

# GIS in Land Protection Assessment and Mapping

A comparison of tools and spatial analysis in ArcGIS and QGIS



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# Background

- Real world analysis
   "Skykomish Basin Land Protection Assessment & Mapping" Project for Snohomish County under a federal grant from the EPA
- Work performed jointly by
   Forterra (formerly Cascade Land Conservancy) and
   Core GIS (a Seattle based GIS Consulting Company)
- Goals of the project: evaluate riparian ecological resources based on value and threat in order to inform near- and long-term strategies to protect wildlife habitat in support of salmon recovery
- Compare spatial analysis for conservation planning in ArcGIS 10.2/10.4 and QGIS 2.14



# **Approach - Presentation Topic**

Use Skykomish project as a real world example Original work done in ArcGIS 10.4

Re-create key parts of the analysis in QGIS 2.14

- proof of concept NOT exactly replicate entire analysis
- goal to compare work flows and tools
- highlight similarities and differences

Determine key analytic tools & compare workflow

- Overview of important tools used in the analysis
- Compare availability, name and use



### **Assumptions and Goals**

- Presentation audience mostly familiar with ArcGIS
- A comparison of tools in ArcGIS and QGIS is valuable for new users of QGIS
- Proof of concept Real world example will showcase the analytic power of QGIS & associated toolset
- To help new QGIS users to jumpstart spatial analysis in conservation planning and beyond



### Next in the presentation

- Overview of QGIS
- Review of Skykomish Project work
- ArcGIS QGIS Comparison of Key analysis tools used in the Skykomish Project
  - Overview slides
  - More detailed look at three tasks /analysis

### Conclusions



# **Overview - QGIS**

# a very capable and flexible Desktop GIS





#### **QGIS - Desktop GIS**

originally a GIS viewing environment QGIS for the Linux desktop but is available for Solaris, Windows and Mac. Support for many data formats







Main supporter of Quantum GIS	Gary Sherman and others				
Туре	Desktop GIS Viewer				
Functionality	Can be used as a UI to GRASS GIS with GRASS Plug-in, Python bindings allow for programmatic interaction				
Operating sys- tems	Multi platform				
Project started	2002				
Implementation	C++, Depends on QT widget				
OS libraries	OGR/GDAL				
PostGIS sup- port	Yes				
License	GPL				



# QGIS Highlights



- "Intermediate" Desktop GIS
- all basic and intermediate GIS Functionality
- support for many input formats
- easily extensible and highly customizable
- extended comprehensive Analytic capabilities -> Processing Tools and modeler
- automation and custom tool development via
  - Python scripting (Python bindings and pyQT integration)
  - Enables plug-in and user interface development
- Very active User and Developer Community
  - rapid development, good community support



# **QGIS - Python Interface**



### Three Options

- Python console
- Processing tools
- Plugins

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₹	1	Python Console Use iface to access Q	GIS API interface <b>or</b> Type help <b>(</b> iface <b>) for</b> n	n
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2	>>>		GRASS GIS 7 commands [153 geoalgorithm] GRASS GIS 7 commands [153 geoalgorithm] LecoS (Landscape ecology statistics) [16 Models [2 geoalgorithms]	ns] geoalgorithms]
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Add script from file Create new script

🗄 🔆 🔀 Tools for LiDAR data [82 geoalgorithms]

• TauDEM (hydrologic analysis) [26 geoalgorithms]

Get scripts from on-line scripts collection

Scripts [1 geoalgorithms]

Contour

Tools

User scripts

Advanced interface

#### Tools such as

- WinPython (IDE + QT Designer)
- QT Designer
- <u>Plugin-Builder</u> Plugin ☺



# **Tool comparison ArcGIS - QGIS**

#### Both have a rich set of tools

Arc	Tool	box
<b>R</b>	Arc	Toolbox
+	Ψ.	3D Analyst Tools
+	Ϋ́,	Analysis Tools
+	4	Cartography Tools
+	Ϋ́,	Conversion Tools
+	1	Data Interoperability Tools
+	Ϋ́,	Data Management Tools
+	Ψ.	Editing Tools
+	ΨŶ.	Geocoding Tools
+	1	Geostatistical Analyst Tools
+	Υ.	Linear Referencing Tools
+	Ϋ́	Multidimension Tools
+	1	Network Analyst Tools
+	T.	Parcel Fabric Tools
+	Υ.	Schematics Tools
+	1	Server Tools
-	¥,	Spatial Analyst Tools
	+	🗞 Conditional
	+	🗞 Density
	+	🗞 Distance
	+	Sector Extraction
	+	🗞 Generalization
	+	🗞 Groundwater
	+	🗞 Hydrology
	+	S Interpolation
	+	🗞 Local
	+	🗞 Map Algebra
	+	🗞 Math
	+	🗞 Multivariate
	+	🗞 Neighborhood
	+	🗞 Overlay
	+	Naster Creation
	+	🗞 Redass
	+	🗞 Solar Radiation
	+	🗞 Surface
	+	🗞 Zonal
+	1	Spatial Statistics Tools
+	4	Tracking Analyst Tools





#### SKYKOMISH BASIN Land Protection Assessment & Mapping Project



#### by Matt Stevenson, Core GIS, Seattle

**DECEMBER 16, 2015** 

# Variables Identified for the Analysis

#### **Score Variables**

#### Conservation

Salmon Population

Salmon Stream Length

Floodplain

Low Lying Acres

**Upland Wetlands** 

**Forested Acres** 

Acres Of Forested Buffer

Acres Of Trees 90'+ Within Buffer

Pervious Surface

**Unweighted Conservation** 

Weighted Conservation

#### **Development**

Land Value

Urban Growth Area

Surrounding Development

Percent Slope

Potential Development

**Unweighted Development** 

Weighted Development

#### **Assessment Maps**

**Unweighted Assessment** 

Weighted Assessment

# **Overview of the Skykomish Basin Project**

- Score calculation for each of the variables in the development and conservation categories
- Each calculated score for the variables was standardized to a 0-4 rating scale
- Result maps created using a 4\*4 matrix of Conservation Value & Development Threat that was developed for the project
- A weighted result of the initial matrix based map was created as the final result / synthetic map



# Synthetic map - Skykomish Basin Project based on 4\*4 matrix

- convey the relative conservation value and likelihood of development for every parcel
- a top-level picture of conservation opportunities at the parcel level





### **Example- Unweighted Conservation Score**

added the scores for all nine variables together and divided by nine

([Salmon\_Spp\_Score]+[Salmon\_Strm\_Score]+
 [Floodplain\_Score]+ [Wetland\_NonFlood\_Score]+
 [Low\_elv\_Score]+ [Forested\_Score]+
 [For\_Buff\_Score]+ [For\_100plus\_Score] +
 [Pervious\_score]) / 9



#### Key analysis and tools used - Skykomish Basin Project

Analysis	description	ArcGIS Tool used	QGIS tool
Surrounding development evaluation	summarize attributes of polygon neighbors	Polygon Neighbors tool	python script OR using SQL query in PostGIS or via DB
Urban Growth Area Score	calculate distance between each parcel and the nearest UGA	near tool	
Salmon Population Score	counted the number of salmon populations present within or adjacent to each parcel.	euclidean allocation	proximity
Salmon Stream Length Score	extended parcel boundaries until they met	euclidean allocation	region growing algorythm
Slope Score	Slope tool with the percent option	slope	slope
		zonal statistics	zonal statistics tabulate area
General / multi purpose	surface tools	aspect contour hillshade dissolve clip union vector - raster conversion	aspect contour hillshade dissolve clip union vector - raster conversion

Spatial Analyst	Grass Plug-In
Arcinfo	SCP Plug-In

PostGIS based

#### Analysis using simple attribute column calculations are not listed



#### Key analysis and tools used - Skykomish Basin Project

Analysis	description	ArcGIS Tool used	QGIS tool
Floodplain Score	intersected floodplain + parcels calculated acreage of floodplain	intersect	intersect
300' Buffer on Perennial Streams		buffer, union + dissolve	buffer, union + dissolve
Upland Weltands Score	used the floodplain to erase wetlands from the NWI layer	erase	difference
Low-Lying Relative to Channel	sustract river height raster from the bare earth elevation raster	raster calculator	raster calculator
Forest Height	subtracted the bare earth raster from the first return LiDAR	raster calculator	raster calculator
Land Cover Classification			
Calculate Normalized Difference Vegetation Index (NDVI)	using 1m resolution NAIP 4 band imagery	raster calculator	raster calculator SCP Plug-In
Create two texture layers (bands)	focal mean 7*7 range	focal mean tool	r.neighbors tool (via Grass

maximum likelihood tool

maximum incerynood analysis	Maximum	likelyhood	analys is
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**vs is** using signatures of 96 training polygons

Spatial Analyst Grass Plug-Inst Archito SCP Plug-In

PostGIS based

Analysis using simple attribute column calculations are not listed

maximum likelyhood analysis



### A more Detailed Look

Comparison of Analysis in ArcGIS 10.4 and QGIS 2.14

Surrounding Development Score neighboring Polygon developed or not

Land Cover Classification



# **Surrounding Development Score**

Neighboring Polygon developed or NOT

The map shows a score for each parcel based on the percentage of developed parcels surrounding it.

Scores were determined as shown:

$$4 = 75 - 100\%$$
  

$$3 = 50 - 74.9\%$$
  

$$2 = 25 - 40.9\%$$
  

$$1 = 0.1 - 24.9\%$$
  

$$0 = 0$$



#### Credit: Matt Stevenson Core GIS, Seattle



# **Surrounding Development Score**

neighboring Polygon developed or not

### ArcGIS Polygon Neighbors





#### Map by M. Stevenson



#### **Tool Comparison**

# **QGIS - Surrounding Development Score**



#### ArcGIS - Map by M. Stevenson

#### **QGIS - Map by K.Vennemann**



### **QGIS - Surrounding Development Score**

- Import data to PostGIS or Spatialite
- Run SQL query to create result layer

SELECT row\_number() over (order by a1.parcel\_id) as serial\_number, COALESCE(SUM(a2.mkimp),0) as nb\_devscore, a1.parcel\_id, count(1) as nb\_parcels\_num,st\_collect(a1.geom) as geom Into newresults FROM parcelsresult a1 LEFT OUTER JOIN parcelsresult a2 ON NOT a1.parcel\_id = a2.parcel\_id AND st\_intersects(a2.geom, a1.geom) GROUP BY a1.parcel id

Alternatively use python script <u>neighbors.py</u>



#### Land Cover Classification - Skykomish Basin

Derived from 2013 NAIP 4band 1m orthophotos





#### Map by M. Stevenson Core GIS, Seattle



#### Land Cover Classification - Skykomish Basin

- Calculating Normalized Difference Vegetation Index (NDVI)
   = (Near IR - Red) / (Near IR + Red)
- Produce texture layer Focal Mean tool with a 7x7 moving window + RANGE variable (Band2Rng7x7" + "Band4Rng7x7") / 2
- 96 Training Polygons
- Maximum Likelihood tool to generate classified land cover



#### Credit: Matt Stevenson Core GIS, Seattle



### **QGIS - Land Cover Classification**

- Calculating Normalized Difference Vegetation Index (NDVI) (Near IR - Red) / (Near IR + Red)
- Produce texture layer Focal Mean tool with a 7x7 moving window + RANGE variable (Band2Rng7x7" + "Band4Rng7x7")/ 2
- 96 Training Polygons import
- Signature Creation for 6 bands
- Maximum Likelihood tool to generate classified land cover

Calculate using the SCP Plug-In

Using Grass Plug-In r.neighbors Tool

Import or create signatures to SCP ROI creation Window



Run in SCP Classification Window



### **QGIS - Land Cover Classification**

Calculating Normalized Difference Vegetation Index (NDVI)

using the SCP Plug-In Main window

Ser	ni-Automatic Classification Plugin									
	Tools	st processing								
R-	nd list									
Ra	Raster bands									
	Variable	Band name								
3	raster3	neighbor_band4_7 Band list								
4	raster4	ndvi.tif								
5	raster5	bandset#b1 Refresh list								
6	raster6	bandset#b2								
7	raster7	bandset#b3								
8	raster8	bandset#b4								
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Ou	tput raster									
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#### **Tool Comparison**

### **QGIS - Land Cover Classification**

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Add to signature										
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Rapid ROI on band						1 🜩				
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### **QGIS - Land Cover Classification**

### Produce texture layer Using Grass Plug-In r.neighbors Tool

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### **QGIS - Land Cover Classification**

### Maximum Likelihood Run in SCP Classification Window

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Sign	ature	list							
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2	×	5	Deciduous	5	Deciduous				
3	×	1	Water	1	Water				
4	×	3	Grass	3	Grass				
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### **Conclusions I**

- Both ArcGIS and QQGIS have extensive and often similar analytic capabilities
- As expected some tools are very similar while others require a different approach, or are simply listed under a different name
- QGIS has a comprehensive toolset capable of replicating the entire analysis done for the Skykomish Project
- The QGIS Processing tool box makes analysis providers of other GIS system available in QGIS



### **Conclusions II**

- The GRASS Plug-in for QGIS allows to access the full power of GRASS GIS from within QGIS
- The Semi-automatic Classification Plug-in (SCP) makes remote sensing available in QGIS. Imagery can be browsed and downloaded from with in QGIS (Landsat and Sentinel archives)
- Remote Sensing Capability is also included in ArcGIS via the Spatial Analyst toolbox
- As expected moving between tools for the same analyses requires getting used to differing tools, tool names, syntax, and work flows

