Using GIS in the Classroom

GIS Educational Technology Consultants

SchoolSite 10th Annual User Conference July 6-8, 2011

GIS Transforms Students into 21st Century Learners while Stimulating Teachers to Become Highly Qualified

Roger & Anita Palmer
GISetc
www.gisetc.com

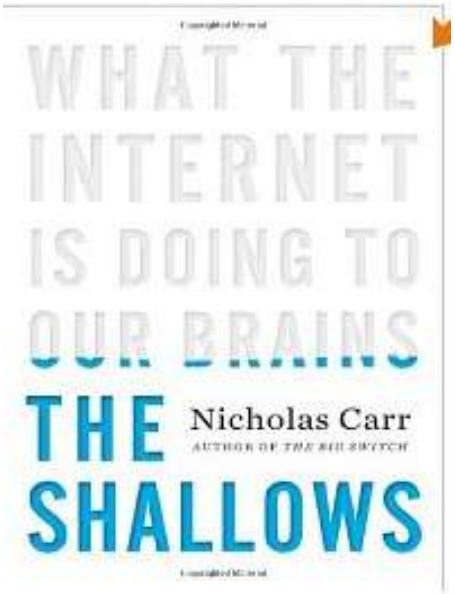
Schools spend a good deal of money on technology.

- Projects attempted should justify this expense
- Not just better looking work but work that could only be possible without these tools
- Stakeholders should be proud of work you do

Students spend a lot of time online

- Kaiser Family Foundation recently reported that an average student spends 7 ½ hours online based on surveys of 2000 students from across the country
- Because of multitasking they actually stream over 10 hours of media daily
- Media browsing has a slight negative correlation to school performance and direct relation to risky behaviors

Some ask what impact technology use produces in us



"Raising the Bar"
highly valued skills in business

• **Analyze and solve complex problems**	**79%**
• **Connect actions to ethical decisions**	**75%**
• **Collaborate with others in diverse group settings**	**71%**
• **Innovate and be creative**	**70%**
• **Implement developments in science and technology**	**70%**
• **Organize and evaluate info from multiple sources**	**70%**

Hart Research Associates study of 300 business owners hiring over 25 employees

What should technology assisted learning look like?

- Challenging
- Fun and inspiring
- Give progressive feedback that they are on track with finding patterns
- Invite discussion / collaboration
- Require data to test hypothesis
- Address problems students feel are real or important

How is GIS well suited for the challenges facing education?

- GIS is a critical thinking platform
- Critical thinking is a lifelong professional skill
- Makes quick sense of tedious amounts of data
- Listed as one of top 3 job growth areas
- Facilitates networks to people in the know

GIS effectively visualizes, analyzes, and models academic content

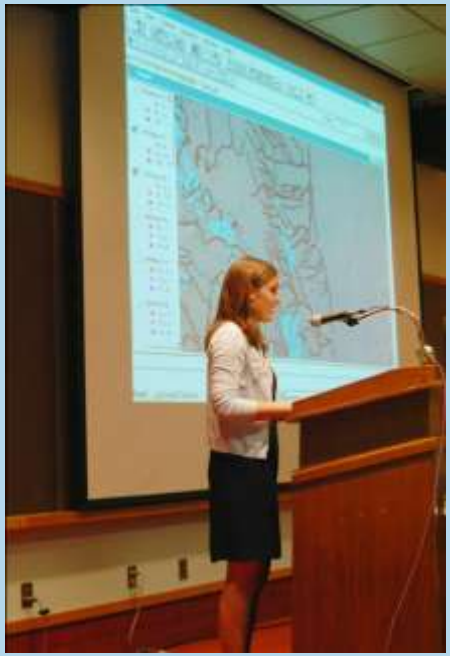
- Science – probeware, imagery, gps
- Math – tables, graphs, coordinates
- Language Arts – sense of place for literature/writing/lit critique
- Social Studies – demographics, politics, economics, culture, historical imagery
- Physical Education – hiking, biking, geocaching, photography, lifetime sports

GIS sharpens student skills

- Multiple representations of data
- Pattern finding
- Simple to complex modeling
- Data manipulation
- Query and subset large datasets
- Analysis
- Prediction

GIS assesses student understanding

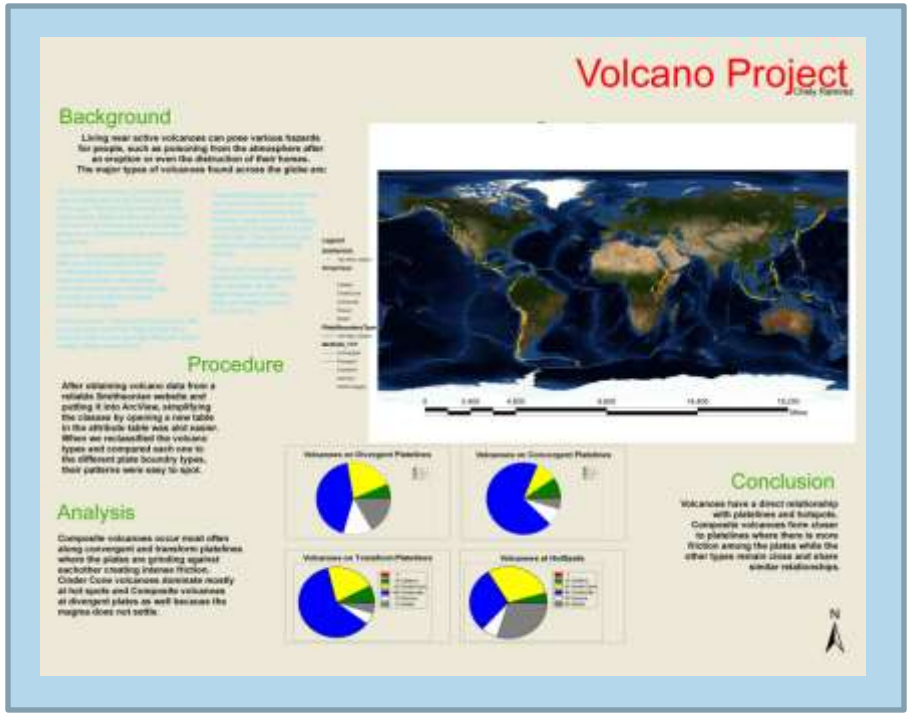
- Source of blackline master maps
- Real life problem solving
- Data based argumentation
- Solve Scenarios
- Create Data Mashups



How Do You Assess Your Students…
Are they creating data based arguments?
Are they asking their own questions?
Do they recommend or set up their own experiments?
…

GIS helps students understand inquiry

- Hypothesize
- Experiment design
- Data gathering
- Analysis
- Check hypothesis
- Conclusion
- Graphic layout reports



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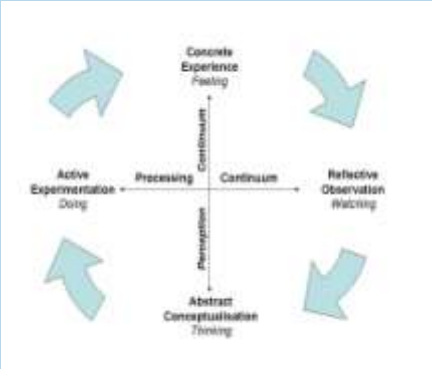
GIS appeals to multiple learning styles

- Myers Briggs E/I N/P T/F P/J
- Visual, Auditory,Tactile
- Gardner's: Visual, Aural, Verbal, Kinesthetic, Mathematical, Social, Solitary, Natural
- Kolb: concrete-abstract, random-sequential

  reflect observe-active experiment



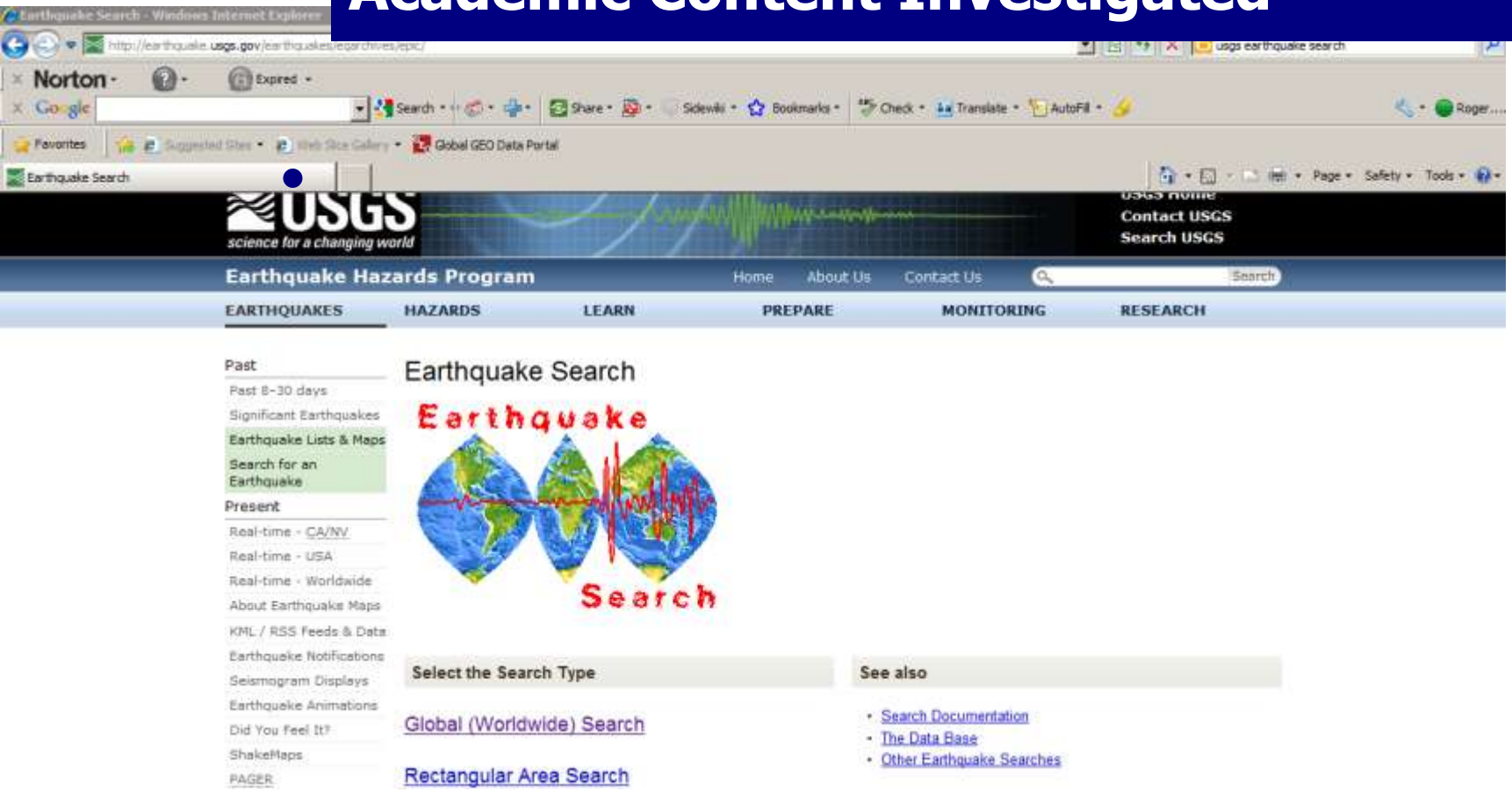
GIS in PD helps make teachers highly effective

- Wholistic
- Interdisciplinary
- Engaging for teachers
- Creates new contexts for teachers specialty
- Way to see content differently
- Teach with primary source data

I am having an absolute blast teaching with this software.
Mike Monson
20 yrs experience
Center, ND

GIS has changed the way I will teach. It has made me excited about my subject in a much deeper way!
Tisha Giddes
5th yr teacher Killeen, TX

Academic Content Investigated



Grabbing Current Data

NEIC: Earthquake Search Results

```
Year,Month,Day,Time(hhmmss.mm)UTC,Latitude,Longitude,Magnitude,Depth
 2008,01,01,063227.96, 40.29,  72.99,5.6,  6
 2008,01,01,100851.24,-35.76,-103.69,5.0, 10
 2008,01,01,185459.01, -5.88, 146.88,6.3,
 2008,01,01,191305.11, -5.90, 146.97,5.8,
 2008,01,02,084229.20,-23.10, -70.44,5.0,
 2008,01,02,114454.17,-23.67,-114.86,5.0,
 2008,01,02,151856.40,-36.85, -94.25,5.2,
 2008,01,02,200412.65, -6.99, 125.23,5.0,5
 2008,01,03,105817.28, -5.16, 152.07,5.0,
 2008,01,03,111548.51, -5.92, 122.66,5.4,
 2008,01,04,012631.20,-21.64, -68.63,5.3,1
 2008,01,04,072918.30, -2.78, 101.03,6.0,
 2008,01,04,114637.82, 51.92,-170.10,5.0,
 2008,01,05,015645.46, 14.13, -91.48,5.6,
 2008,01,05,060226.06, 14.29, 124.60,5.1, 37
```

- Cut
- Copy
- Paste
- Select All
- Print...
- Print Preview...
- Search for "Year,Month,Day,Time(hhmmss.m..."
- More Search Types
- Send To
- Page Info

Microsoft Excel - Book1

File Edit View Insert Format Tools Data Window Help

Arial Unicode MS 10

A1 = Year,Mor ...de,Longitude,Magnitude,Depth

	A	B	C	H	I
1	Year,Month,Day,Time(hhmmss.mr			Depth	
2	2008,01,01,063227.96, 40.29, 72				
3	2008,01,01,100851.24,-35.76,-10				
4	2008,01,01,185459.01, -5.88, 146				
5	2008,01,01,191305.11, -5.90, 146				
6	2008,01,02,084229.20,-23.10, -70				
7	2008,01,02,114454.17,-23.67,-11				
8	2008,01,02,151856.40,-36.85, -94				
9	2008,01,02,200412.65, -6.99, 125				
10	2008,01,03,105817.28, -5.16, 152				
11	2008,01,03,111548.51, -5.92, 122				
12	2008,01,04,012631.20,-21.64, -68				
13	2008,0	3, 101.03,6.0, 35			
14	2008,0	2,-170.10,5.0, 35			
15	2008,0	3, -91.48,5.6, 66			
16	2008,01,05,060226.06, 14.29, 124.60,5.1, 37				

Sort...
Filter
Form...
Subtotals...
Validation...
Table...
Text to Columns...
Consolidate...
Group and Outline
PivotTable and PivotChart Report...
Get External Data
Refresh Data

Format Cells...
Pick From List...
Hyperlink...

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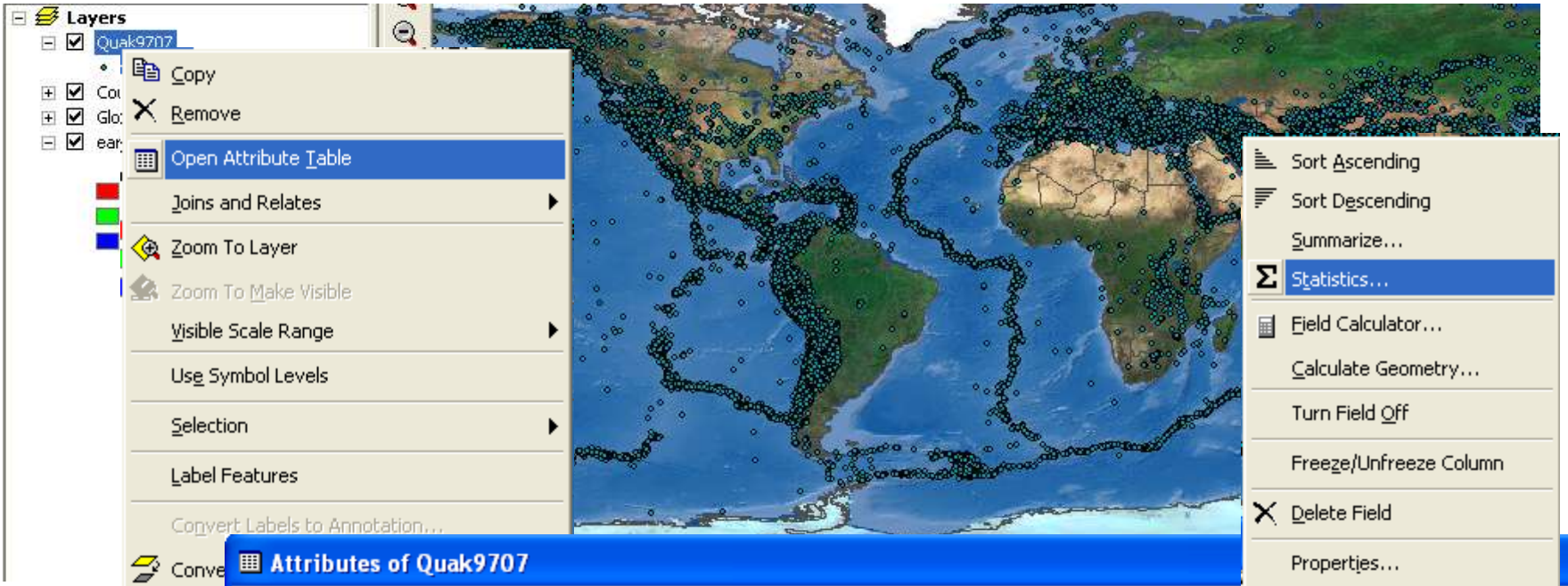
Stories aren't always spatially distributed



Attributes of Quak9707

FID	Shape *	OBJECTID	Year_	Month_	Day_	Time_	Latitude	Longitude	Magnitude	Depth
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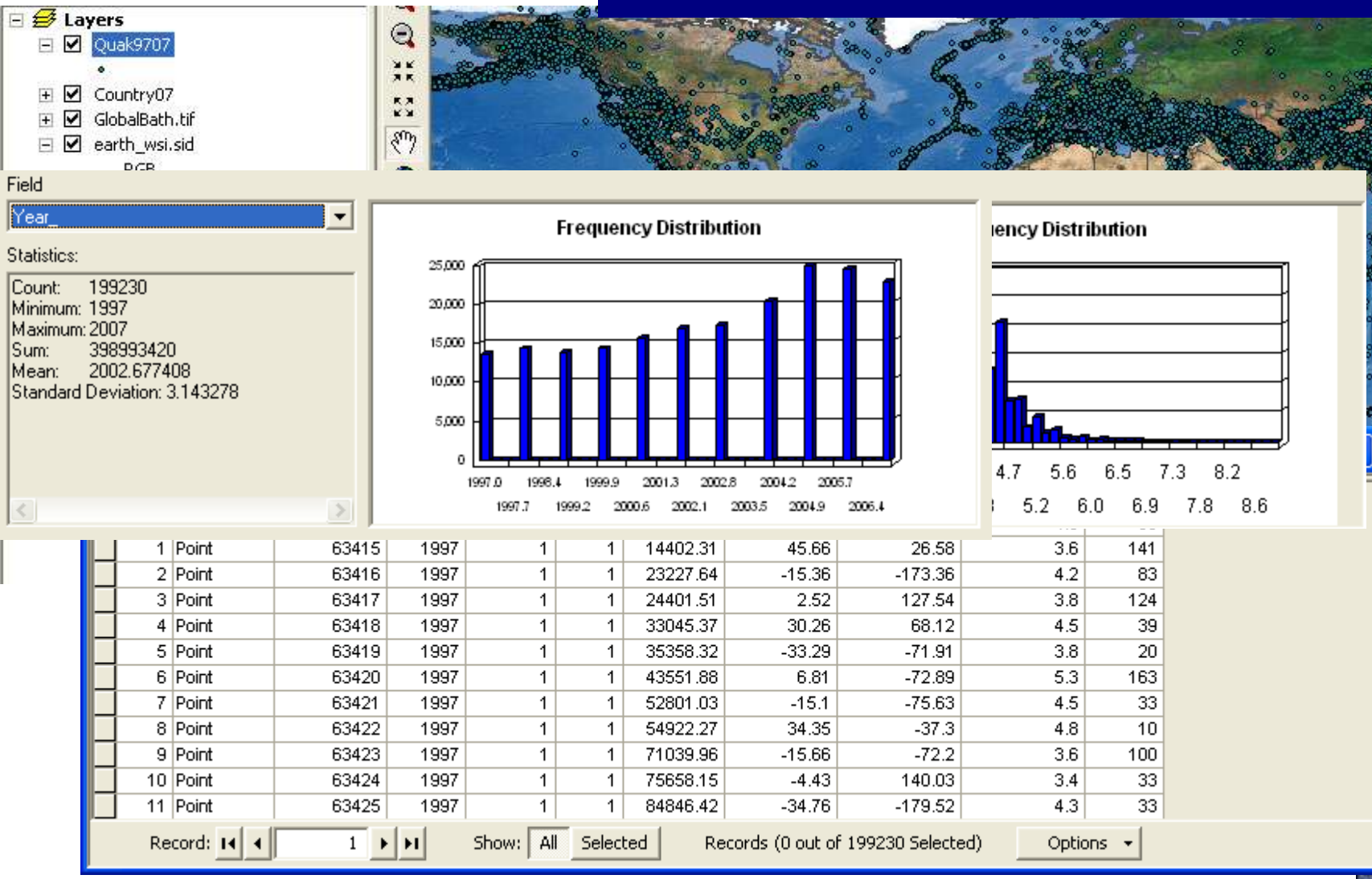
1	Point	63415	1997	1	1	14402.31	45.66	26.58	3.6	141
2	Point	63416	1997	1	1	23227.64	-15.36	-173.36	4.2	83
3	Point	63417	1997	1	1	24401.51	2.52	127.54	3.8	124
4	Point	63418	1997	1	1	33045.37	30.26	68.12	4.5	39
5	Point	63419	1997	1	1	35358.32	-33.29	-71.91	3.8	20
6	Point	63420	1997	1	1	43551.88	6.81	-72.89	5.3	163
7	Point	63421	1997	1	1	52801.03	-15.1	-75.63	4.5	33
8	Point	63422	1997	1	1	54922.27	34.35	-37.3	4.8	10
9	Point	63423	1997	1	1	71039.96	-15.66	-72.2	3.6	100
10	Point	63424	1997	1	1	75658.15	-4.43	140.03	3.4	33
11	Point	63425	1997	1	1	84846.42	-34.76	-179.52	4.3	33

Record: 1 Show: All Selected Records (0 out of 199230 Selected) Options

The Stories in the Statistics



1	Point	63415	1997	1	1	14402.31	45.66	26.58	3.6	141
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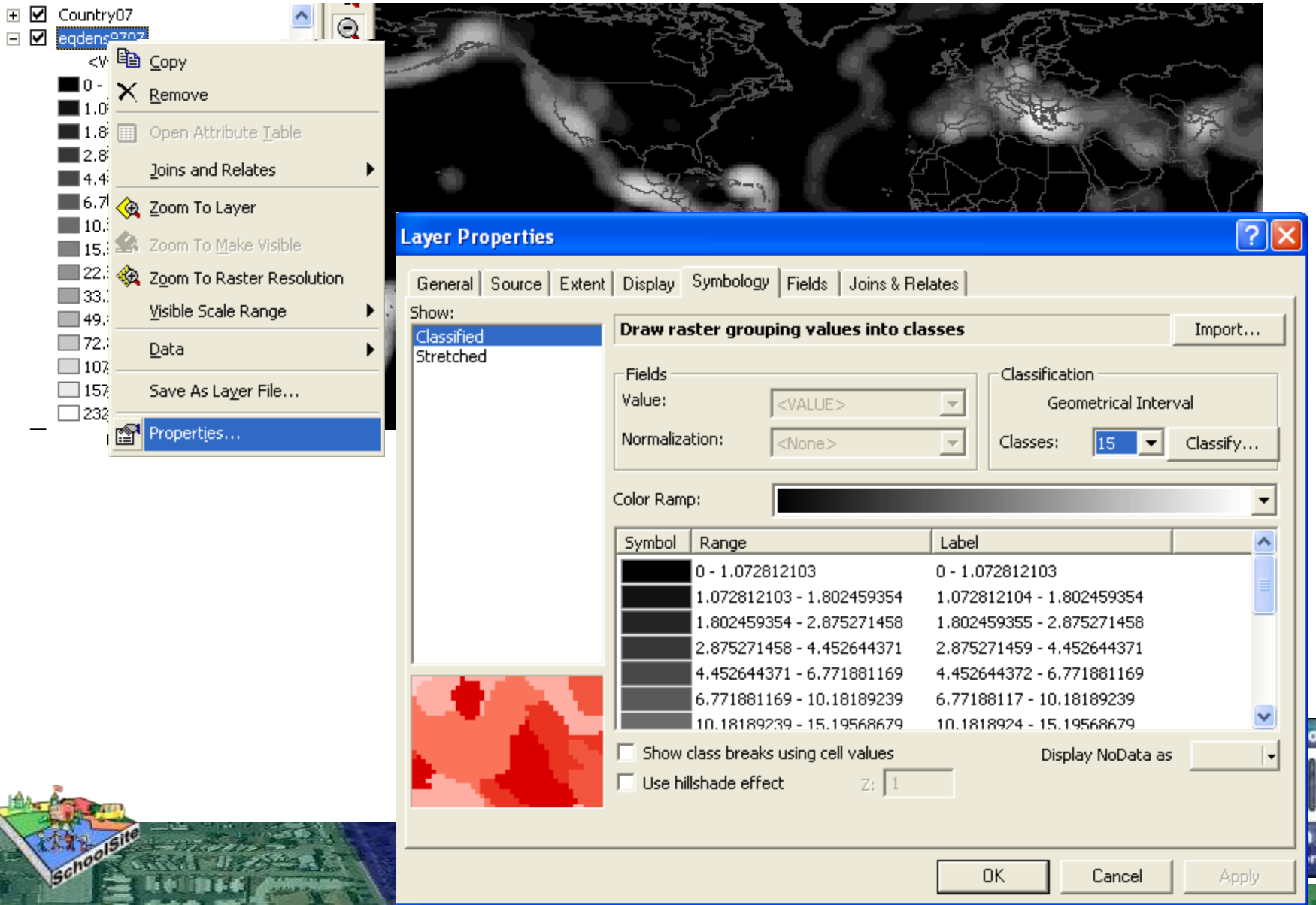
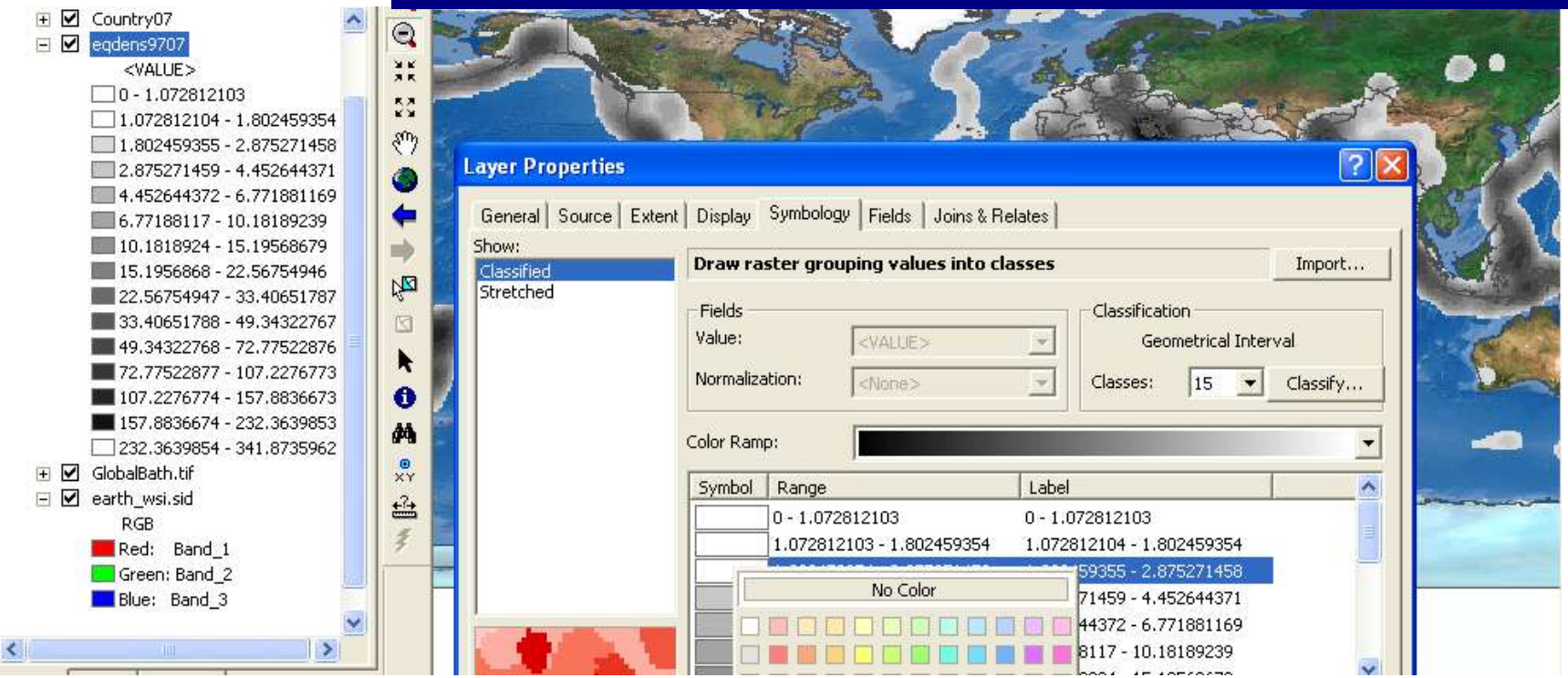
11	Point	63425	1997	1	1	84846.42	-34.76	-179.52	4.3	33

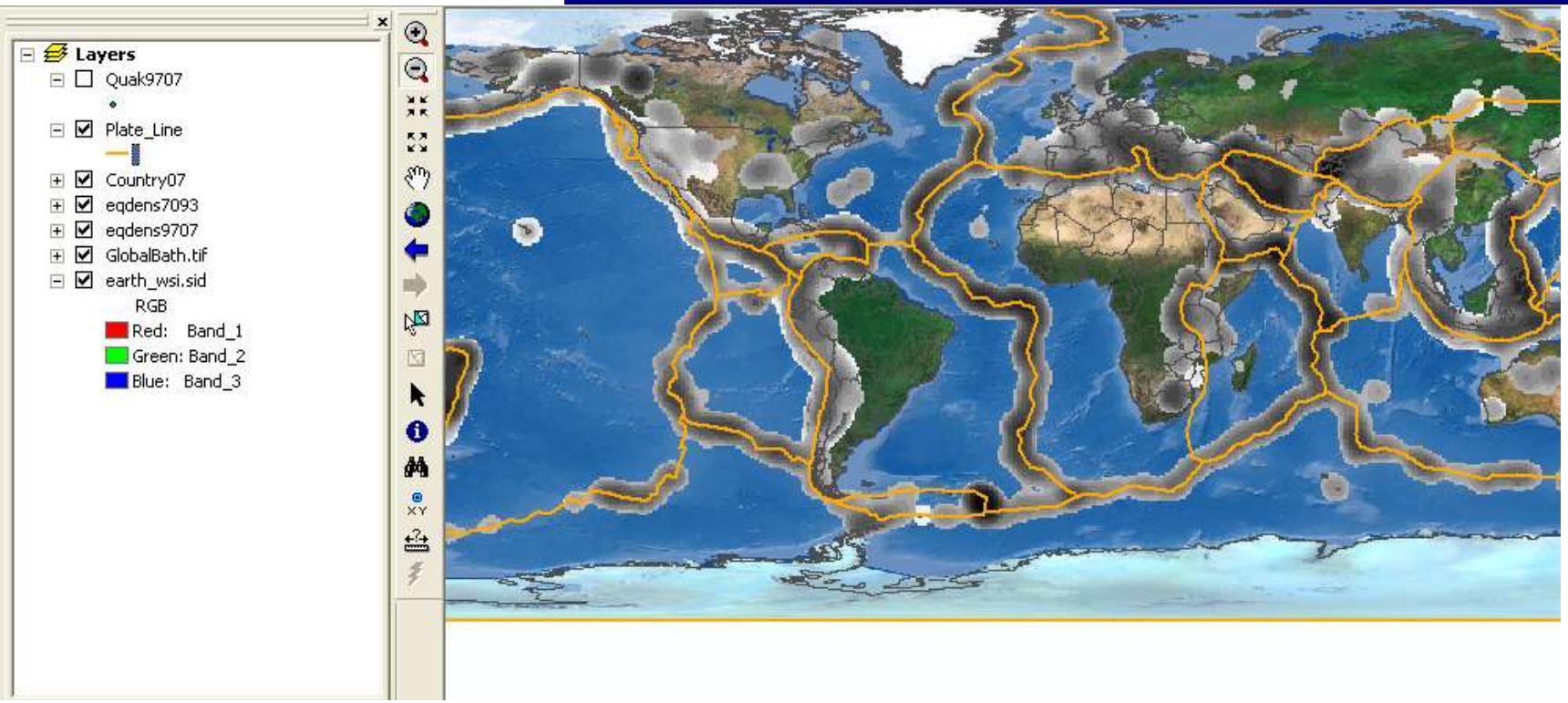
Extrapolating data to analyze



Earthquakes per degree over 10 years



Finding tectonic plates from Data



Grids help find changes from average activity

Who_Is_Next.mxd - ArcMap - ArcView

File Edit View Insert Selection Tools Window Help

1:199,573,223

Spatial Analyst | Layer: eqdens04

- Distance
- Density...
- Interpolate to Raster
- Surface Analysis
- Cell Statistics...
- Neighborhood Statistics...
- Zonal Statistics...
- Reclassify...
- Raster Calculator...
- Convert
- Options...

Raster Calculator

Layers:
- 10 yr avg Qk Density
- 2004 Qk Density
- earth_wsi.sid
- GlobalBath.tif

*	7	8	9	=	<>	And
/	4	5	6	>	>=	Or
-	1	2	3	<	<=	Xor
+	0	.	(	)	Not	

[2004 Qk Density] - [10 yr avg Qk Density]

About Building Expressions | Evaluate | Cancel | >>

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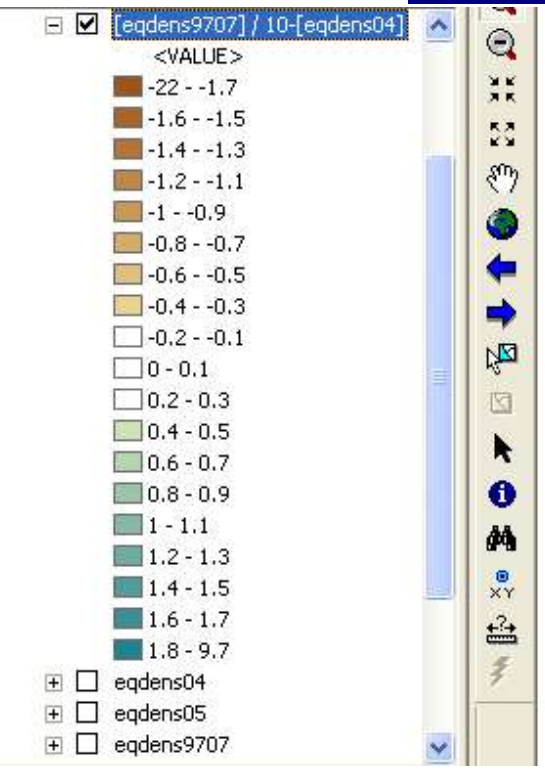
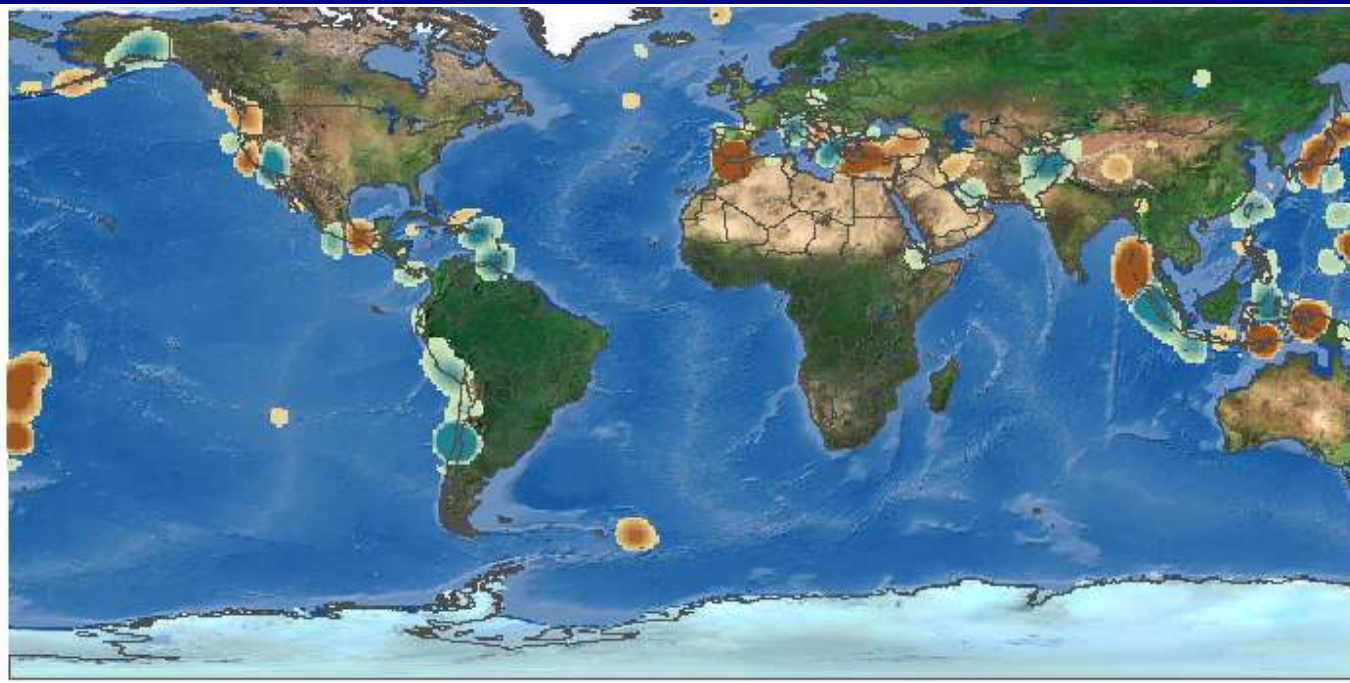
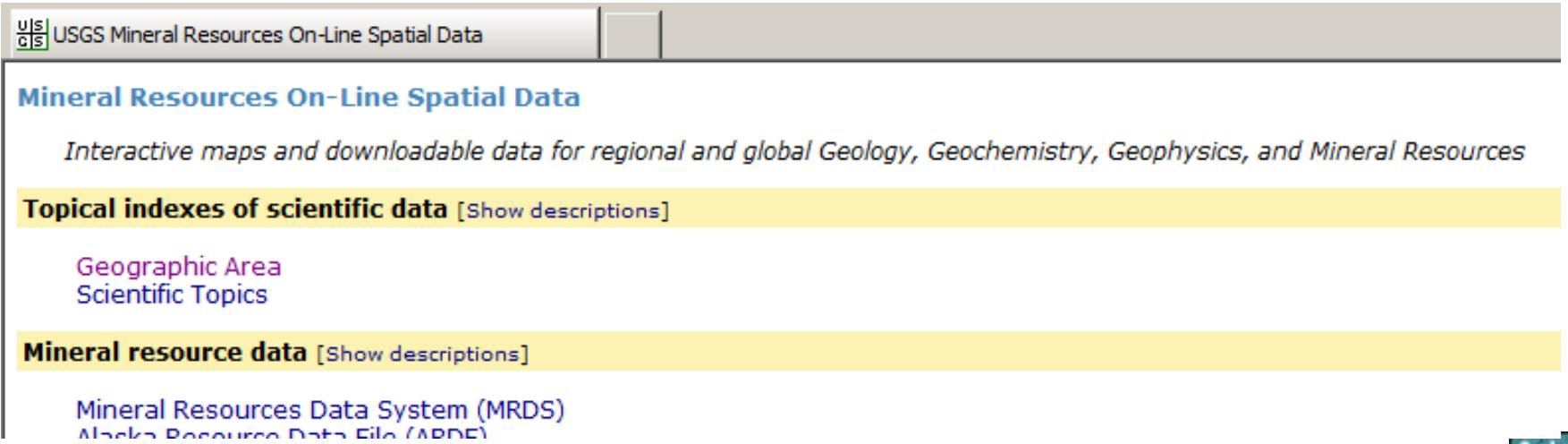
Red Had Fewer Earthquakes in 2004
Blue Had More Earthquake Activity





Other Science Stories

- MRData Soil Chemistry to see evidence of natural history forces of continental formation
- Understand growing regions
- Illustrate irrigation issues in the arid west



USGS National Geochemical Survey database

USGS
science for a changing world

Mineral Resources On-Line Spatial Data

Mineral Resources > Online Spatial Data

National Geochemical Survey database

National-scale geochemical analysis of stream sediments and soils in the US, from existing data, reanalysis of existing samples, and new sampling. G

View:

Show in a web browser window:

Continental US

Alaska

Show in Google Earth or download KML:

- KMZ, compressed, 2.2M bytes

Show in your GIS using OGC WMS:
http://mrdata.usgs.gov/cgi-bin/mapserv?map=ngs.map&request=GetCapabilities&service=WMS&version=1.1.1

Download:

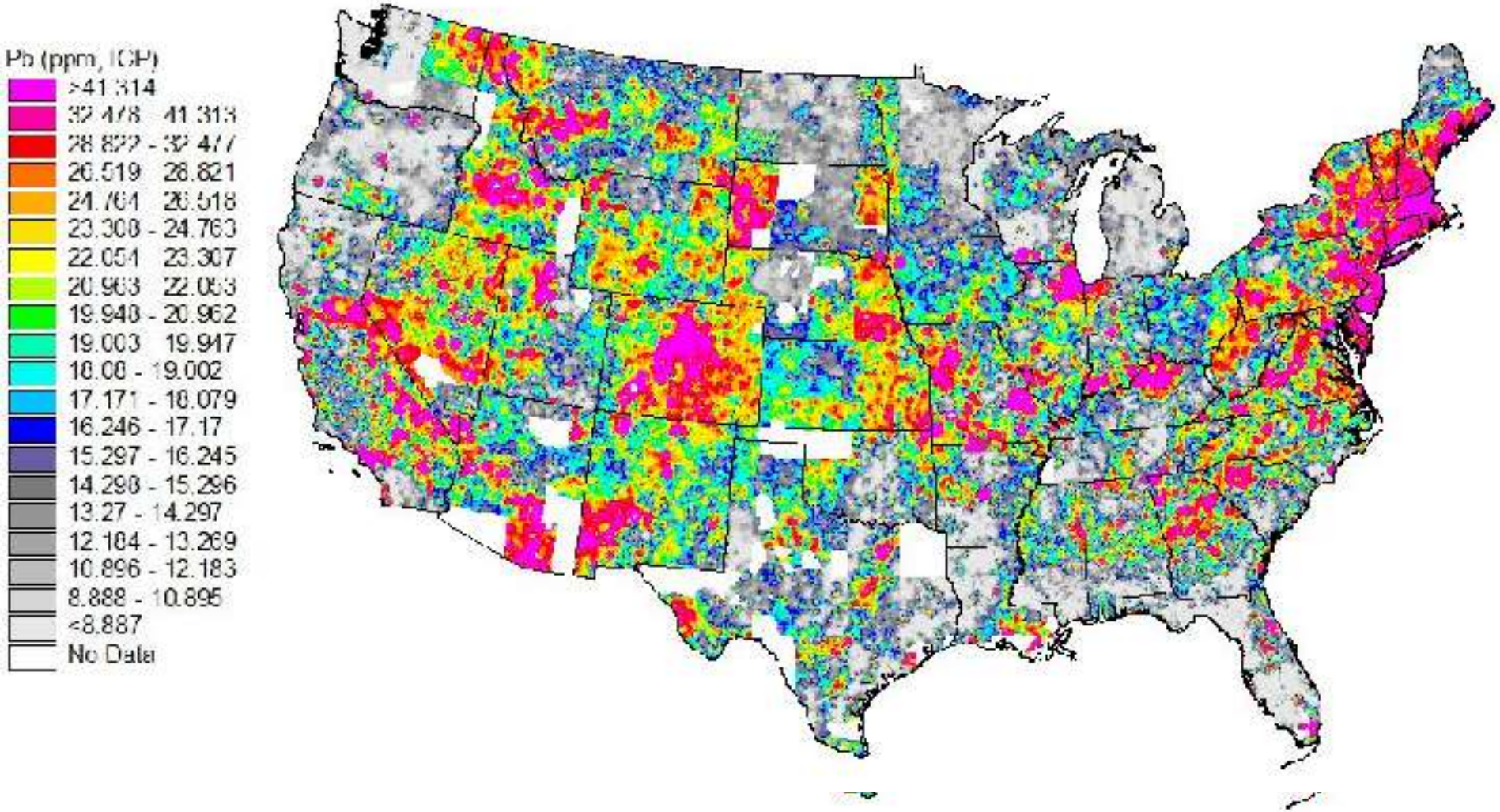
Download data for geographic areas you choose

Get the entire data set

- Shapefile with a subset of 53 attributes: ICP40, As, Se, Hg (74,409 samples, 5.2MB .ZIP package)
- dBase file with all 287 attributes (77,212 records, 19.6MB .ZIP package)

Documentation:

National Geochemical Survey - Full documentation



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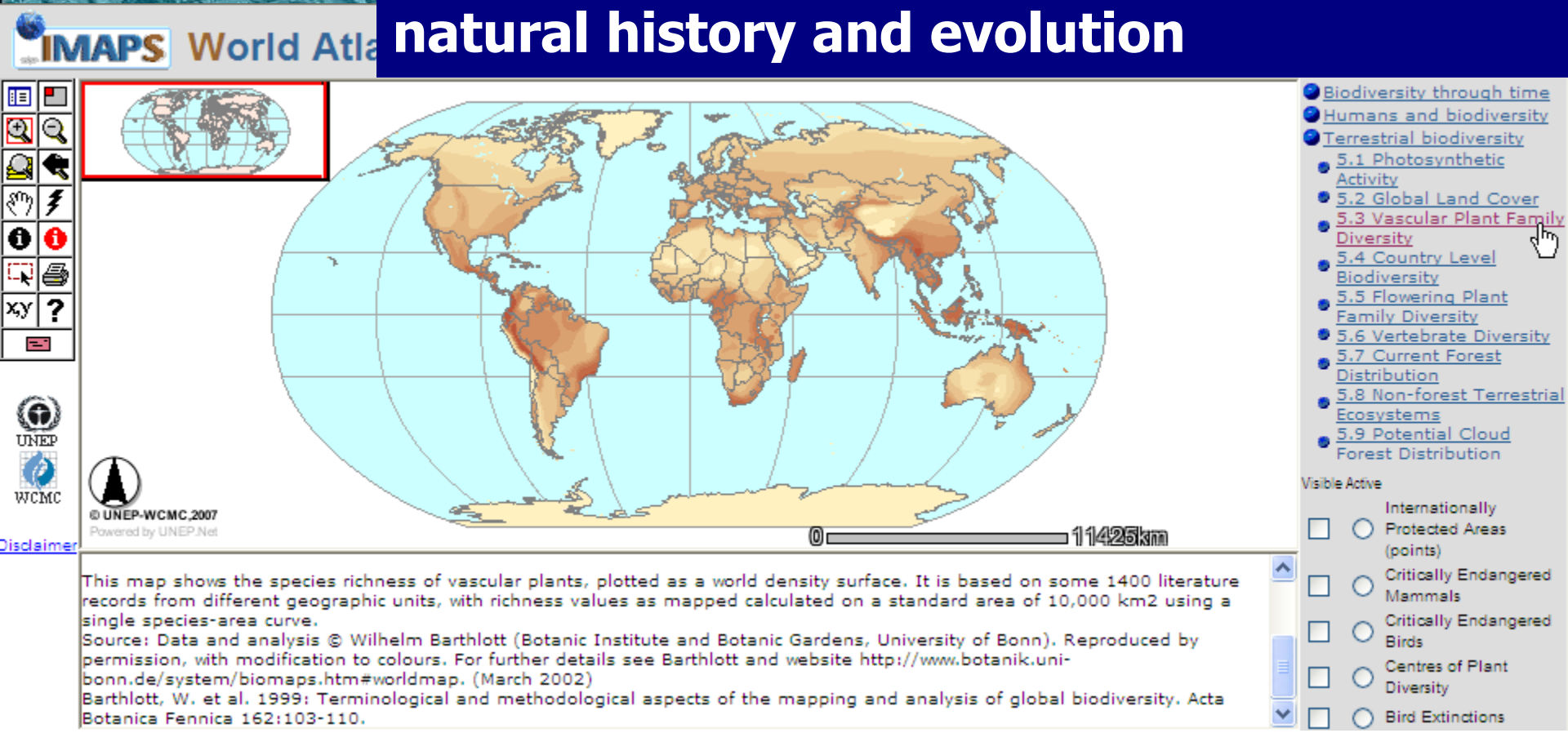
Pairing these map sources to teach natural history and evolution



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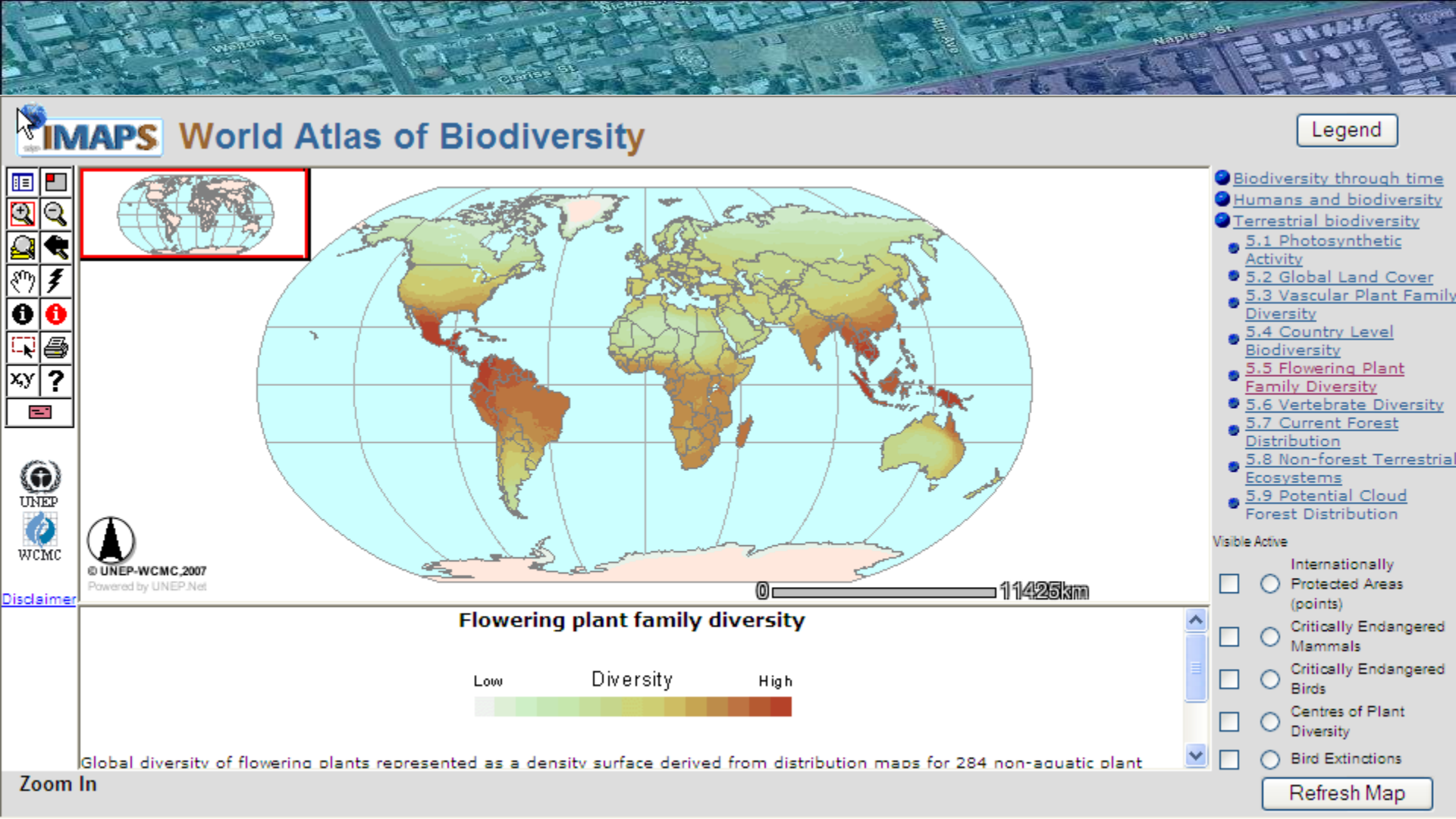
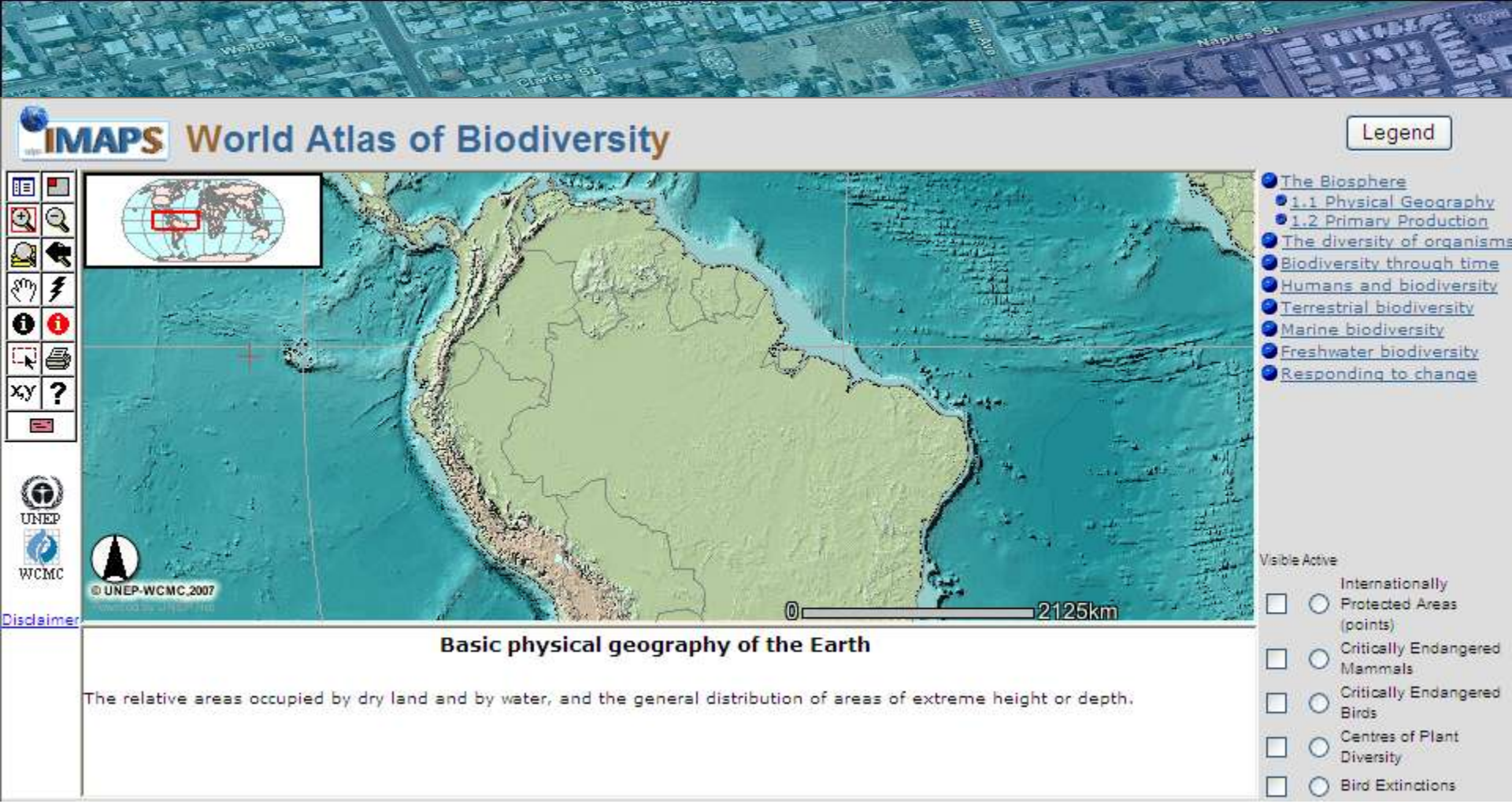
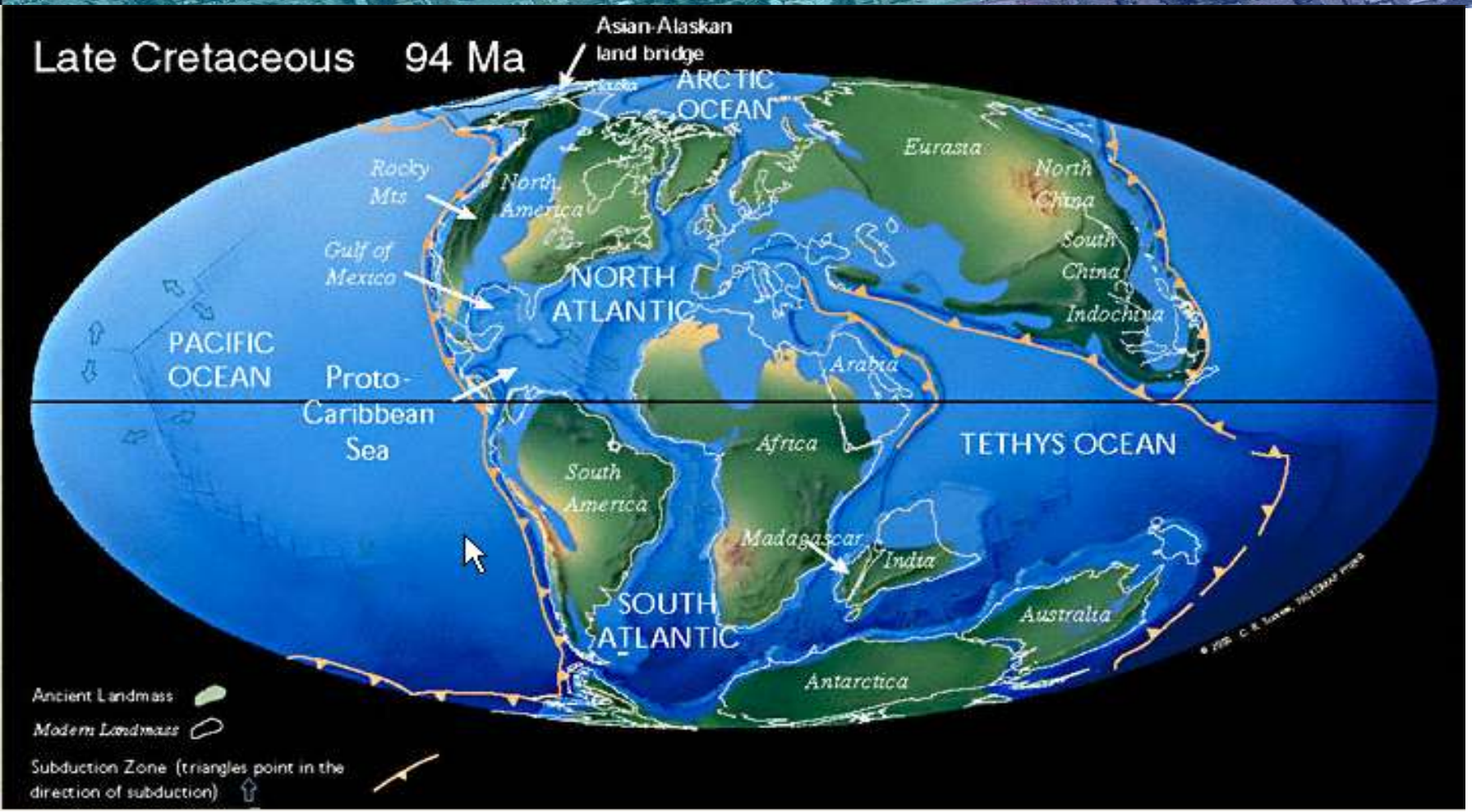


- **What makes south and central America such strong centers of speciation?**



The elevation uniformity makes it more sensitive to climate changes in recent glacial times forming pocket biomes isolated from each other. Isolated vascular plants have opportunities to evolve separately when wetter times rejoin the rainforest fragments.

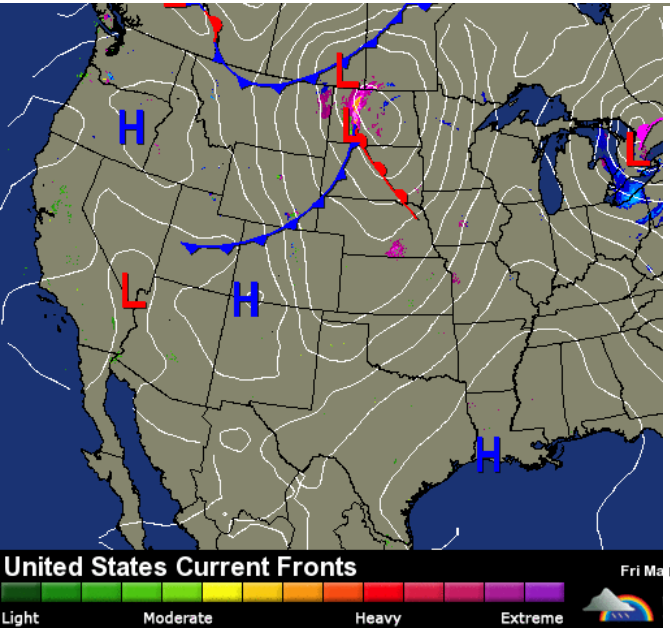


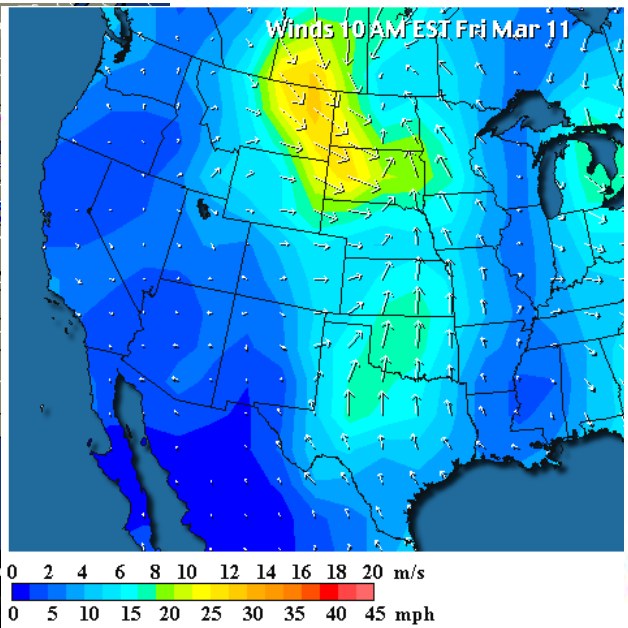
The central American isthmus arose slowly as island chains forming a competitive advantage for flowering plants able to migrate before other plants or predators.

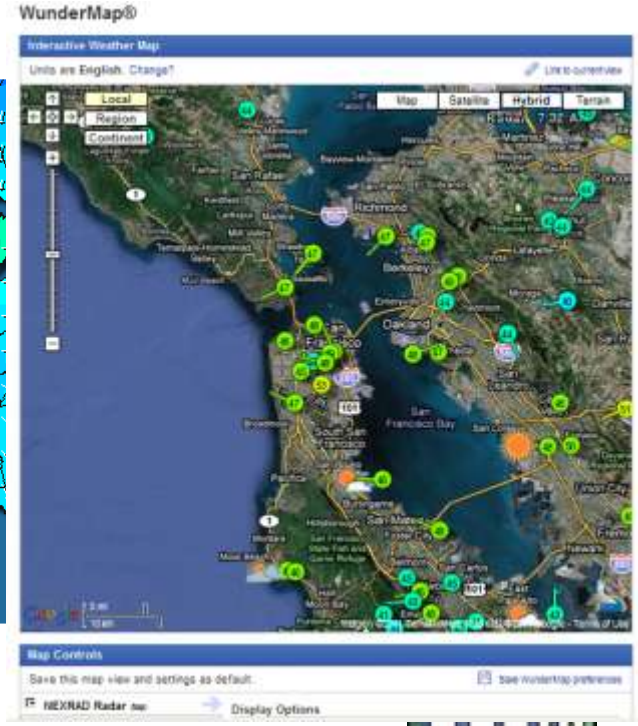
Weather Mapping

- Compare these to locally measured variables with probeware such as PASCO, Vernier, or Fourier

Weatherunderground.com



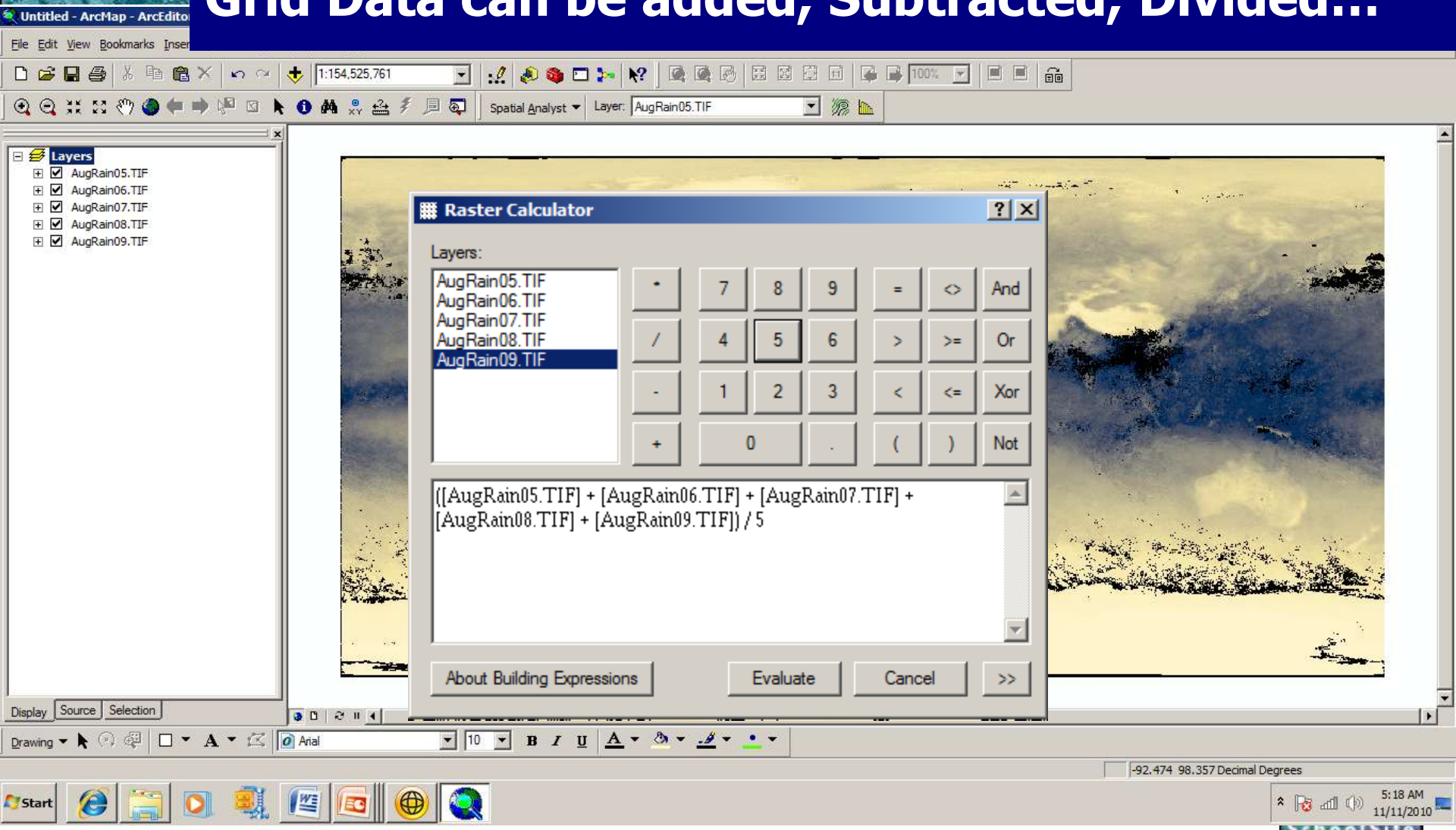




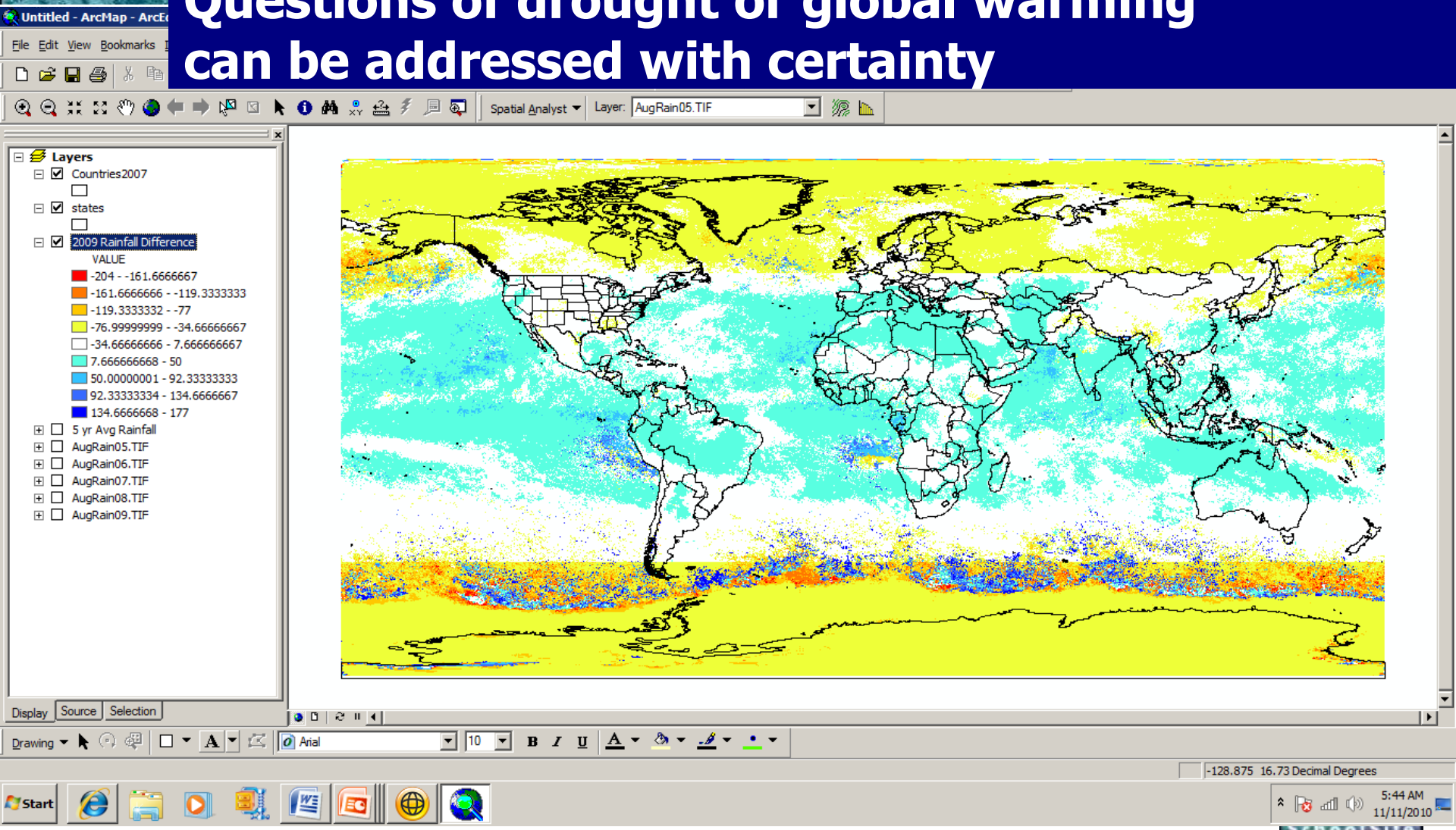
Climate

- Rainfall data from NASA Earth Observation

Grid Data can be added, Subtracted, Divided…



Questions of drought or global warming can be addressed with certainty



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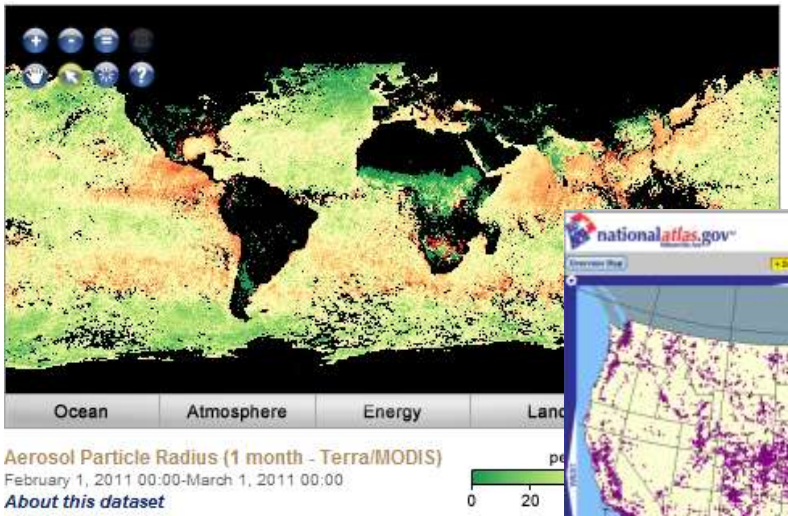
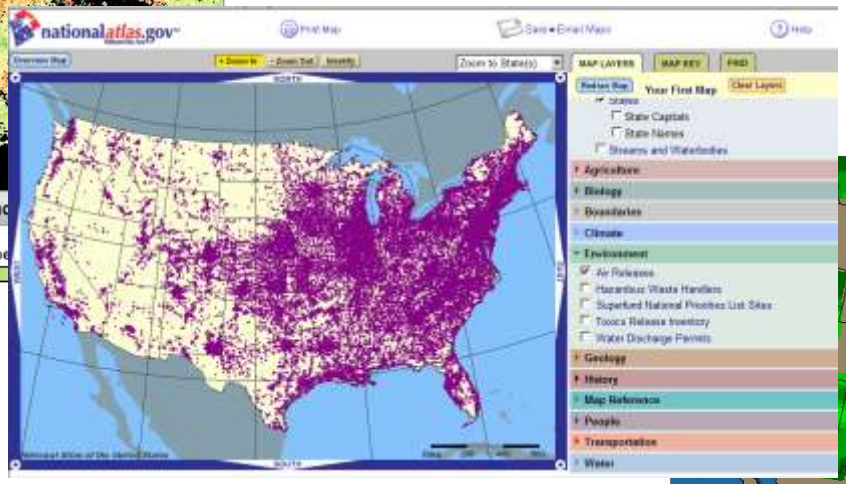
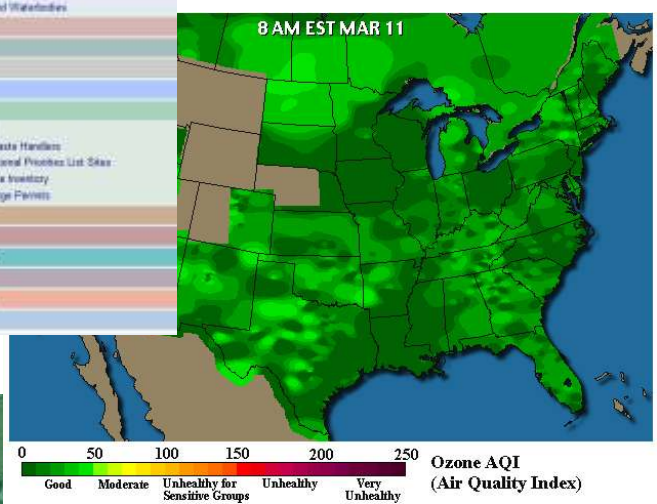
Air Quality Measures

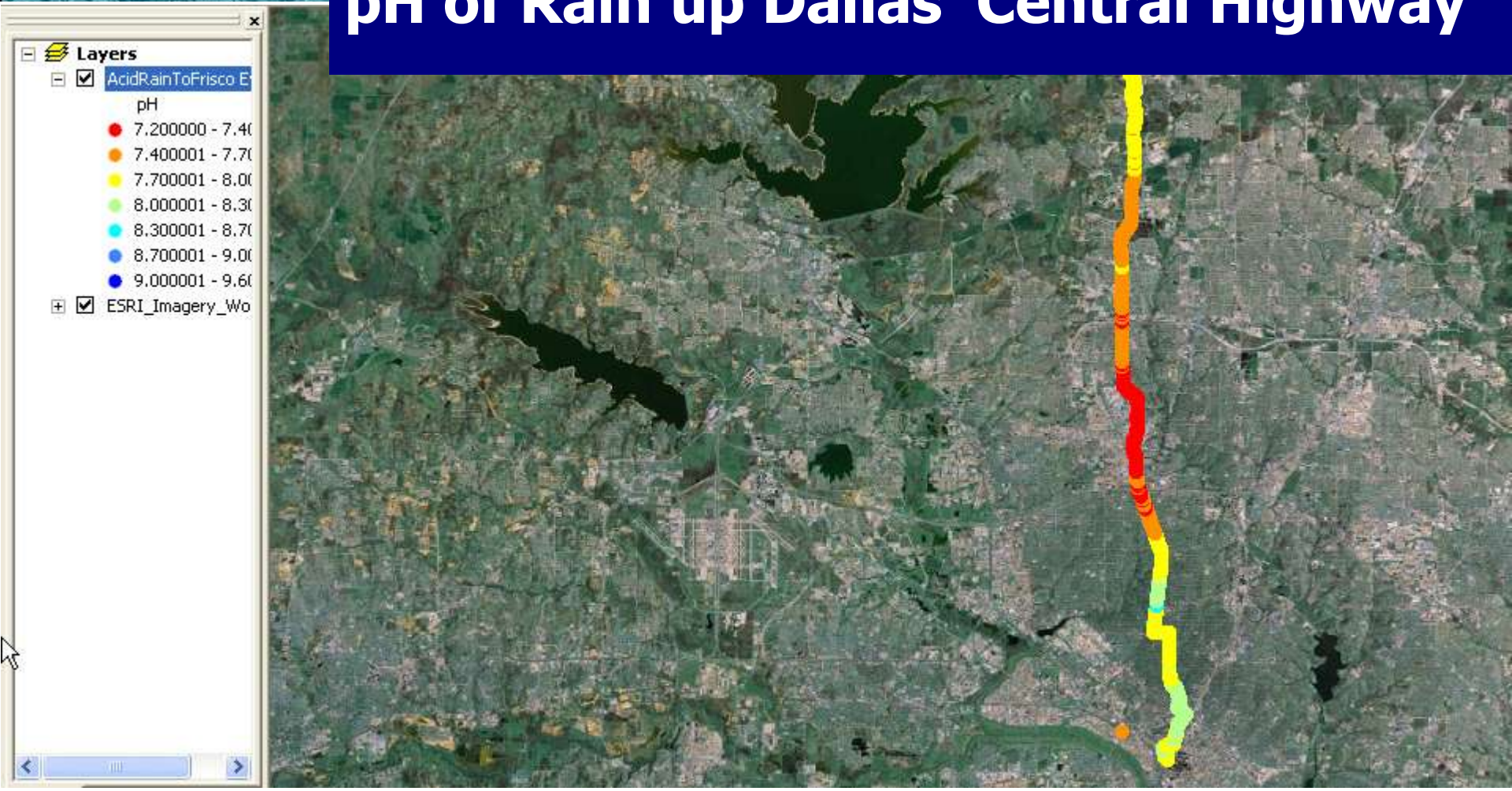
- Weatherunderground, weather.com
- Dust measurements from NEO
- Toxic Release maps (national atlas)







pH of Rain up Dallas' Central Highway



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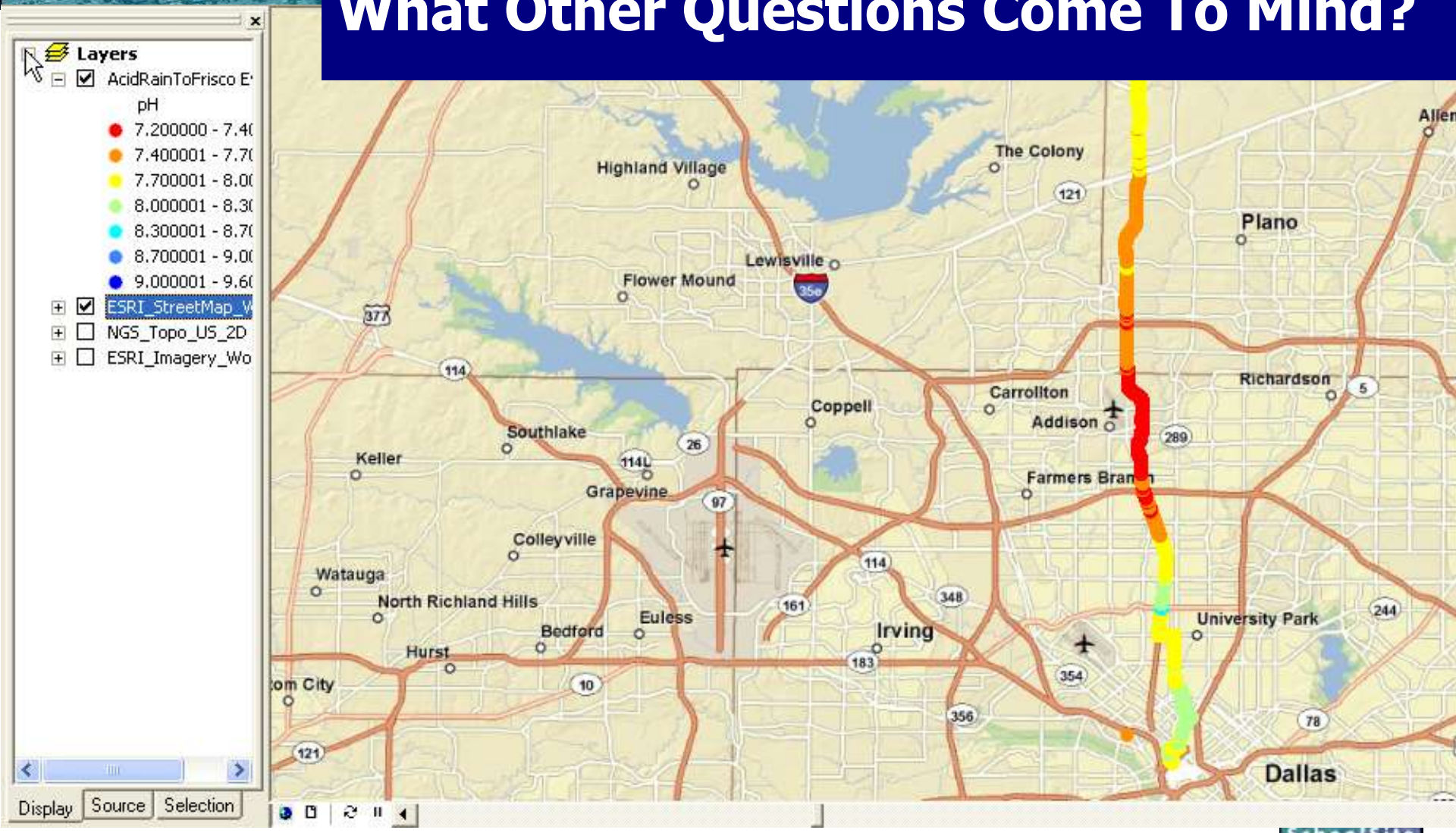
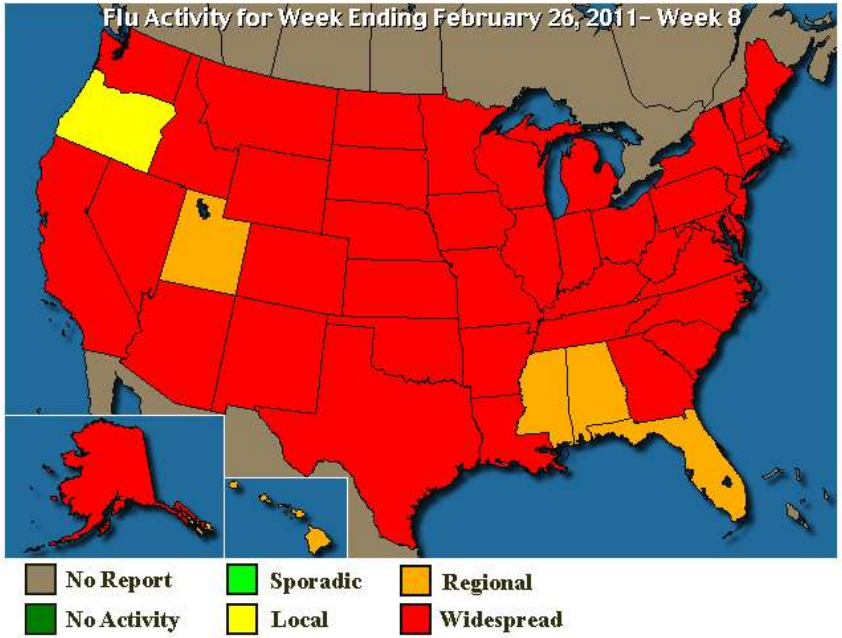
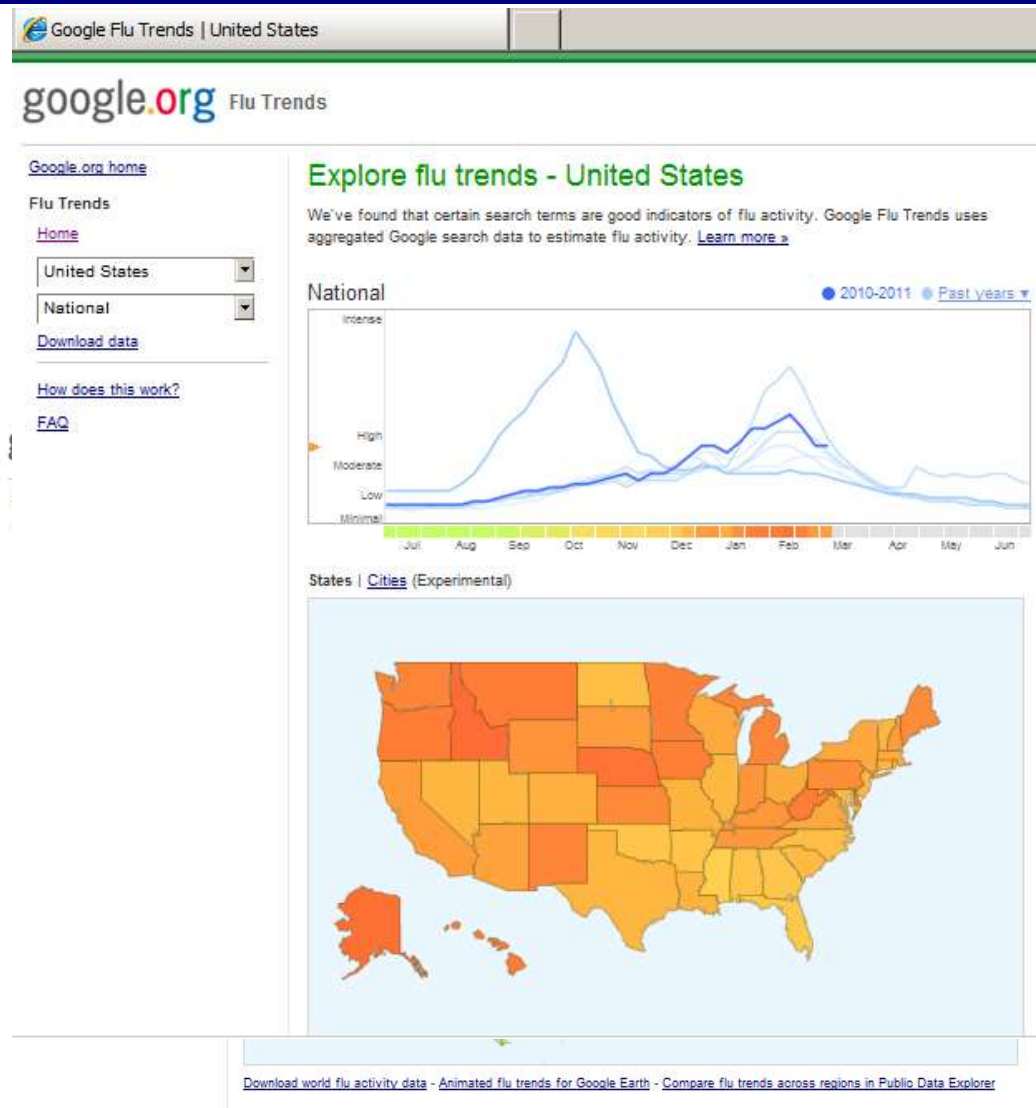
What Other Questions Come To Mind?

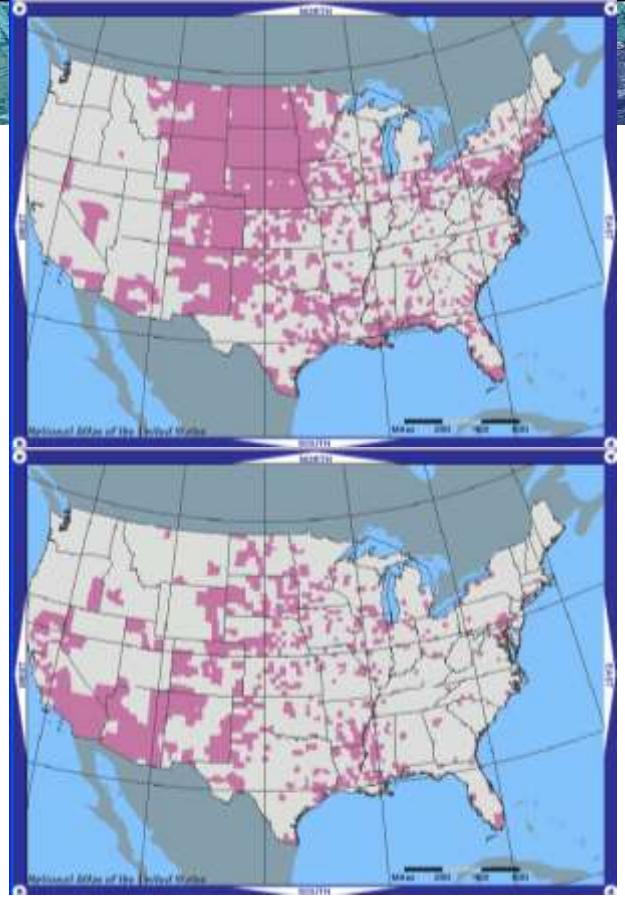


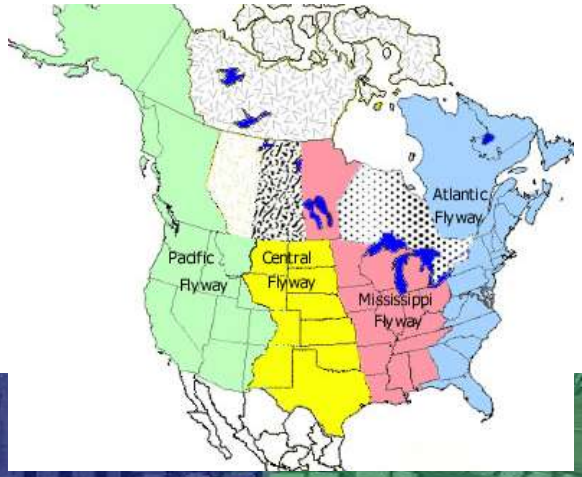
Epidemiology

- Weatherunderground
- National Atlas
- Google flu tracker









Where is the origin of West Nile and what are possible vectors to transmit it?

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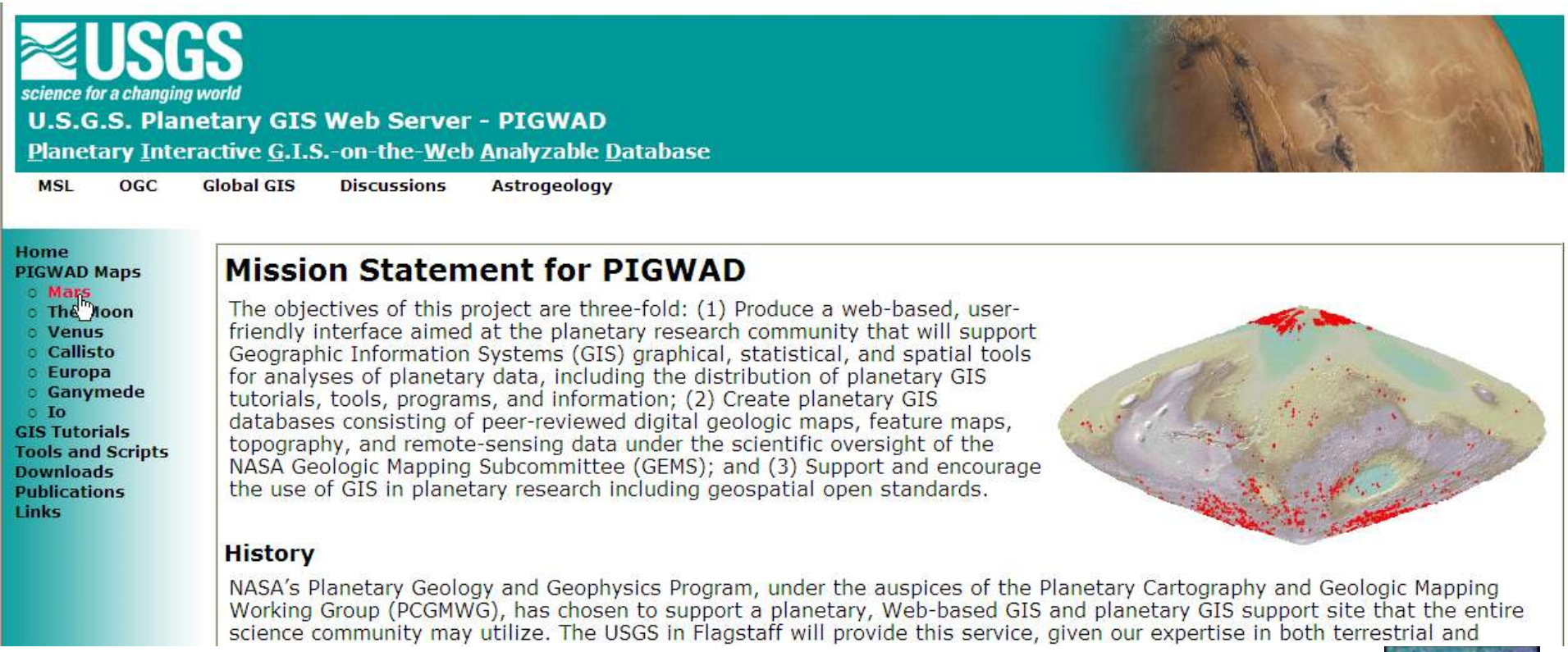
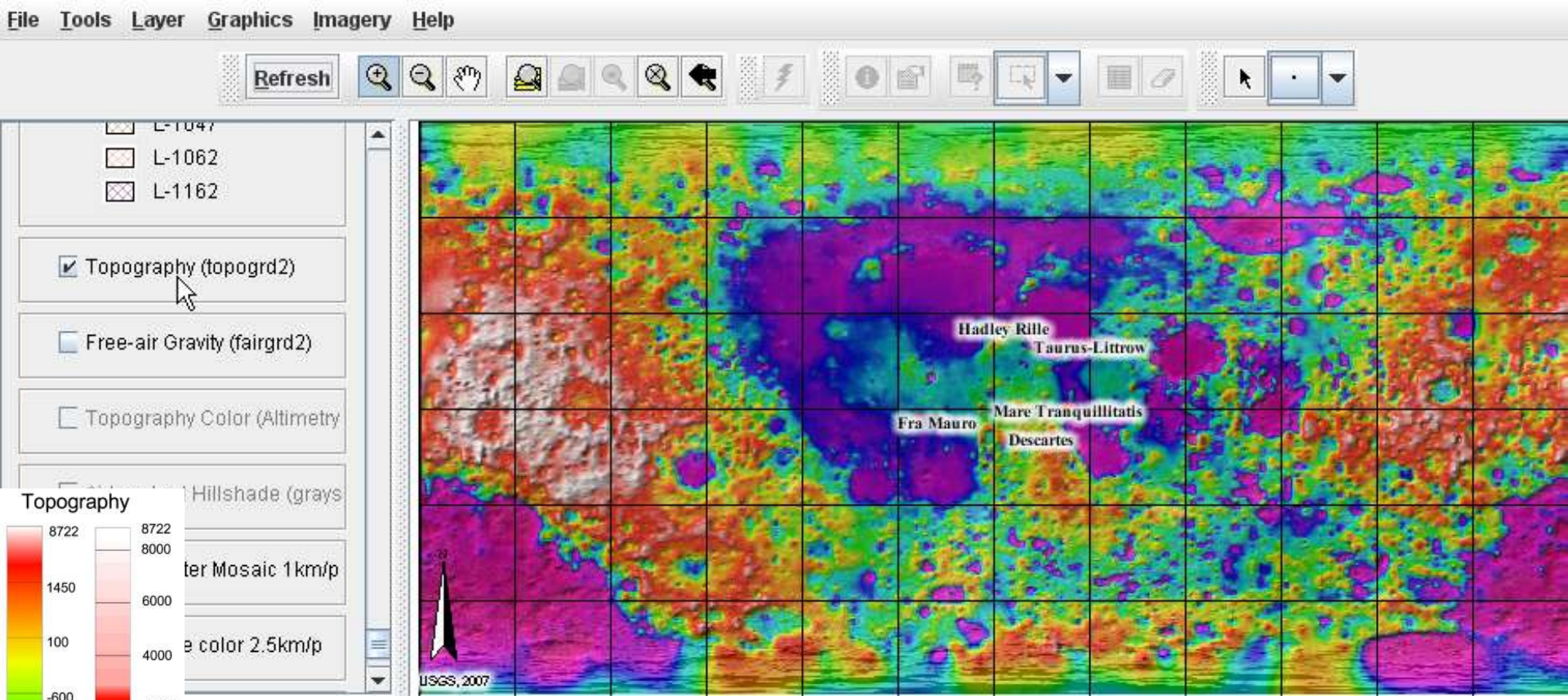
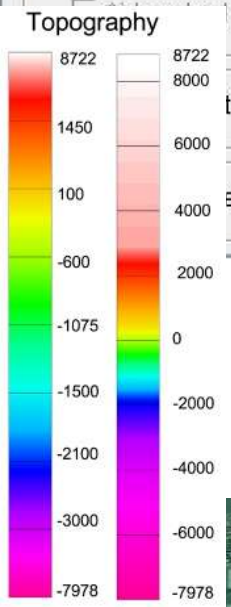
Off World Online GIS

- PIGWAD enables students to investigate NASA's goal of reaching the Moon Mars and beyond.



Moon Missions: Where will we find water





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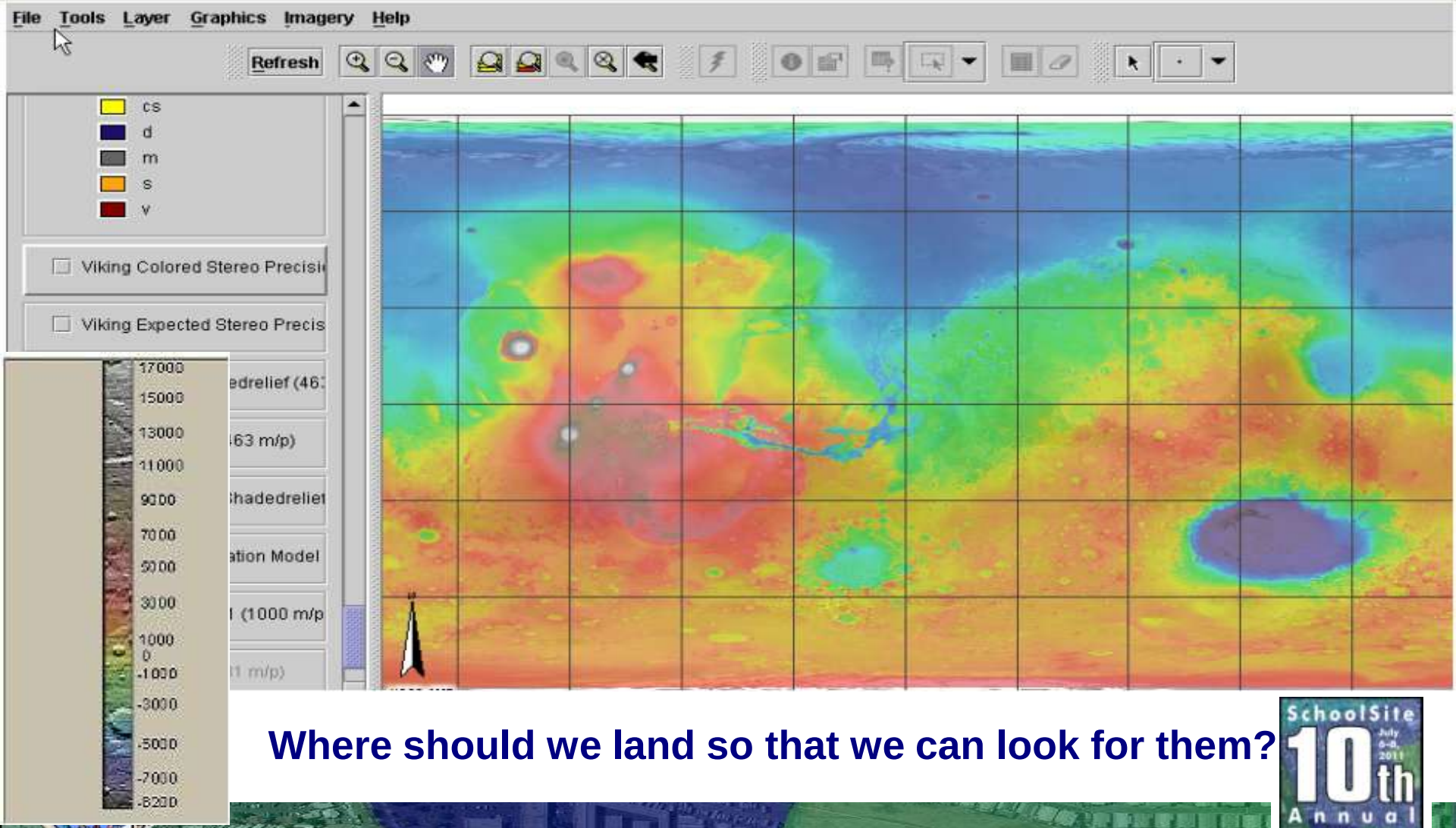
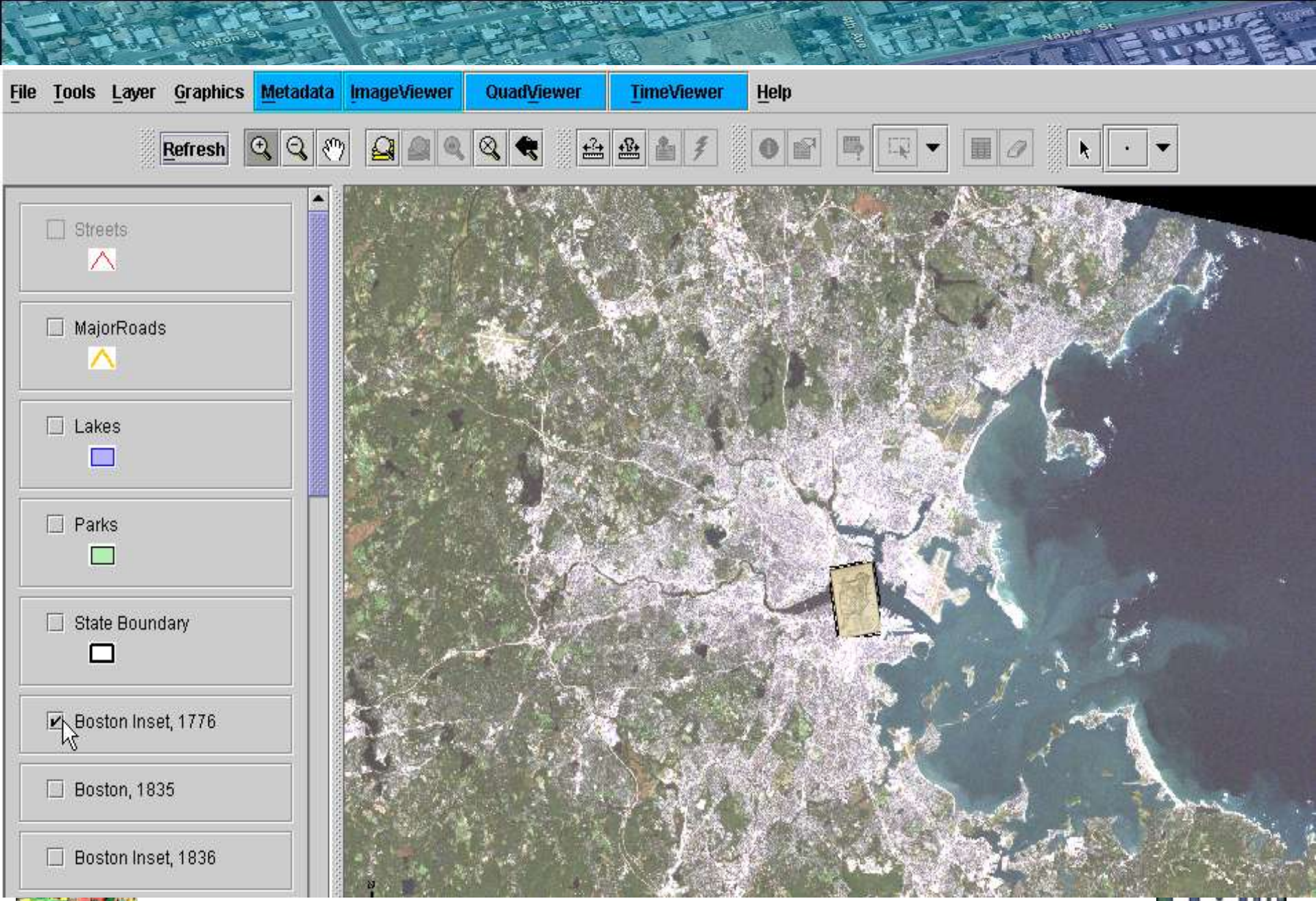
Mars: What resources are most important?



Where should we land so that we can look for them?

History is also well suited to maps


File
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Metadata
ImageViewer
QuadViewer
TimeViewer
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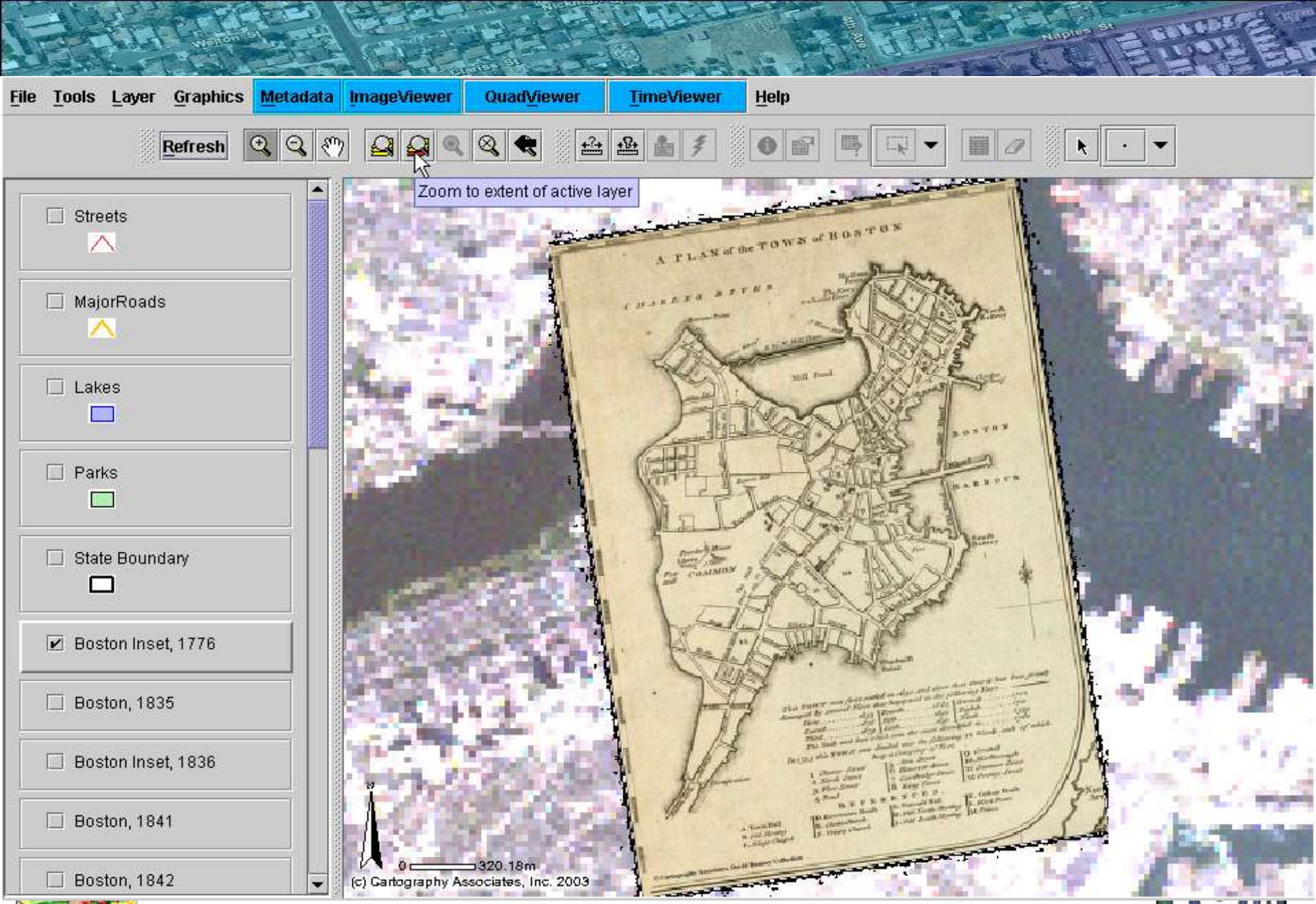
Streets
MajorRoads
Lakes
Parks
State Boundary
Boston Inset, 1776
Boston, 1835
Boston Inset, 1836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TimeViewer
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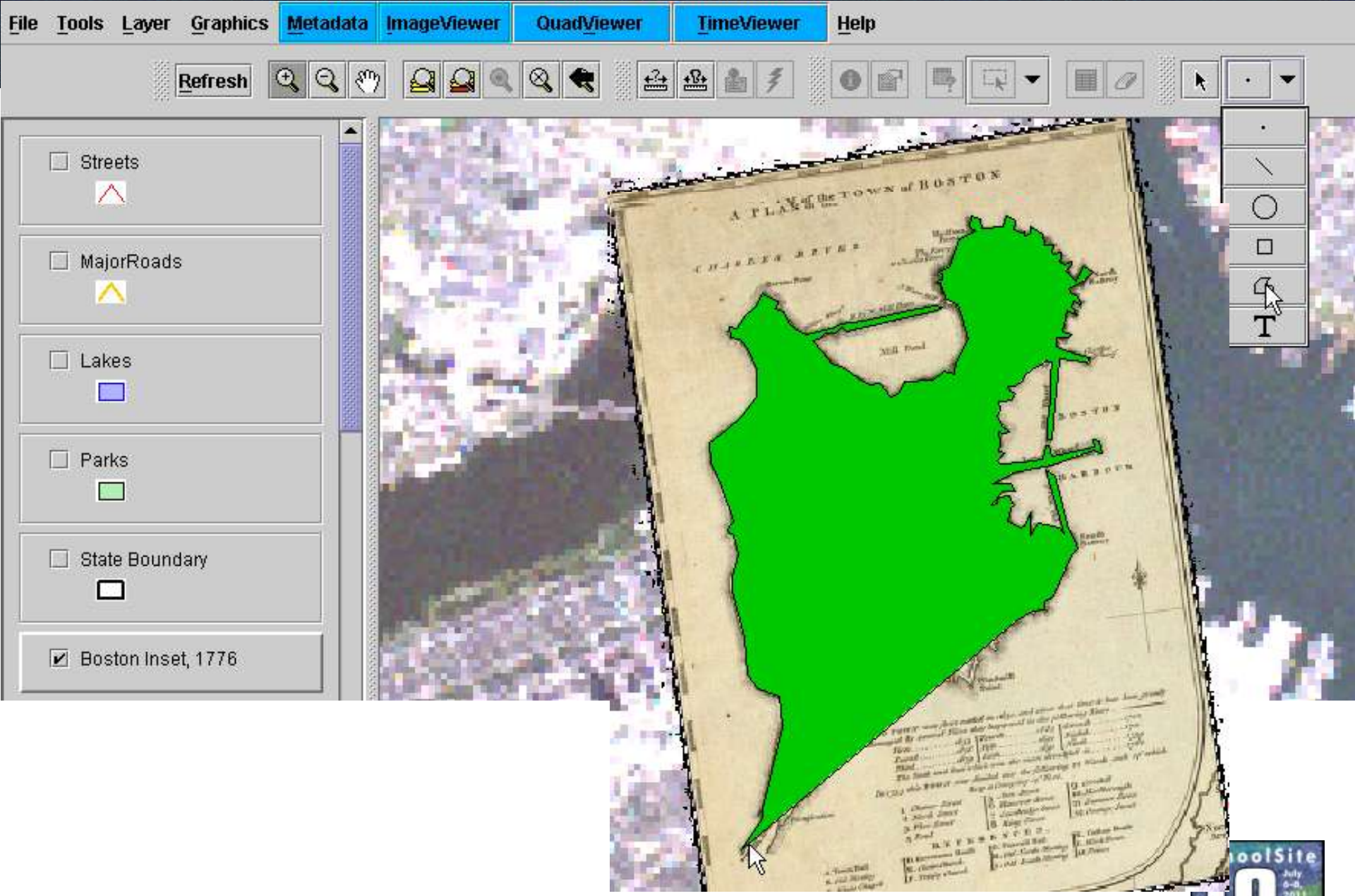
Zoom to extent of active layer
Streets
MajorRoads
Lakes
Parks
State Boundary
Boston Inset, 1776
Boston, 1835
Boston Inset, 1836
Boston, 1841
Boston, 1842
A PLAN of the TOWN of BOSTON
0
320.18m
(c) Cartography Associates, Inc. 2003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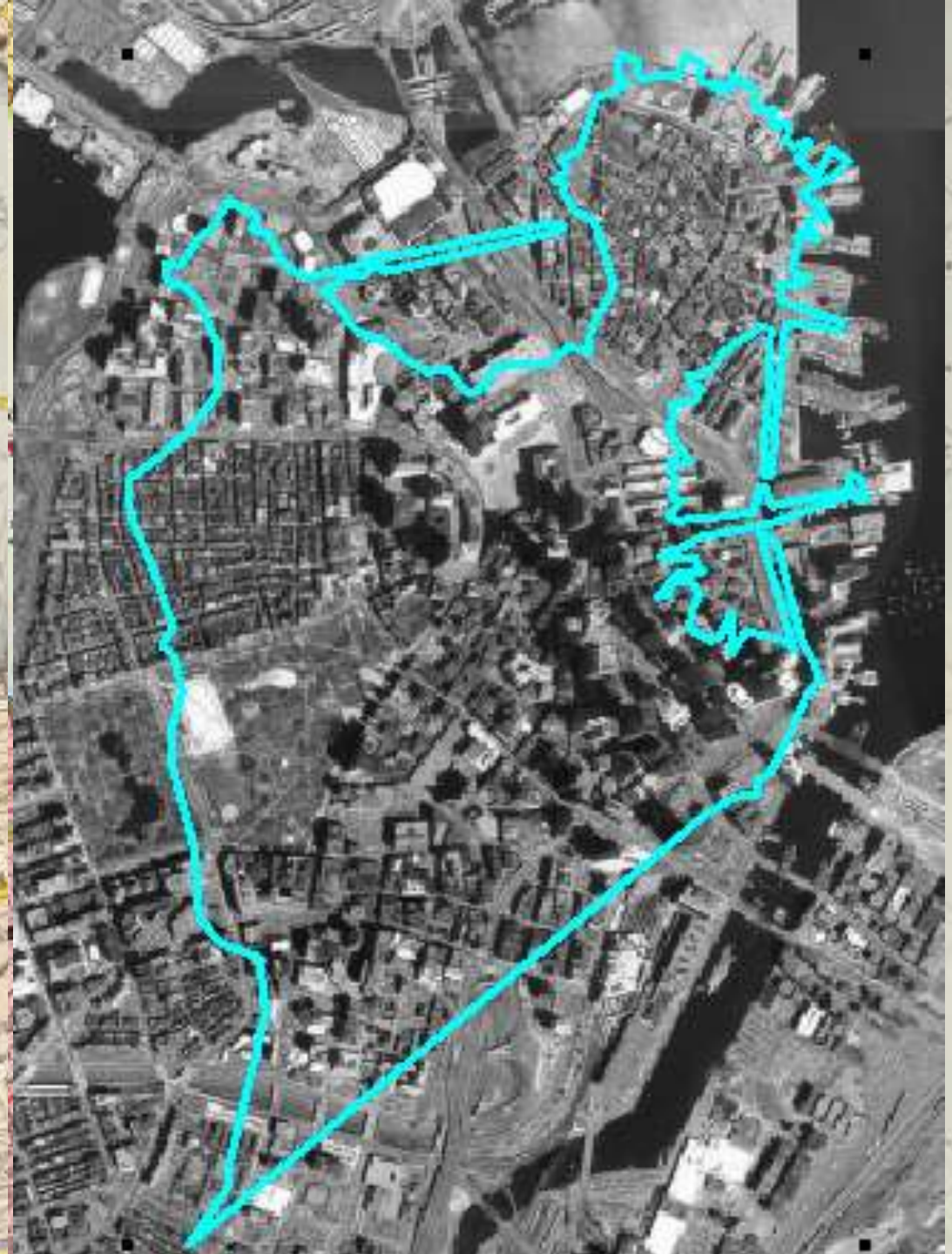
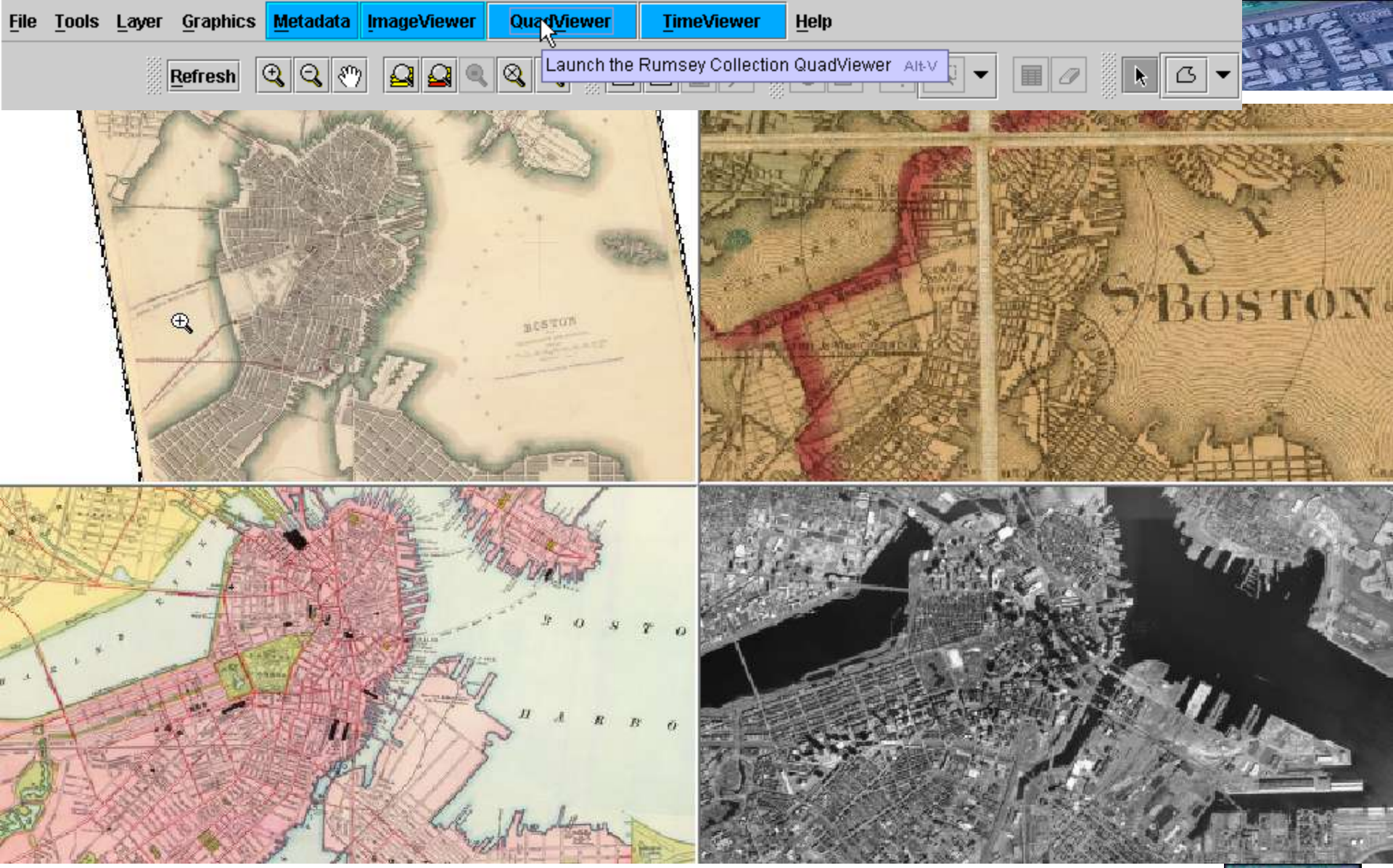
State Boundary
Boston Inset, 1776
A PLAN of the TOWN of BOSTON



1835,1846,1852, 1874, 1897, and current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TimeViewer
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Launch the Rumsey Collection QuadViewer Alt-V
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Historical Census Browser

What can you do on this site?

- **Examine state and county topics for individual census years.**
  - examine multiple topics within a census year
  - produce tables of data by state or county
  - sort data by selected categories
  - create ratios between any two data categories

Choose a census year to begin examining data:								
1790	1800	1810	1820	1830	1840	1850	1860	1870
1880	1890	1900	1910	1920	1930	1940	1950	1960

- **Examine state and county topics over time.**
  - examine a topic across multiple census years

About the Historical Census Browser

The data and terminology presented in the Historical Census Browser are drawn directly from historical volumes of the U.S. Census of Population and Housing.

To Cite This Collection (APA Style)

(2004). Historical Census Browser. Retrieved [Date you accessed source], from the University of Virginia, Geospatial and Statistical Data Center: http://fisher.lib.virginia.edu/collections/stats/histcensus/index.html.

http://fisher.lib.virginia.edu/collections/stats/histcensus/

Historical Census Browser

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1880	1890	1900	1910	1920	1930	1940	1950	1960

- **Examine state and county topics over time.**
  - examine a topic across multiple census years
  - produce tables of data by state or county

Choose a category to begin examining data:	
General Population	Ethnicity/Race/Place of Birth
Education & Literacy	Agriculture
Economy/Manufacturing/Employment	Slave Population

- **Generate maps of selected data** Click on "Map It!" at the top of data columns to

About the Historical Census Browser

The data and terminology presented in the Historical Census Browser are drawn directly from historical volumes of the U.S. Census of Population and Housing.

To Cite This Collection (APA Style)

(2004). Historical Census Browser. Retrieved [Date you accessed source], from the University of Virginia, Geospatial and Statistical Data Center: http://fisher.lib.virginia.edu/collections/stats/histcensus/index.html.

Historical Census Browser

Census Data Over Time

Display data from:

1790 **to:** 1960

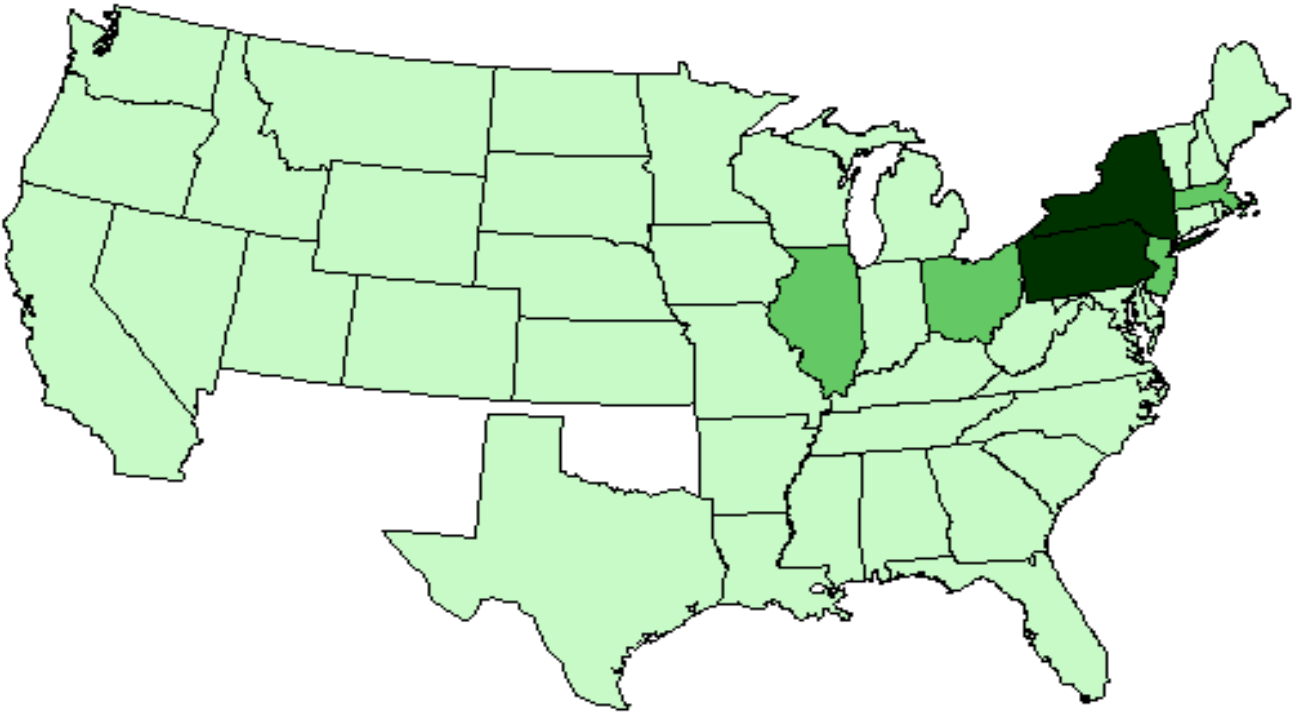
Select from the topics below in the category of Economy/Manufacturing/Employment:

- COST OF RAW MATERIALS IN MANUFACTURING (1860--1940)
- MANUFACTURING ESTABLISHMENTS (1860--1940)
- PERSONS ENGAGED IN MANUFACTURING (1820--1880)
- TOTAL CAPITAL INVESTED IN MANUFACTURING (1840--1900)
- TOTAL WAGES PAID IN MANUFACTURING (1860--1940)

Submit Query | Reset

TOTAL CAPITAL INVESTED IN MANUFACTURING

State *To retrieve county-level data, select a state and click the submit button below*	1840 Map it!	1850 Map it!	1860 Map it!	1870 Map it!	1880 Map it!	1890 Map it!	1900 Map it!
All States							
Alabama	2,130,064	3,450,606	9,098,181	5,714,032	9,668,008	46,123	70,370
Arkansas	424,467	324,065	1,316,610	1,782,913	2,953,130	14,971	35,961
California	N/A	1,006,197	22,043,096	39,728,202	61,243,784	146,798	205,395
Colorado	N/A	N/A	N/A	2,835,605	4,311,714	26,652	62,825
Connecticut	13,669,139	23,890,408	45,590,430	95,281,278	120,480,275	227,004	314,697
Delaware	1,589,215	2,978,945	5,452,887	10,839,093	15,655,822	33,695	41,203
Florida	669,490	544,260	1,874,125	1,679,930	3,210,680	11,110	33,107
Georgia	2,899,565	5,460,483	10,890,875	13,930,125	20,672,410	56,922	89,790
Idaho	N/A	N/A	N/A	N/A	N/A	1,049	2,942
Illinois	3,136,512	6,385,387	27,548,563	94,368,057	140,652,066	502,005	766,830
Indiana	4,132,043	7,842,362	17,881,586	52,052,425	65,742,962	131,605	234,482
Iowa	199,645	1,292,875	7,247,130	22,420,183	33,987,886	77,513	102,733
Kansas	N/A	N/A	1,084,935	4,319,060	11,192,315	43,926	66,827
Kentucky	5,945,259	12,350,740	20,256,579	29,277,809	45,813,039	79,812	104,071
Louisiana	6,430,699	5,318,074	7,151,172	18,313,974	11,462,468	34,754	113,084
Maine	7,105,620	14,700,452	22,044,020	39,796,190	49,988,171	80,420	122,919



Outlines **Layers** Labels

- [ ] Current US Cities [ ]
- [ ] Waterways [ ]
- [ ] Current US States [ ]
- [ ] Geology [ ]
- [ ] Image [ ]
- [x] Data Layer [ ]

Data Label Data

Refresh Map

Tools

Classification/Legend

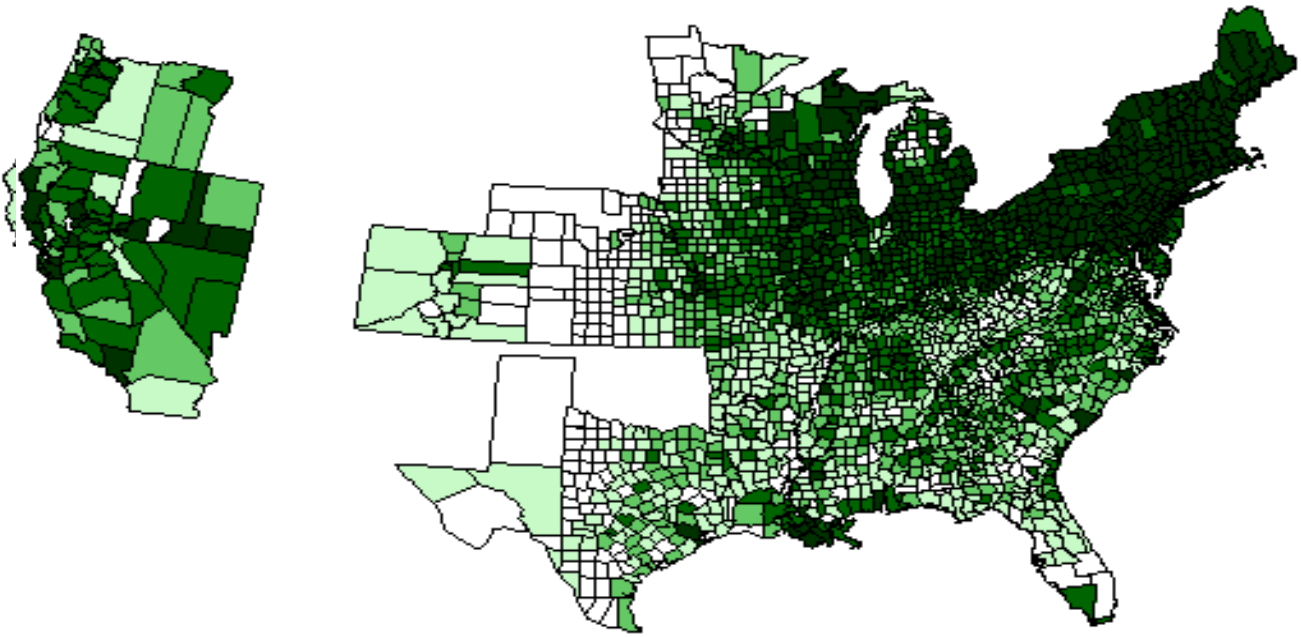
Equal Interval Customize Values

Open legend in new window.

- 1473 - 413907
- 413907 - 826341
- 826341 - 1238775
- 1238775 - 1651210
- Missing Data

UNITED STATES COUNTIES IN 1870: TOTAL CAPITAL INVESTED IN MANUFACTURING

The data and terminology presented in the Historical Census Browser are drawn directly from historical volumes of the U.S. Census of Population and Housing.



Outlines **Layers** Labels

- [ ] Current US Cities [ ]
- [ ] Waterways [ ]
- [ ] Current US States [ ]
- [ ] Historic US States [ ]
- [ ] Geology [ ]
- [ ] Image [ ]
- [x] Data Layer [ ]

Data Label: Data

Refresh Map

Tools

Classification/Legend

Equal Count

Customize Values

Open legend in new window.

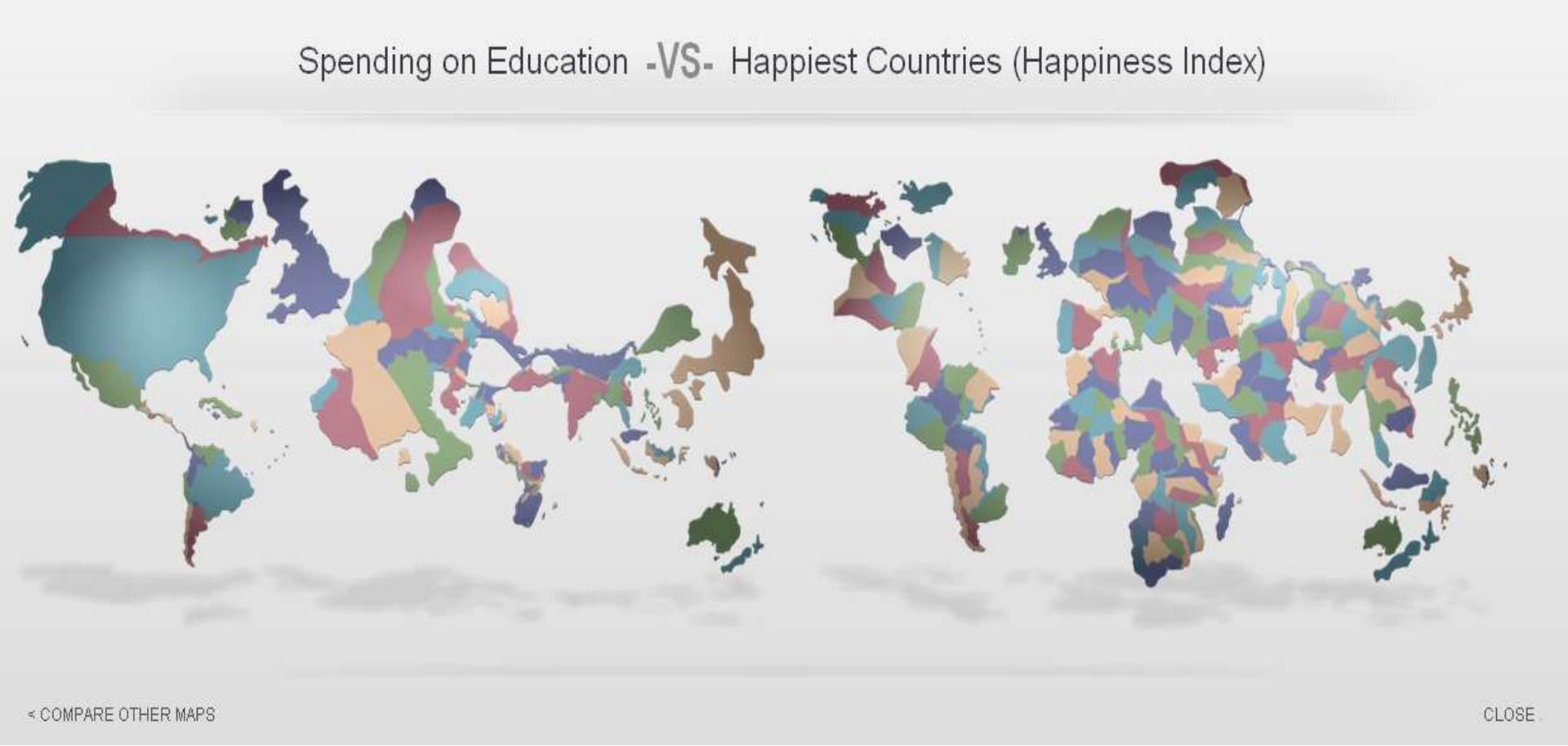
- 150 - 30525
- 30550 - 102335
- 102621 - 437167
- 437213 - 174016674
- Missing Data

Consider online webmapping sites for what they offer:

- quick access to data
- growing database of varied topics
- visualization of large data sets easing interpretation
- chance for students to build evidence based understanding of the world.

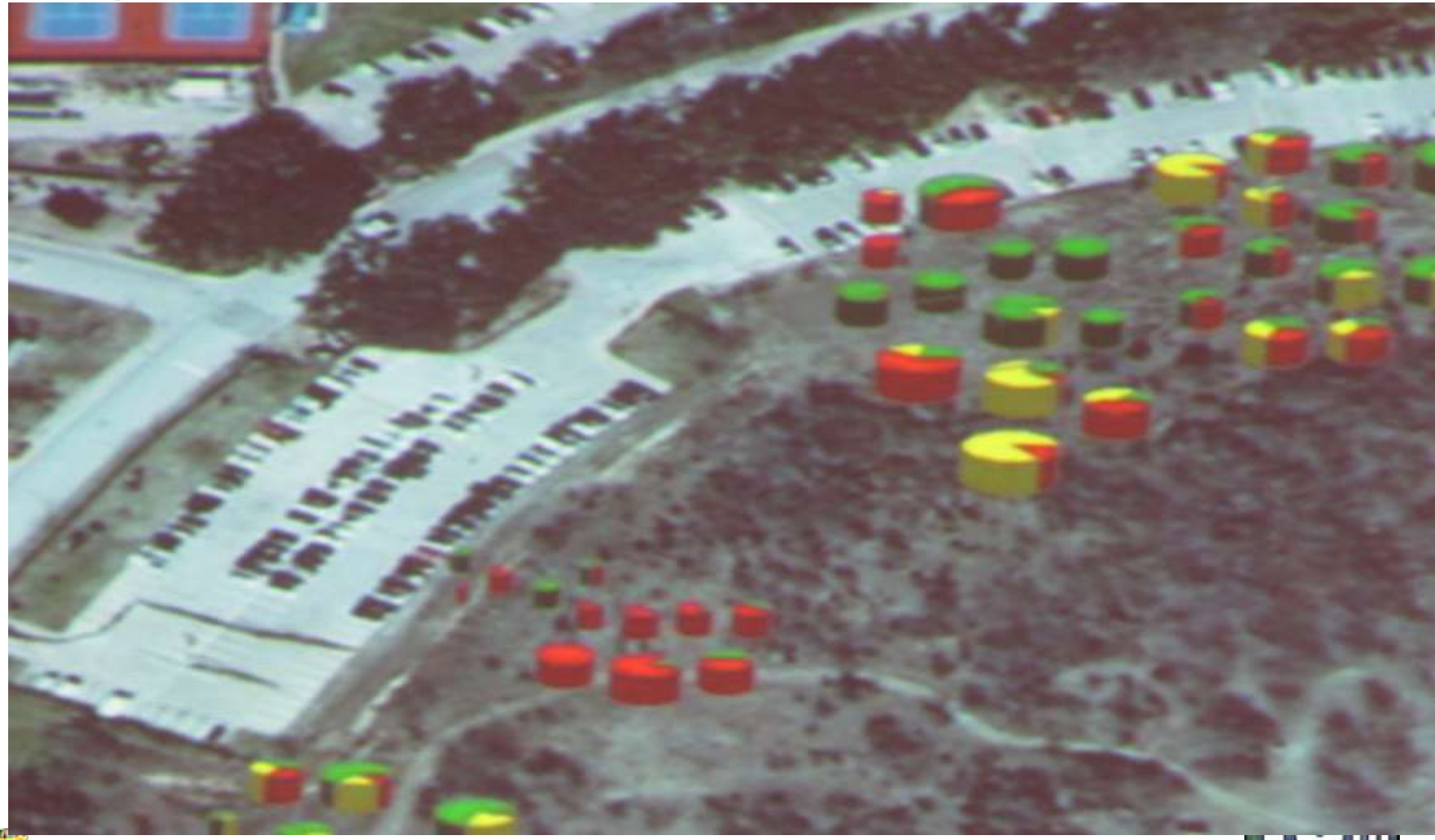
Typical GIS Integration Pathways:

1.) Use curriculum:
Our World Series,
GIS Tutorial,
Eyes in the Sky II
www.esri.com/arclessons,
STEM lessons at James Madison University,
Earth exploration tool book



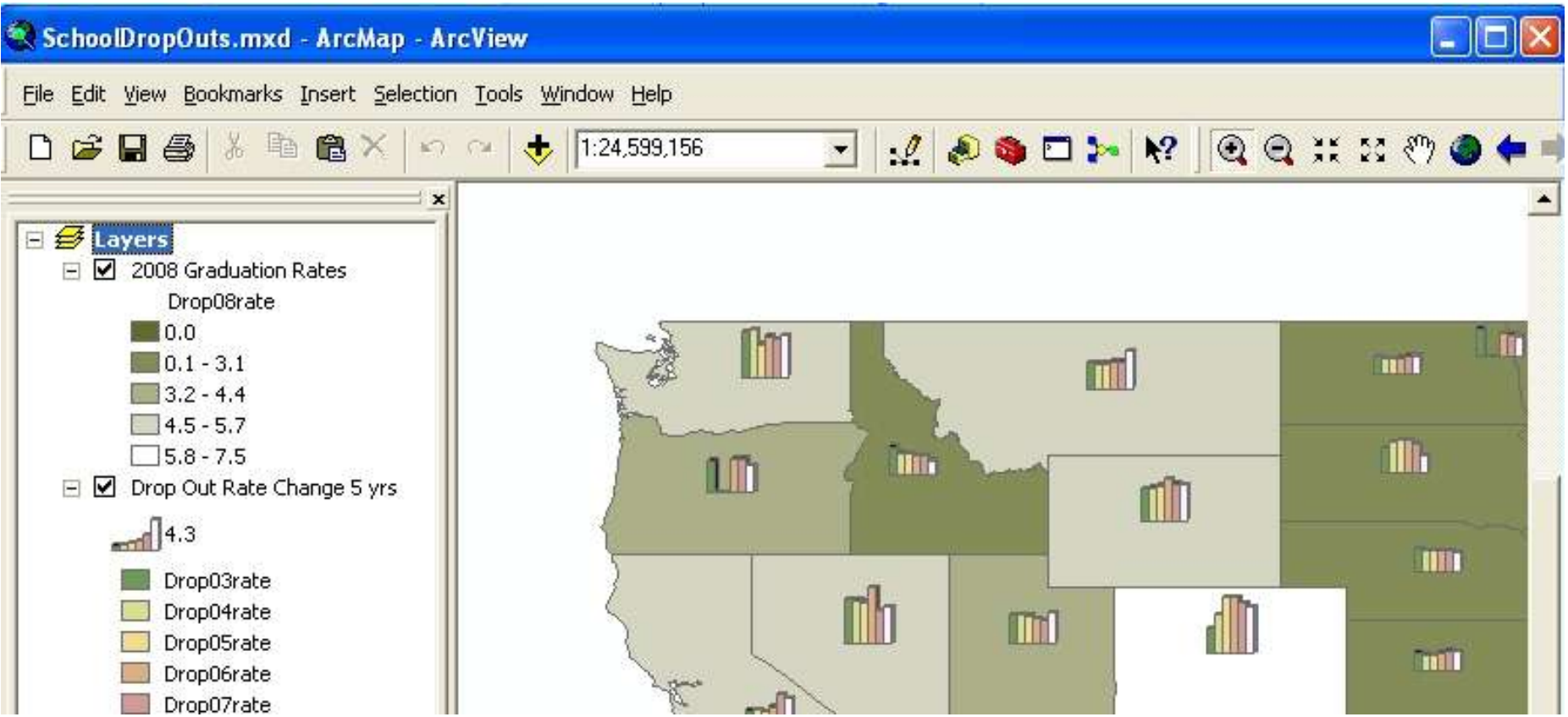
2.) Encourage Online Map Use to Start Discussions:
National Atlas, World Mapper, Nation Master, State Mapper, Gap Minder, American Factfinder

3.) Using GPS to add points to a streamed background map from ArcGIS online.



Finding your own data

4.) Join tables of data to existing geographies



Adding your own data

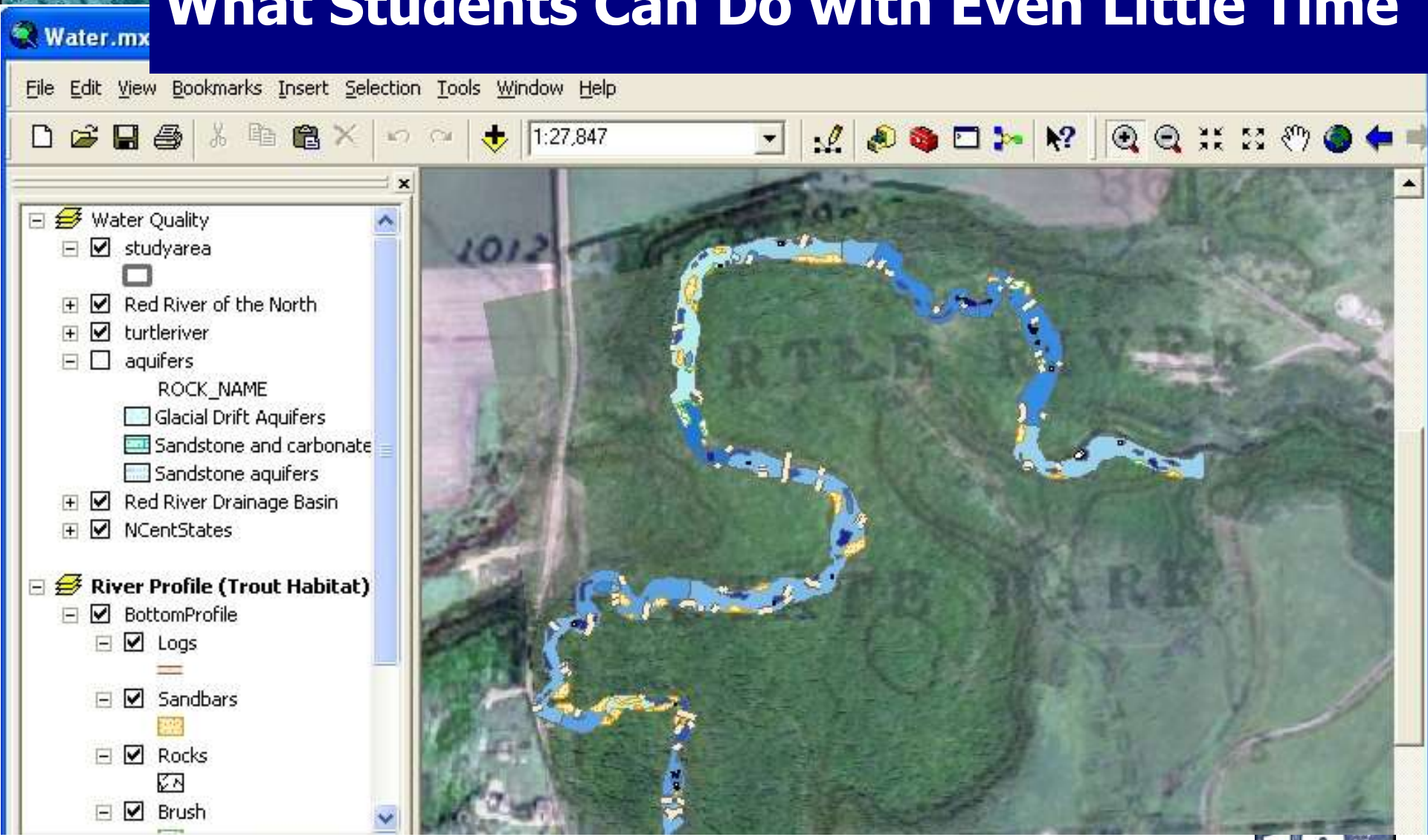
4b.) Digitizing your own data

- Trails, census data, businesses
- Geocoding addresses

4c.) Calculating new grids from Elevation or point concentrations

- Slope, aspect
- Reclassifying grids for simpler additions
- Doing grid calculations
- Creating Models

What Students Can Do with Even Little Time



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10th Annual User Conference

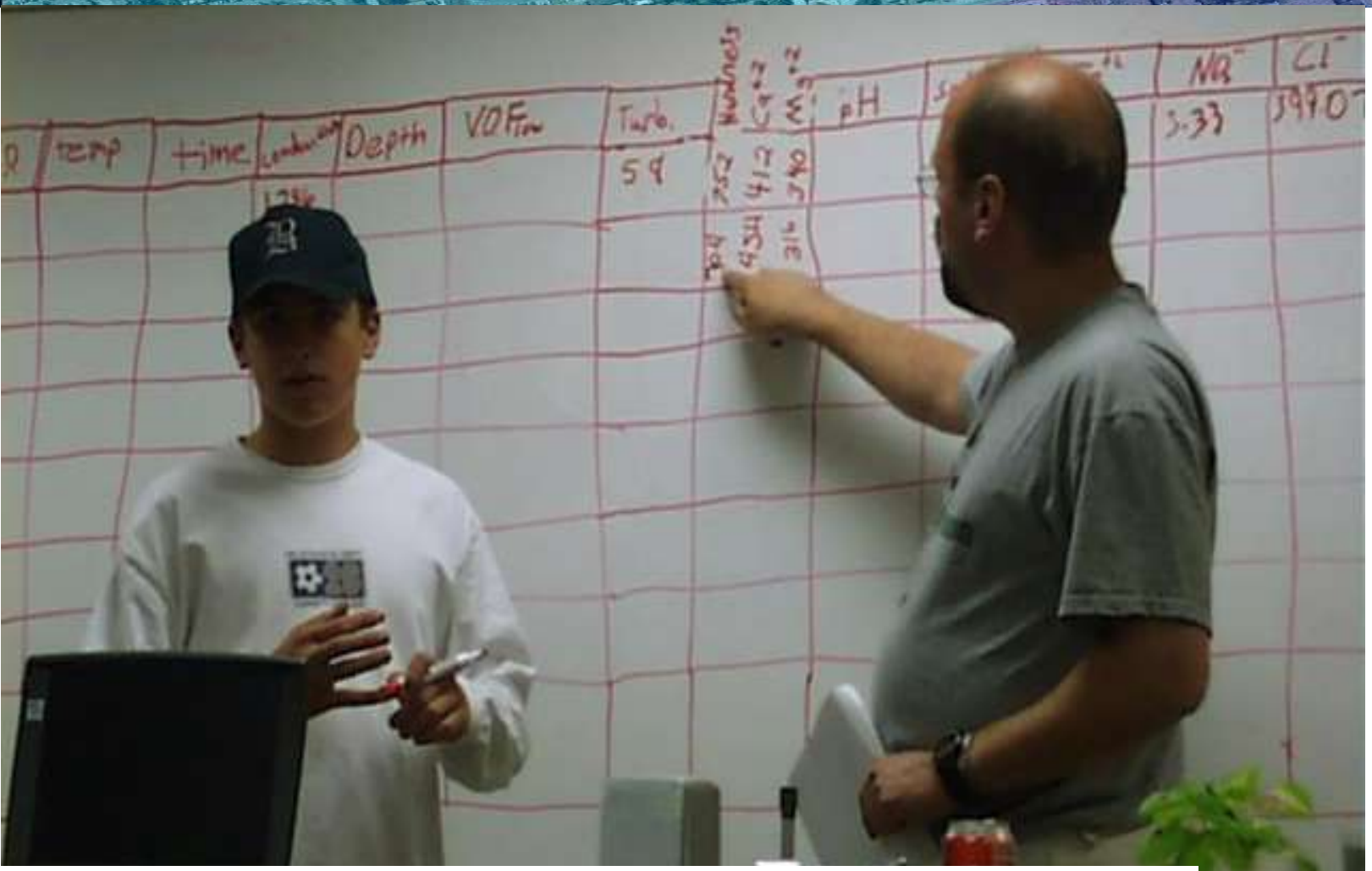
Summer Field Science: 1 wk 8 hrs /day

SchoolSite 10th Annual User Conference July 6-8, 2011

- While appropriate tools and clothes get you out into the field,

- It’s a challenge to bring the data and experiences back to the classroom

- Nothing replaces observations & a note book!



- **Work in teams, divide labor and build a common table back in the classroom**

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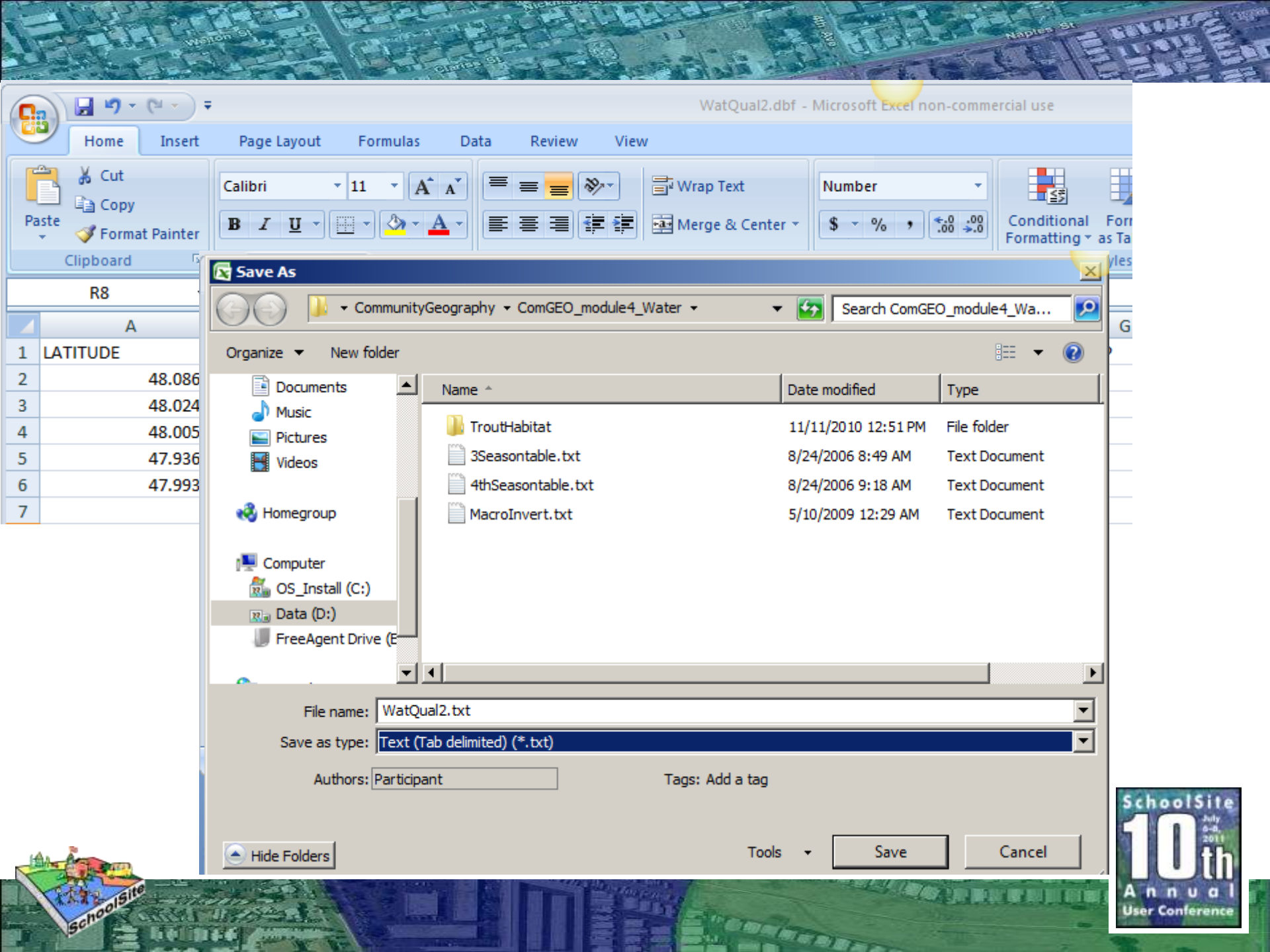
- **Compare data for consistency, then quickly enter it into spread sheets and share it.**


WatQual2.dbf - Microsoft Excel non-commercial use
Home
Insert
Page Layout
Formulas
Data
Review
View
Paste
Cut
Copy
Format Painter
Clipboard
Calibri
11
Wrap Text
Merge & Center
Number
Conditional Formatting
R8
A
LATITUDE
48.086
48.024
48.005
47.936
47.993
Save As
CommunityGeography
ComGEO_module4_Water
Search ComGEO_module4_Wa...
Organize
New folder
Documents
Music
Pictures
Videos
Homegroup
Computer
OS_Install (C:)
Data (D:)
FreeAgent Drive (E
Name
Date modified
Type
TroutHabitat
11/11/2010 12:51 PM
File folder
3Seasontable.txt
8/24/2006 8:49 AM
Text Document
4thSeasontable.txt
8/24/2006 9:18 AM
Text Document
MacroInvert.txt
5/10/2009 12:29 AM
Text Document
File name:
WatQual2.txt
Save as type:
Text (Tab delimited) (*.txt)
Authors:
Participant
Tags: Add a tag
Hide Folders
Tools
Save
Cancel
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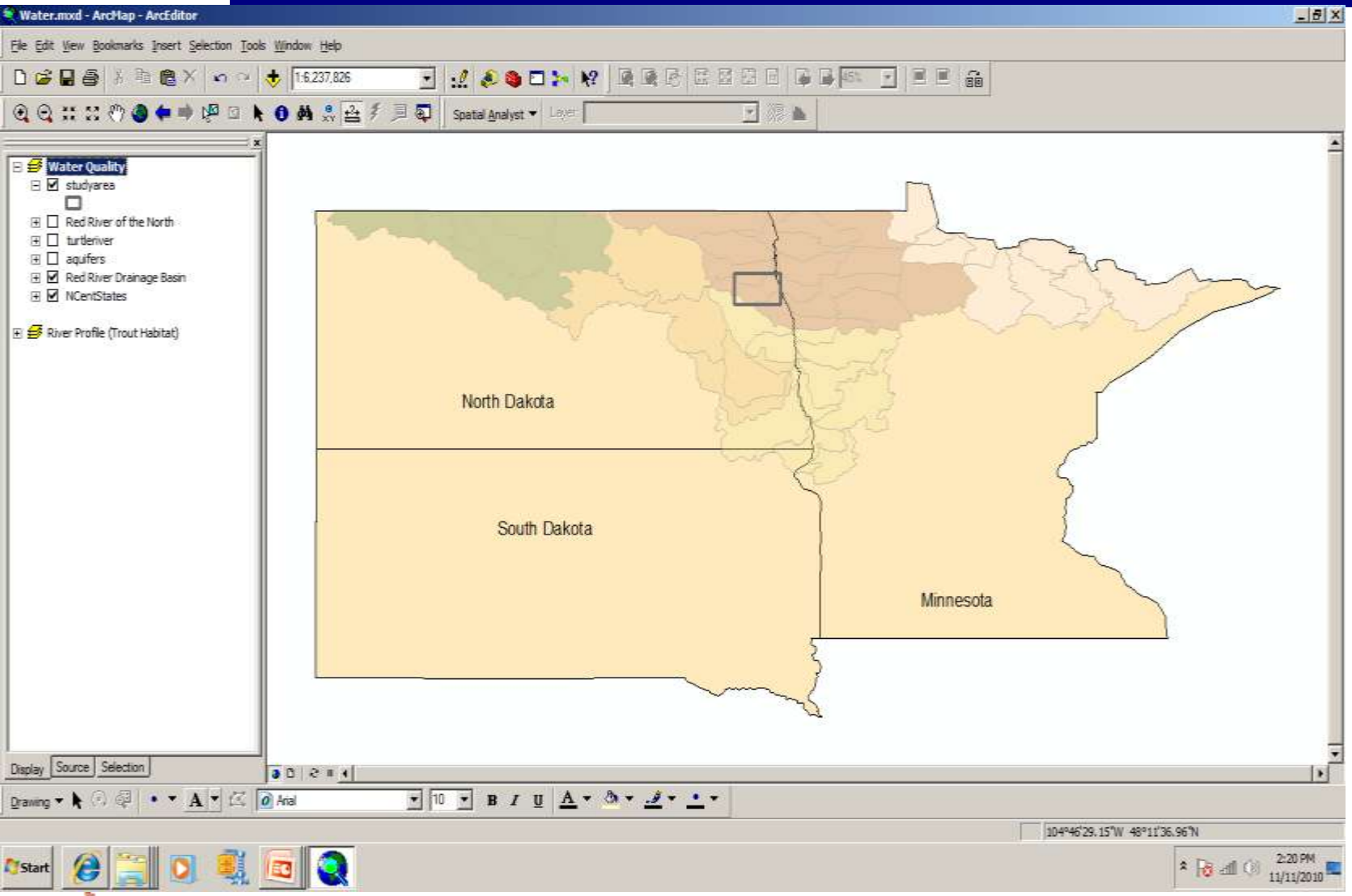
Assemble a basemap to display your data



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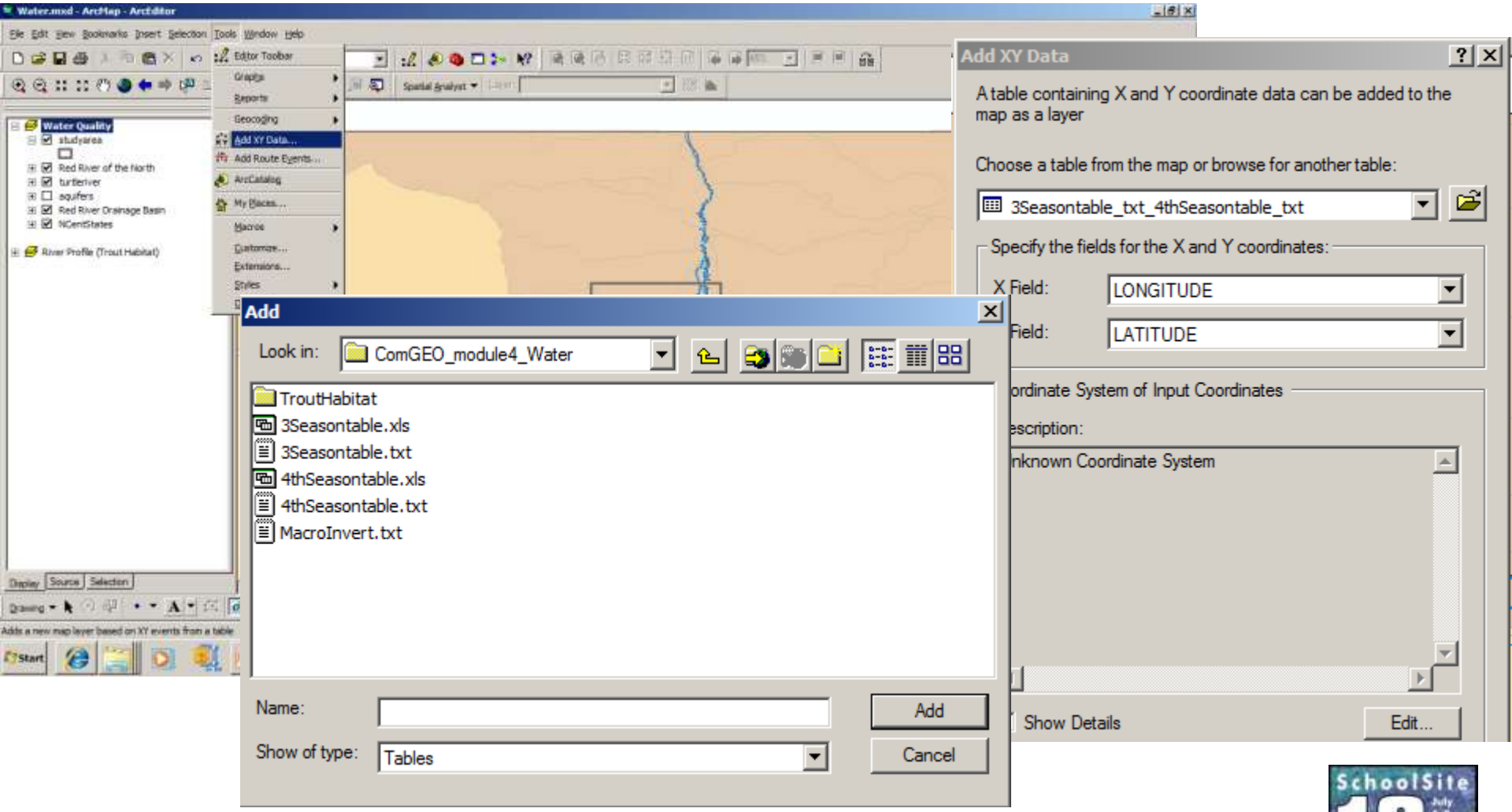
Adding data students gathered



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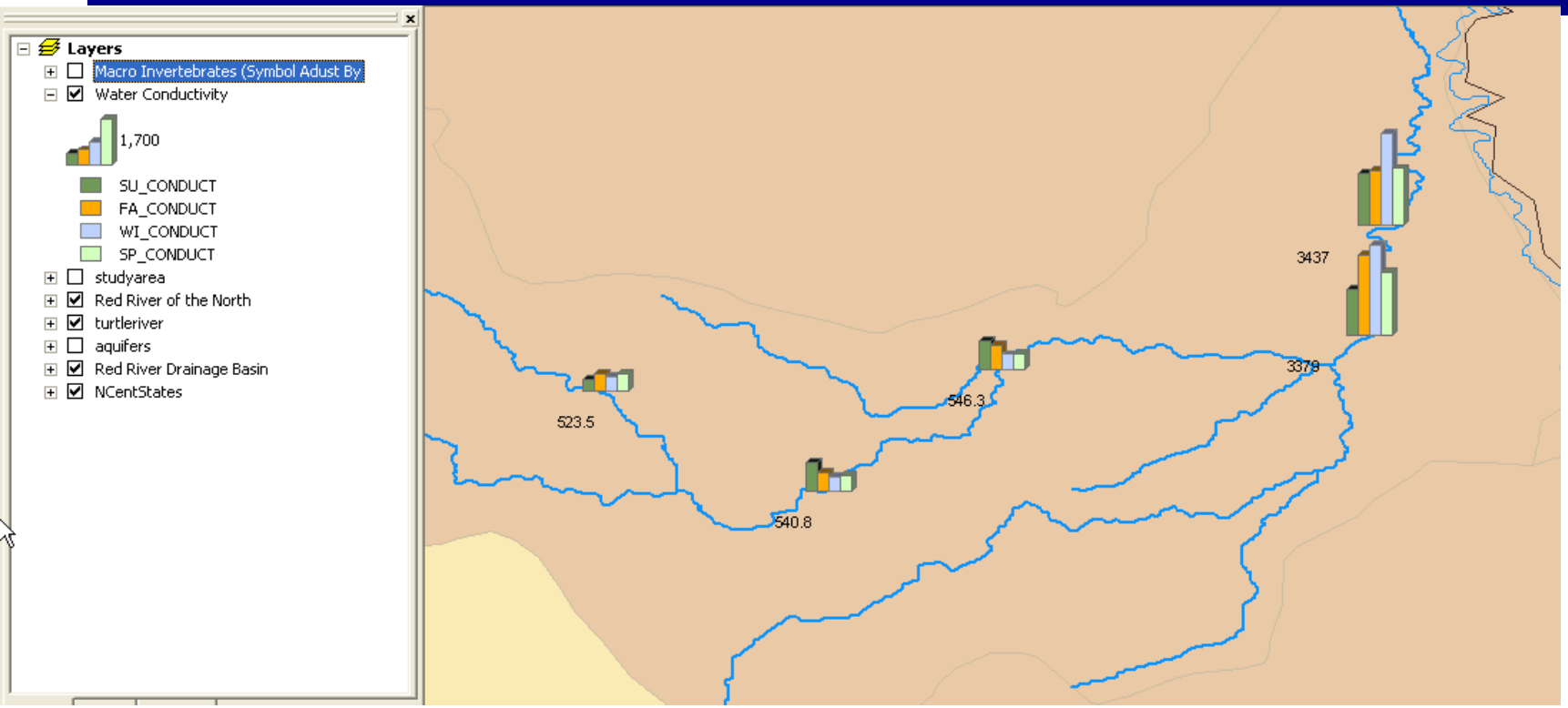
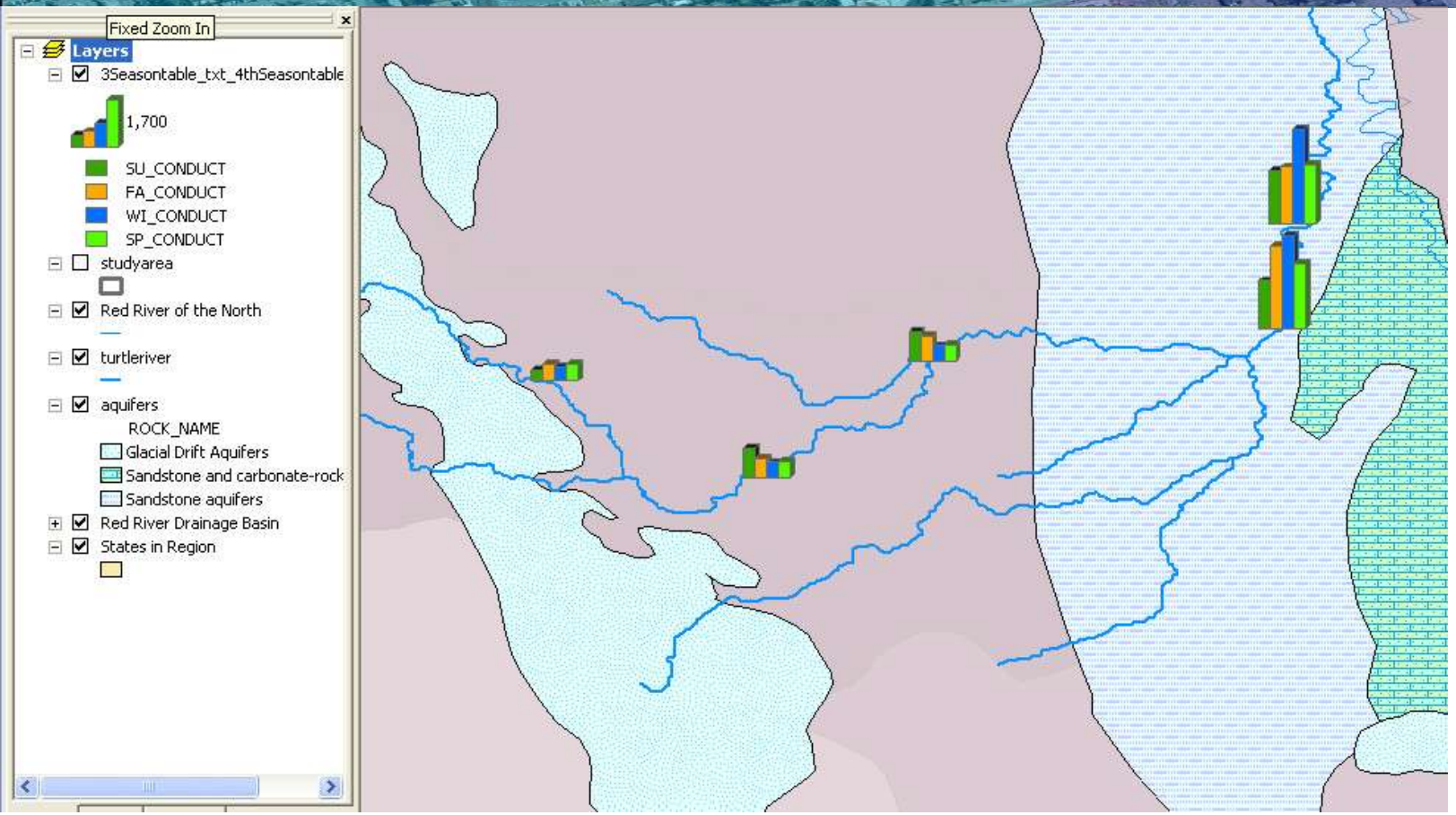
Choosing an appropriate representation



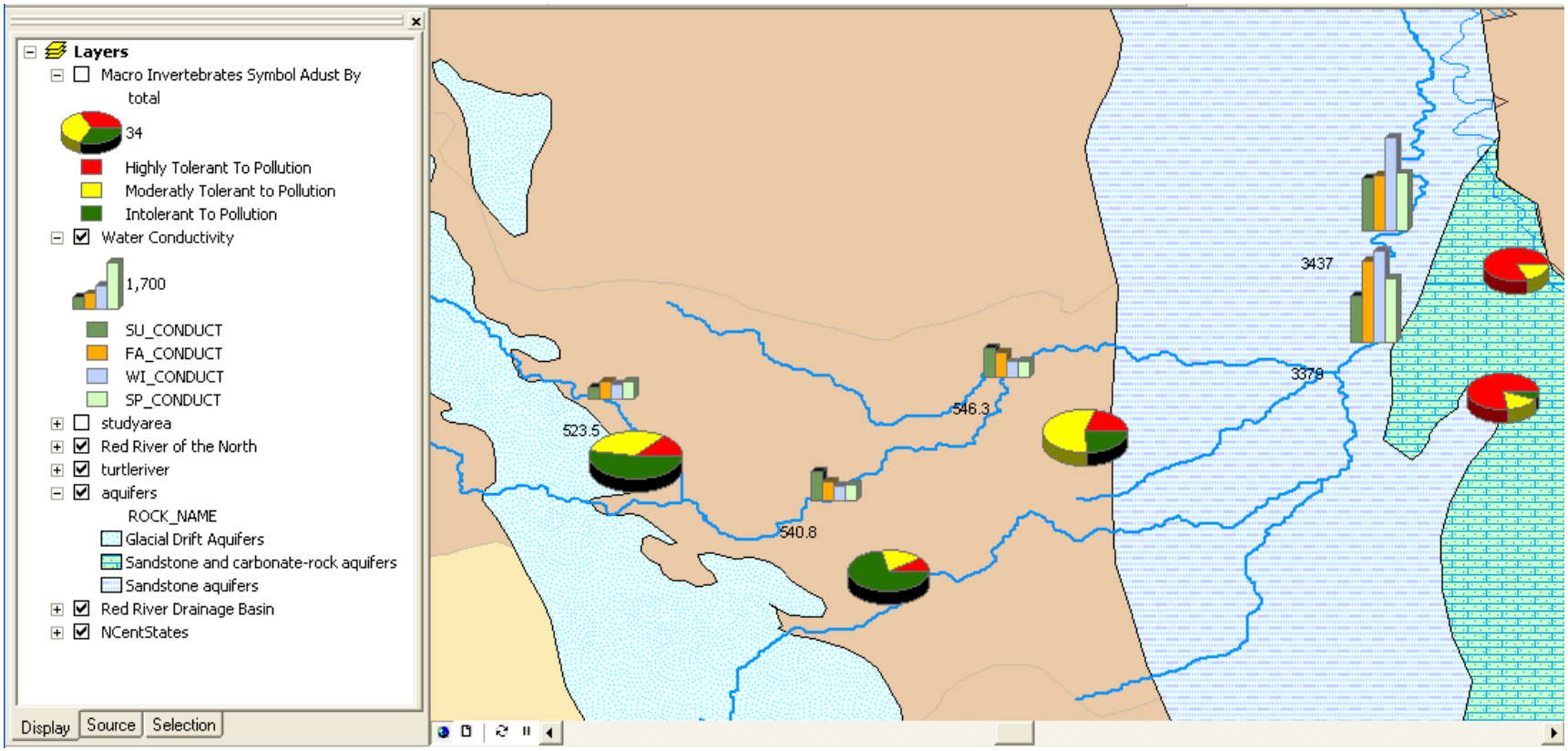
- While many variables were collected. What questions does conductivity raise?



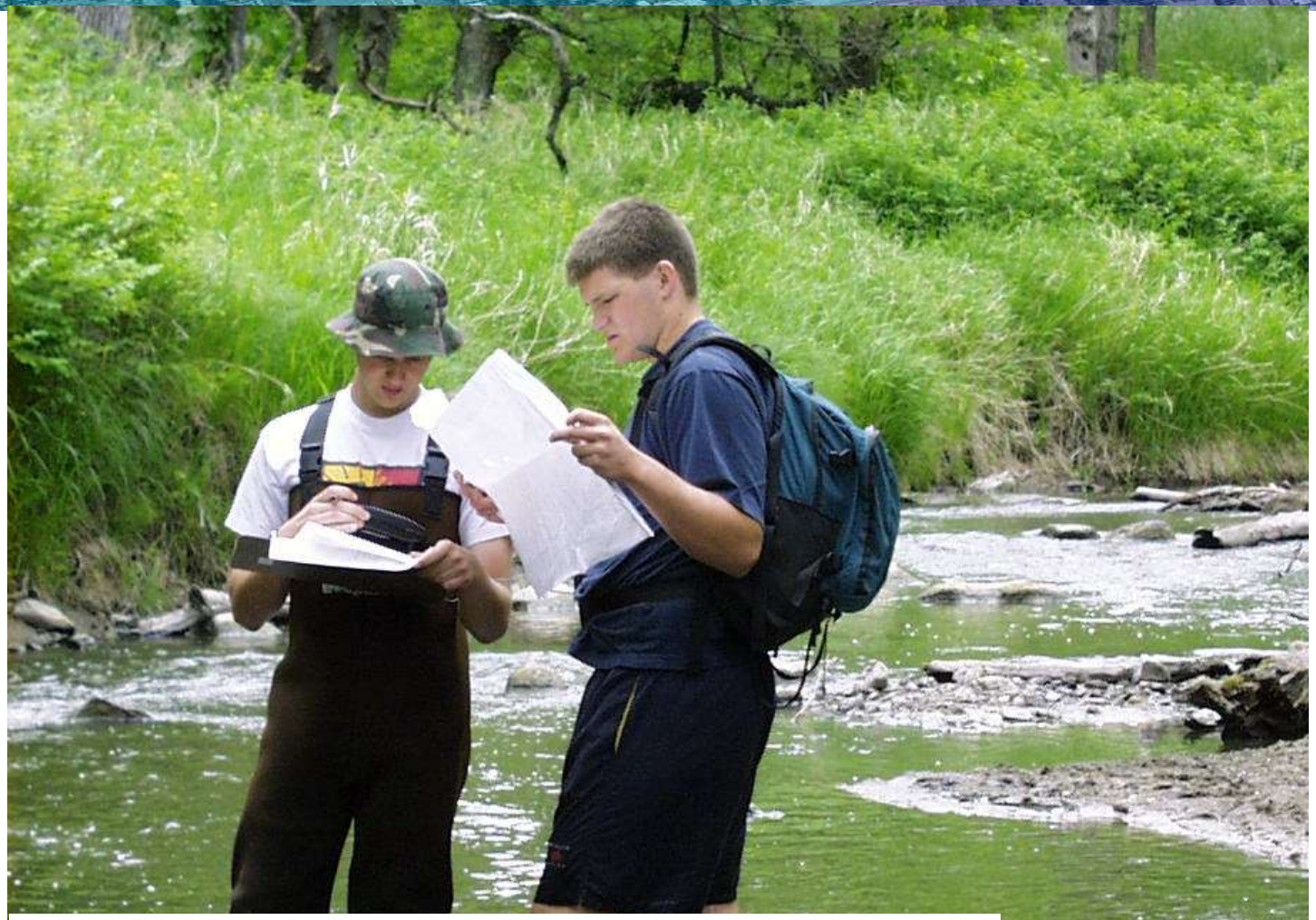
- The Blue-green areas are aquifers that feed these streams.
- How do they affect what can live in the river?

Student water quality projects

Water Quality Impacts What Lives in River

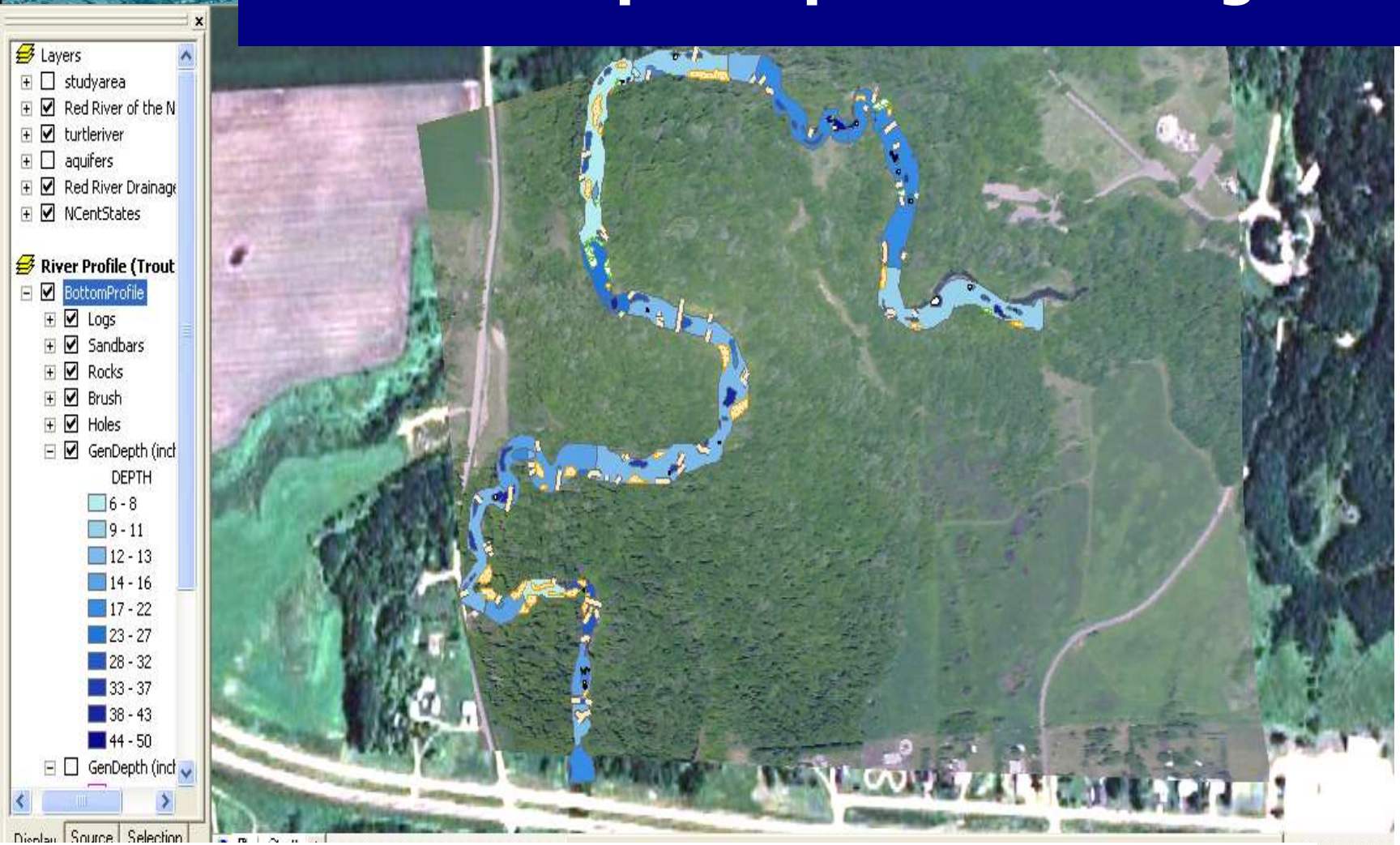


- **Students reported their results at interpretive talks at the park, in newspaper articles, in local tv news and at professional conferences!**



- Even hand draw maps can be registered if marked with GPS

Finished Maps Help Draw Fishing Tourism



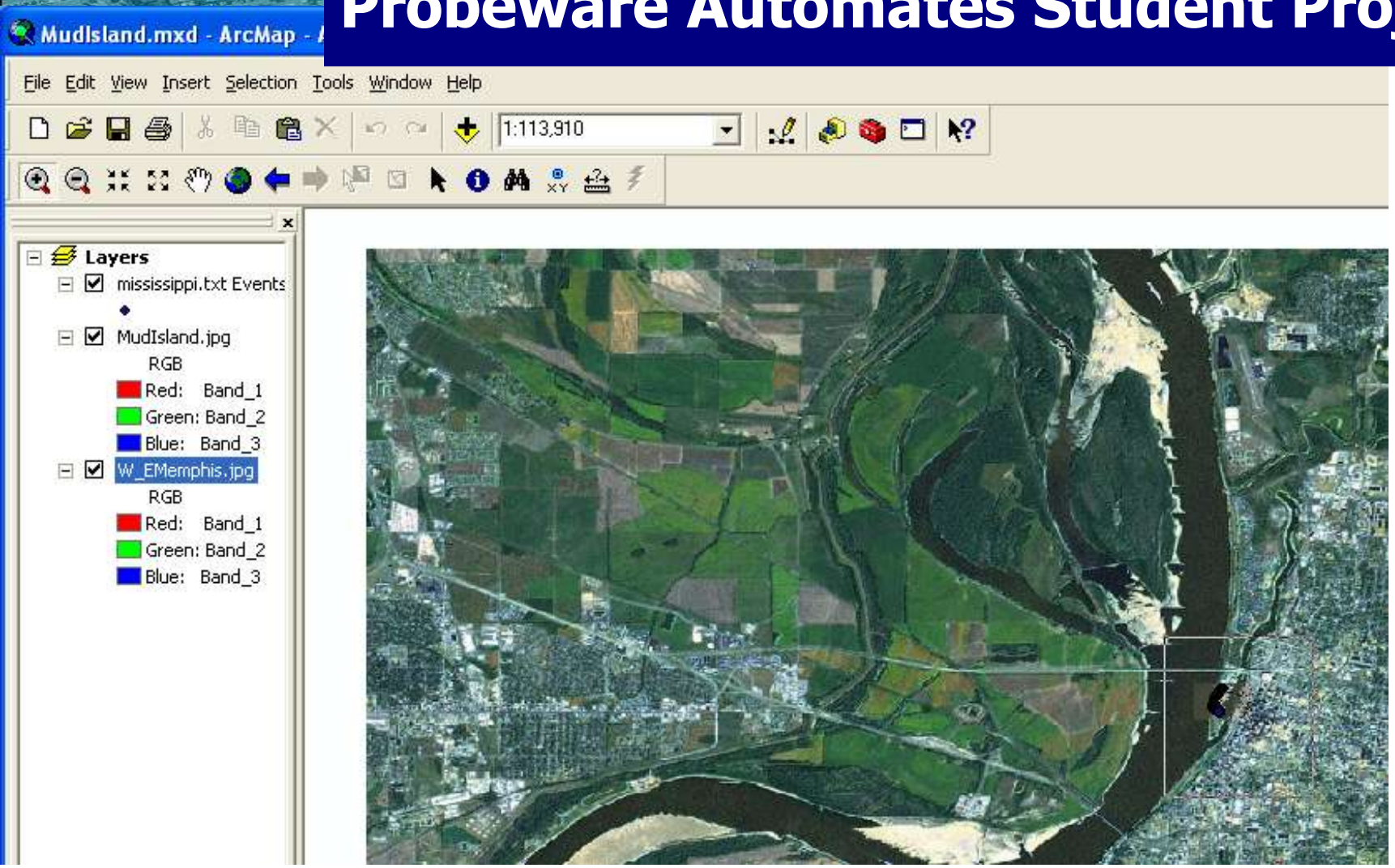
- Students followed up by surveying the river bottom profile to understand fish habitat preferences.

And Raise More Questions

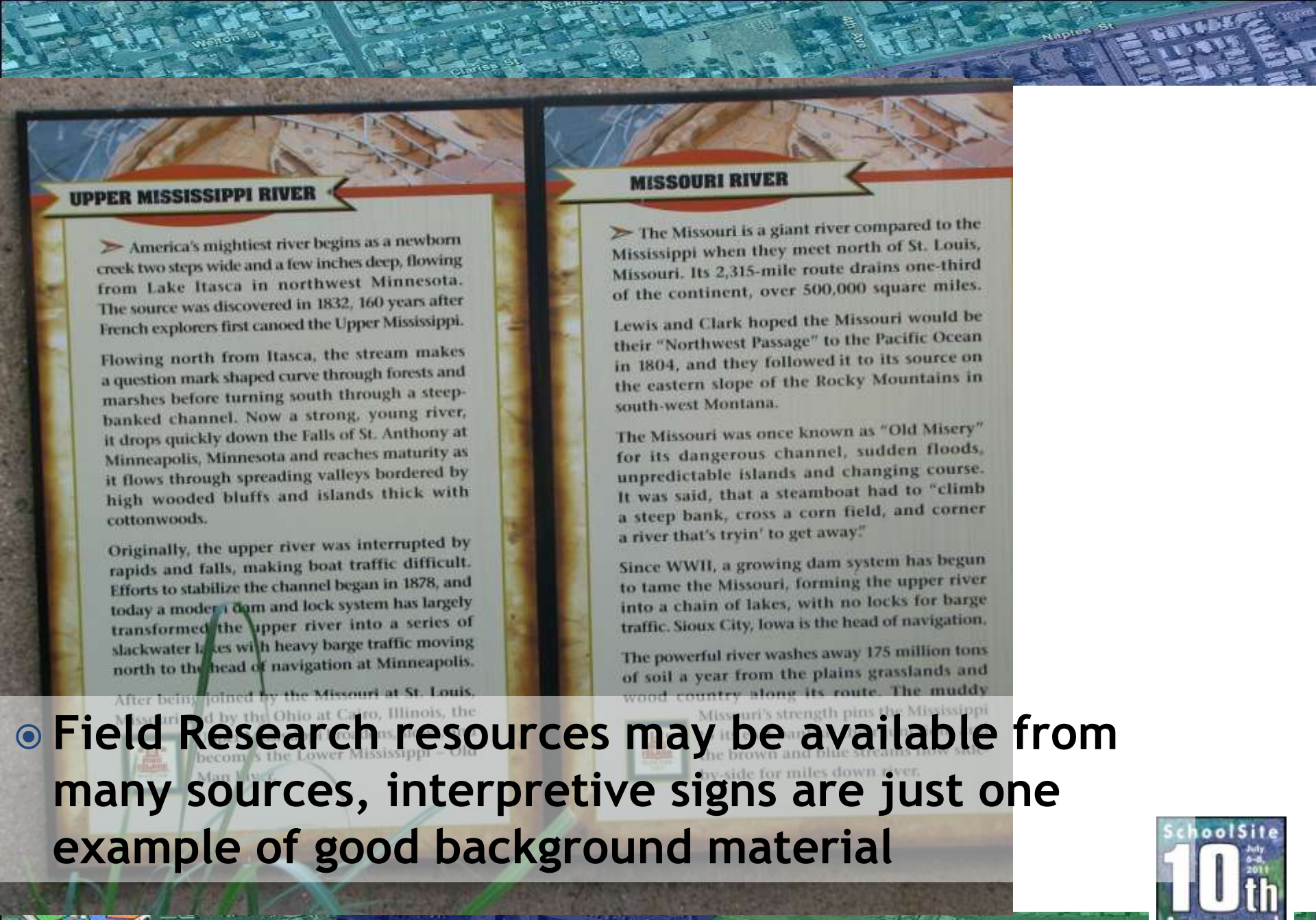
- Students worked to find out species preferences for ponds, riffles and sheltering debris.

- Students presented their work as part of the scientific community

Probeware Automates Student Projects



- Probeware can tie GPS and environmental data together ready to be mapped!



- Field Research resources may be available from many sources, interpretive signs are just one example of good background material

MudIsland.mxd - ArcMap - ArcView

File Edit View Insert Selection Tools Window Help

1:4,941

Layers

mississippi.txt Events

Temperatur

23.900000 - 24.5

24.500001 - 25.1

25.100001 - 25.7

25.700001 - 26.7

26.700001 - 28.2

MudIsland.jpg

RGB

Red: Band_

Green: Band_

Blue: Band_

W_EMemphis.jpg

RGB

Red: Band_

Green: Band_

Blue: Band_

Layer Properties

General | Source | Selection | Display | Symbology | Fields | Definition Query | Labels | Joins & Relates

Show:

Features

Categories

Quantities

Graduated colors

Graduated symbols

Proportional symbols

Charts

Multiple Attributes

Draw quantities using color to show values.

Import...

Fields

Value: Temperatur

Normalization: none

Classification

Natural Breaks (Jenks)

Classes: 5

Classify...

Color Ramp:

Symbol	Range	Label
	23.900000 - 24.500000	23.900000 - 24.500000
	24.500001 - 25.100000	24.500001 - 25.100000
	25.100001 - 25.700000	25.100001 - 25.700000
	25.700001 - 26.700000	25.700001 - 26.700000
	26.700001 - 28.200000	26.700001 - 28.200000

Show class ranges using feature values

Advanced

OK Cancel Apply

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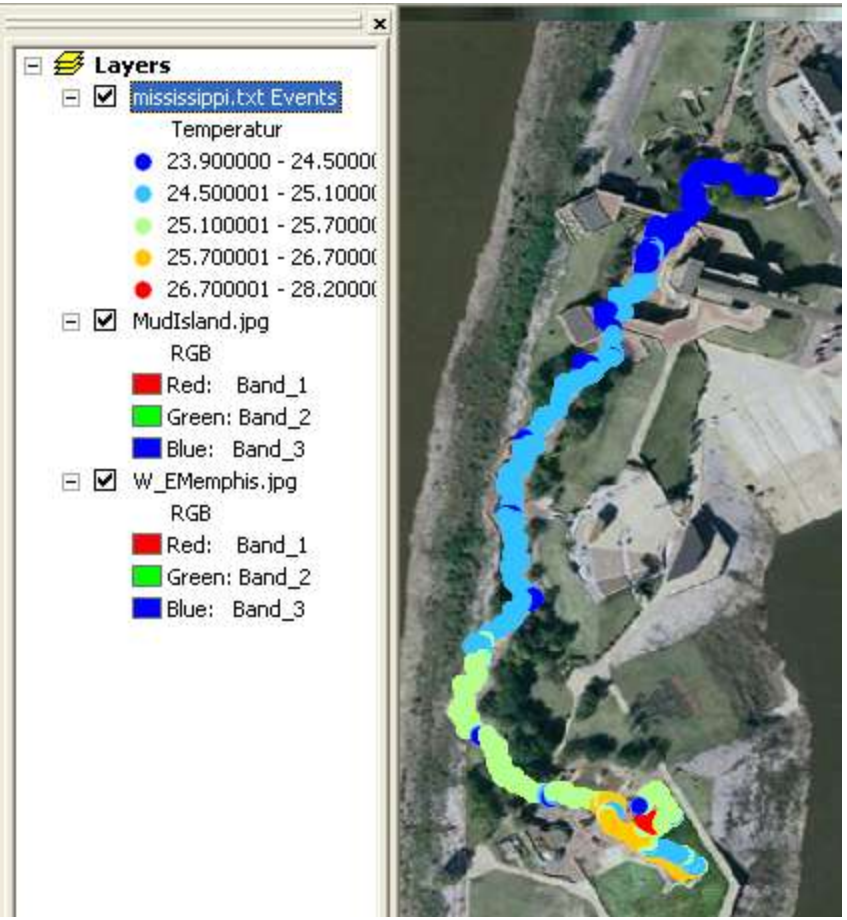
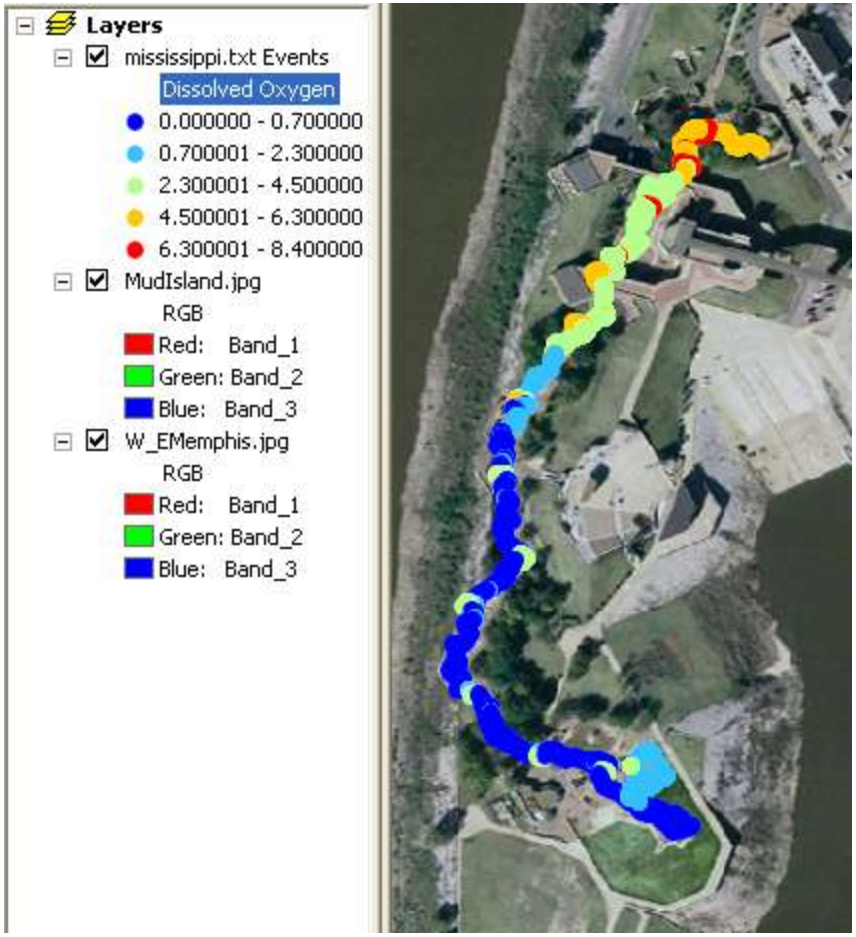
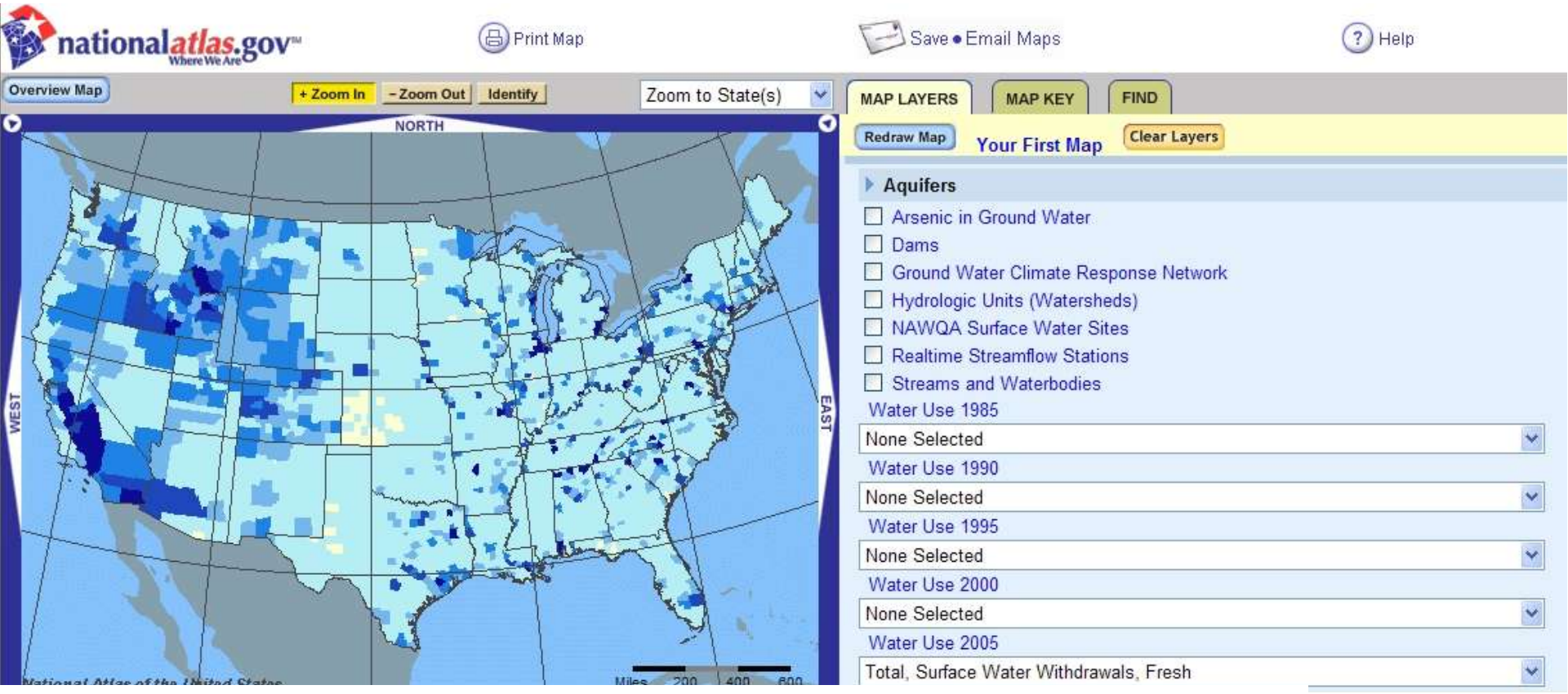
Comparing Variables to Quickly Show Relationships





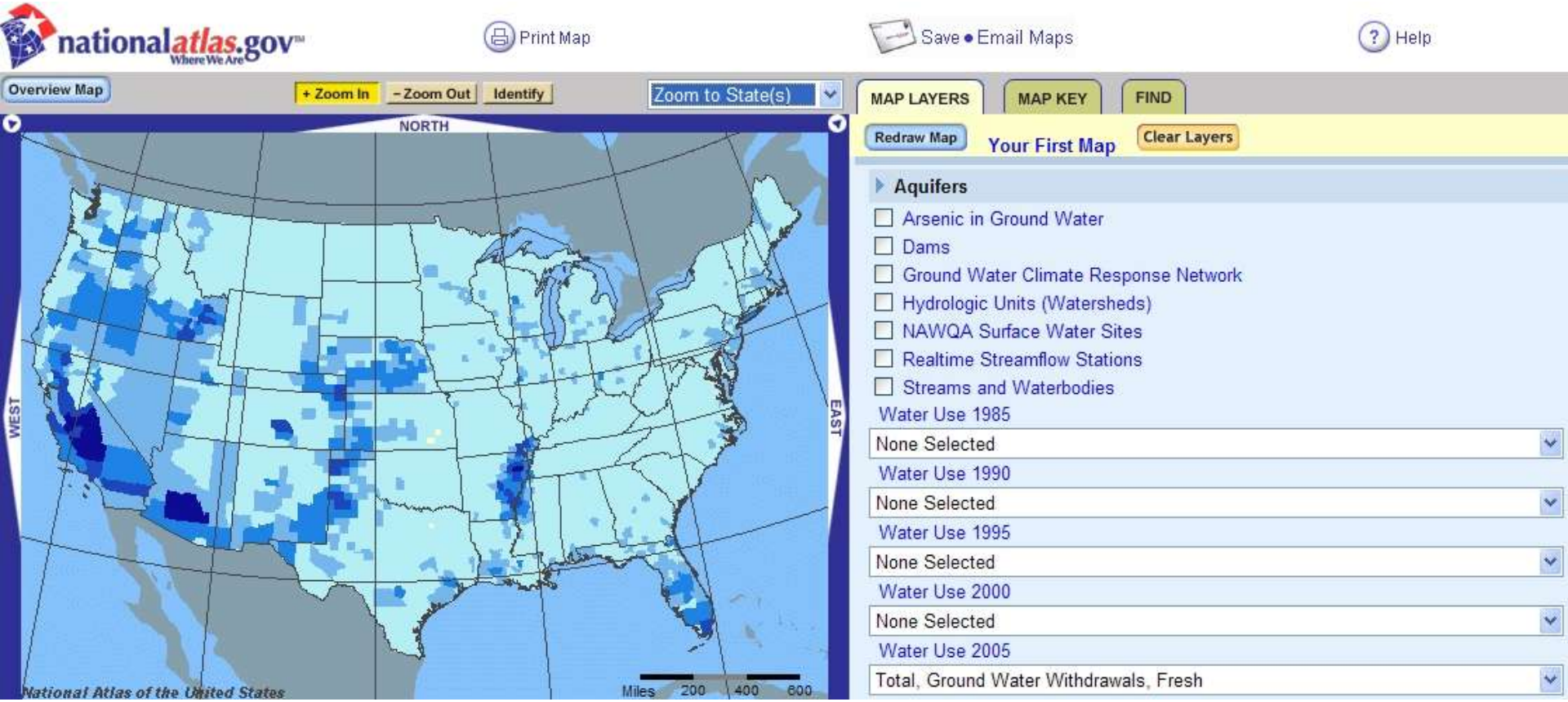
Temperature vs Dissolved Oxygen

Who uses surface waters?



- Surface water withdrawal correlates with US cities implying industrial or personal consumption in the east. The west reflects increased surface water use for agriculture.

Even ground waters tell important stories



- **Agricultural use of ground water has lowered aquifers in western plain states by up to 200 m!**

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Students compare local values to real time networks

Real-time water quality

WaterQualityWatch -- Continuous Real-Time Water Quality of Surface Water in the United States

About USGS WaterQualityWatch

Current RTWQ Maps Redisplay

State: United States

Measurement: Specific Conductance

Animate Map

RTWQ Sites

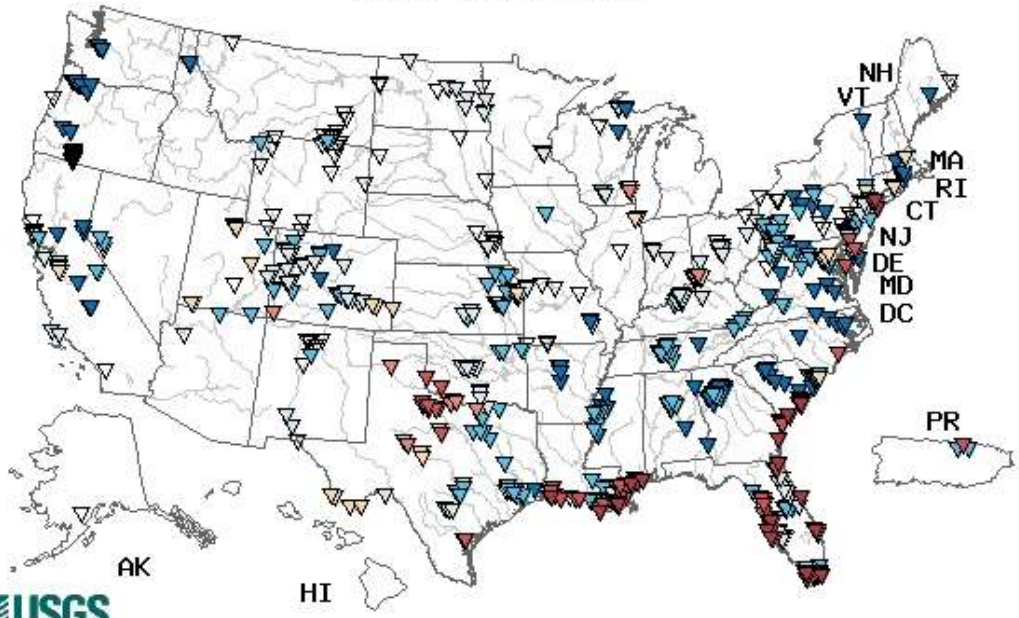
Google Map of all USGS Real-Time Water Data

RTWQ FAQ

- What is the USGS?
- What is continuous RTWQ?
- How are sites selected?
- Why continuous and real time?
- How are these data used?
- What are these measurements?
- How are monitors maintained?
- What is a surrogate?

Real-Time Specific Conductance, in µS/cm

January 20, 2011 17:34ET



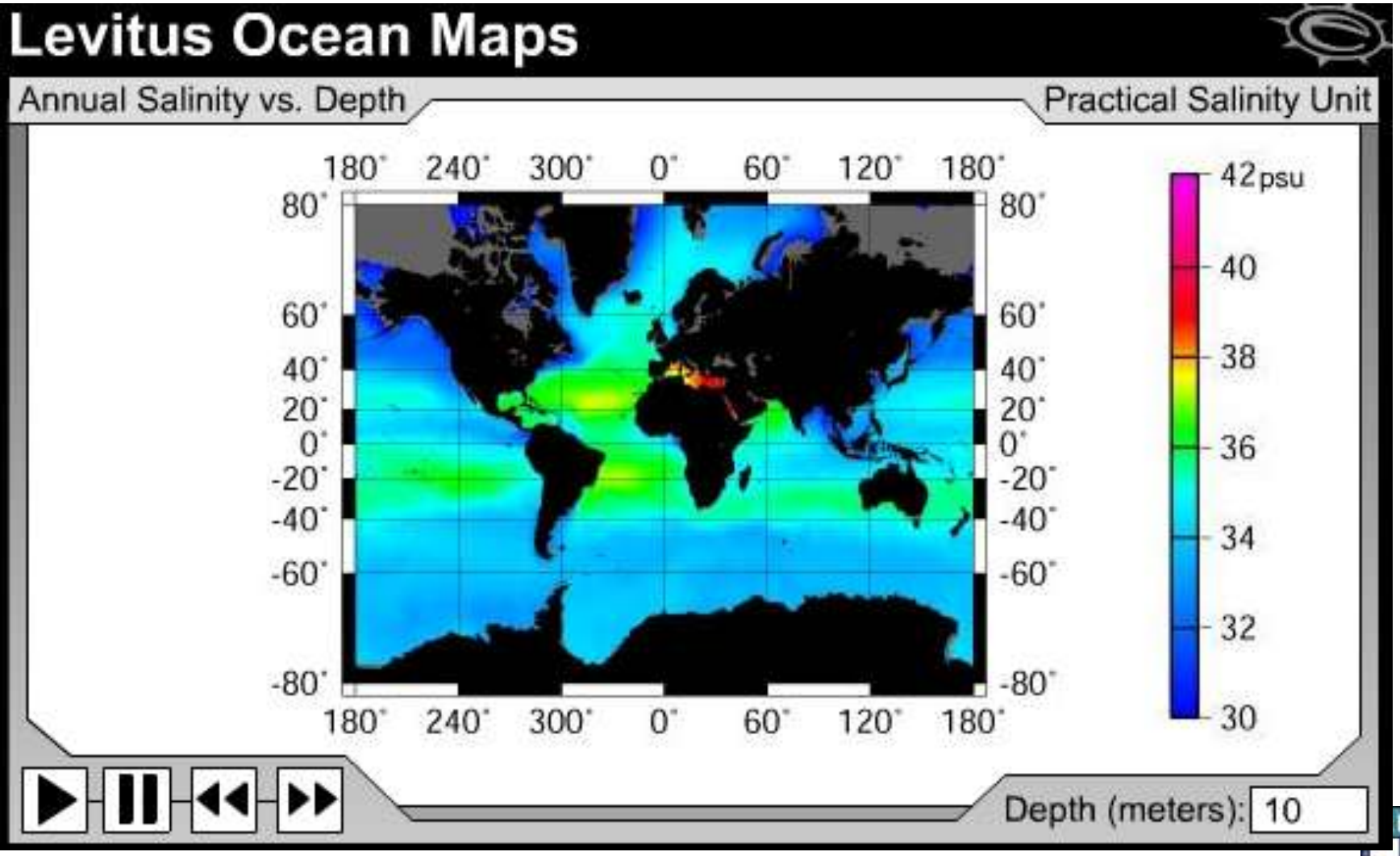
USGS

Explanation							
<250	250-749	750-2,240	2,250-4,990	5,000-9,990	10,000-35,000	>35,000	No Data

Temp | Cond | pH | D.O. | Turb | Disch

SchoolSite 10th Annual User Conference

Where do these water pollutants end up?



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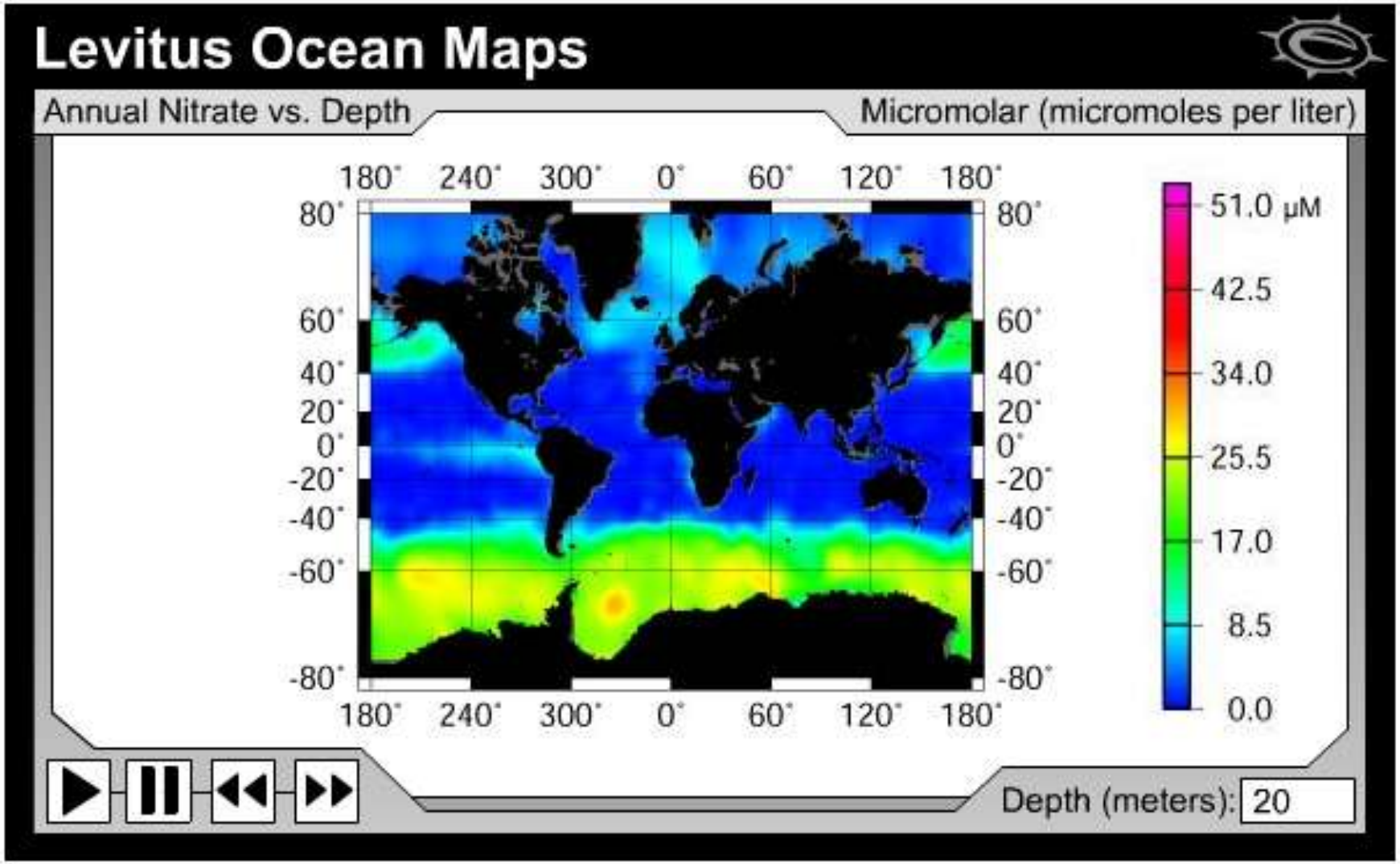

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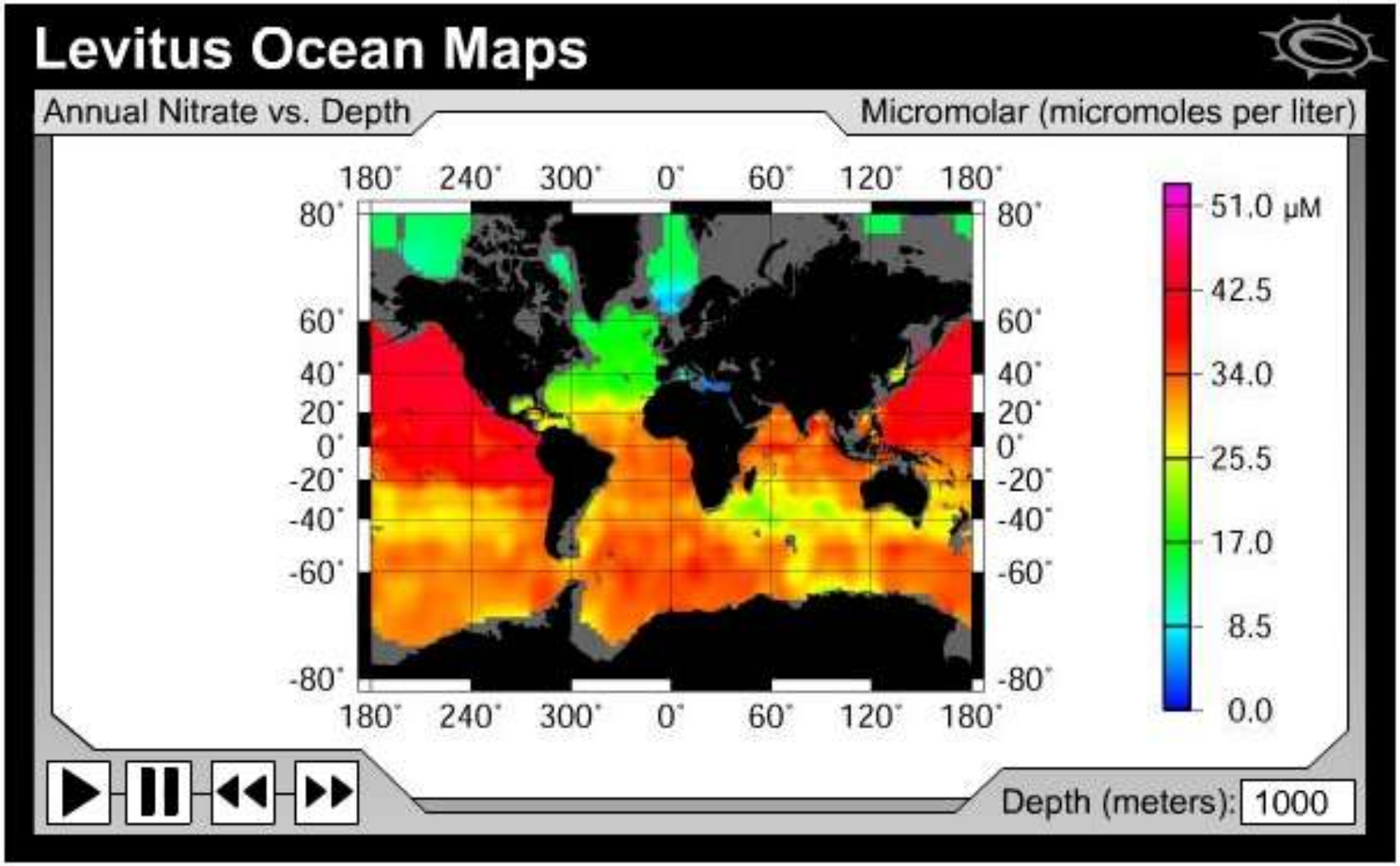

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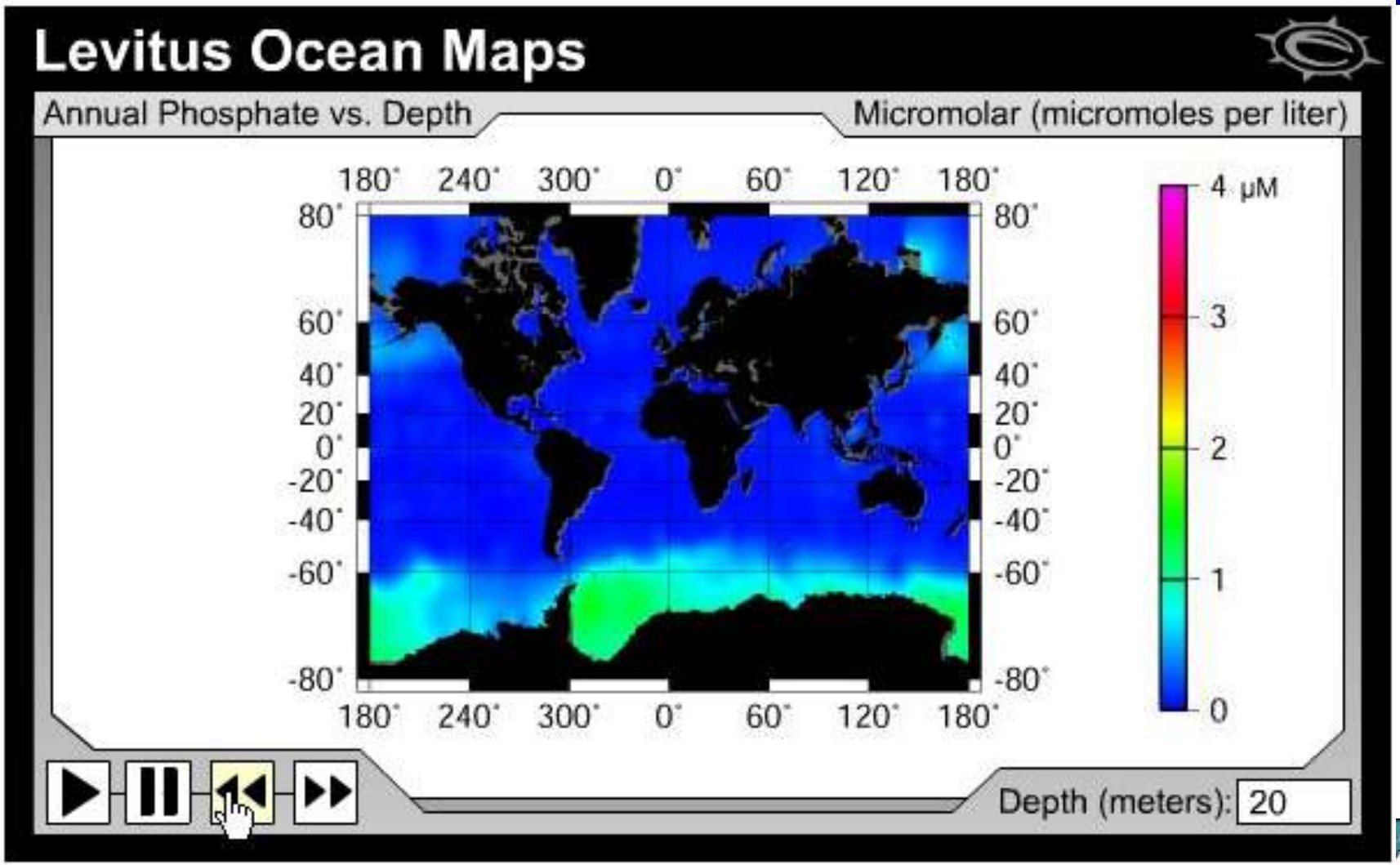

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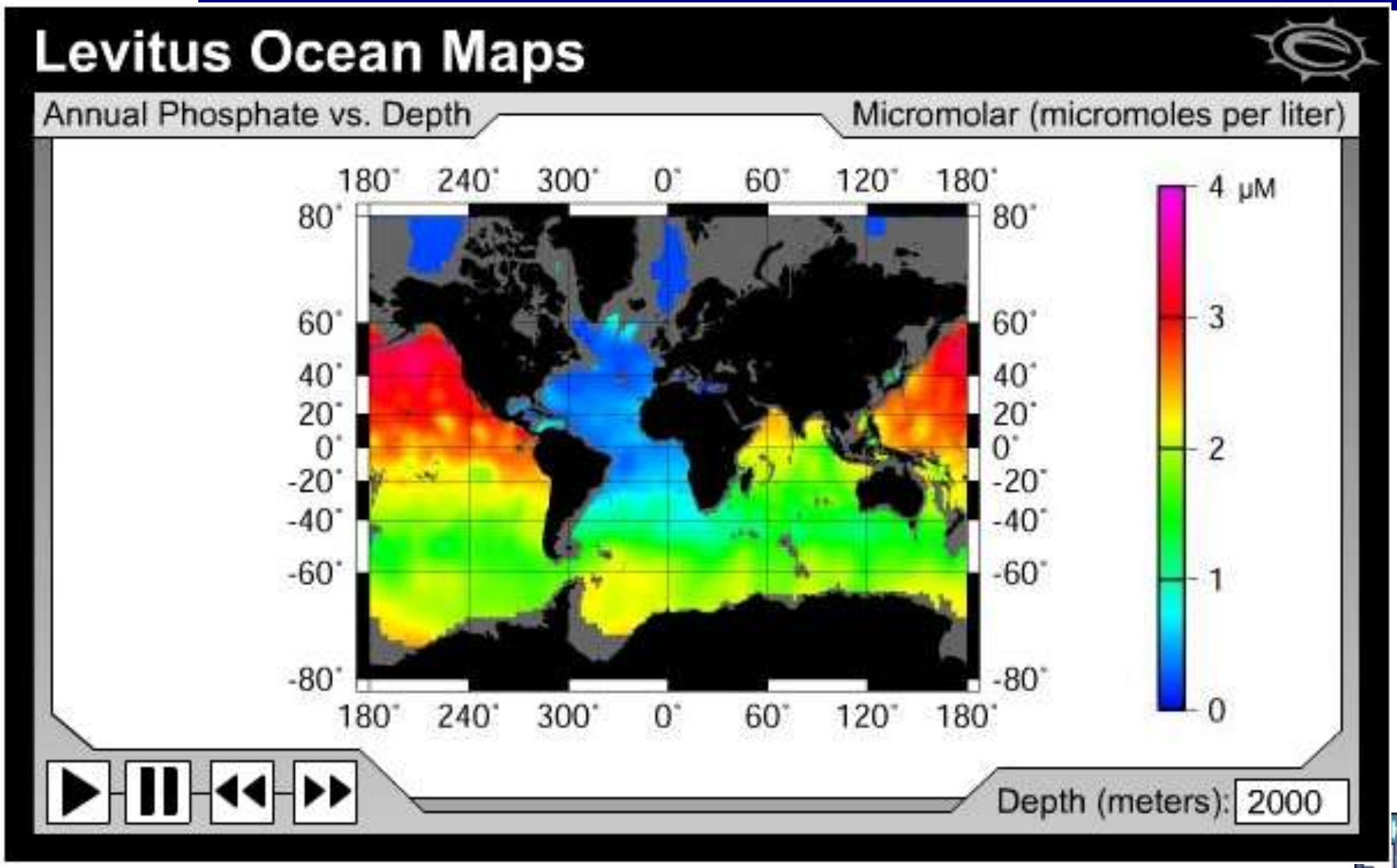

Encourage GIS use to leverage thinking back in your classrooms!

- Put current events in contexts
- Incorporate multimedia
- Collaborate
- Compare layers for insight into patterns
- Use data to support theories
- Find patterns visually… tell powerfull stories to engage students to think!

Your Part in Creating Capacity

- How you can influence course offerings at your district
  - Stand alone classes in CTE
  - Inserting GIS exercises into standard classes
    - Science, Social Studies, Mathematics, English language, ROTC, Physical Education
- Where to find help or expertise to do projects
  - Student interns from your school district
  - Community College program interns
  - Local business partnerships

Main Ideas

- GIS is Critical thinking
- GIS is analysis not just visualization
- GIS accesses data and impacts learning across the curriculum
- GIS engages students in local issues
- GIS is an important tool to inform good administrative decision making
- GIS is a 21st century skill with job potential
- GIS is a robust tool visualizing our growing world of information without becoming an overload
- GIS enables us to leverages work across the school district and beyond.

Thanks for Your Interest!

- GISetc consists of 25 years of teaching experience
- Other services from GISetc
  - Software and Curriculum sales
  - Professional Development
  - Geospatial Technology in Classroom Support
- For information:
  - Visit www.gisetc.com
  - Contact Anita Palmer – anita@gisetc.com
    Roger Palmer – roger@gisetc.com