



Which Birds Are Found Here?

Serving Up Large Overlapping Polygon Data for Web Queries.

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Presentation Overview

- Challenge -concepts, data intensive spatial queries
- Background –objectives, data preparation
- Methods – overview
- Deliverables - create map server and web application
- Timeline
- Closing – acknowledgments, references, questions



Challenge

- Let's say you want to know what all the plant or butterfly species you might be seeing on your walk in the San Francisco Bay. Can you get that information on your mobile phone?
- What if you are planning a visit to a remote nature lodge in the Amazon and want to take a list of the birds you might see there?
- Guide books have range maps for individual species, but how can you overlay all those species and see which ones are found in one place?



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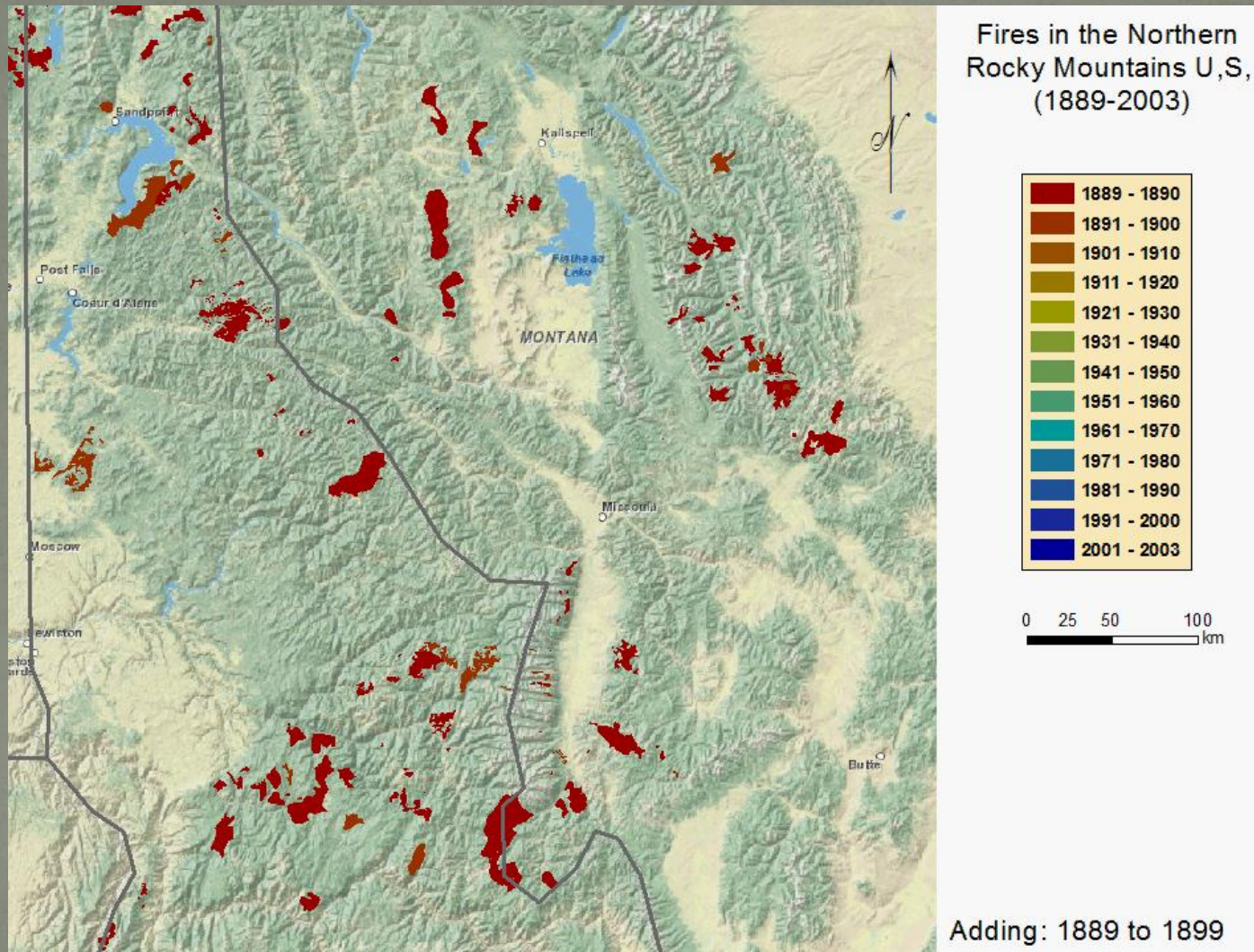
Closing



Concepts

- Overlapping spatial phenomena exist in the same space–ecosystem
- It can be 3-dimensional, sharing overlapping XY coordinates but different time or heights
- The challenge is when there are so many overlapping phenomena, some of which are very complex, that spatial queries cannot be done quickly and easily

Example: Historical Fires Over Time



Challenge

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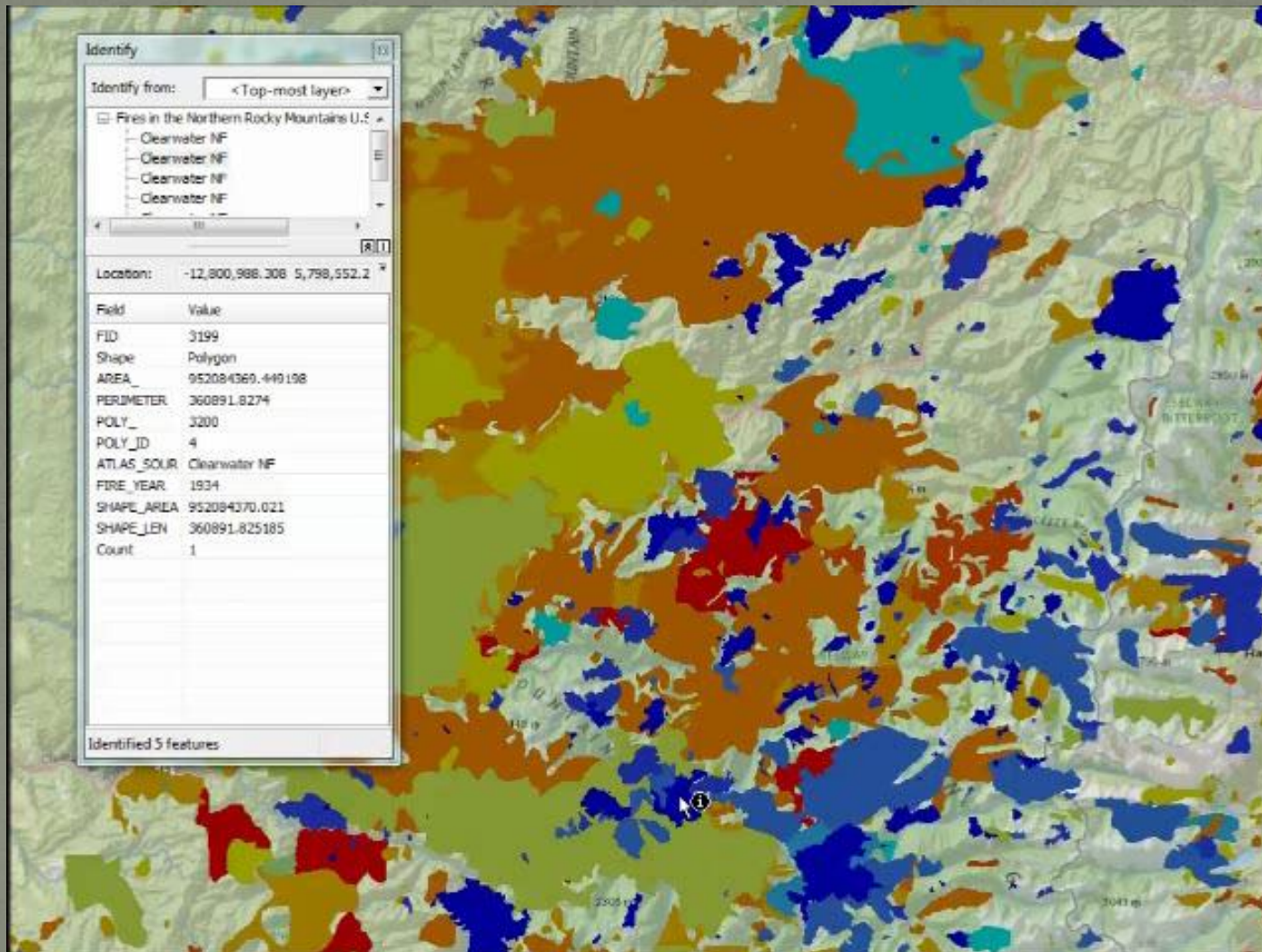
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Spatial Queries on Historical Fires



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Data Intensive Spatial Queries

- The greatest challenge is computing power: the sheer number of computations
- The number of points in polygons directly affects the computational complexity
- Overlapping polygons of natural phenomena are topologically dirty: They rarely share boundaries, and when they do, it is usually a physical boundary, such as a coastline.



Objectives

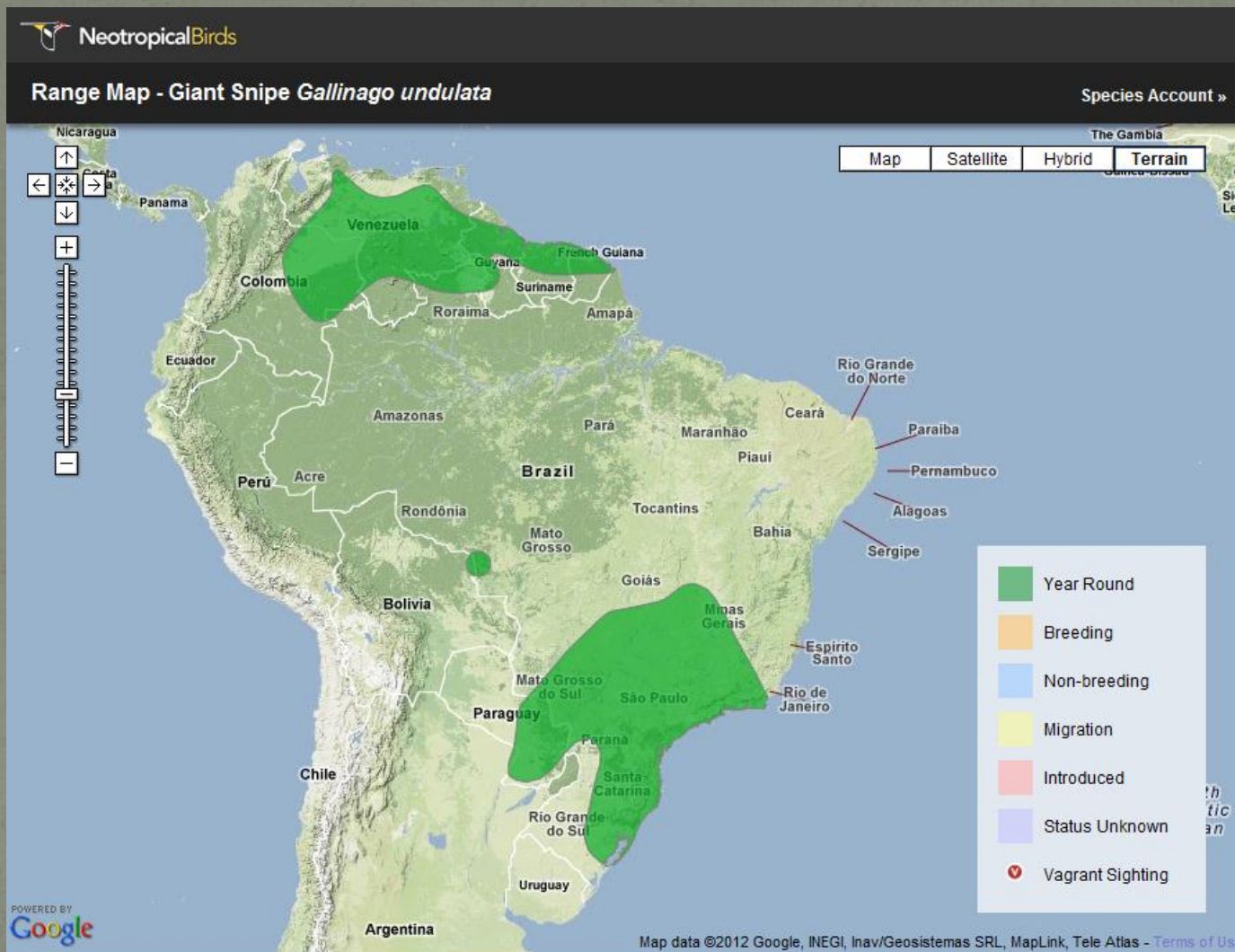
- The goal of this project is to prepare bird range data for overlay spatial queries
- These include point-in-polygons (pushpin) and polygons-in-polygons (cookie cutter) queries
- Techniques to enable data intensive spatial searches in a web application include:
 - Careful spatial data preparation, including generalization and simplification
 - Hybrid use of rasters and vectors
 - Map tiling
 - Caching



Maps of the Birds of the Western Hemisphere

- These bird distribution polygons were prepared by NatureServe (Ridgely et al. 2007)
- The ranges are available as shapefiles for individual bird species You can see what these ranges at <http://neotropical.birds.cornell.edu/>

Example: Range of the Giant Snipe



Challenge

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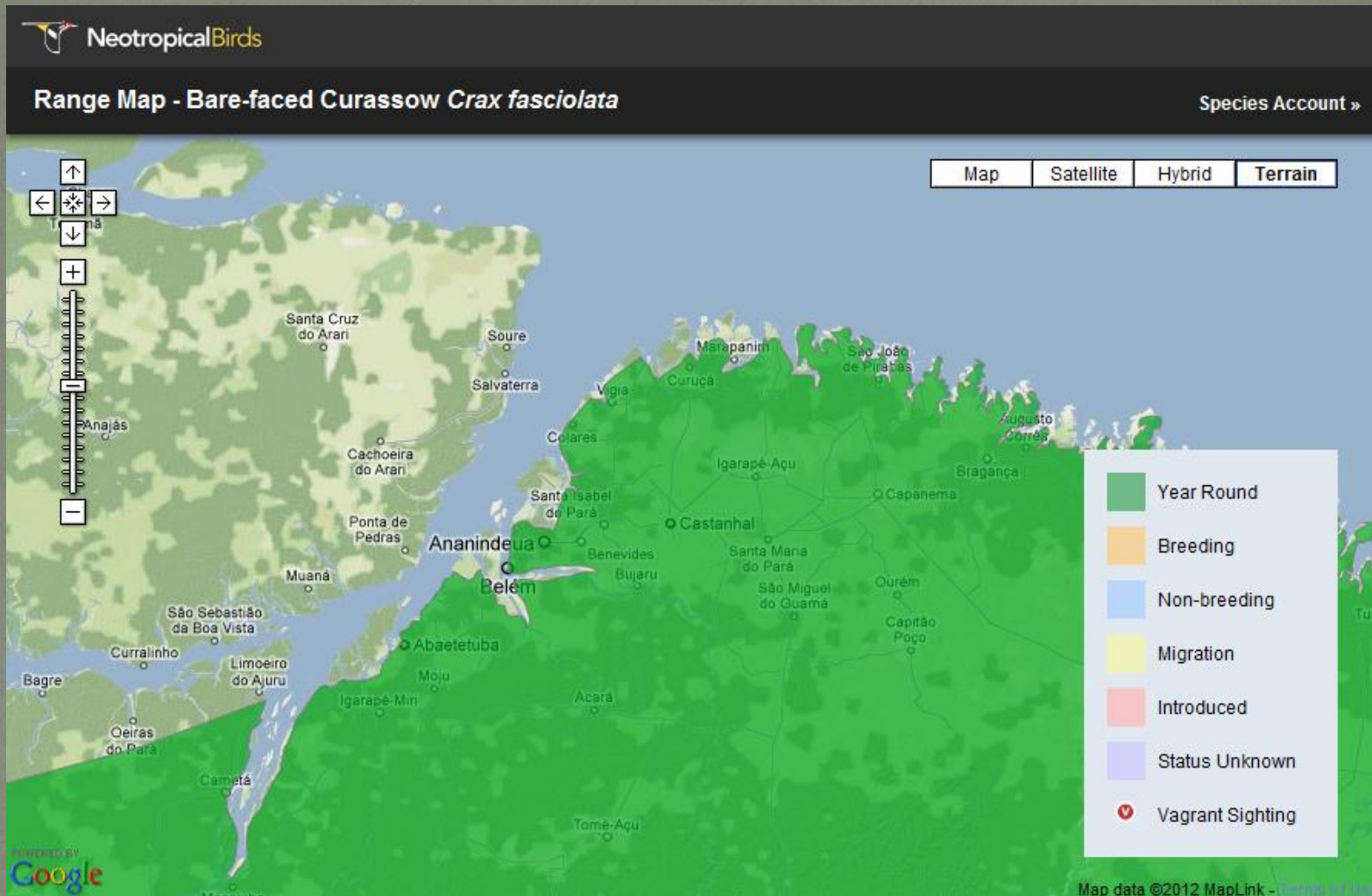
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Example: Range of the Bare-faced Currasow



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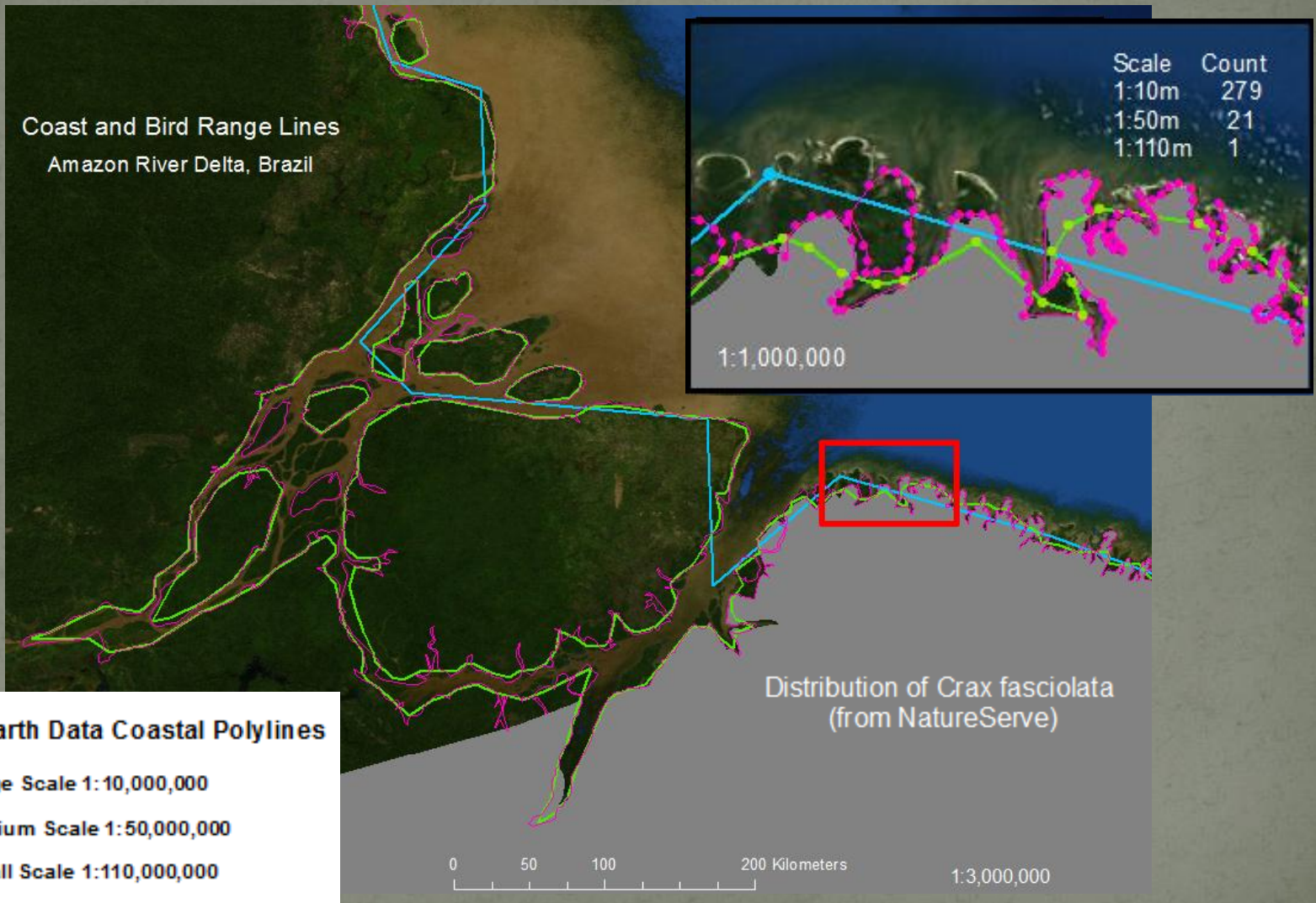
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Various Representations of this Coastline



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Highest Areas of Coastline Vertex Density



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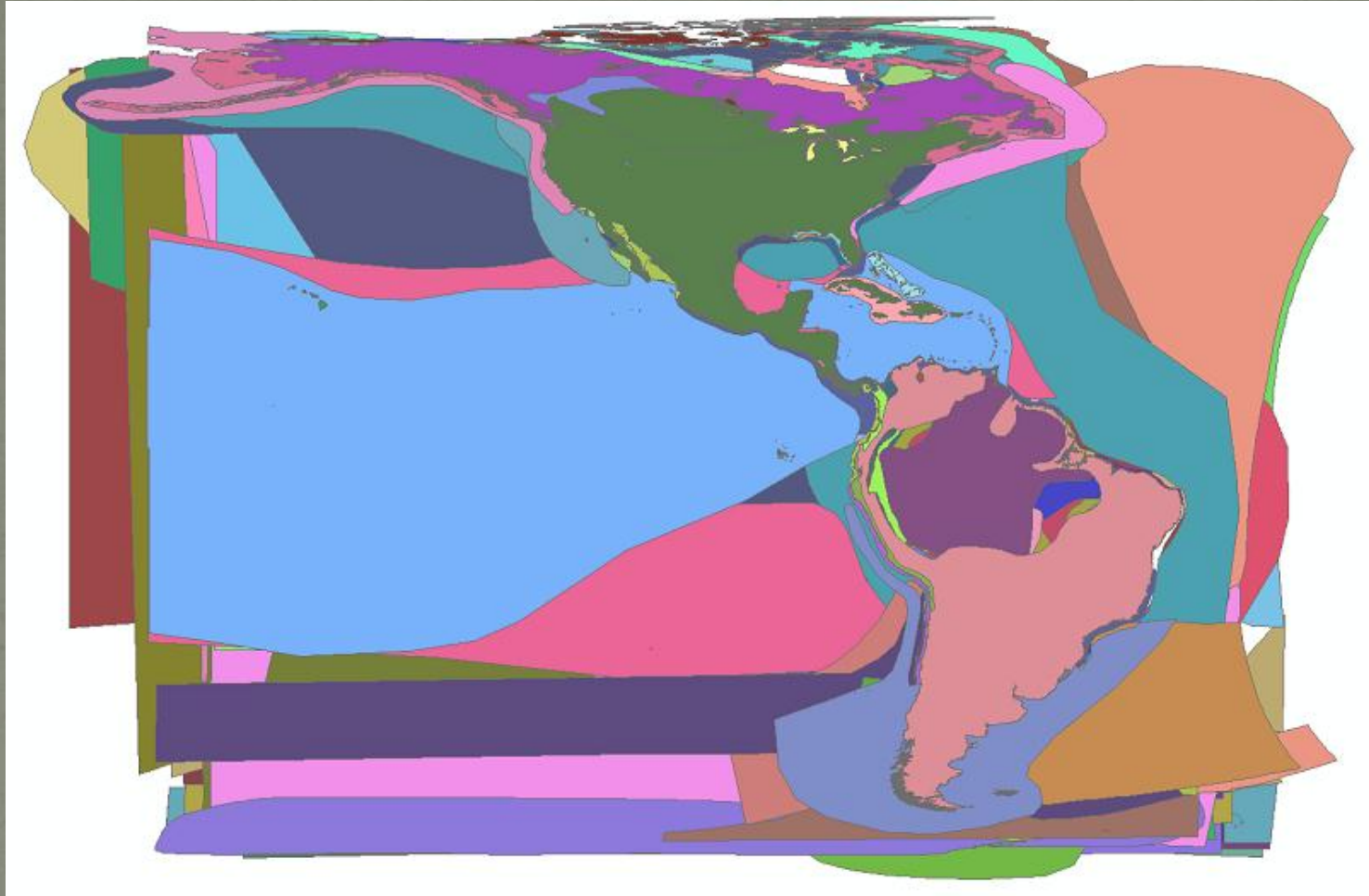
Coastline Complexity

- Fixing polylines with too many vertices is a process known as Dicing Godzillas
- Generalizing coastlines involves three steps:
 - Dilate (buffer out)
 - Erode (buffer back)
 - Simplify by the use of point removal or bend simplification tools
 - It is better to err on the side of including water as land than not including real inside the coastline!

Methods

- The NatureServe bird data consists of individual shapefiles by species
- Using separate shapefiles for species is not suitable for this type of analysis
- Data must be moved into a relational database
- It is important to check and repair feature geometry
- Workflow using ModelBuilder and/or Python scripts should be used to prepare the data in a documented and reproducible manner

What Do the Bird Ranges Look Like?



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Requirements

- For this prototype, I am using ArcGIS for Server on Amazon EC2 (a 60-day free trial)
- The prepared data needs to be cached and served up for use by web applications
- Client side must be platform-independent and as browser agnostic as possible
- Web application will be developed using the ArcGIS Java Web Application Developer Framework (ADF)

Tasks – Map Server

- Much of the groundwork has been done (See: Zhang 2009)
- Incremental approach
- Initially, for development and testing purposes, I will only be working with the data as clipped to the State of California
- Conduct tests to determine how best to serve up the data for the entire Western Hemisphere for efficient searches

Tasks – Web Application

- Create prototype of the application limited to California using drop-down selectors (e.g., county or park)
- Search results will open in a window and be downloadable by the user as KML, PDF, XLS, XML, HTML, or text
- Descriptive attributes, references, and links for more information will be included
- Later versions will expand functionality—e.g., upload your own study area polygon



Acknowledgments

Bird Range Data provided by NatureServe in collaboration with Robert Ridgely, James Zook, The Nature Conservancy - Migratory Bird Program, Conservation International - CABS, World Wildlife Fund - US, and Environment Canada - WILDSPACE.

Digital Distribution Maps of the Birds of the Western Hemisphere
Version 3.0

- Data available at
- <http://www.natureserve.org/getData/birdMaps.jsp>
- Metadata
- http://www.natureserve.org/getData/Metadata_Birds_ver_3.0_Oct_07.pdf
- Original Project Description
- <http://www.natureserve.org/library/birddistribmapsproject.pdf>

Carly E Gibson, June 1, 2005, "Fire History Polygons for Northern Rockies - 1889 - 2003" (accessed March 6, 2012)

- Data available at
- http://www.fs.fed.us/r1/gis/thematic_data/fire_history_nrocky_1889_2003.zip
- Metadata:
- http://www.fs.fed.us/r1/gis/thematic_data/fire_history_nrocky_1889_2003.htm

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- Ridgely, R. S. et al. 2007. Digital Distribution Maps of the Birds of the Western Hemisphere, version 3.0. NatureServe, Arlington, Virginia, USA.
- Souza-Filho, Pedro et al. 2008. The Subsiding Macrotidal Barrier Estuarine System of the Eastern Amazon Coast, Northern Brazil. Published in *Geology of Brazilian Coastal Barriers* (S. Dillenburg and P. Hesp, eds.). *Lecture Notes in Earth Sciences*, Vol. 107. New York: Springer-Verlag.
- Zhang, Jianting. 2009. Efficient managing large scale species range maps in a spatial database environment. Paper presented at the *Geoinformatics, 2009 17th International Conference*, pp. 1-6.

Questions?



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