Seabird and Marine Mammal Aerial Survey GIS Toolbox
Using ModelBuilder to Create Custom Data Processing Tools

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Introduction

Left: Fin Whale (*Balaenoptera physalus*); Right: Sooty Shearwater (*Puffinus griseus*). Photos by J. Felis.

The US Geological Survey Western Ecological Research Center is conducting new seabird and marine mammal surveys for the **US Bureau of Ocean Energy Management (BOEM)** Pacific Outer Continental Shelf Region as part of the **Pacific Continental Shelf Environmental Assessment (PaCSEA).** Data collected from the aerial surveys will inform future alternative energy planning, development, and management. The primary survey area extends from Fort Bragg, California (38° N) to Grays Harbor in Washington (47° N). Effort is focused on Federal Waters outside of the 3-mile state boundary and includes some inshore waters and marine protected areas.

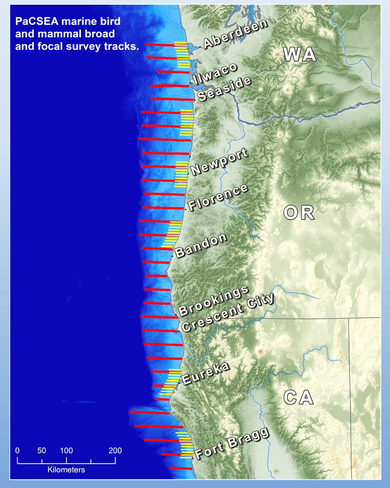
Building on earlier aerial survey work in Southern California during 1999-2002 (Mason et al. 2007), we developed custom tools using Modelbuilder to process GPS track log data and visual species observations in a GIS, generating spatial representations of the flight paths and observations for species-specific density calculations within study bin polygons that accurately represent the area surveyed. The output study bin polygons are useful to analyze and visualize species distributions and are also used to extract environmental information such as bathymetry, elevation, slope, and sea surface temperature.

In addition to handling the data processing and density calculations for our current project, we have designed our tools to accept historic input data so we can compare our results with those from earlier efforts.

Data Acquisition

Left: Survey aircraft (Partenavia P-68); Right: Two observers counting all seabirds and mammals sighted. Photos by J. Felis.

Broad and focal surveys are being conducted from a small fixed-wing, twin engine plane at low altitude (200 feet above sea level). GPS coordinates are collected along the flight path using a handheld GPS with an external antenna. Simultaneously, species observation counts and flight notes are recorded by the survey observers and are assigned GPS coordinates based on time post-survey. This data is later collated into Excel spreadsheets which are used as inputs to the ModelBuilder tools.

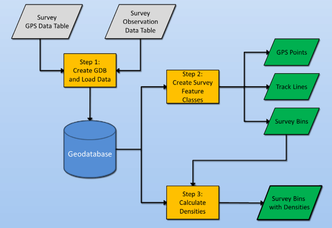


Methods

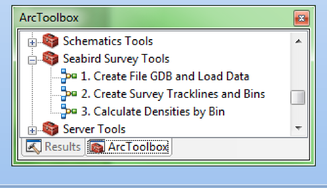
We divided the tasks needed to process our survey data into three logical steps to outline the GIS workflow:

1. Create a new geodatabase and store the flight track and species observation tabular data inside of it.
2. Create the spatial features associated with the survey (GPS points, flight track lines) and polygon bins based on user-defined study length and view distance from the plane.
3. Calculate the species densities for each bin from the observation data and embed that information in the feature class.

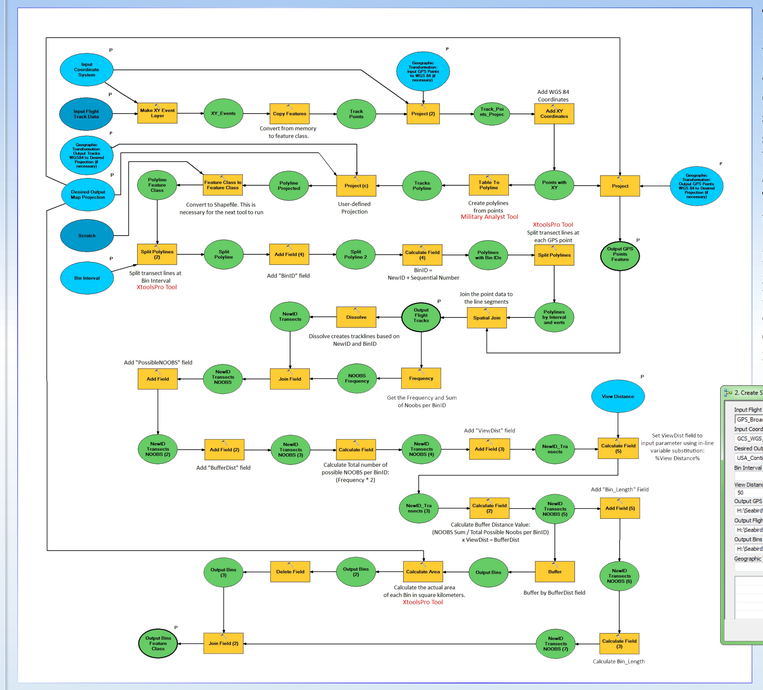
GIS Workflow



Once the general outline of the process was determined, we proceeded to string all of the necessary geoprocessing tasks together in the ArcGIS 9.3 version of ModelBuilder. The tasks were saved as tools inside an ArcToolbox, and left as three steps to aid in trouble-shooting.

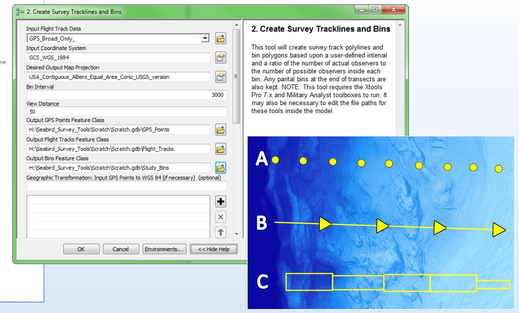


Create Survey Tracks and Bins

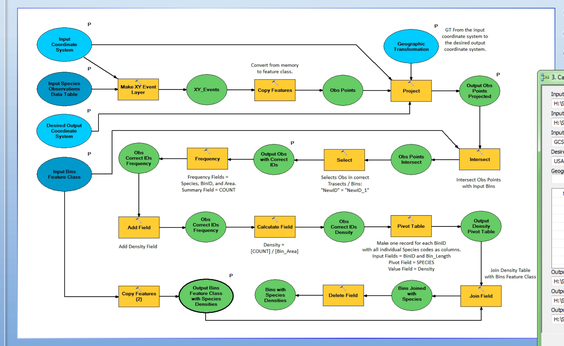


This tool accepts the survey GPS geodatabase tables saved in Tool 1 as its primary data input. The process graphic below illustrates the basic steps involved. The tool generates the coordinate locations along the flight path (A), preserving the order in which the coordinates were recorded. It then generates the track lines (B) and splits them into bin-length segments designated by the user. The segments are buffered into individual polygon bins (C) where the buffer distance of each bin is based on a user-defined view distance and the number of observers that were recorded across that segment. The number of observers can fluctuate from 0-2 along the path due to changes in environmental conditions (glare or fog).

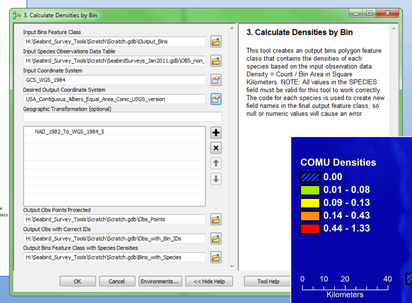
In order to generate the lines, segments, and bins correctly, geoprocessing tools from the Military Analyst extension and XTools Pro were required. To provide more flexibility to study scenarios and allow for other project data inputs, we included parameters to define bin length, view distance, and input/output coordinate system information (including geographic transformations).



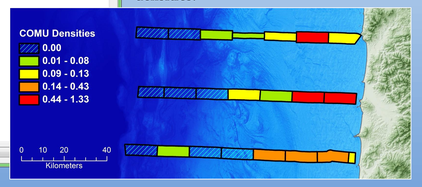
Calculate Densities by Bin



Once the survey bins have been created, they are used as an input along with the actual species observation data to calculate the densities for each bin. This is done for all species included in the observation table.

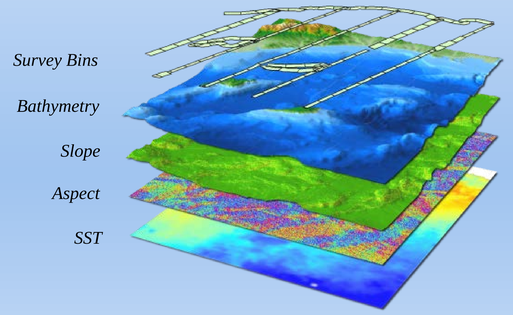


This example of the tool includes intermediate data sets set as parameters so that the output files could be used for trouble-shooting and error-checking. The exaggerated bins below demonstrate fluctuations in polygon size and species densities.



Environmental Data

Certain bathymetric features often are good predictors for seabird density distributions. Therefore, we used the output bins to populate our database with extracted zonal statistics* from static bathymetric layers (NGDC's 3 arc-second U.S. Coastal Relief Model [CRM]). Useful bathymetric parameters include depth (in meters), slope (percent rise), and Aspect (degrees, proxy for wave exposure).



In future analyses we will use this tool to include raster-based zonal statistics for certain oceanographic remote sensing products including sea surface temperature (SST), primary productivity (i.e., chlorophyll concentration), and sea surface elevation.

*Using the "Feature Statistic to Table" tool from the National Water-Quality Assessment (NAWQA) Area-Characterization Toolbox we were able to collect accurate zonal statistics from environmental rasters where survey bin polygons overlap.

Conclusions/Future Directions

Building custom tools allows for:

- Cross-study standardization for comparative analyses
- Decreased time spent processing data, important when applied to rapid natural resource damage assessments (e.g., during oil-spill response)
- Reduced potential for user-error when conducting repetitive, complex workflows
- Model builder is best for linear geoprocessing steps, a good tool for documenting workflows, and is a visual development environment
- Potential to use these tools for other types of surveys including past and ongoing aerial surveys and ship-based transect surveys

Acknowledgments

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Common Murres (*Uria aalge*). Photo by Abe Borker.

Literature Cited

Mason, J. W., G. J. McChesney, W. R. McIver, H. R. Carter, J. Y. Takekawa, R. T. Golightly, J. T. Ackerman, D. L. Orthmeyer, W. M. Perry, J. L. Yee, M. O. Pierson, and M. D. McCrary. 2007. At-sea distribution and abundance of seabirds off southern California: a 20-year comparison. Studies in Avian Biology, No. 33. 95 pp.

Price, C. V., Nakagaki, Naomi, and Hitt, K. J., 2010, National Water-Quality Assessment (NAWQA) Area-Characterization Toolbox, Release 1.0: U.S. Geological Survey Open-File Report 2010-1268. [online-only] http://pubs.usgs.gov/of/2010/1268

For more information on the PaCSEA project, please visit:
http://www.werc.usgs.gov/PaCSEA
For more information on these data processing tools, please contact:

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