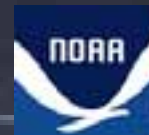


Integrating an OLAP Data Cube with ArcMap

Lt. (j.g.) William Winner, NOAA
Deb Agarwal, UC Berkeley
Catharine van Ingen, Microsoft



Microsoft

Project Origins

- Began at UC Berkeley
 - Proposal to NSF for a watershed data synthesis center
 - Proposal to Microsoft to create a demonstration centered around California water issues (2006)

Original Objectives

- Database requirements
 - Needed large storage capacity
 - Needed ability to merge data from different agencies in different formats
 - Needed to handle different types of data
 - Needed the ability to perform analyses quickly

What is a Data Cube?

- An N-dimensional database
 - Traditional DBs can do this too, but...
 - Data must be flattened
 - Done using Aggregations, Group By's and Cross Tabs

What is a Data Cube?

SALES			
Model	Year	Color	Sales
Chevy	1990	red	5
Chevy	1990	white	87
Chevy	1990	blue	62
Chevy	1991	red	54
Chevy	1991	white	95
Chevy	1991	blue	49
Chevy	1992	red	31
Chevy	1992	white	54
Chevy	1992	blue	71
Ford	1990	red	64
Ford	1990	white	62
Ford	1990	blue	63
Ford	1991	red	52
Ford	1991	white	9
Ford	1991	blue	55
Ford	1992	red	27
Ford	1992	white	62
Ford	1992	blue	39

What is a Data Cube?

SALES			
Model	Year	Color	Sales
Chevy	1990	red	5
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Chevy	1992	red	31
Chevy	1992	white	54
Chevy	1992	blue	71
Ford	1990	red	64
Ford	1990	white	62
Ford	1990	blue	63
Ford	1991	red	52
Ford	1991	white	9
Ford	1991	blue	55
Ford	1992	red	27
Ford	1992	white	62
Ford	1992	blue	39

Aggregate



Sum

Group By (with total)

By Color
RED
WHITE
BLUE

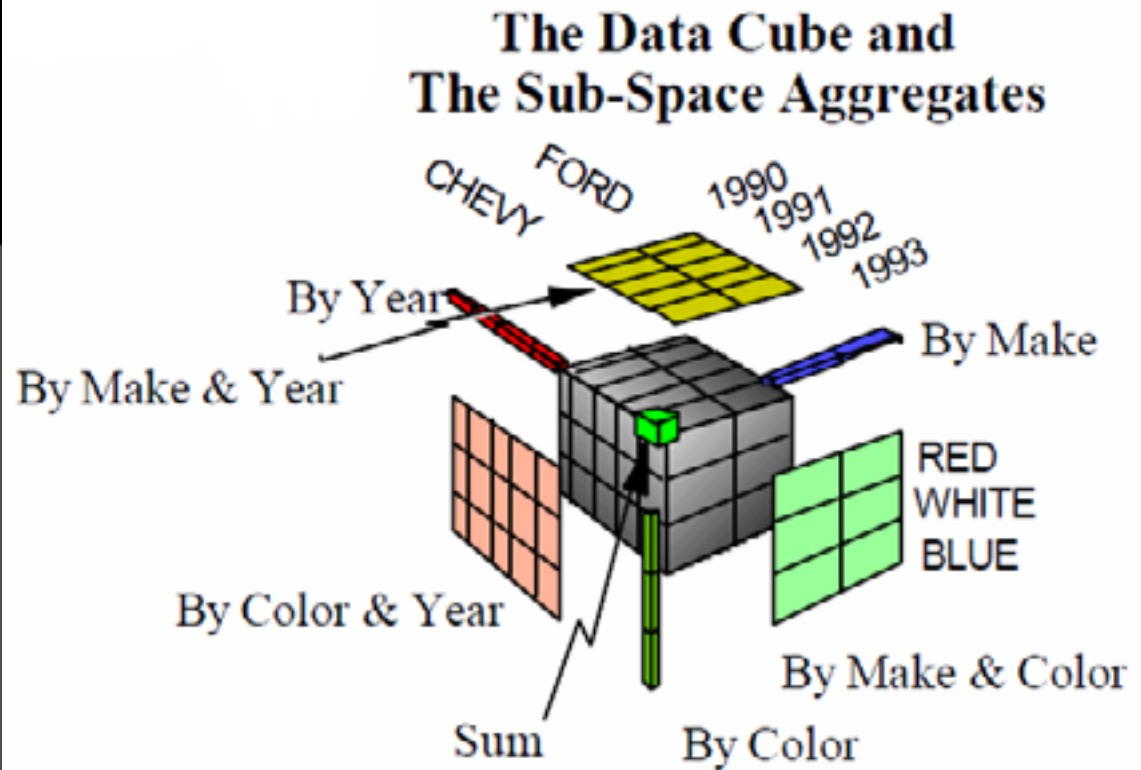
Sum

Cross Tab

Chevy Ford By Color
RED
WHITE
BLUE
By Make

Sum

What is a Data Cube?

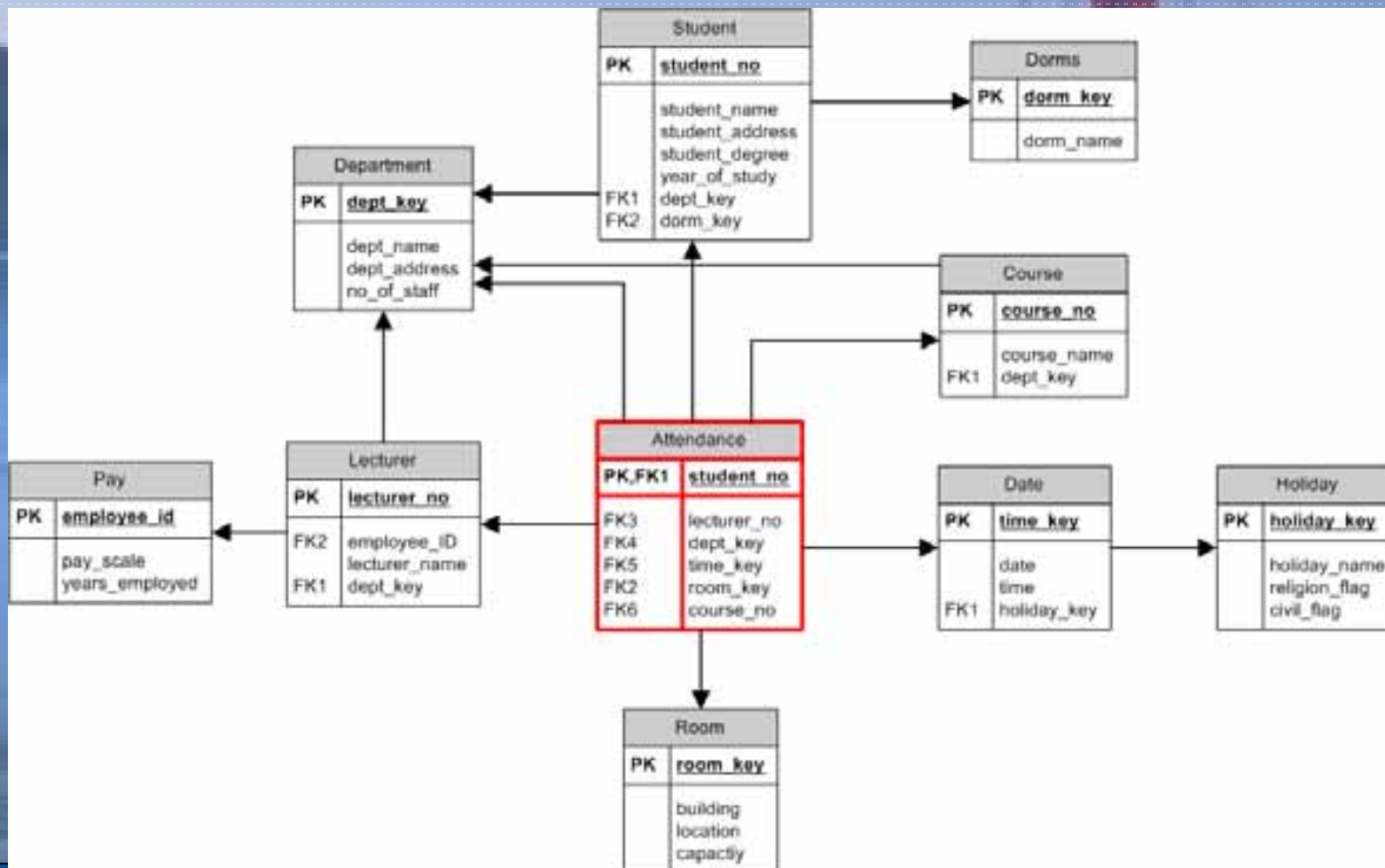
SALES			
Model	Year	Color	Sales
Chevy	1990	red	5
Chevy	1990	white	87
Chevy	1990	blue	62
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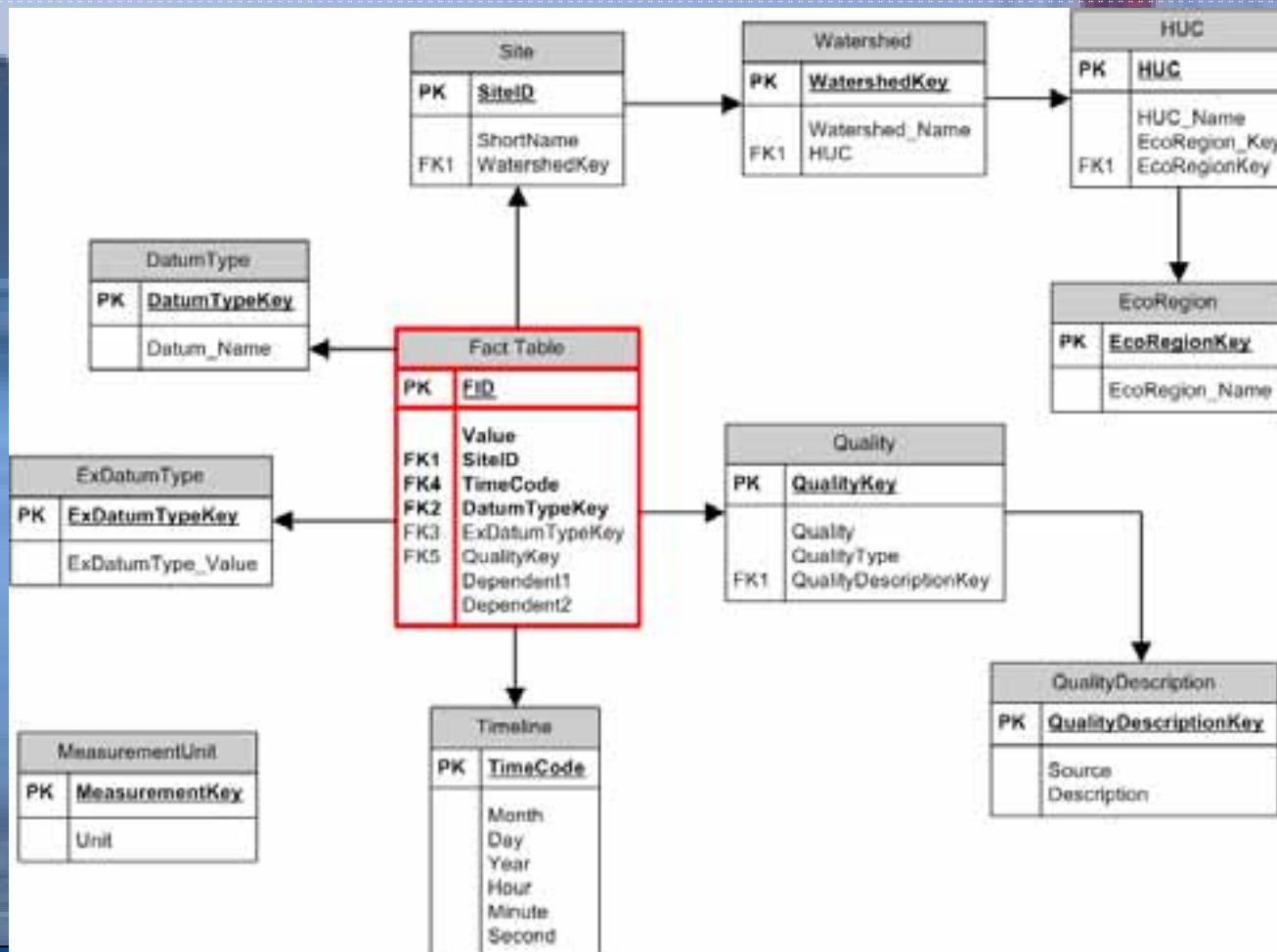
How is the Cube stored?

- The Cube is a computed product from a series of relational tables
- Our Cube is based on a Context-Dependent Snowflake Schema

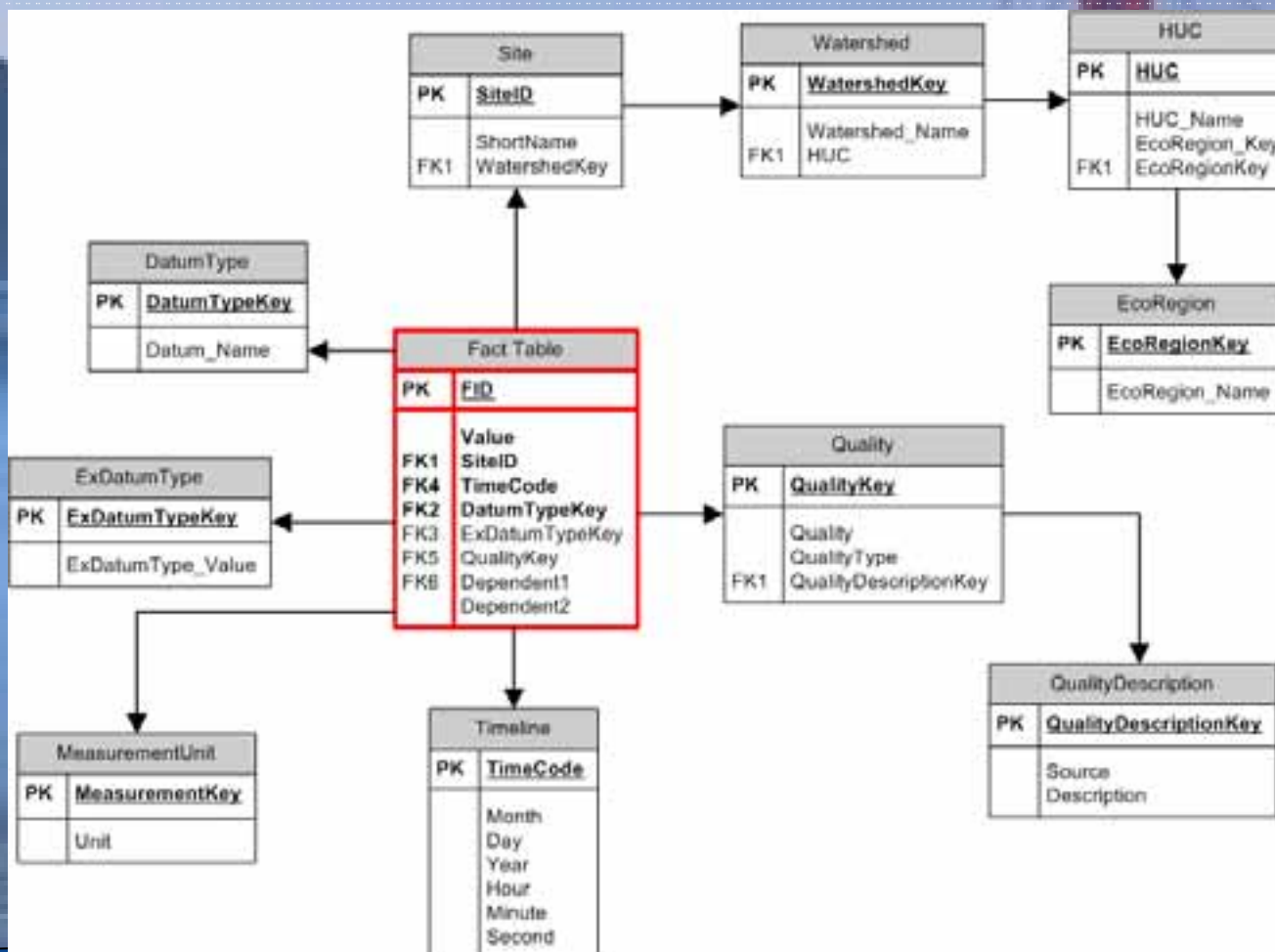
Snowflake Schema



Snowflake Schema



Context-Dependent Snowflake



NMFS Involvement

- Came aboard at the end of 2008
- Saw the potential to use this to help inform Salmonid Recovery Plans
- Saw the potential to include a spatial component with the data

Toolbar Requirements

- Allow for spatial queries
- Flatten data to fit within a shapefile's attribute table
- Provide some way to visually move through the data

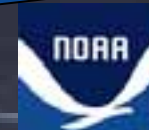
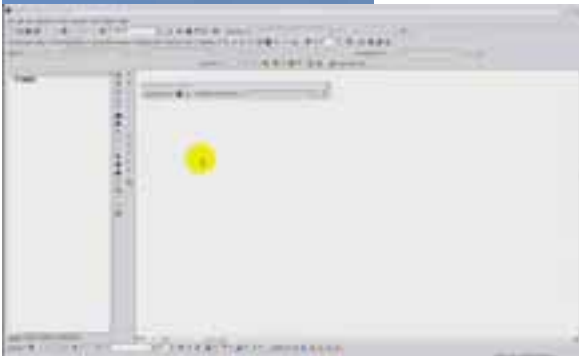
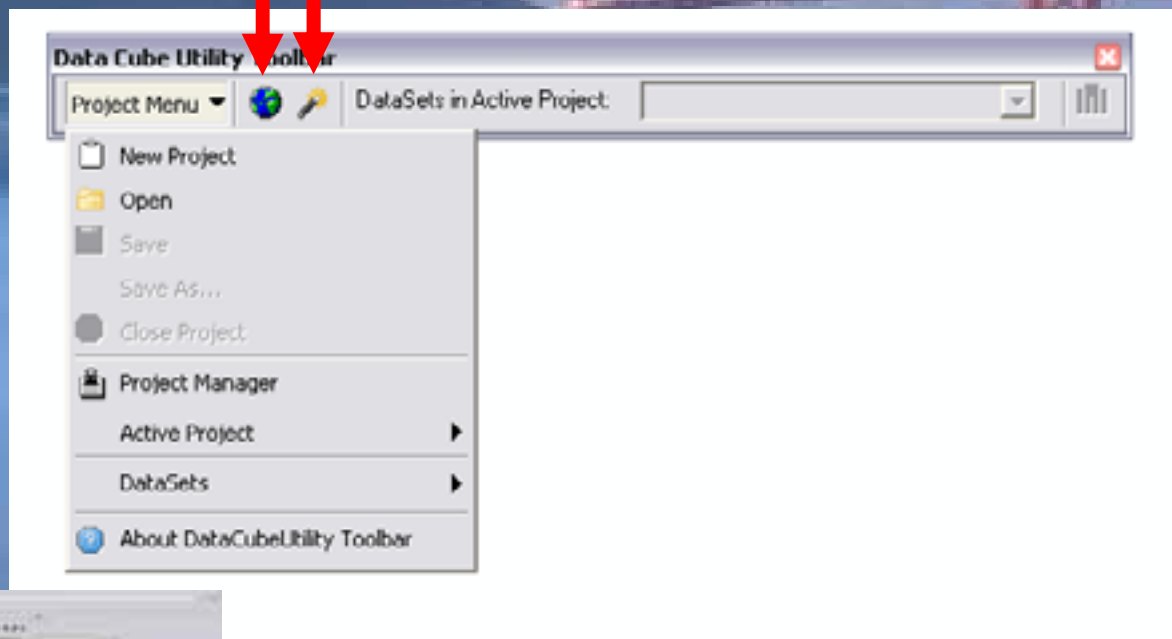
How did we do it?

- The toolbar was written using Visual Studio 2008 along with the ArcGIS API's.
- Also included project management and storage
- Written with just shy of 10,000 lines of designer- and user-generated code

Data Cube Utility Toolbar

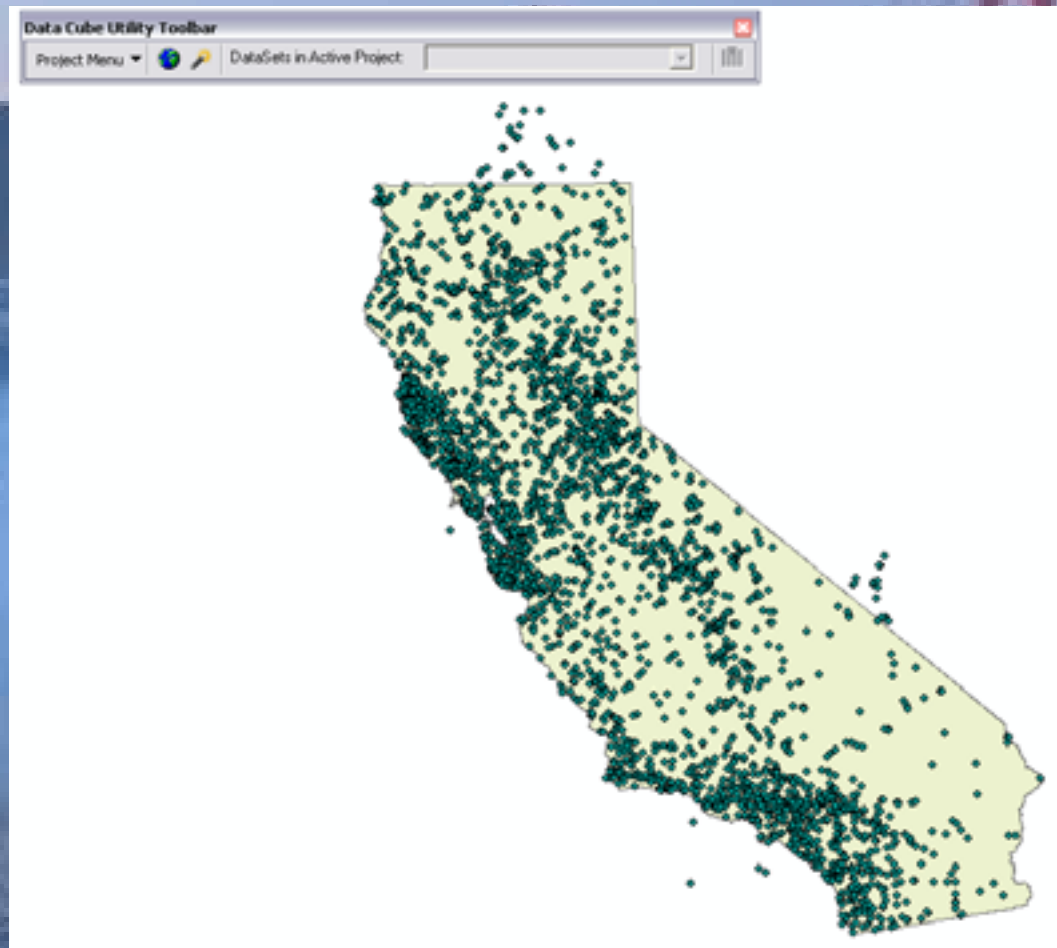
View Sites

Site Selection Wizard

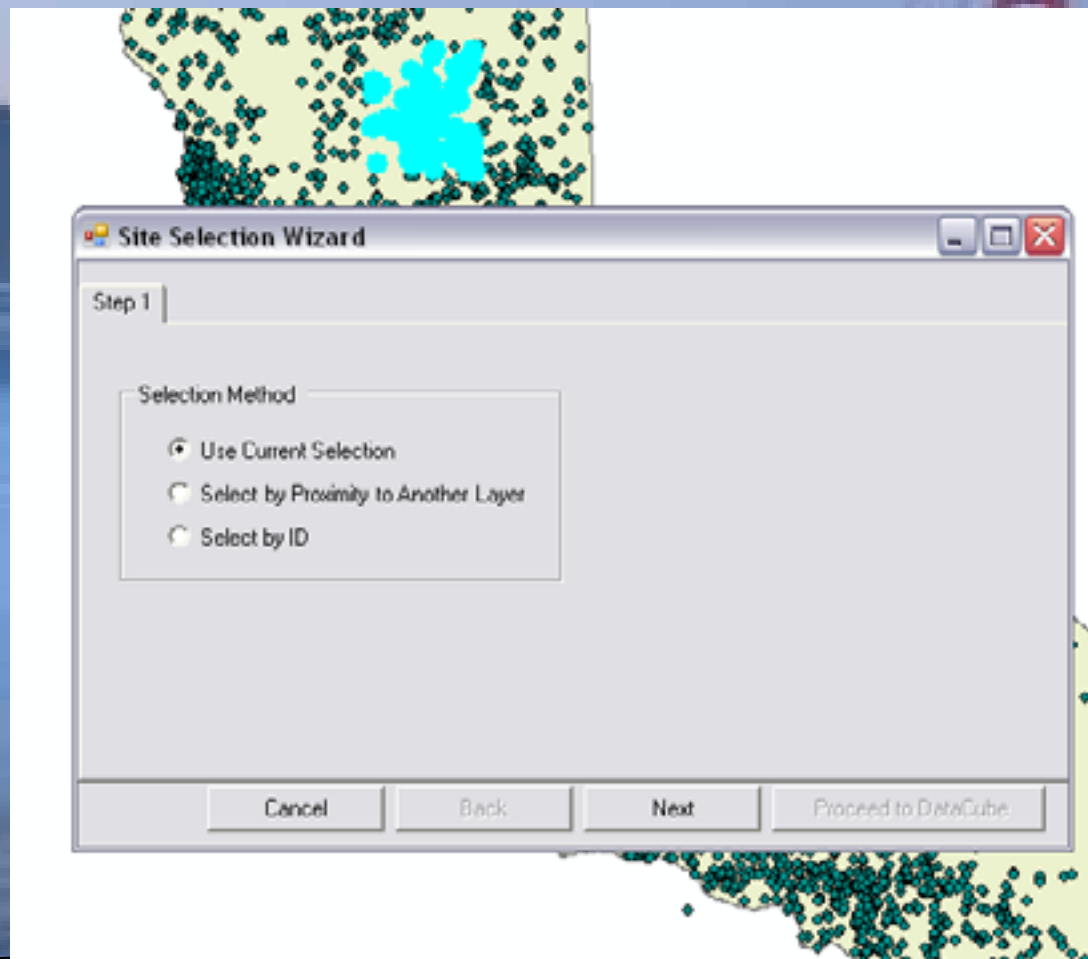


Microsoft

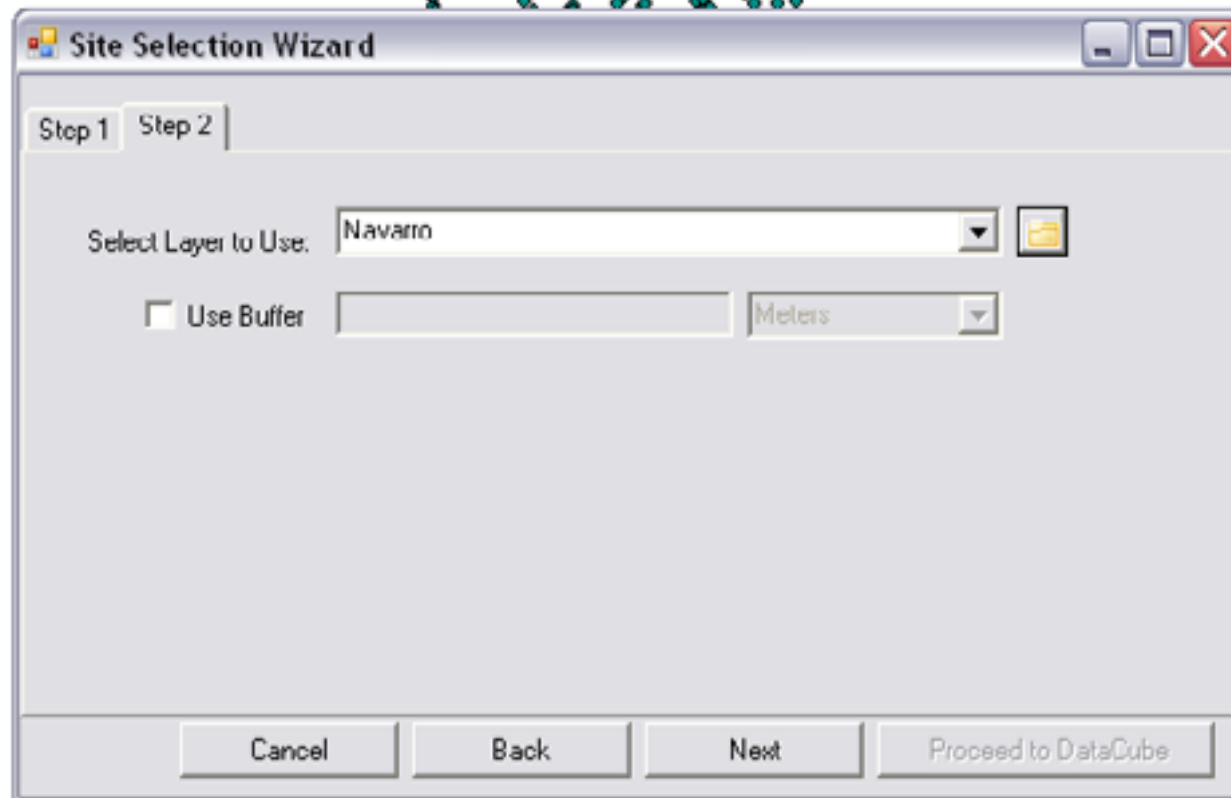
Data Cube Utility Toolbar



Data Cube Utility Toolbar



Data Cube Utility Toolbar



The image shows a 'Site Selection Wizard' dialog box with a title bar containing standard Windows window controls. It has two tabs: 'Step 1' (selected) and 'Step 2'. Under 'Step 1', there is a label 'Select Layer to Use:' followed by a dropdown menu showing 'Navarro' and a folder icon. Below this is a checkbox labeled 'Use Buffer' which is unchecked, followed by an empty text input field and a unit dropdown menu set to 'Meters'. At the bottom, there are four buttons: 'Cancel', 'Back', 'Next', and 'Proceed to DataCube'.

Site Selection Wizard

Step 1 Step 2

Select Layer to Use: Navarro

☐ Use Buffer

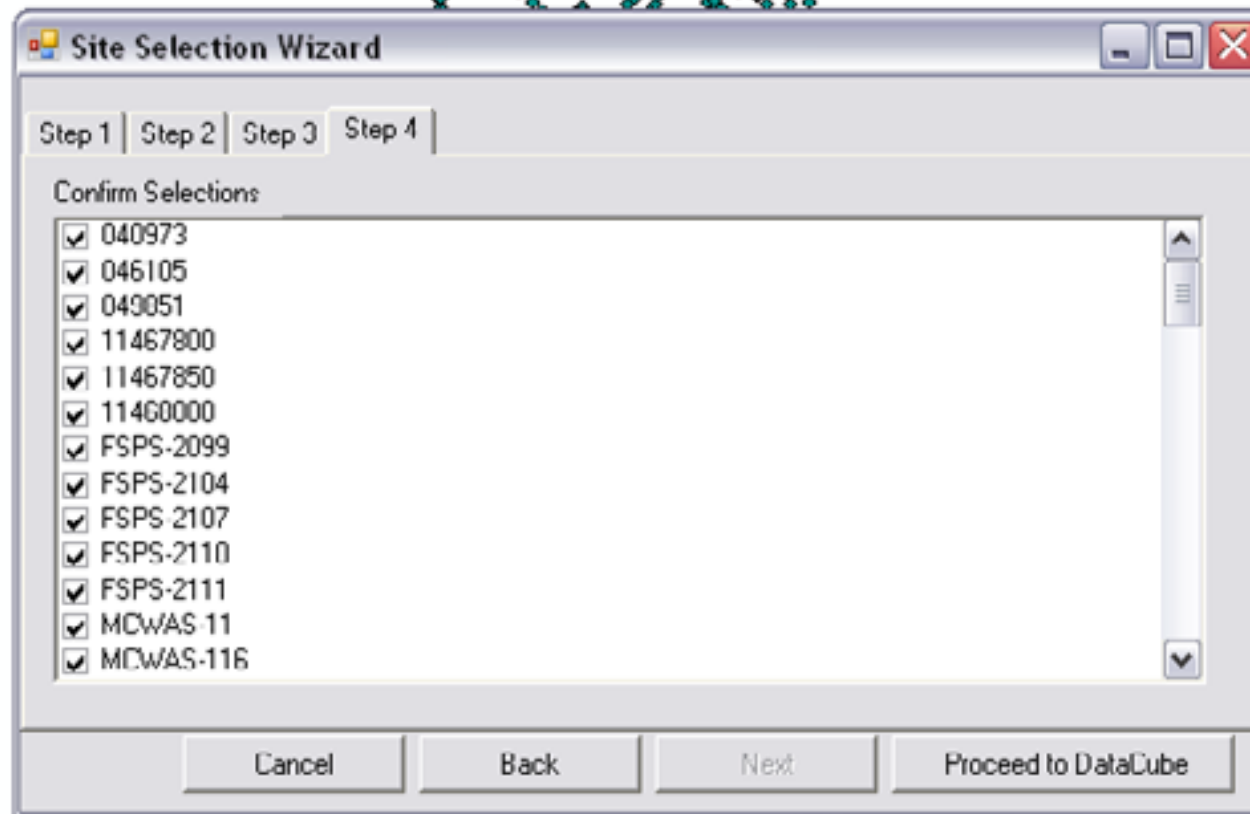
Meters

Cancel Back Next Proceed to DataCube

Data Cube Utility Toolbar



Data Cube Utility Toolbar



Data Cube Utility Toolbar

The screenshot shows a 'Data Cube Selection' dialog box with the following components:

- Datasets to Query:** A text area labeled 'New Dataset'.
- Data Type:** A dropdown menu set to 'WaterTEMP'.
- Ex Data Type:** A dropdown menu set to '(None)'.
- Measure:** A dropdown menu set to 'Average'.
- Column Selection:** Two dropdown menus: 'Timeline 1' set to 'Decade to Month' and 'Timeline 2' set to 'DAYS'.
- Filters:** A section with two columns of filters. The left column has a 'Quality' filter. The right column has a 'Year' filter with a list of years: 1998, 1999, 2000, 2001, 2002, 2003, and 2004.
- Submit Query(s):** A button at the bottom right.

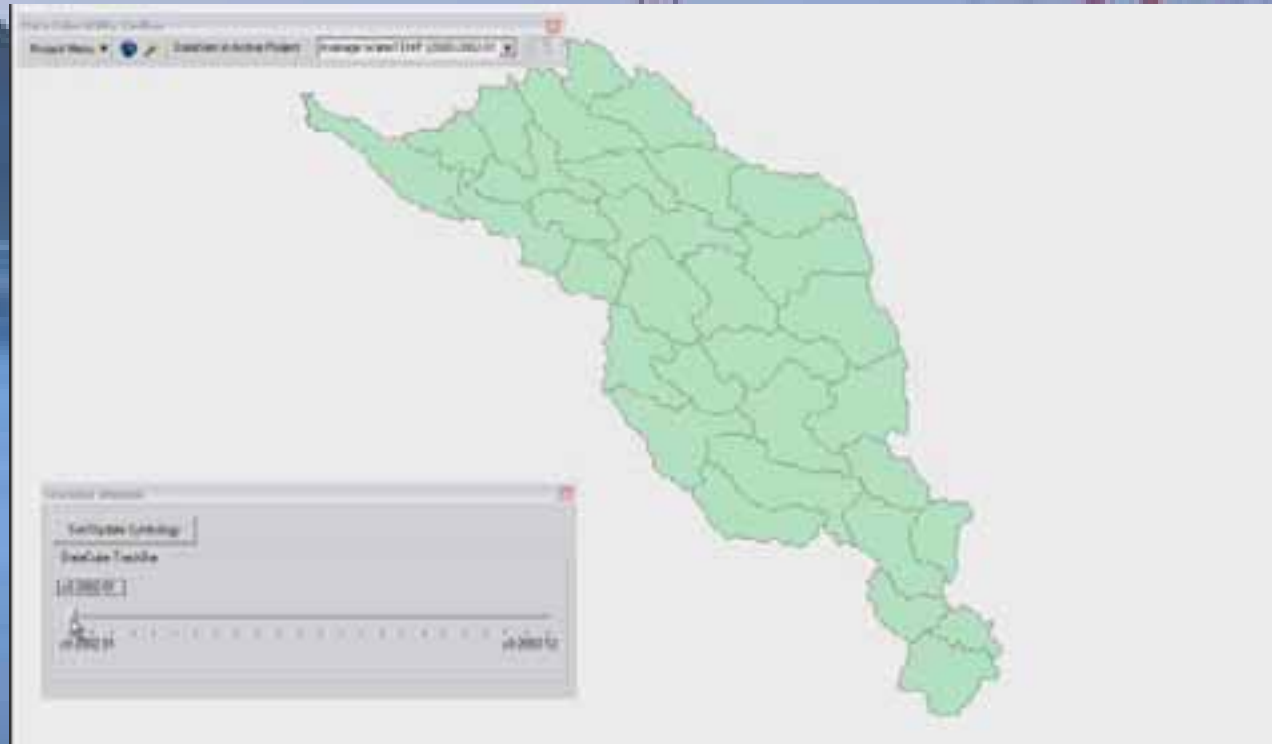
Data Cube Utility Toolbar

Attributes of Temporary Sites

PTS	Shape	SiteID	e6-2002-01	e6-2002-02	e6-2002-03	e6-2002-04	e6-2002-05	e6-2002-06	e6-2002-07	e6-2002-08	e6-2002-09	e6-2002-10	e6-2002-11	e6-2002-12	e6-2003-01	e6-2003-02
1	Point	MPC05-T06-01	-9999	-9999	-9999	-9999	-9999	17.543	18.4738	21.0012	20.009	18.7521	15.5162	-9999	-9999	-9999
2	Point	MPC05-T06-21	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999
3	Point	MPC05-T06-20	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999
4	Point	MPC05-T06-02	-9999	-9999	-9999	-9999	-9999	12.5839	18.3545	18.8482	17.433	15.2041	12.5985	-9999	-9999	-9999
5	Point	MPC05-T06-01	-9999	-9999	-9999	-9999	-9999	15.6818	18.3090	18.5488	17.7916	16.1162	13.6123	-9999	-9999	-9999
6	Point	MPC05-T05-21	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999
7	Point	MPC05-T05-20	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999
8	Point	MPC05-T05-07	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999
9	Point	MPC05-T05-08	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999
10	Point	MPC05-T05-05	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999
11	Point	MPC05-T05-02	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999
12	Point	MPC05-T05-01	-9999	-9999	-9999	-9999	-9999	13.8296	15.8442	17.2338	15.6158	14.4054	11.5052	-9999	-9999	-9999
13	Point	MPC05-T02-20	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999
14	Point	MPC05-T02-21	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999
15	Point	MPC05-T02-26	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999
16	Point	MPC05-T02-25	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999
17	Point	MPC05-T02-24	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999
18	Point	MPC05-T02-23	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999
19	Point	MPC05-T02-22	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999
20	Point	MPC05-T02-21	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999
21	Point	MPC05-T02-09	-9999	-9999	-9999	-9999	-9999	10.0105	11.6463	12.9064	12.5742	11.6164	9.9672	-9999	-9999	-9999
22	Point	MPC05-T02-08	-9999	-9999	-9999	-9999	-9999	10.9582	12.4813	14.1535	13.2504	12.3407	9.5297	-9999	-9999	-9999
23	Point	MPC05-T02-07	-9999	-9999	-9999	-9999	-9999	8.8725	11.7306	13.1199	12.8518	12.2318	10.5234	-9999	-9999	-9999
24	Point	MPC05-T02-06	-9999	-9999	-9999	-9999	-9999	10.0804	11.8401	13.0075	12.7185	12.2784	10.7279	-9999	-9999	-9999
25	Point	MPC05-T02-05	-9999	-9999	-9999	-9999	-9999	17.7049	20.0604	21.4089	19.5965	18.4067	15.3053	-9999	-9999	-9999
26	Point	MPC05-T02-04	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999
27	Point	MPC05-T02-03	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999

Records: 1 | Show: All Selected | Records (2 out of 71 Selected) | Options

Data Cube Utility Toolbar



Future Goals

- Integrate spatial attributes directly into the cube
- Improve post-query speed
- Allow for other cubes
- Incorporate other data types