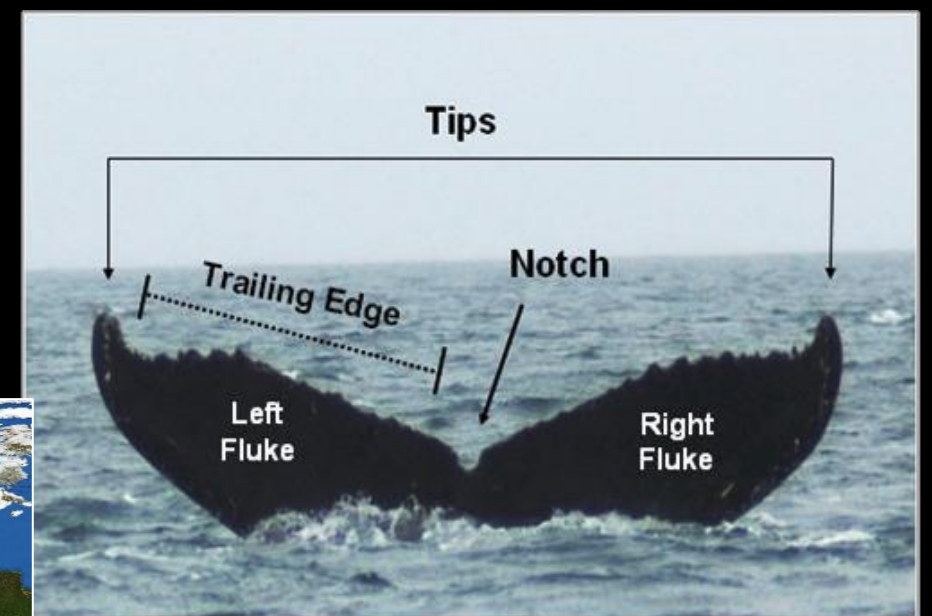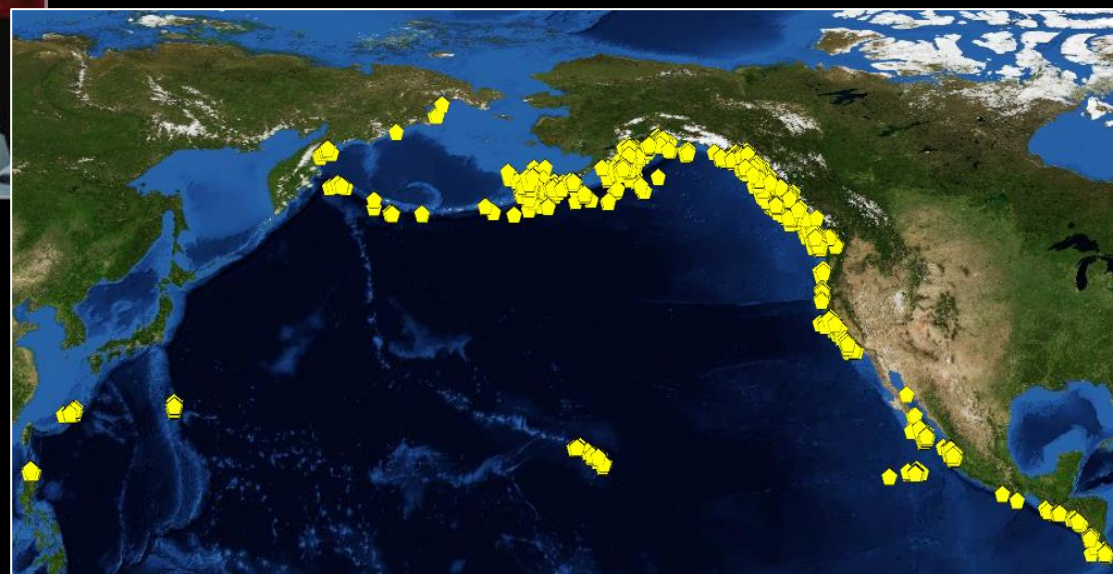# *geneGIS:*

Computational tools for spatial analyses of DNA profiles with associated photo-identification records

Dori Dick, Shaun Walbridge, Dawn Wright, John Calambokidis,
Erin Falcone, Debbie Steel, Tomas Follett,
Jason Holmberg, C. Scott Baker

http://www.nationalgeographicstock.com/ngsimages/explore/
explorecomp.jsf?xsys=SE&id=1231238

http://www.afsc.noaa.gov/ABL/Humpback/WhyPhoto.htm

SMM 2013 Dunedin, New Zealand

The Problem...

Cetacean research:

- Individual-based studies using photo-identification and genetics are becoming more common
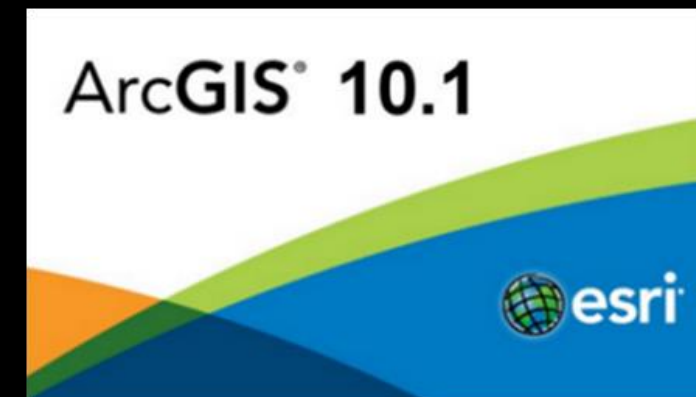

- Integration of these databases is rare

- Few tools exist to handle, explore or visualize the spatial patterns of such data
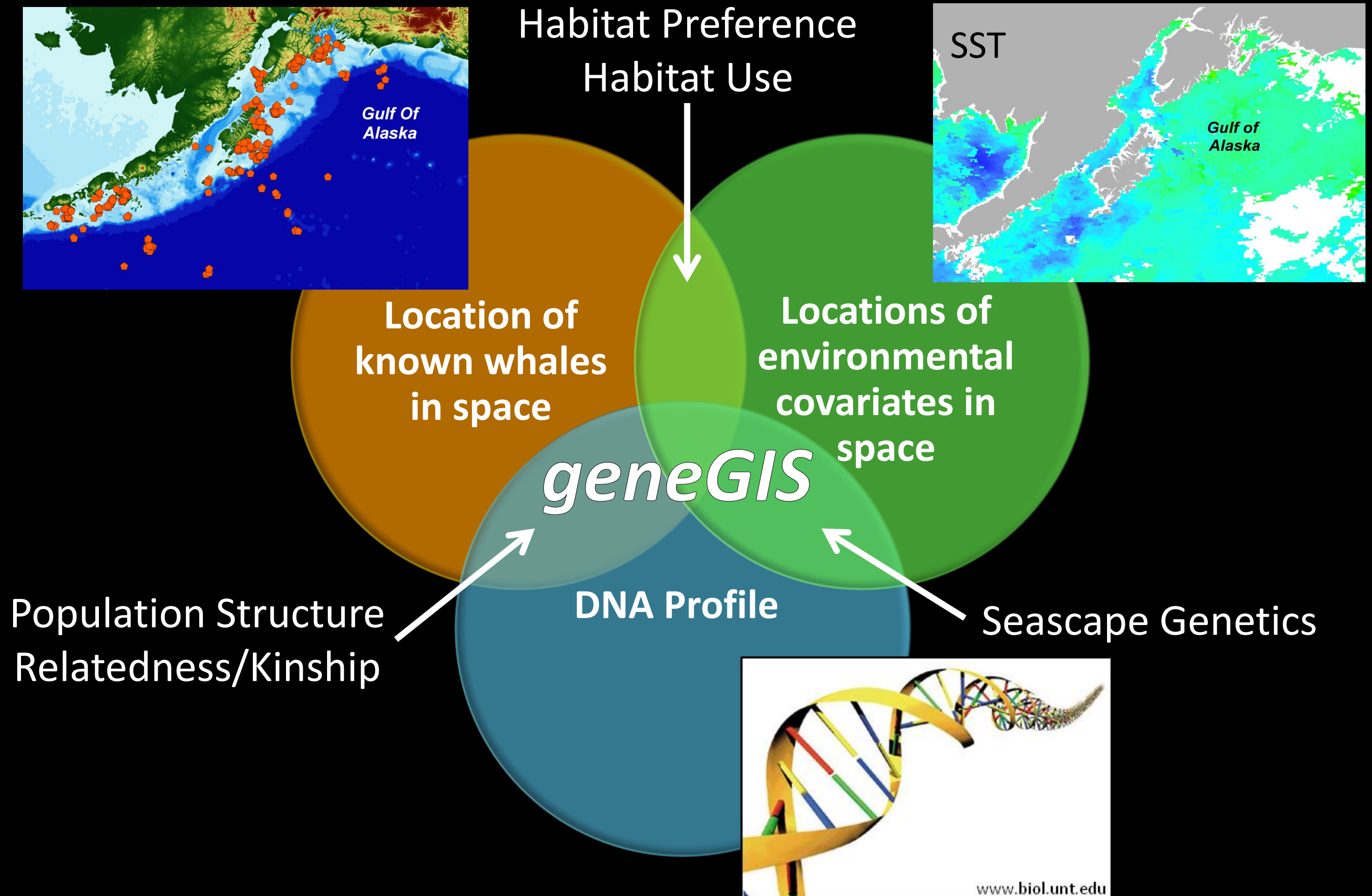
The Solution...

Our Approach:

- Provide suite of ArcGIS tools for use with integrated individual-based data

- Easily accessible for non-GIS users
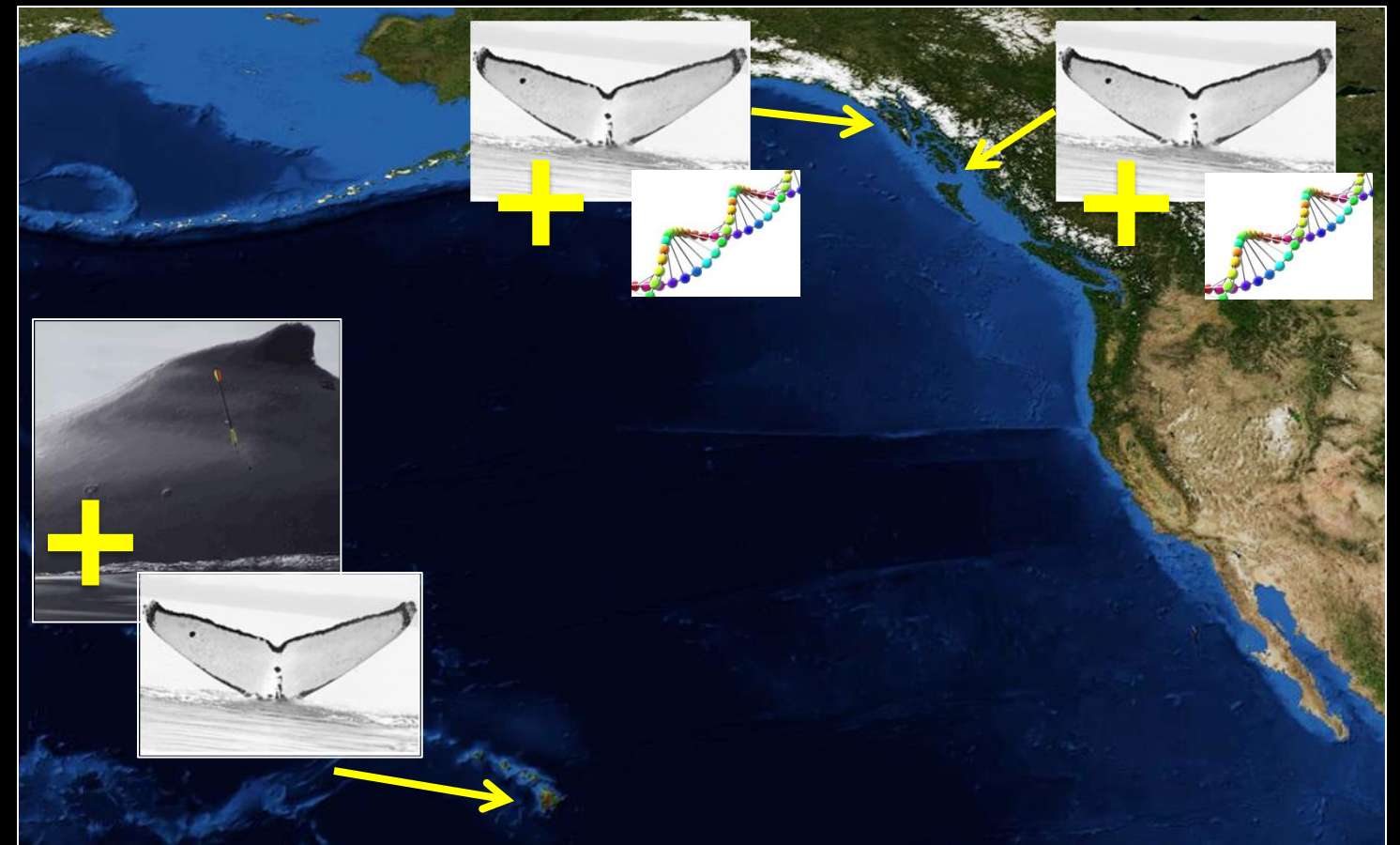
- Tools and geoprocessing scripts open source

geneGIS Framework

Habitat Preference
Habitat Use

SST

Gulf Of Alaska

Gulf of Alaska

Location of known whales in space

Locations of environmental covariates in space

geneGIS

DNA Profile

Population Structure
Relatedness/Kinship

Seascape Genetics

www.biol.unt.edu

Our database…

- *geneGIS* developed and implemented using SPLASH*, a collated & extended database of N. Pacific humpback whale records

  - 8,000+ naturally marked individuals

  - 2,700 associated DNA profiles (10 microsatellite loci, mtDNA, sex)

- 2 different development environments

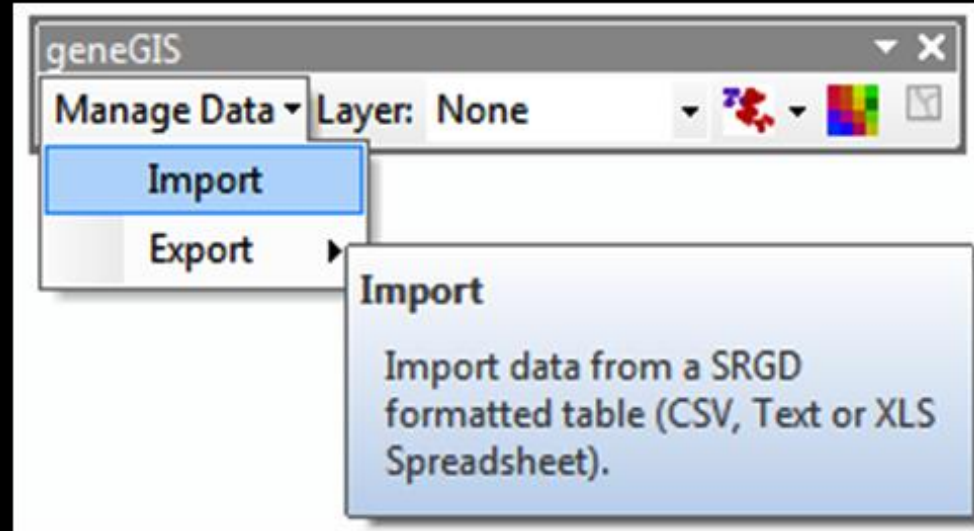 1. Java-based, web interface data management system supported by Wildbook http://www.wildme.org/wildbook/doku.php)

  2. ArcGIS

*Structure of Populations, Levels of Abundance and Status of Humpback Whales in the North Pacific

Working within *geneGIS*

- To provide a suite of ArcGIS tools to researchers who want to:

    1. Visualize data on a map

    2. Spatially explore, display, and select data

    3. Export data to formats required by other genetic analyses software

    4. Extract data from environmental layers

    5. Conduct basic spatial analyses

Working within *geneGIS*

To provide *quantitative* approach to *conservation priorities* by mapping spatial data and attributes of individuals to improve ability to *study influence of seascape on population structure*

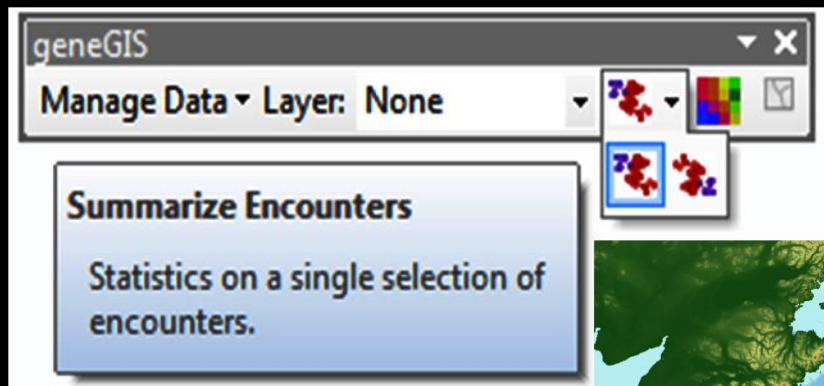# 1. Data Visualization

1. Data Visualization

1. Data Visualization

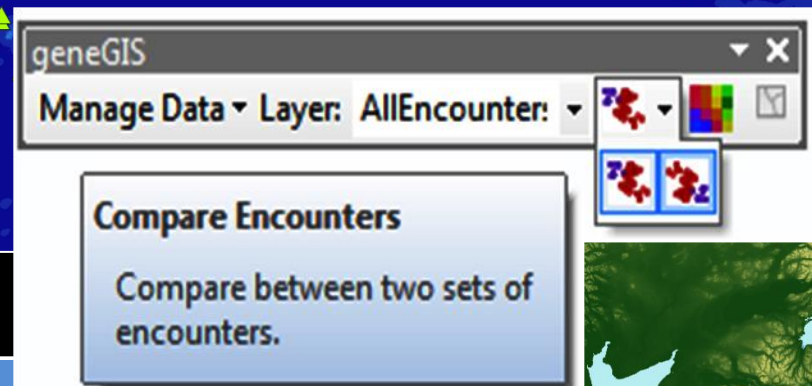All encounters of known individuals from the SPLASH Program

2. Spatially Explore, Display and Select

Are humpback whale populations in the Western Gulf of Alaska and Southeast Alaska genetically differentiated?

geneGIS
Manage Data ▾ Layer: None

Summarize Encounters
Statistics on a single selection of encounters.

Gulf of Alaska

Encounters in selection
Encounters: 586
Individuals: 339

geneGIS
Manage Data ▾ Layer: AllEncounter:

Compare Encounters
Compare between two sets of encounters.
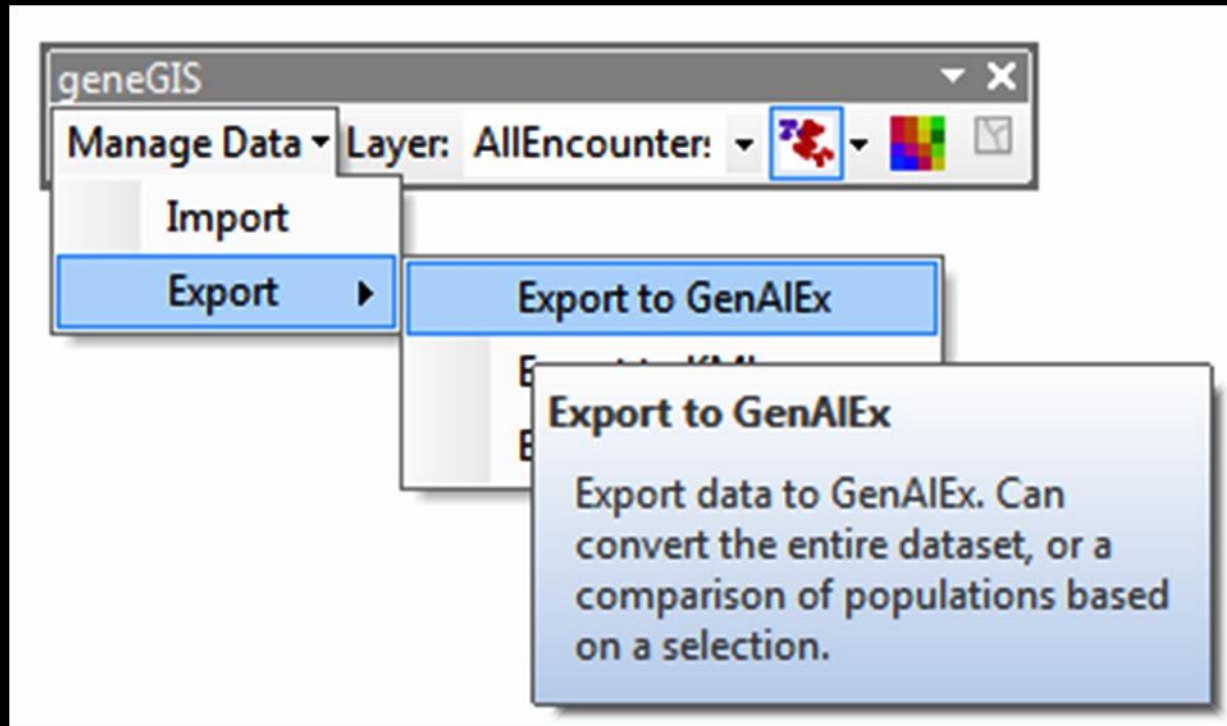
Gulf of Alaska

Comparison Results
First Set: 586 encounters, 339 individuals
Second Set: 2770 encounters, 1172 individuals

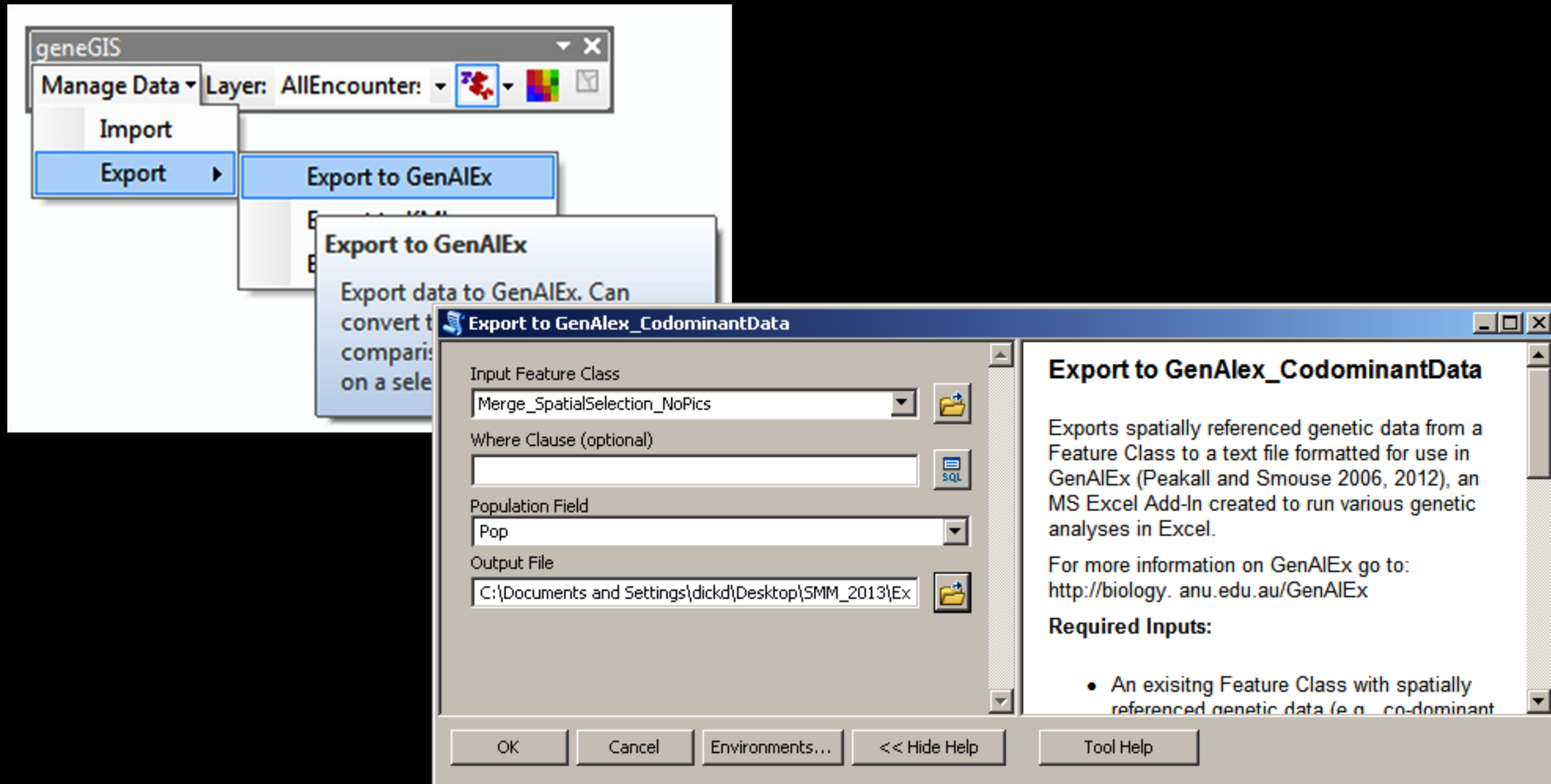Common to both: 2
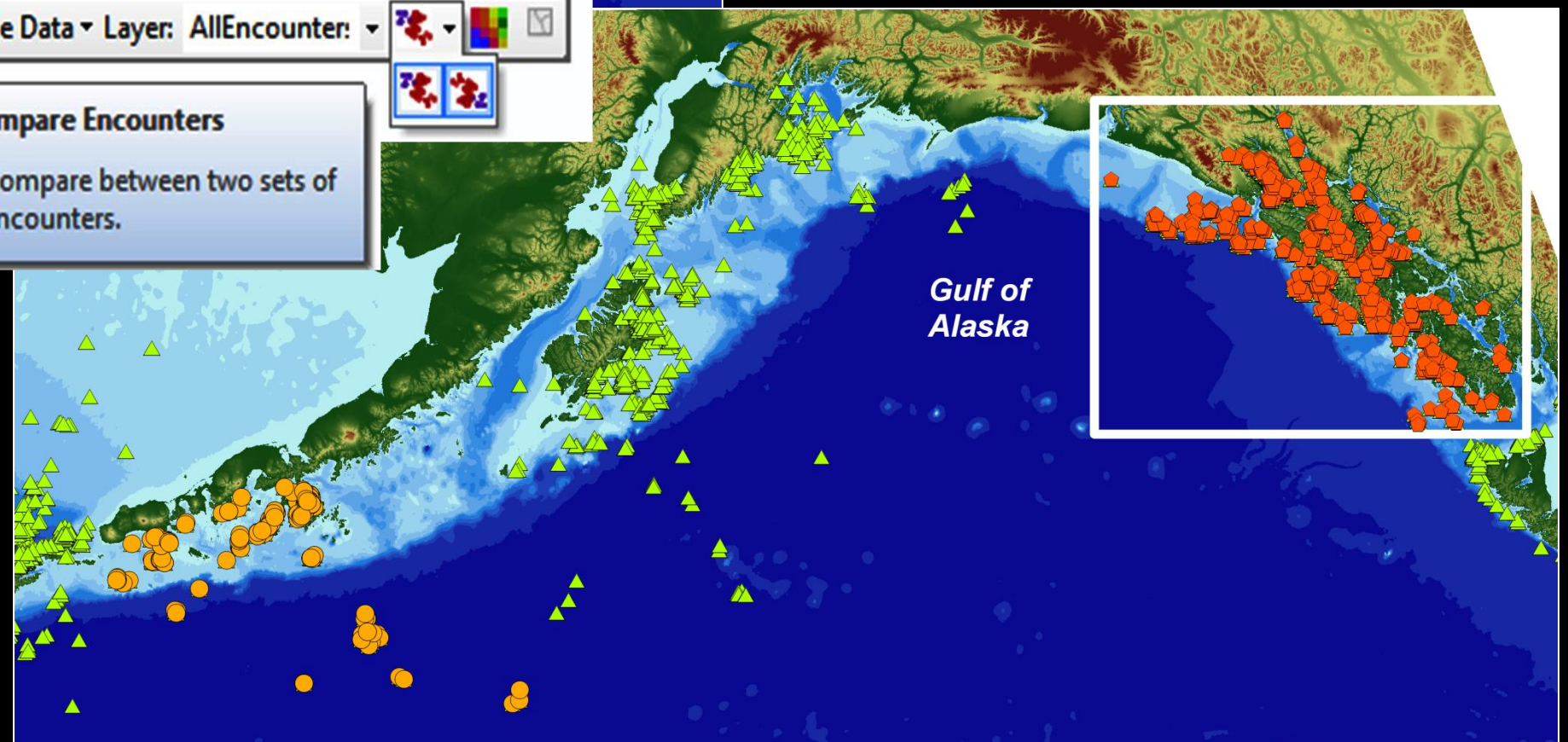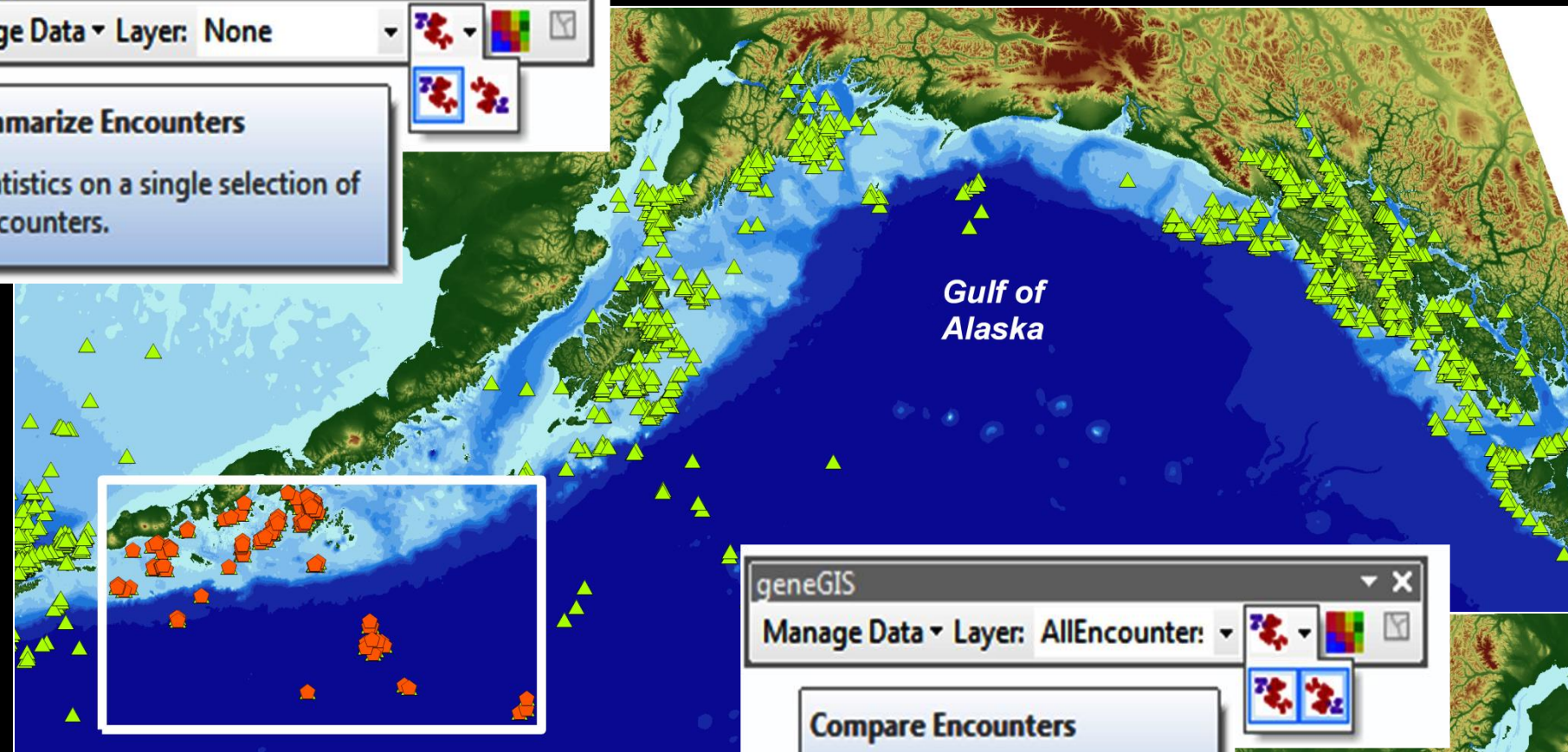
3. Data Export & Analysis Outside ArcGIS

Other Export Options:

Alleles in Space

GenAlEx

Genepop

KML files

3. Data Export & Analysis Outside ArcGIS
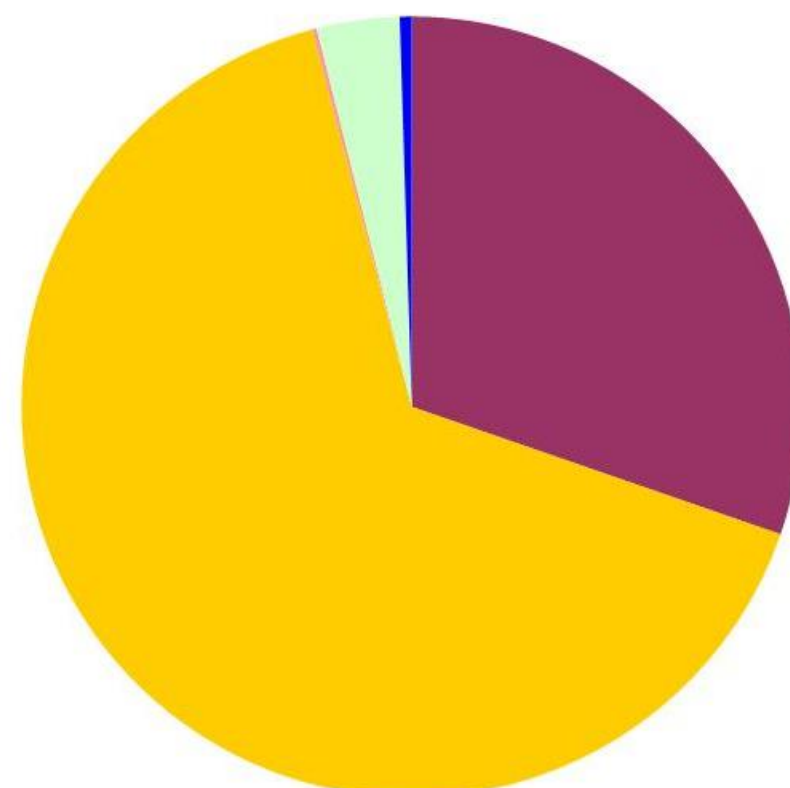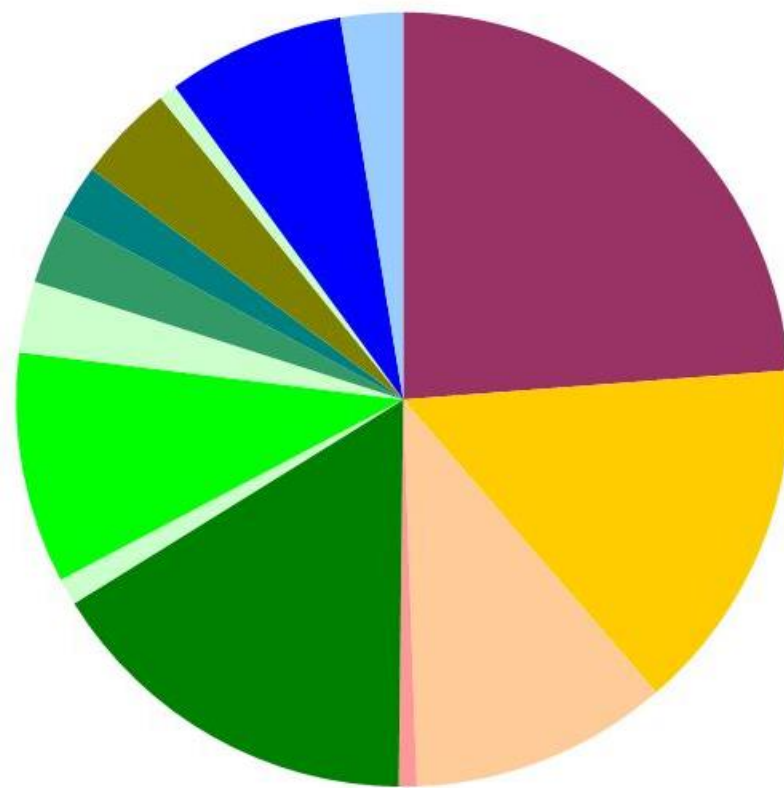
3. Data Export & Analysis Outside ArcGIS

GenAlEx: ($F_{ST} = 0.197$, p < 0.01)

Populations are significantly genetically differentiated based on mtDNA haplotypes

mt DNA haplotype frequencies for:
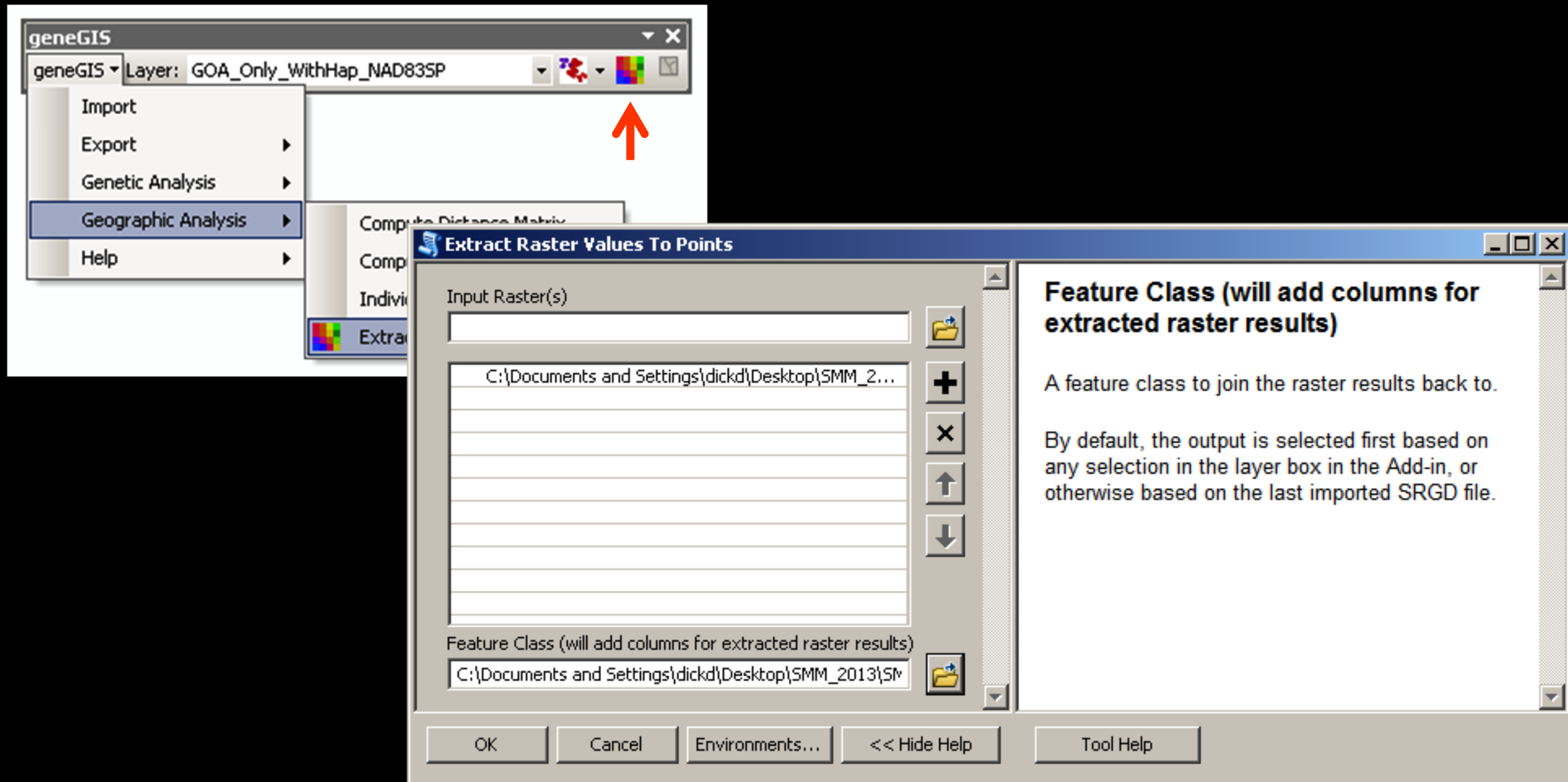
A) Western Gulf of Alaska   B) Southeast Alaska

A+ A- A3 A4 A5 E1 E2 E3 E4 E5 E6 E7 E14 F2 F4
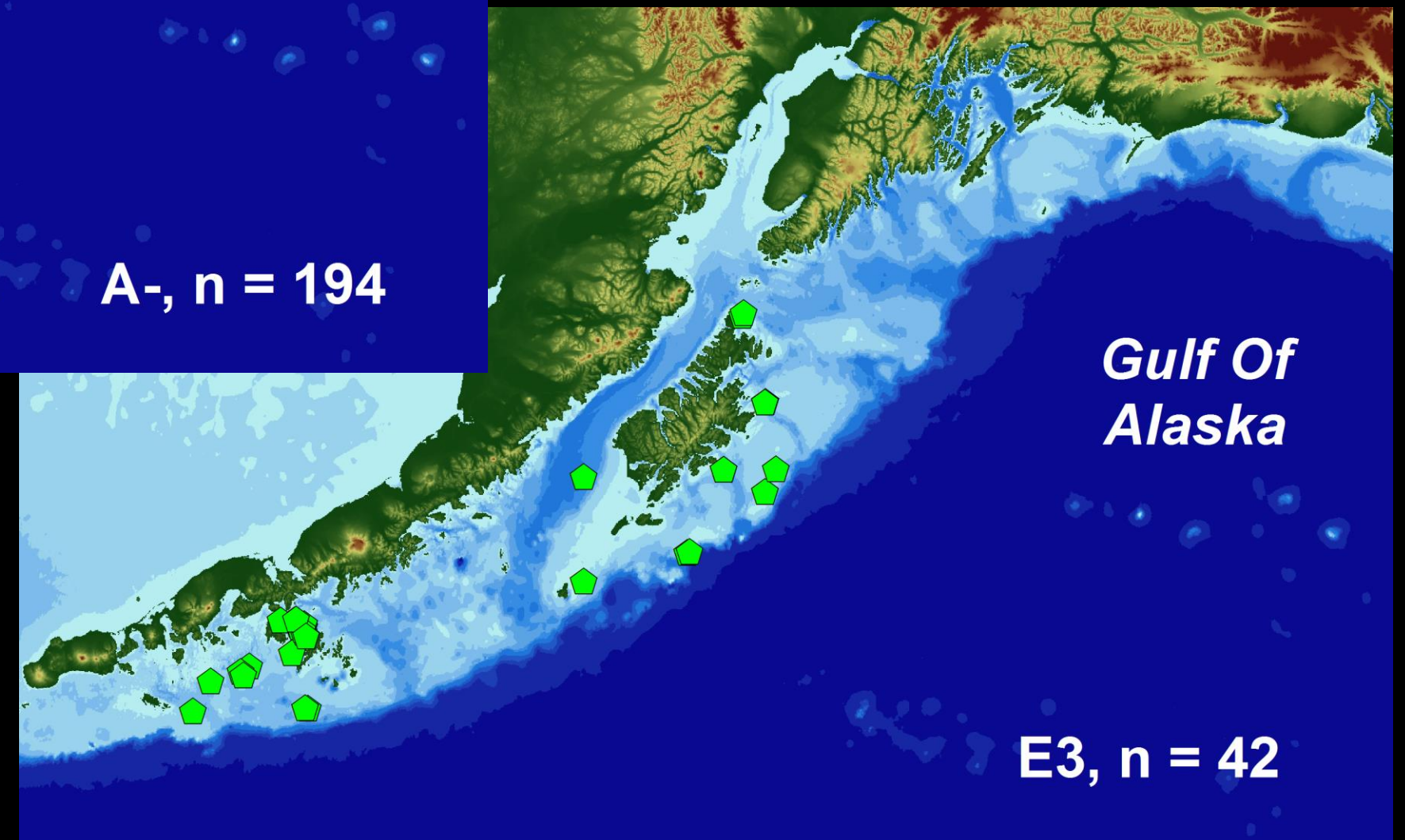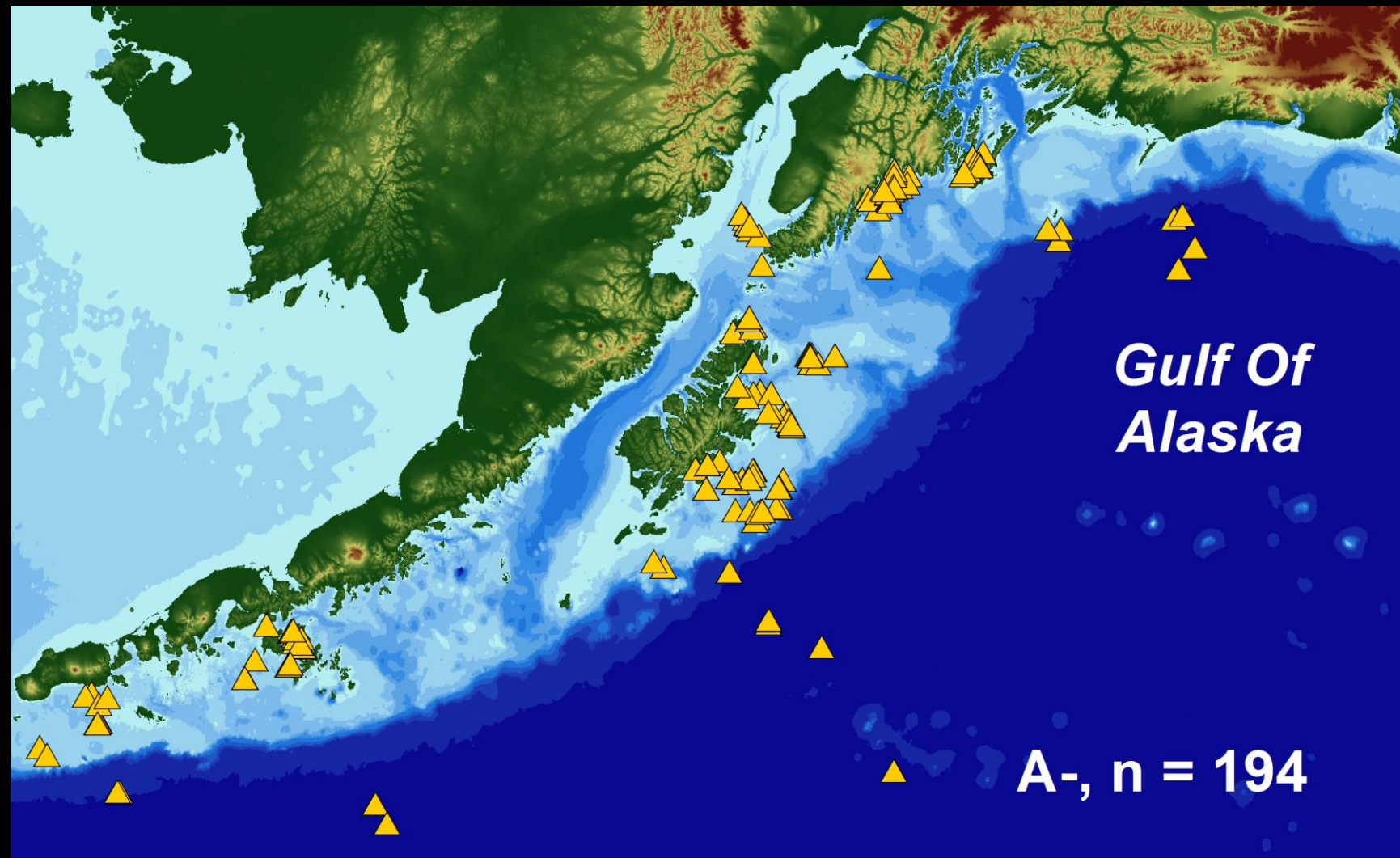
4. Data Extraction

Within a set of whales of known mtDNA haplotype is there any evidence of preference for particular depths?

Cell values from a raster surface (bathymetry, SST, Chl a, etc.) are added to the input feature class.
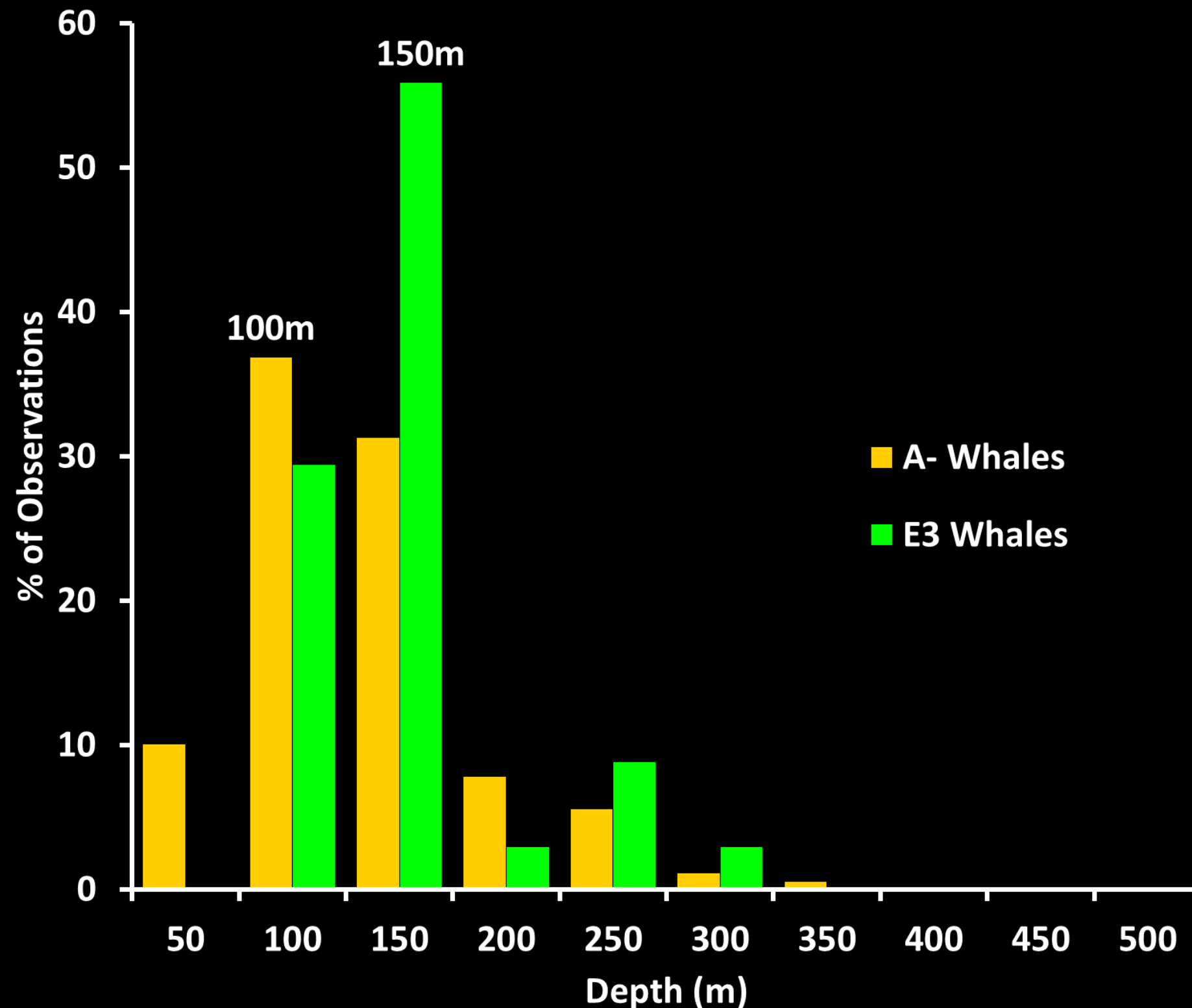
4. Data Extraction

Within a set of whales of known mtDNA haplotype is there any evidence of preference for particular depths?

Gulf Of Alaska

A-, n = 194

Gulf Of Alaska
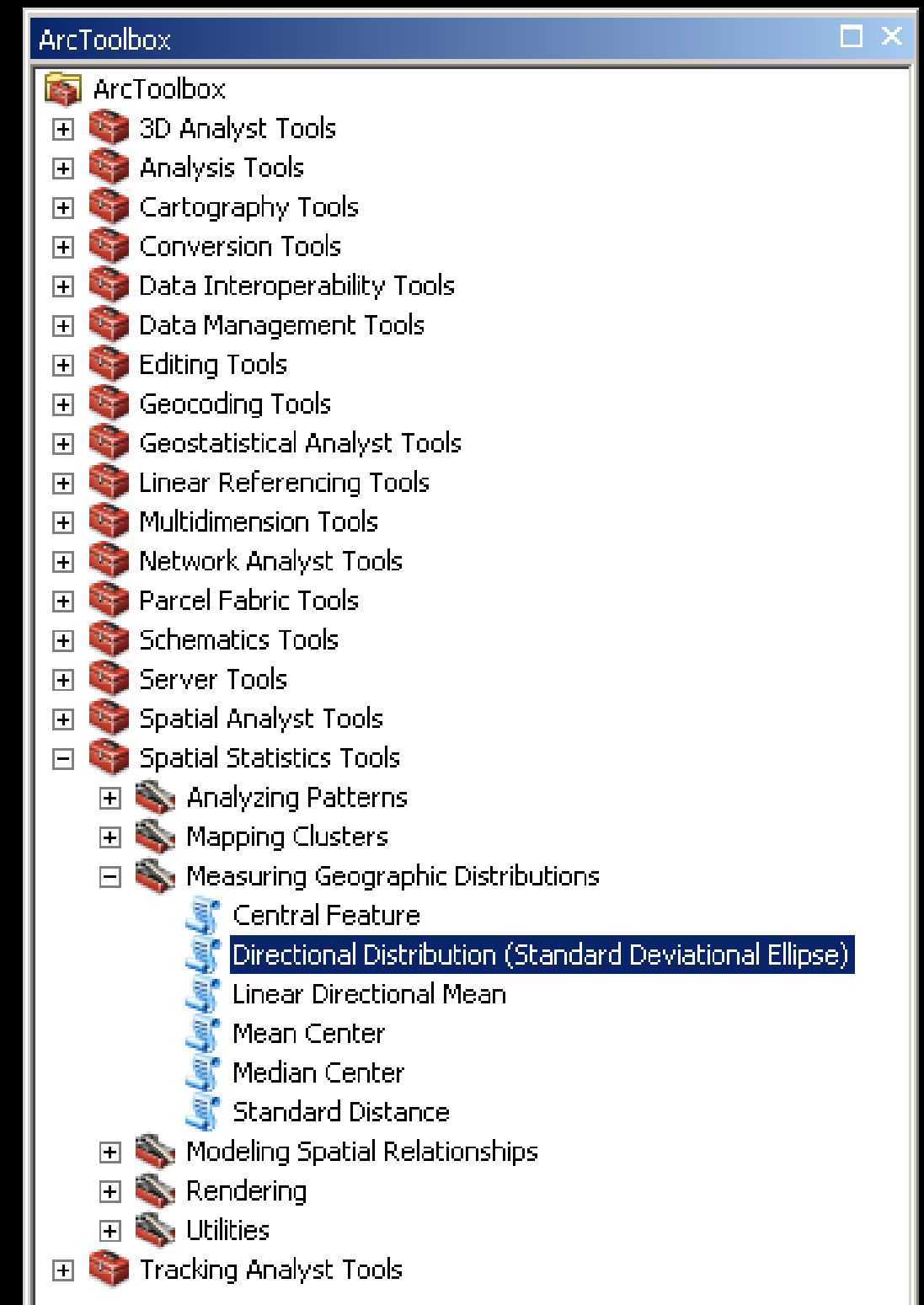
E3, n = 42

4. Data Extraction

Within a set of whales of known mtDNA haplotype is there any evidence of preference for particular depths?
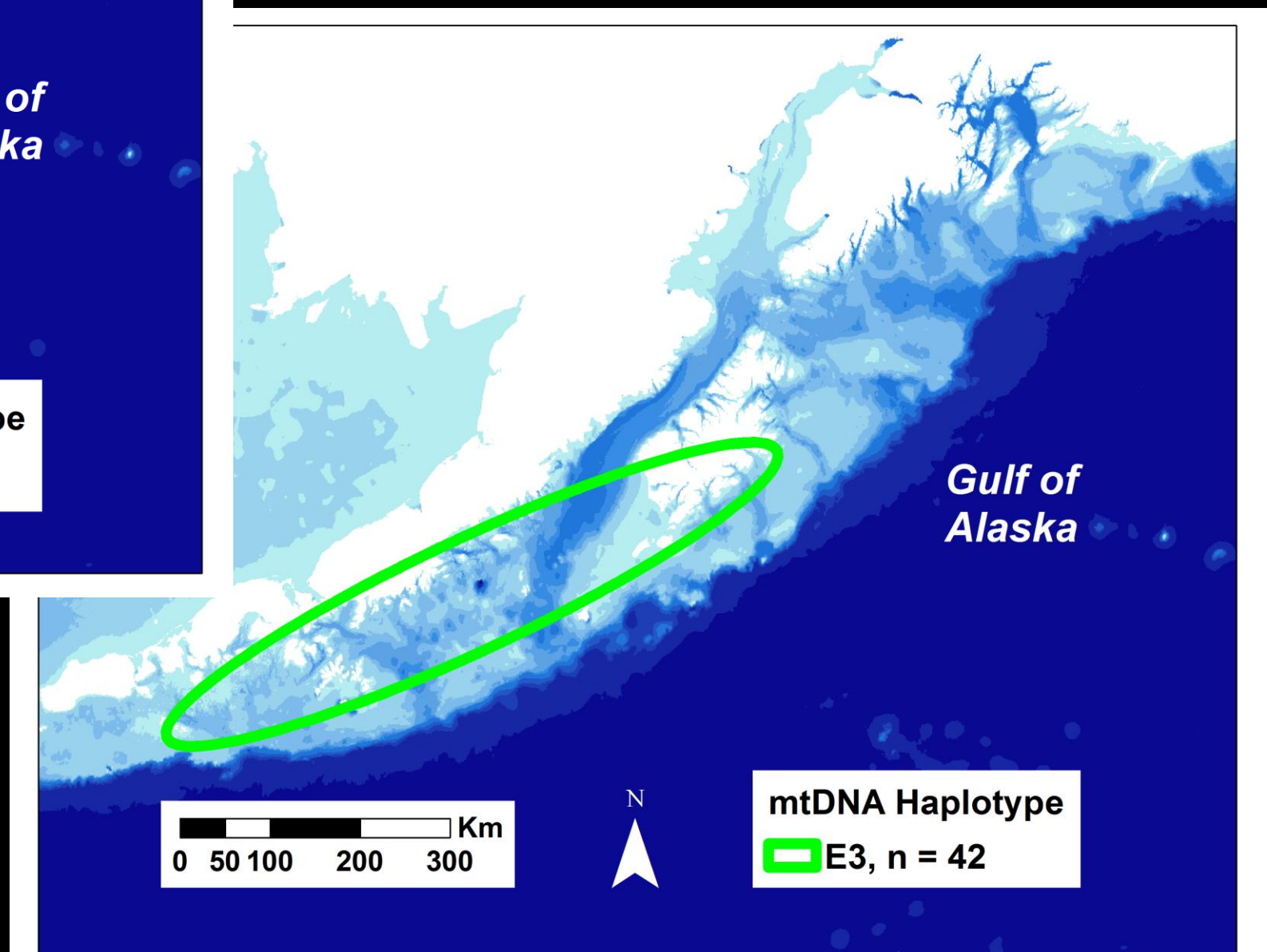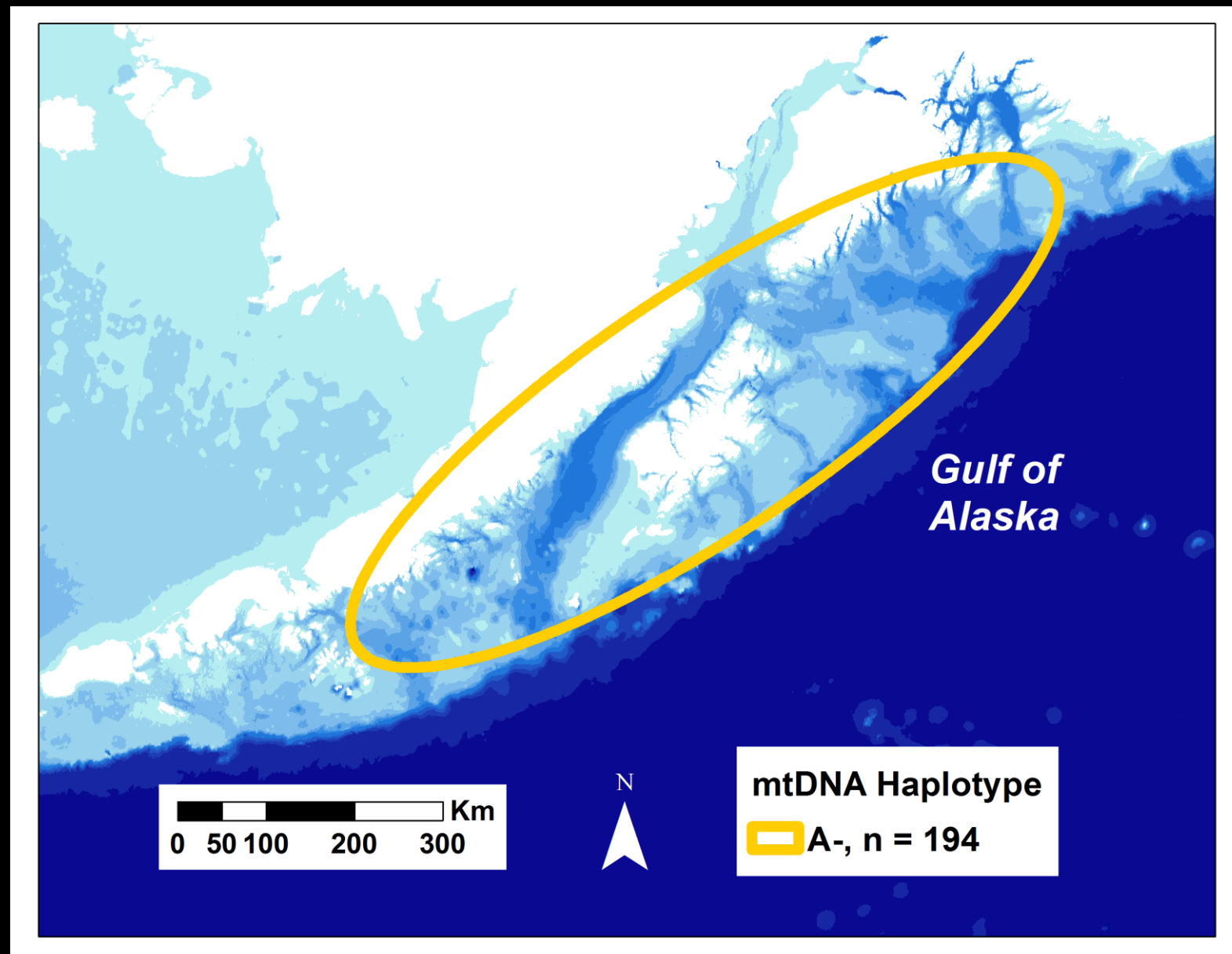
5. Spatial Analyses

How do the spatial distributions of humpback whale haplotypes vary?

- Turn to the Standard ArcGIS ArcToolbox options

- Directional Distribution

- Conduct standard deviation ellipse analysis

- Summarizes central tendency, dispersion and directional trends in X and Y directions

5. Spatial Analyses

How do the spatial distributions of humpback whale haplotypes vary?

geneGIS.org

- Installation File with instructions

- Basic background information & documentation including tool help

- Link to GitHub repository

Summary

- Introduced and demonstrated some geneGIS functionality to explore spatially explicit individual-based cetacean data

- Shown geneGIS can be combined with standard ArcGIS functions → further exploration on the influence of seascape on humpback whale distribution and population structure

- Provided an example of basic spatial analysis one can do without a strong GIS background → develop spatially explicit hypotheses

Nicole MacKay

Thanks to:

All the researchers involved with SPLASH

Cascadia Research Collective for database maintenance

OSU Cetacean Conservation Genetics Lab for genetic analyses

Contact: dickd@geo.oregonstate.edu