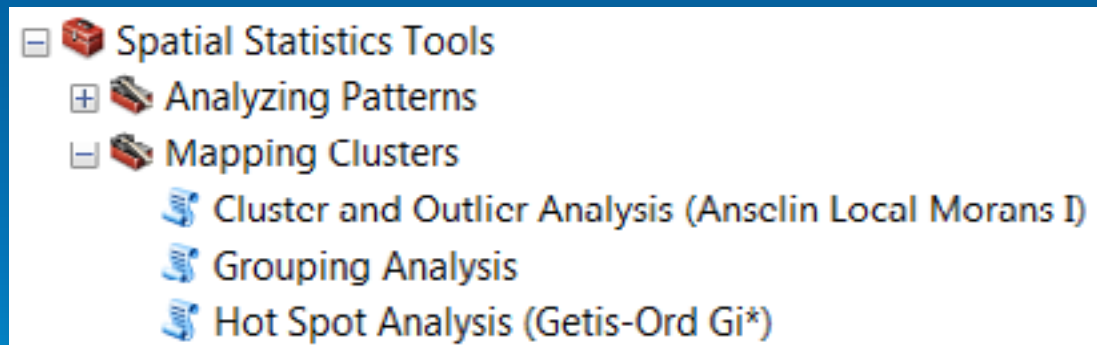


Analyzing temporal data

- **Geoprocessing tools for spatial/temporal data**
- **All GP tools honor time**
- **ArcPy site-package**

Space-time cluster analysis

- ArcToolbox > Spatial Statistics > Mapping Clusters
 - Hot Spot Analysis GP tool
 - Cluster and Outlier Analysis GP tool
 - Grouping Analysis GP tool

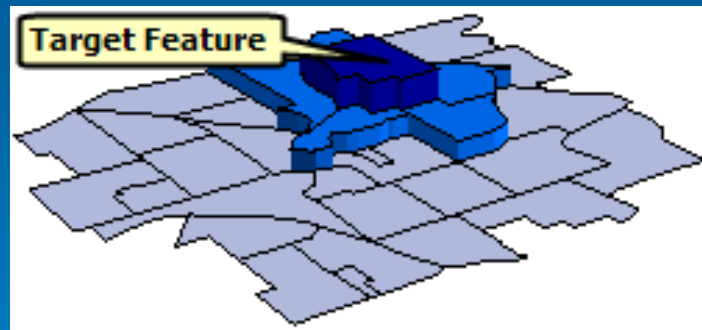


Mapping Clusters

- **Hot Spot Analysis** GP tool
 - Creates a map of statistically significant hot and cold spots
- **Cluster and Outlier Analysis** GP tool
 - Identifies statistically significant hot spots, cold spots, and spatial outliers
- **Grouping Analysis** GP tool
 - Groups features based on feature attributes and optional spatial/temporal constraints

Conceptualization of Spatial Relationships

- A parameter in a number of Spatial Statistics tools in ArcToolbox
- **Generate Spatial Weights Matrix** GP tool – used to define neighbor relationships using both spatial and temporal parameters



All GP tools honor time

- **At 10.1 service pack 1**
 - **GP tools honor temporal setting for time-enabled layers**
 - **Process only features within the time extent set in the Time Slider window**
 - **Similar to a selection or definition query**

ArcPy site-package

- Provides classes and functions to work with time in the map and data
 - DataFrameTime class
 - UpdateLayerTime() function
- Arcpy.time
 - Python module for working with time in ArcGIS

Sharing temporal data

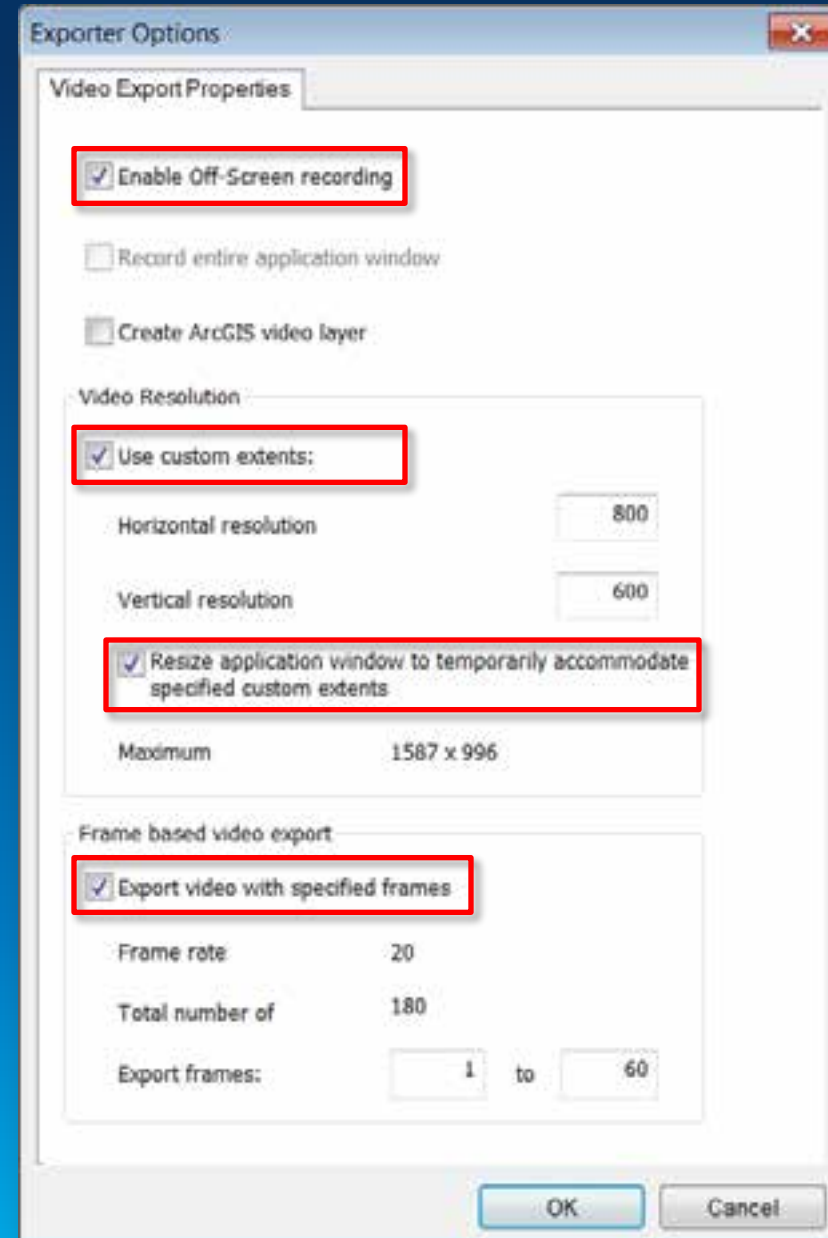


Sharing temporal data

- Time-enabled layer and map packages
- Temporal map books
- Export as video layer files (for ArcGlobe)
- Let's look at each of these in detail in the next few slides:
 - Export as video (AVI)
 - Export as sequential images
 - Create web map services
 - Use in web map
 - Use in a web map app

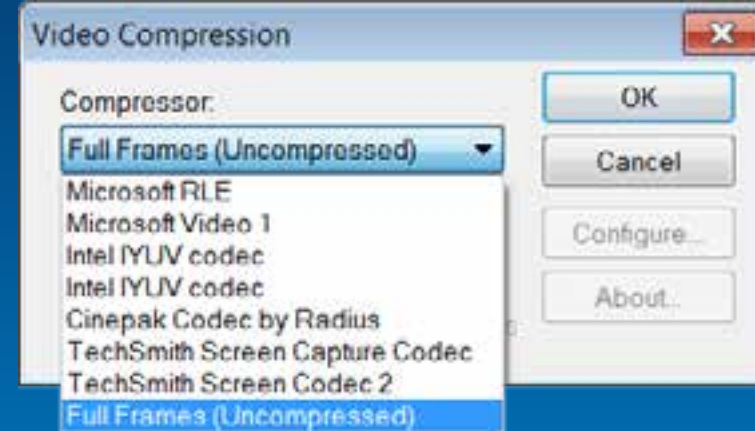
Export as video

- In AVI format
- Works with maps and graphs
- Options for:
 - Off-screen recording
 - Custom extents
 - Web – 800 x 600
 - YouTube – 1280 x 720
 - Temporarily resizing window
 - Frame based export



Export to video

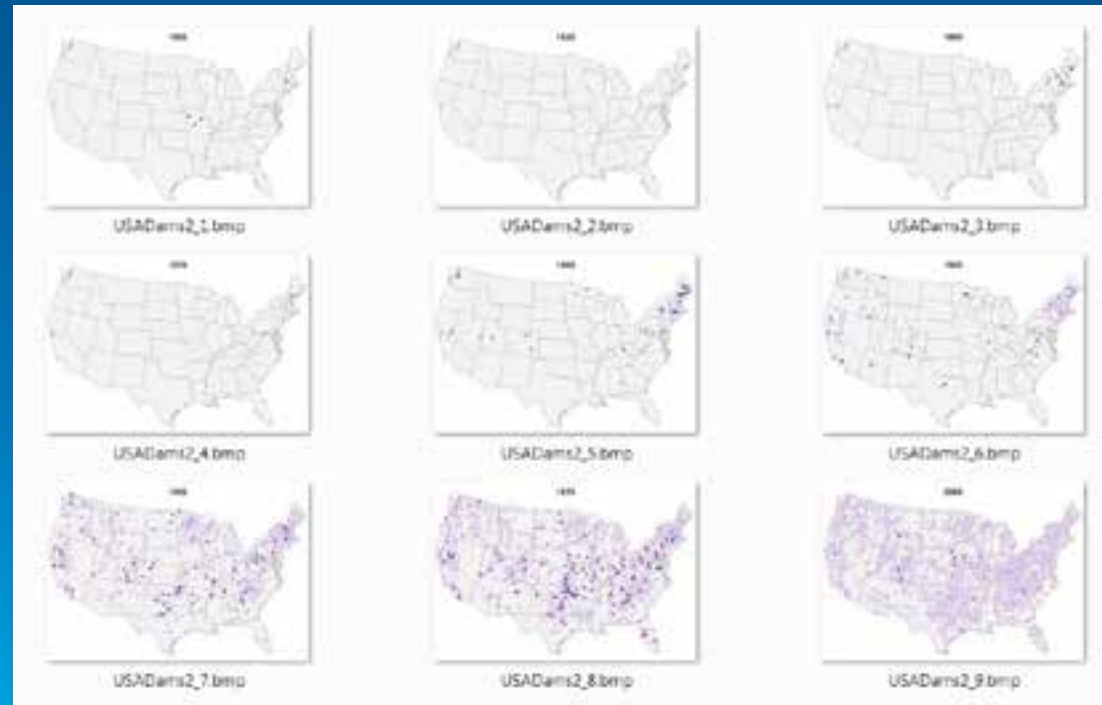
- **Video file size is a function of:**
 - **Frame rate**
 - **Screen size**
 - **Compressor**



For high quality videos, choose a codec that does not have lossy compression, e.g., Full Frames (Uncompressed)

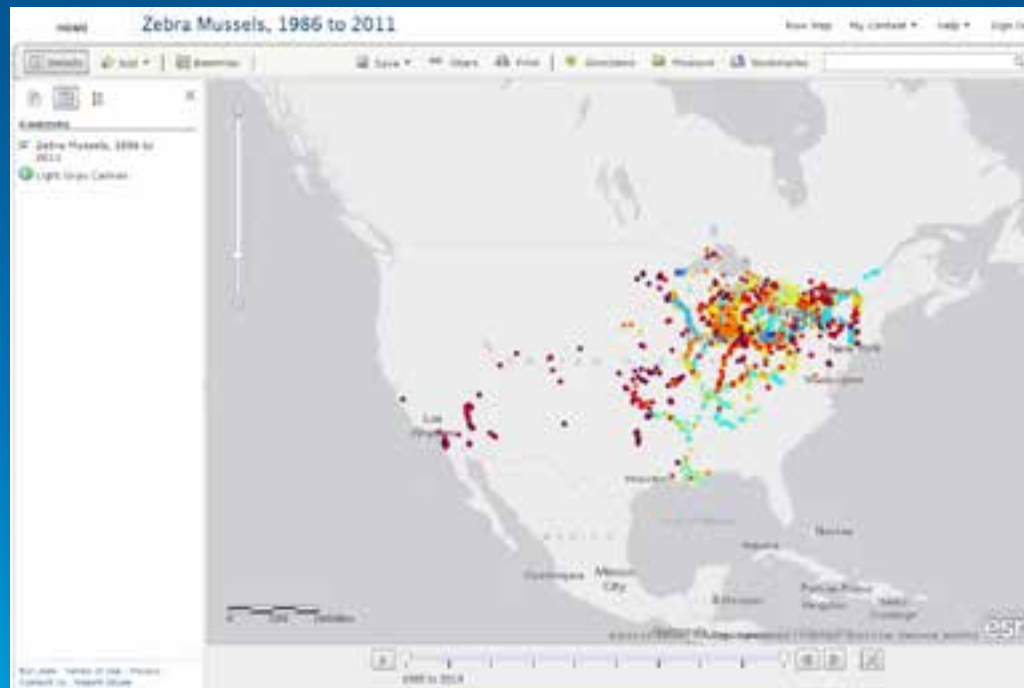
Export as sequential images

- In BMP or JPG format
- Specify the number of images to be exported



Create web map services

- Map services preserve the time information from time-enabled layers
- Use to display or query the map services



Temporal Data in ArcGIS Pro



Thank you...

- **Please fill out the session survey:**

First Offering ID: 1337

Second Offering ID: 1435

Online – www.esri.com/ucsessionsurveys

Paper – pick up and put in drop box



Understanding our world.