



Using Geodatabases in MapWindow and DotSpatial *(with focus on SpatiaLite)*

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Outline

- Spatial Databases
- SpatiaLite
- Creating a custom GIS application with SpatiaLite
 - Network Routing & Shortest Path
 - Time Series Data management

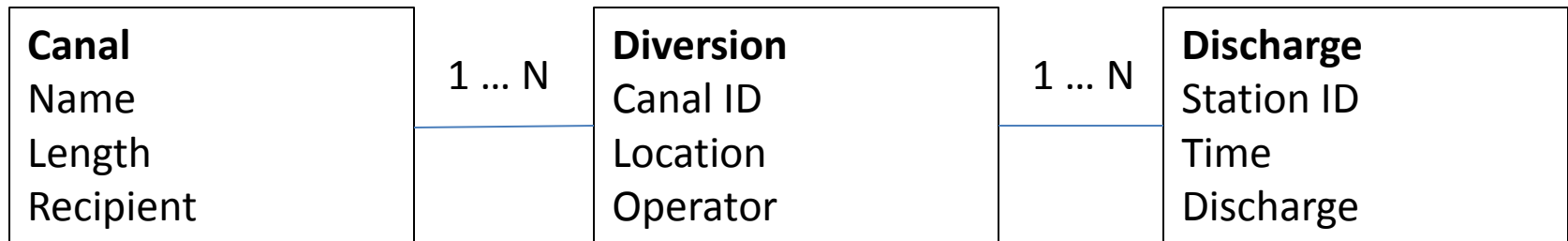
What Is a Geodatabase?

- **Relational Database:**
 - The data is stored in Tables (Relations)
 - Scalability
 - Multi-user read and write access
- **Spatial Database (Geodatabase):**

A **database** designed to store, query, and manipulate geographic information and spatial data.

Spatial Database - Example

- Water Management System



Why use a Geodatabase?

Canal
Name
Length
Recipient

1 ... N

Diversion
Canal ID
Location
Operator

1 ... N

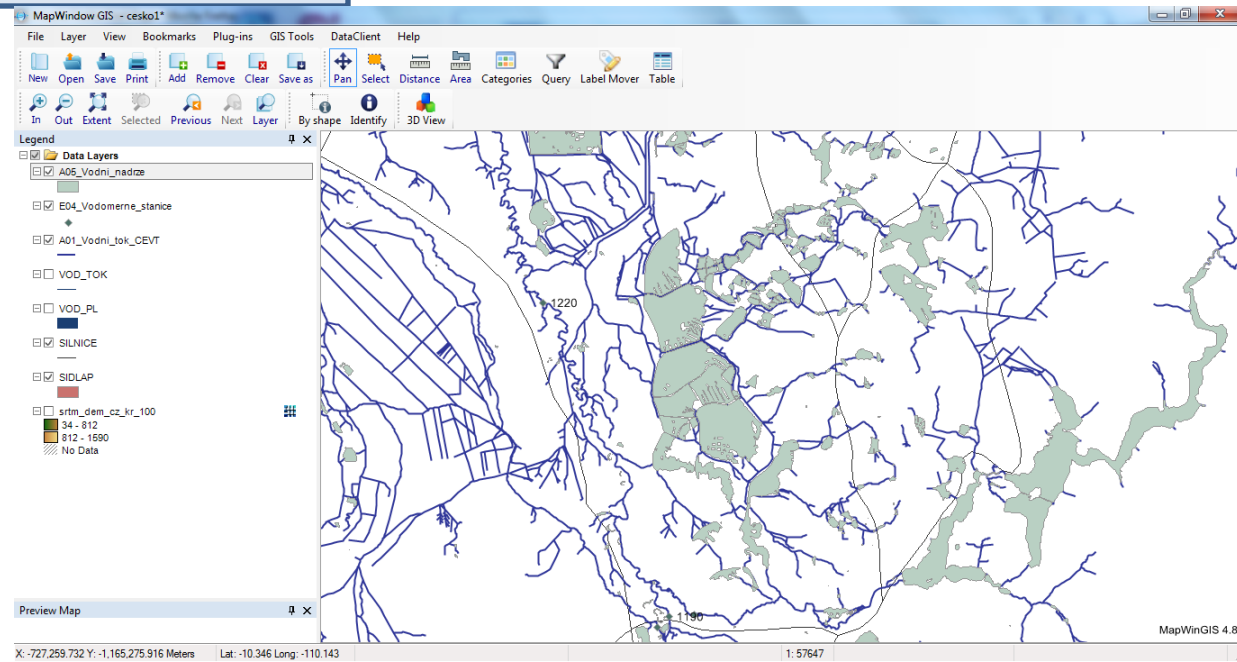
Discharge
Station ID
Time
Discharge

Shapefile Approach

- Canal.shp
- Canal.dbf
- Canal.shx
- Canal.prj
- Diversion.shp
- Diversion.prj
- Diversion.shp.xml
- Diversion.shx
- Diversion.dbf
- Discharge.xls

Geodatabase (Spatialite)

WaterData.sqlite



Types of Geodatabase

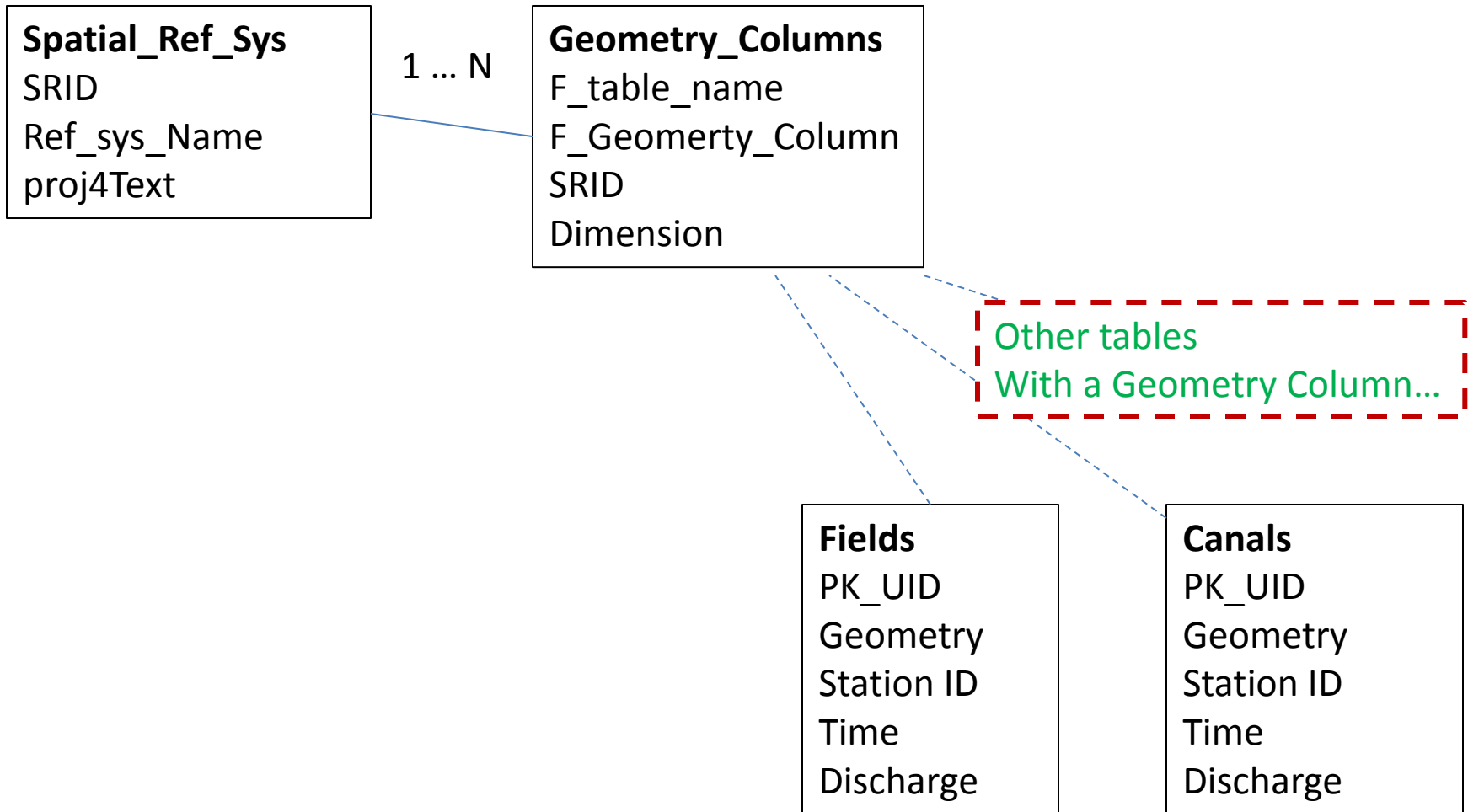
- **Server – Client**
 - ORACLE Spatial
 - SQL Server Spatial
 - PostGIS
 - MySQL Spatial

- **Personal (File based)**
 - ESRI Personal Geodatabase
 - ESRI File Geodatabase
 - **SpatiaLite** (.sqlite)

SpatiaLite

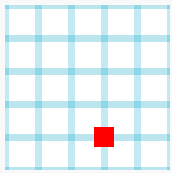
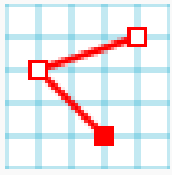
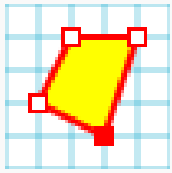
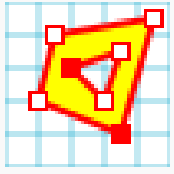
- **SQLite:**
 - File based RDBMS, portable, low memory consumption
- **SpatiaLite:**
 - Adds pre-defined **Geometry Columns and Spatial Queries**

SpatialLite Database Tables



WKB Geometry Format

Geometry column format: **WKB**
(Well-Known Binary)

Type	Examples	
Point	<code>POINT (30 10)</code>	
LineString	<code>LINESTRING (30 10, 10 30, 40 40)</code>	
Polygon	<code>POLYGON ((30 10, 10 20, 20 40, 40 40, 30 10))</code>	
	<code>POLYGON ((35 10, 10 20, 15 40, 45 45, 35 10), (20 30, 35 35, 30 20, 20 30))</code>	

Source: http://en.wikipedia.org/wiki/Well-known_text

Spatial Queries

Query Operations

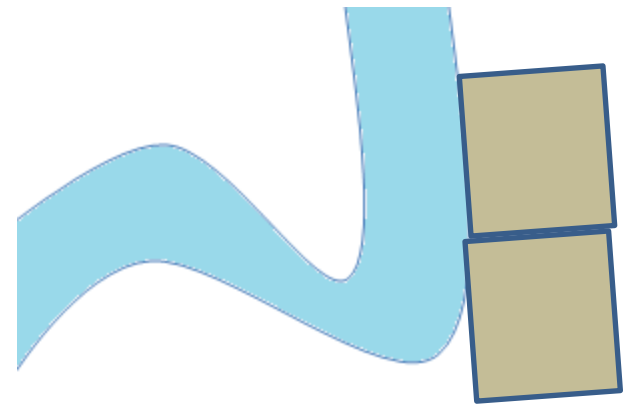
- Equal
- Disjoint
- Touches
- Within
- Overlaps
- Crosses
- Intersects
- Contains

Functions

- Intersection
- Difference
- Union
- Buffer
- ConvexHull
- Build_Network

Example Spatial SQL Query

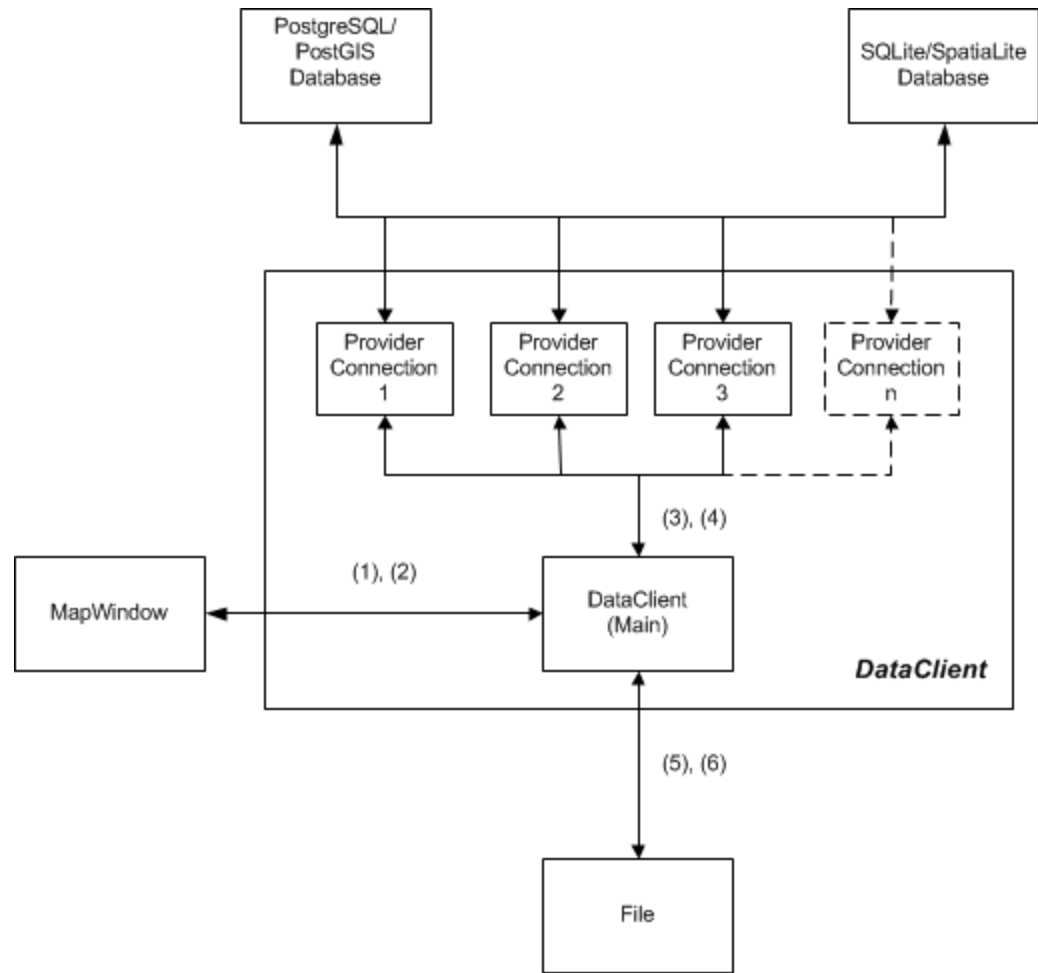
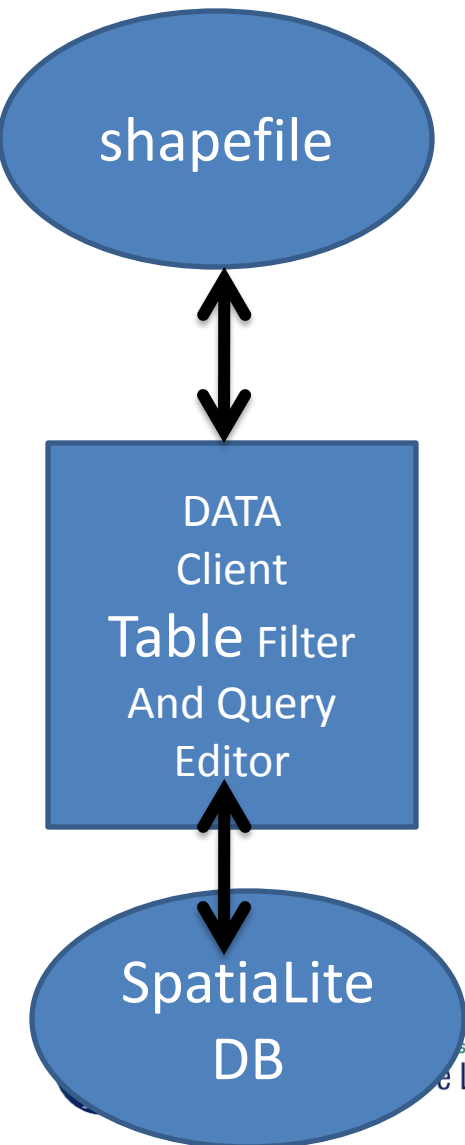
- **Query:** Find the owners of all properties adjoining the Snake River in Idaho Falls
- **SELECT** P1.Owner AS "Property Owner"
- **FROM** Parcels P1,Rivers R1
- **WHERE Touch**(P1.Shape,R1.Shape)=1
- **AND** R.Name ='Portneuf River'



Working With SpatiaLite

- **End-Users (DB Management):**
 - MW DataClient Plug-IN
 - SpatiaLite-GUI
- **Developing Customized Applications:**
 - LibSpatiaLite
 - OGR
 - FDO
 - SharpMap
 - **DotSpatial**

DataClient Plug-in (author: pudtaan)



DataClient Plug-in

CITIES - DataTable

File Edit View Filter MapWindow Database Tools

- Select All
- Clear Selection
- Add Column
- Auto Fill
- Insert Row
- Delete Row(s)
- Row Editor

32275	Homes
39950	Leisure
15975	Cutler
67575	South
56125	Pemine
54300	Palmet
15962	Cutler
36100	Kendal
40737	Lindgre
28525	Hamm
14250	Coral G

2 selected : 3128 total row(s)

VOD_TOK - DataTable

File Edit View Filter MapWindow Database Tools

geometry0 Idaho Roads

NAZEV	TYP_VT	LENGTH	geometry0
	T	10485.216	MULTILINESTRING((-737520.5 -934832.625,-737514.4375 -934873.7...
	T	1343.32	MULTILINESTRING((-738822.5 -943459.5625,-738847.5625 -943547....
	T	8538.741	MULTILINESTRING((-723702.875 -945181.1875,-723806.125 -945136...
	T	11153.646	MULTILINESTRING((-729276.125 -946283.6875,-729370.875 -946221...
	T	3586.125	MULTILINESTRING((-676953.5625 -949765.1875,-676972.8125 -9496...
Smidá	T	13883.461	MULTILINESTRING((-677471.0625 -950838.625,-677572.8125 -95073...
Smidá	T	7325.487	MULTILINESTRING((-686620.4375 -950949.8125,-686640.5625 -9508...
	T	10989.969	MULTILINESTRING((-727351.5625 -947934.1875,-727201 -947917.56...
		179.367	MULTILINESTRING((-744151.75 -952400.25,-744300.0625 -952501.1...
	T	13104.961	MULTILINESTRING((-677302.6875 -951286.4375,-677374.3125 -9513...
	T	19006.07	MULTILINESTRING((-721302.5625 -953420.5625,-721414.9375 -9534...
	B	2112.429	MULTILINESTRING((-744151.75 -952400.25,-744090.875 -952471.5,-...
	T	7065.08	MULTILINESTRING((-717269.75 -951920,-717243.25 -951991.0625,-7...
	B	278.522	MULTILINESTRING((-723037.1875 -955922.6875,-722988.1875 -9559...
	B	1758.416	MULTILINESTRING((-722764 -955868.4375,-722759.875 -955818.5,-7...
	T	2263.149	MULTILINESTRING((-725010.875 -956849.3125,-724909.125 -956798...

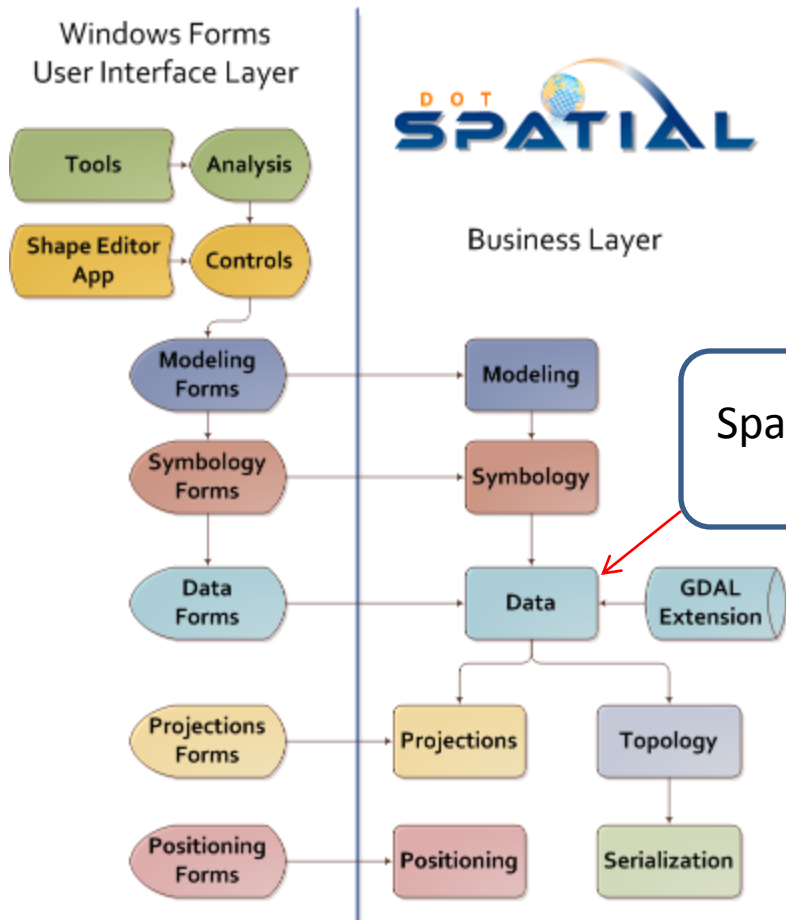
0 selected : 3717 total row(s)

DB Info

- Idaho Roa
- geom
- f_t
- f_c
- typ
- coo
- sric
- spa
- roads_
- Id
- Ne
- spa
- sric
- aut
- aut
- ref
- pro

Column(s)

DotSpatial Components



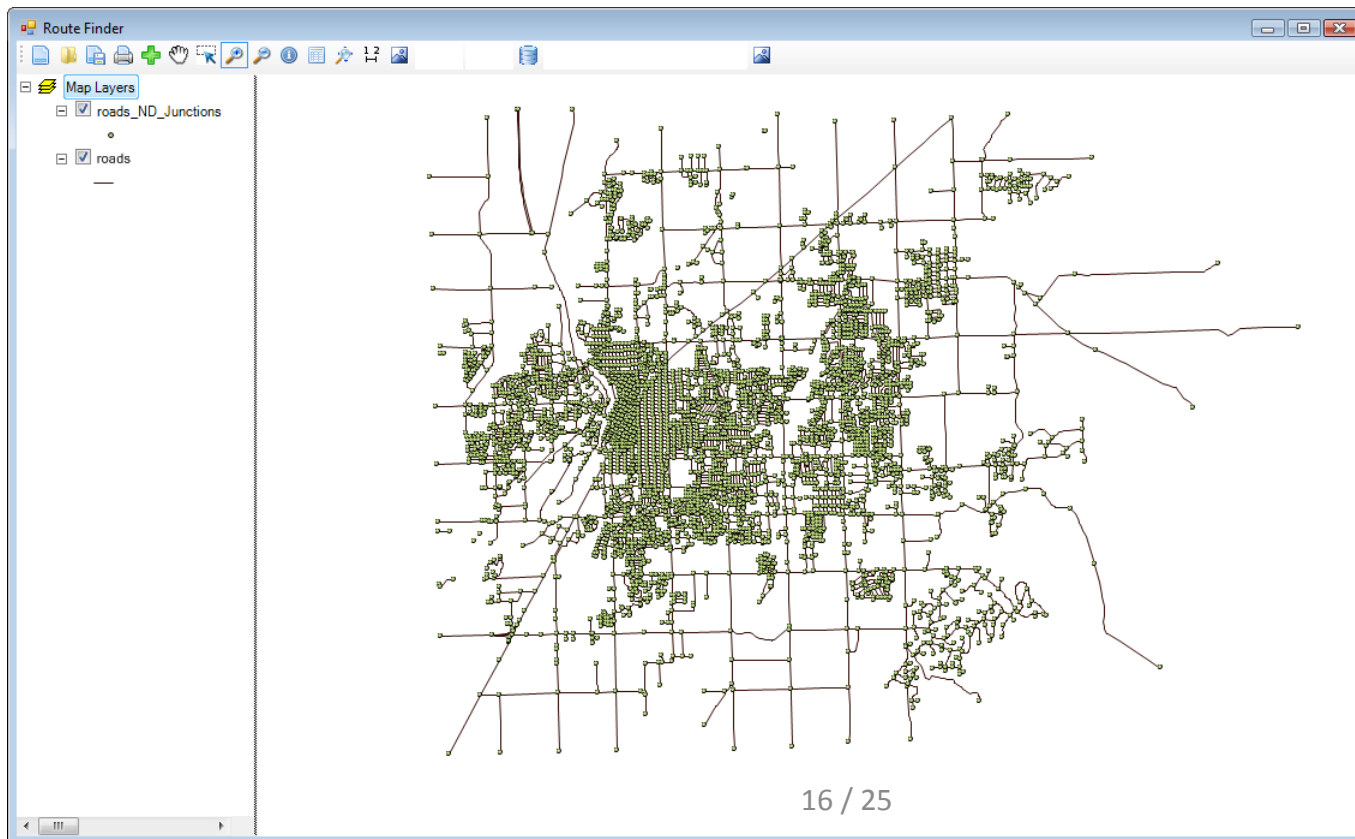
Implements Interface methods:

Open()
CreateNew()

Spatialite Data Provider

SpatiaLite Network Routing

- Find shortest path
- Data Source: Bonneville Country Roads



Build Network

- Specify the line table and Node columns

Build Network

Network configuration

NodeFrom Column: Shape_len, F_NODE, T_NODE

NodeTo Column: T_NODE, Geometry

Geometry Column: T_NODE, Geometry

Base Table [graph]: geometry_columns, roads, spatial_ref_sys, sqlite_sequence

Arc connections: Uni-Directional, Bi-Directional

Cost type: Using GLength(Geometry) as Cost, Using Cost Column

Cost Column: PK_UID, PRE_DIR, NAME

OneWays: Not using OneWay Columns, Using OneWay Columns

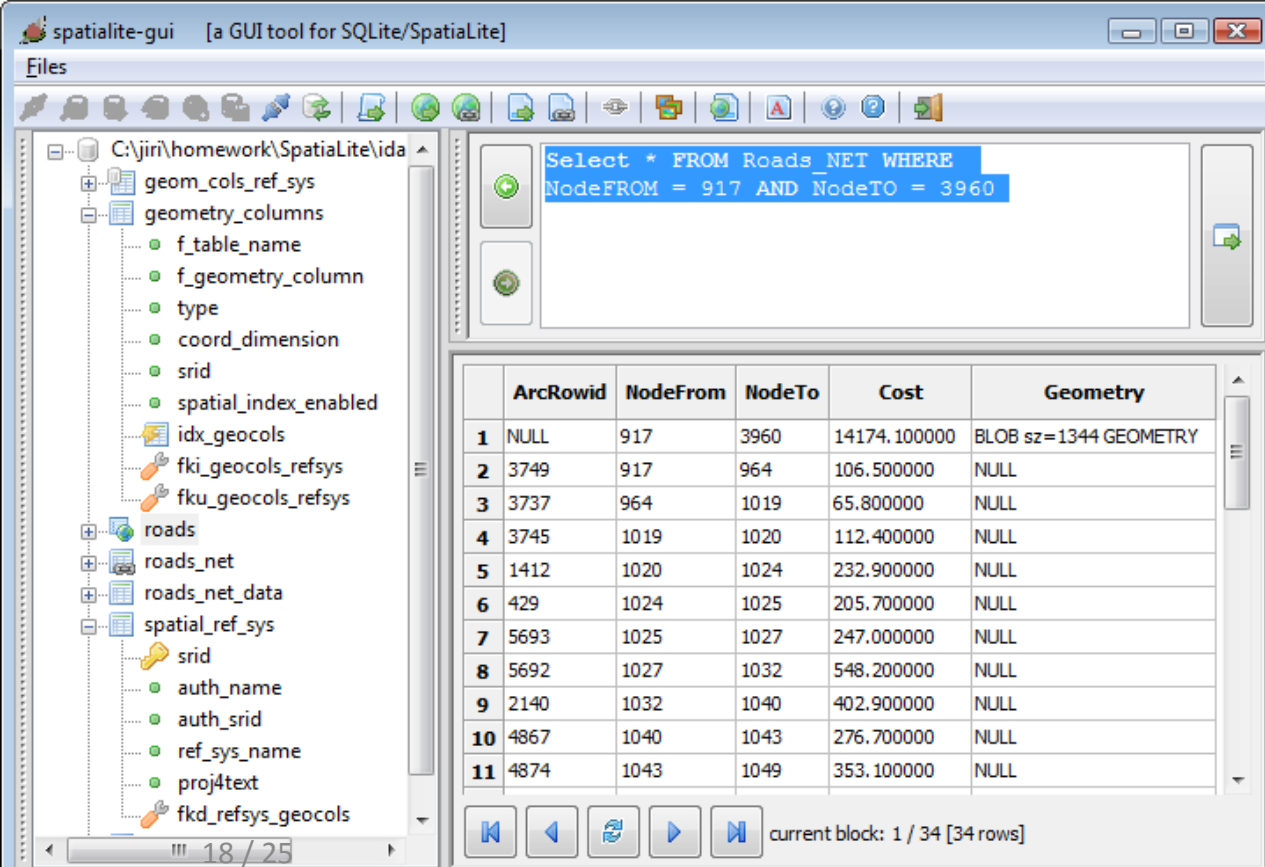
From -> To Column: PK_UID, PRE_DIR, NAME

To -> From Column: PK_UID, PRE_DIR, NAME

OK Cancel

Network Routing SQL Query

Select * FROM Roads_NET WHERE
NodeFROM = 917 AND NodeTO = 3960



The screenshot shows the spatialite-gui application window. The title bar reads "spatialite-gui [a GUI tool for SQLite/Spatialite]". The interface includes a file explorer on the left, a query editor in the center, and a results table at the bottom.

The file explorer shows the following structure:

- C:\jiri\homework\Spatialite\ida
 - geom_cols_ref_sys
 - geometry_columns
 - f_table_name
 - f_geometry_column
 - type
 - coord_dimension
 - srid
 - spatial_index_enabled
 - idx_geocols
 - fki_geocols_refsys
 - fku_geocols_refsys
 - roads
 - roads_net
 - roads_net_data
 - spatial_ref_sys
 - srid
 - auth_name
 - auth_srid
 - ref_sys_name
 - proj4text
 - fkd_refsys_geocols

The query editor contains the following SQL query:

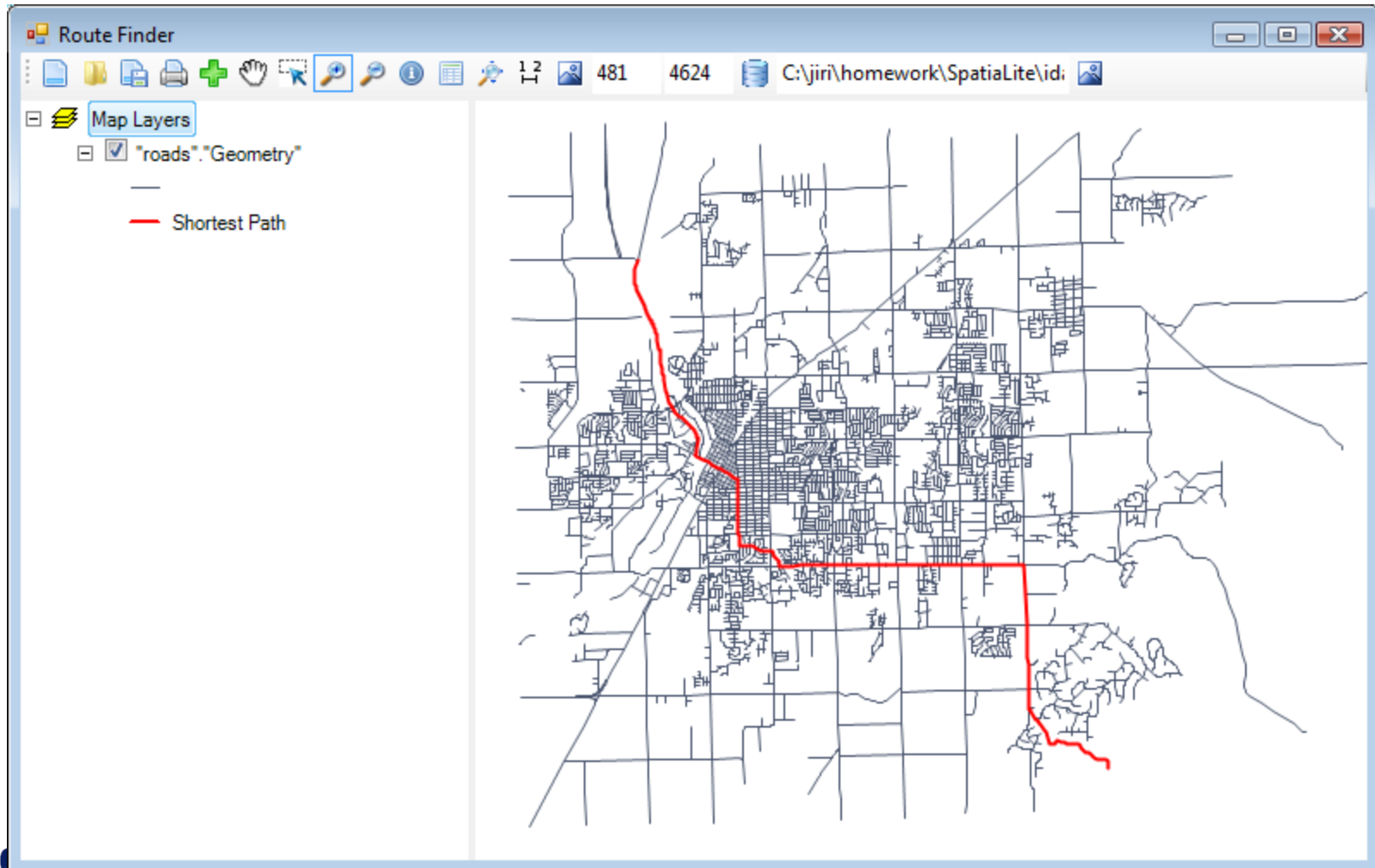
```
Select * FROM Roads_NET WHERE  
NodeFROM = 917 AND NodeTO = 3960
```

The results table displays the following data:

	ArcRowid	NodeFrom	NodeTo	Cost	Geometry
1	NULL	917	3960	14174.100000	BLOB sz=1344 GEOMETRY
2	3749	917	964	106.500000	NULL
3	3737	964	1019	65.800000	NULL
4	3745	1019	1020	112.400000	NULL
5	1412	1020	1024	232.900000	NULL
6	429	1024	1025	205.700000	NULL
7	5693	1025	1027	247.000000	NULL
8	5692	1027	1032	548.200000	NULL
9	2140	1032	1040	402.900000	NULL
10	4867	1040	1043	276.700000	NULL
11	4874	1043	1049	353.100000	NULL

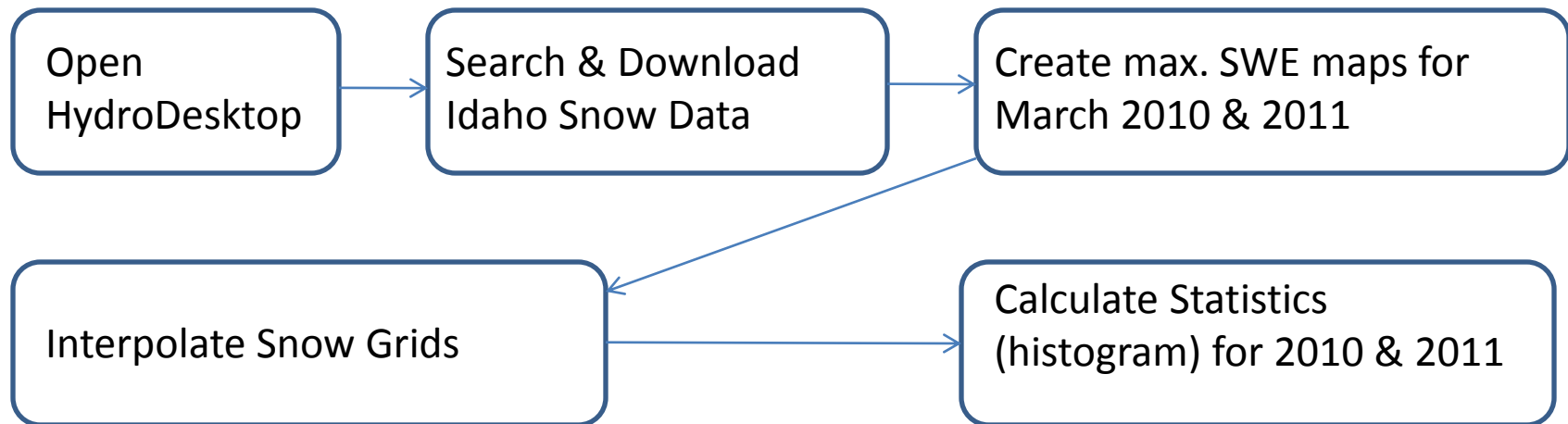
The status bar at the bottom indicates "Current SQLite DB: C:\jiri\homework\Spatialite\idahoroads.sqlite" and "current block: 1 / 34 [34 rows]".

Network Routing – Show on Map



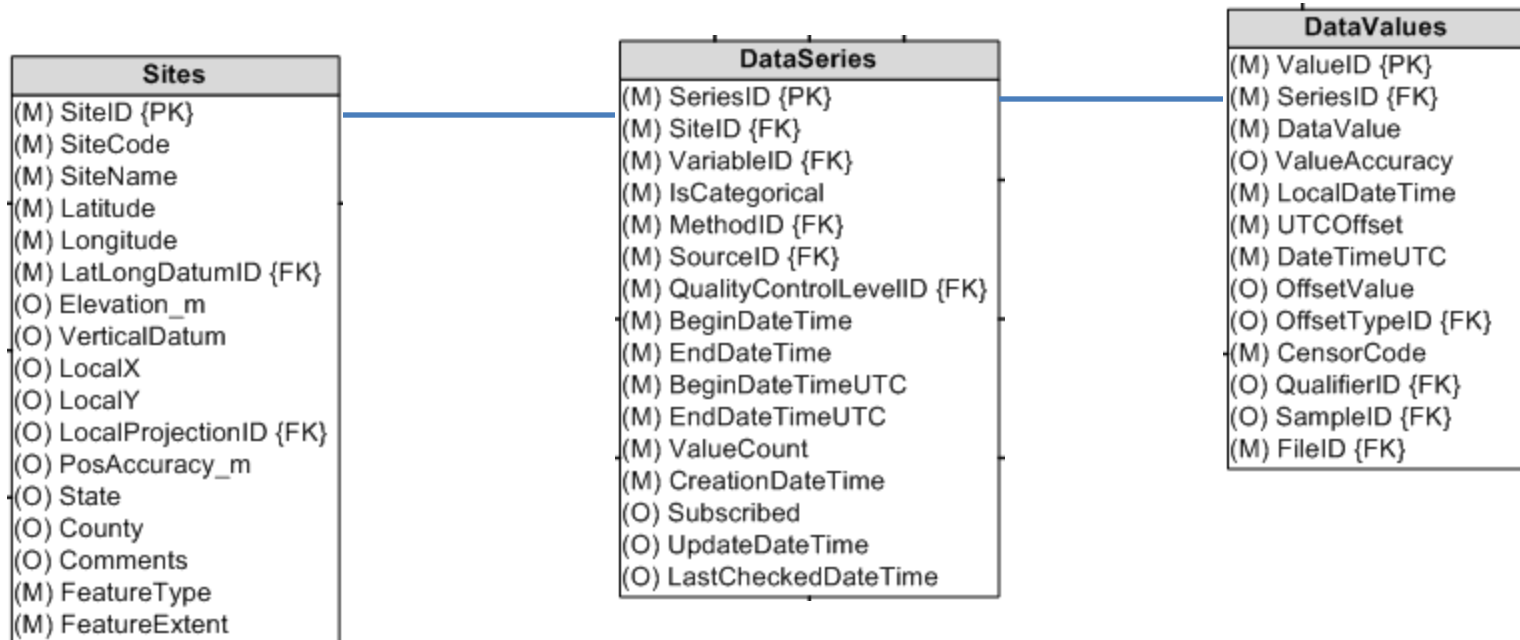
Management of Time Series

- **How much water** is stored in the **snow** in Idaho in March 2011, compared to March 2010?



HydroDesktop DB Schema

One Site – many DataSeries,
One DataSeries – many DataValues



Idaho Snow in HydroDesktop

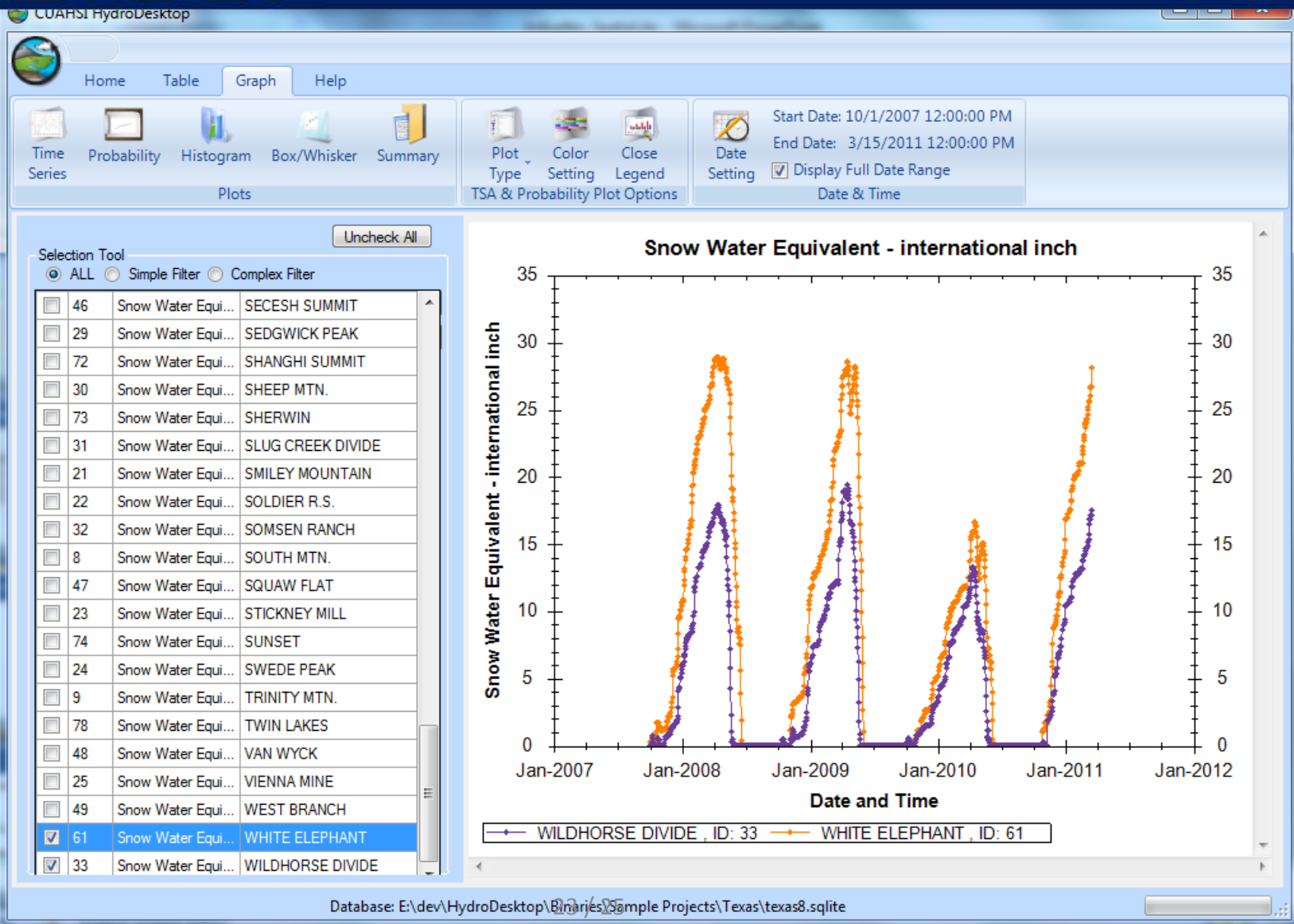
The screenshot displays the CUAFSI HydroDesktop application window. The title bar reads "CUAFSI HydroDesktop". The interface includes a menu bar with "Home", "Table", "Graph", and "Help". Below the menu is a "Map Tools" toolbar with icons for Search, Pan, Zoom In, Zoom Out, MaxExtents, Previous, Next, Add, Identify, Select, Attribute, Measure, Delineate, and EPA Tool. A dropdown menu for "ESRI Hydro Base Map" is set to "Opacity 80".

The "Map Layers" panel on the left shows the following layers:

- Map Layers
 - snow2010
 - snow2011
 - Themes
 - Idaho Snow
 - SNOTEL
 - sanJacinto_disch
 - test-pcp7
 - pcp-5
 - pcp-4
 - pcp-test2
 - test-pcp
 - texas-theme2
 - texas-theme 1
 - texas2
 - hermine flood
 - pcp test
 - Online Basemap
 - basins_dd
 - BASIN_NAME
 - Online Basemap
 - Major Rivers
 - 50mil_us_states

Longitude: 116°35'46"W, Latitude: 48°26'04"N

Snow Time Series at two Sites



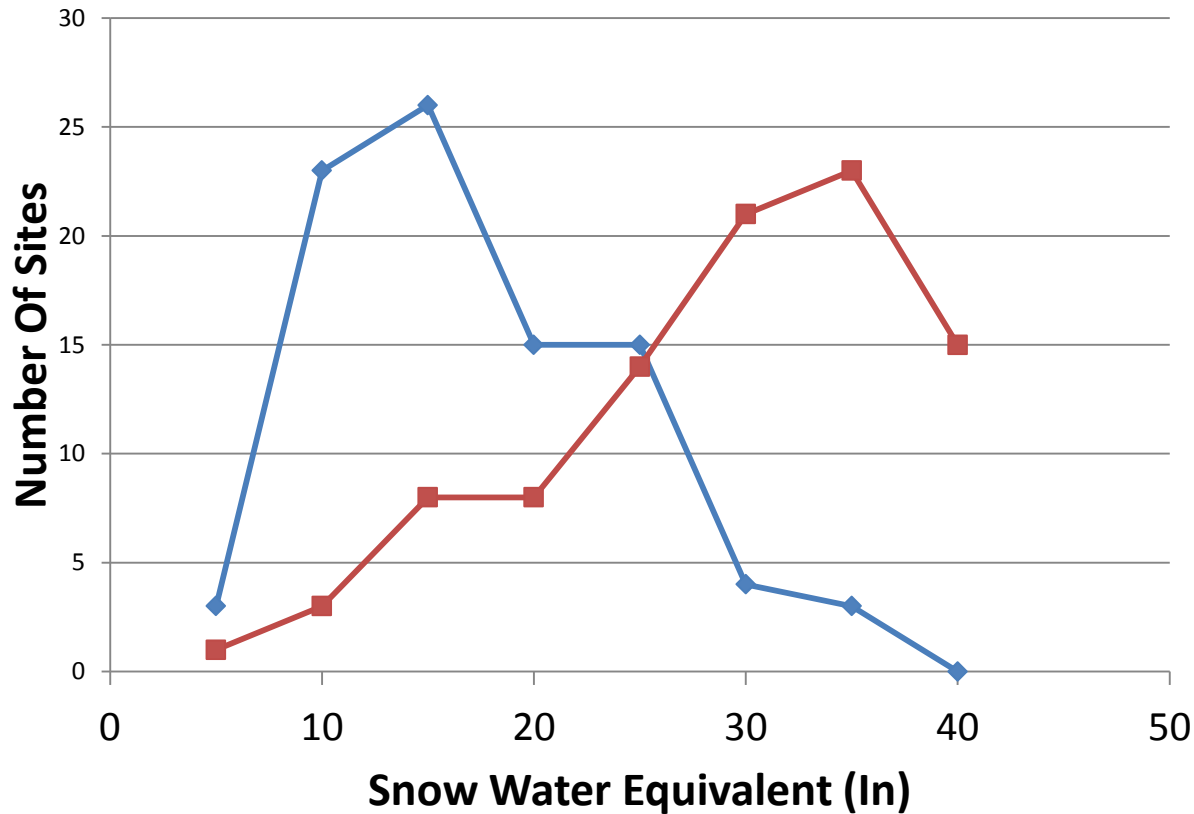
SQL Query

```
SELECT site.SiteName, site.Geometry, dv.DataValue
FROM Sites site, DataSeries series,
  (SELECT max(DataValue), SeriesID FROM DataValues WHERE
DateTime BETWEEN '2010-03-26' AND '2010-03-01'
  GROUP BY SeriesID) dv
WHERE series.SeriesID = dv.SeriesID
AND site.SiteID = series.SiteID;
```

Spatial Property

Time Range

Comparison of Snow Water Equivalent in Apr 2010 and 2011



	2010	2011
Mean	14.0	22.4
Median	12.8	18.9

◆ 2010
■ 2011

Conclusions

- Use SpatiaLite DB as the data store for **Custom GIS Desktop Applications**
- Well documented format + Free software libraries → **quick deployment of custom GIS applications**
- Needed in DotSpatial: SpatiaLite **WRITE** access, handling large datasets

Links

- DotSpatial.org
- <http://www.gaia-gis.it/spatialite/>
- SQLite.org
- HydroDesktop.org

Acknowledgments

Poom (MW User: pudtaan)
developed the DataClient Plug-IN
<http://almanacsoft.tk/>

Fobermaier
(DotSpatial.Data.Database)