

Introduction

The U.S. Geological Survey, San Diego Management and Monitoring Program, U.S. Fish and Wildlife Service, and the Nature Reserve of Orange County have joined together to develop a long-term, coordinated regional monitoring program for the federally-threatened coastal California gnatcatcher (CAGN) (*Poliioptila californica californica*) in the United States portion of the species' range. The objectives of the regional monitoring program are to determine the percent area occupied (PAO) by CAGNs in modeled high and very high suitability habitat on conserved lands and on participating military lands in southern California.

Methods

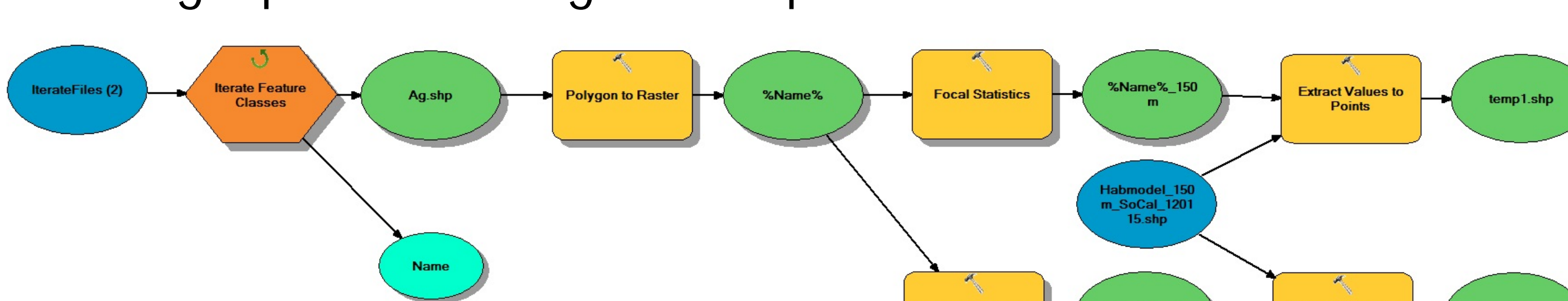
In order to create a sampling frame consisting of modeled high and very high suitability habitat, we created a grid across southern California with important environmental variables, created and evaluated a habitat suitability model, and statistically determined high and very high model value categories. This model was then used to create a spatially balanced sample design.

Environmental Dataset Grid

First, we used the fishnet tool to create a grid of points spaced 150m apart, across all of southern California. A total of 3,048,194 points were created and each was given a unique ID. Next, we gathered dozens of datasets from 12 individual sources to create a grid of environmental variables (see map at bottom). A list of sources and layers collected are listed in the table below.

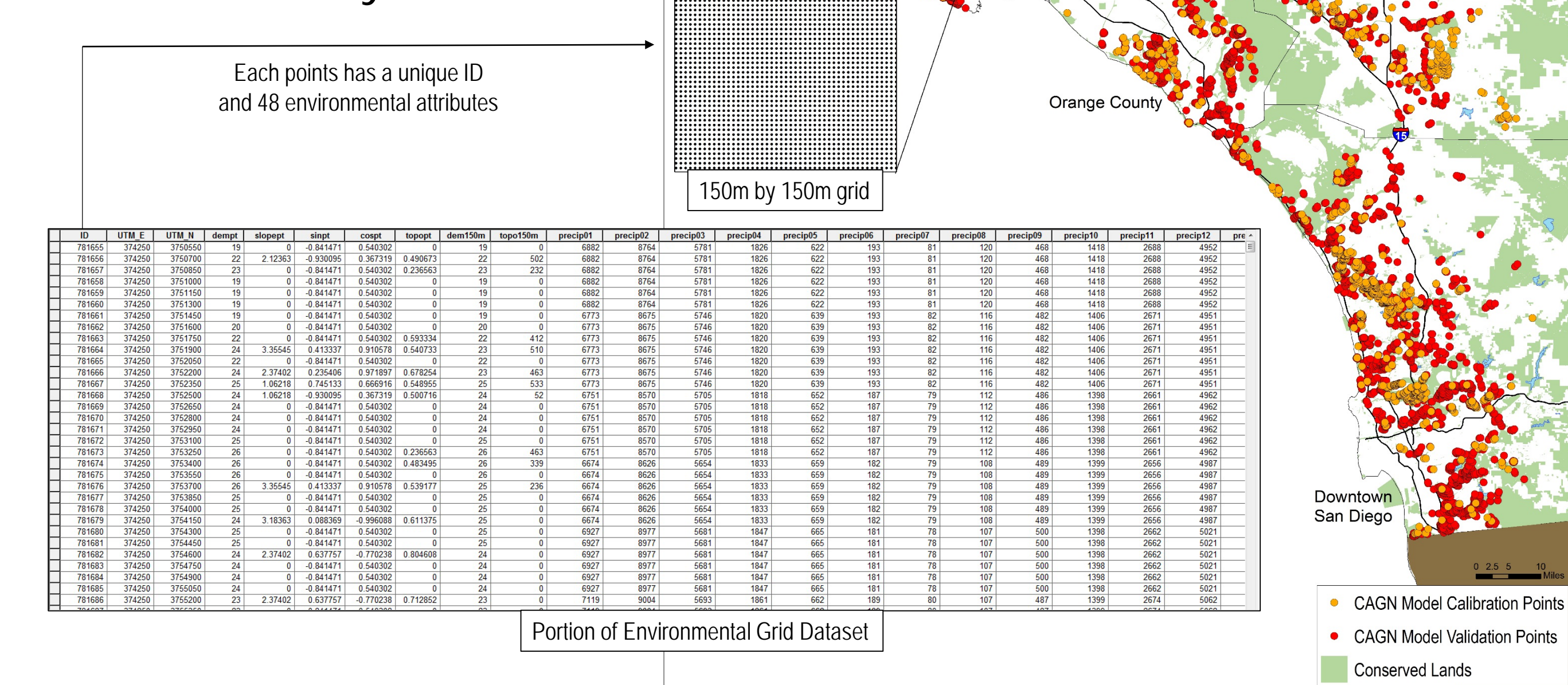
Source	Variables	Scales calculated
USGS National Elevation Dataset	Elevation and elevation derived	At Point
PRISM Oregon State University	Monthly Temperature and Precipitation	At Point
SANDAG Western San Diego Vegetation Mapping	Vegetation	Perc. at 150m,1km
Rancho Mission Viejo	Vegetation	Perc. at 150m,1km
Nature Reserve of Orange County	Vegetation	Perc. at 150m,1km
Western Riverside Regional Conservation Authority	Vegetation	Perc. at 150m,1km
MCAS Miramar	Vegetation	Perc. at 150m,1km
MCB Camp Pendleton	Vegetation	Perc. at 150m,1km
Fire Resource and Assessment Program	Vegetation	Perc. at 150m,1km
Landsat 7 Imagery	NDVI	At Point
NOAA and Light Pollution Science and Tech. Institute	Light Pollution Estimate	At Point
U.C. Riverside	Nitrogen Deposition	At Point
SSURGO USDA Soil Viewer	Soil characteristics	At Point
Fire Resource and Assessment Program	Fire frequency, Fire Year	At Point

The vegetation layer was created from 8 different sources. A crosswalk for each layer was created to unify vegetation categories. The layers were merged together and converted into a raster (10m by 10m) using the maximum category method. We used focal statistics to calculate the percent cover of each vegetation type at 150m and 1km scales.



Habitat Model

Next, SDMMMP constructed a CAGN habitat suitability model using a partitioned Mahalanobis D² approach. CAGN location records were compiled for 2000 to 2013 from a variety of sources and used to develop and evaluate the performance of alternative habitat models. Spatially redundant location records (≤150m apart) were also removed from the modeling datasets. We used 2,805 location records from multiple datasets to calibrate the models and 3,073 records from the USFWS database to independently evaluate and compare the performance of alternative habitat suitability models.



Selection of High and Very High Suitability

We divided the region up into five sampling units: Los Angeles/Ventura; Riverside/San Bernardino; Orange; San Diego Coastal; and San Diego Inland. We randomly subsampled 50 gnatcatcher locations from each area (i.e. a total of 250 gnatcatcher locations) and calibrated the model. We repeated this subsampling for 1,000 iterations and then averaged the results to develop a final model from which the Mahalanobis D² values were calculated across the landscape.

Habitat suitability for each grid cell in the study area is indicated by a Habitat Similarity Index (HSI) value that ranges from 0 (least similar to occupied habitat and considered least suitable) to 1 (most similar to occupied habitat and most suitable). Habitat suitability strata for the SDMMMP model are defined by HSI values as: Very High = 0.75-1.00; High = 0.50 – 0.74; Moderate = 0.25-0.49; and Low = 0-0.24.

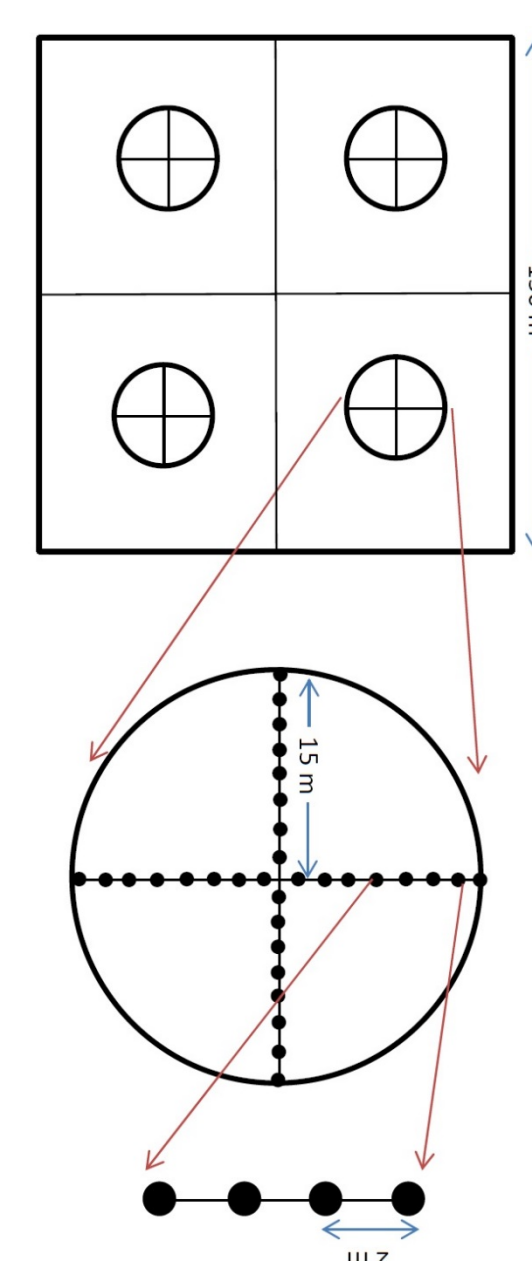
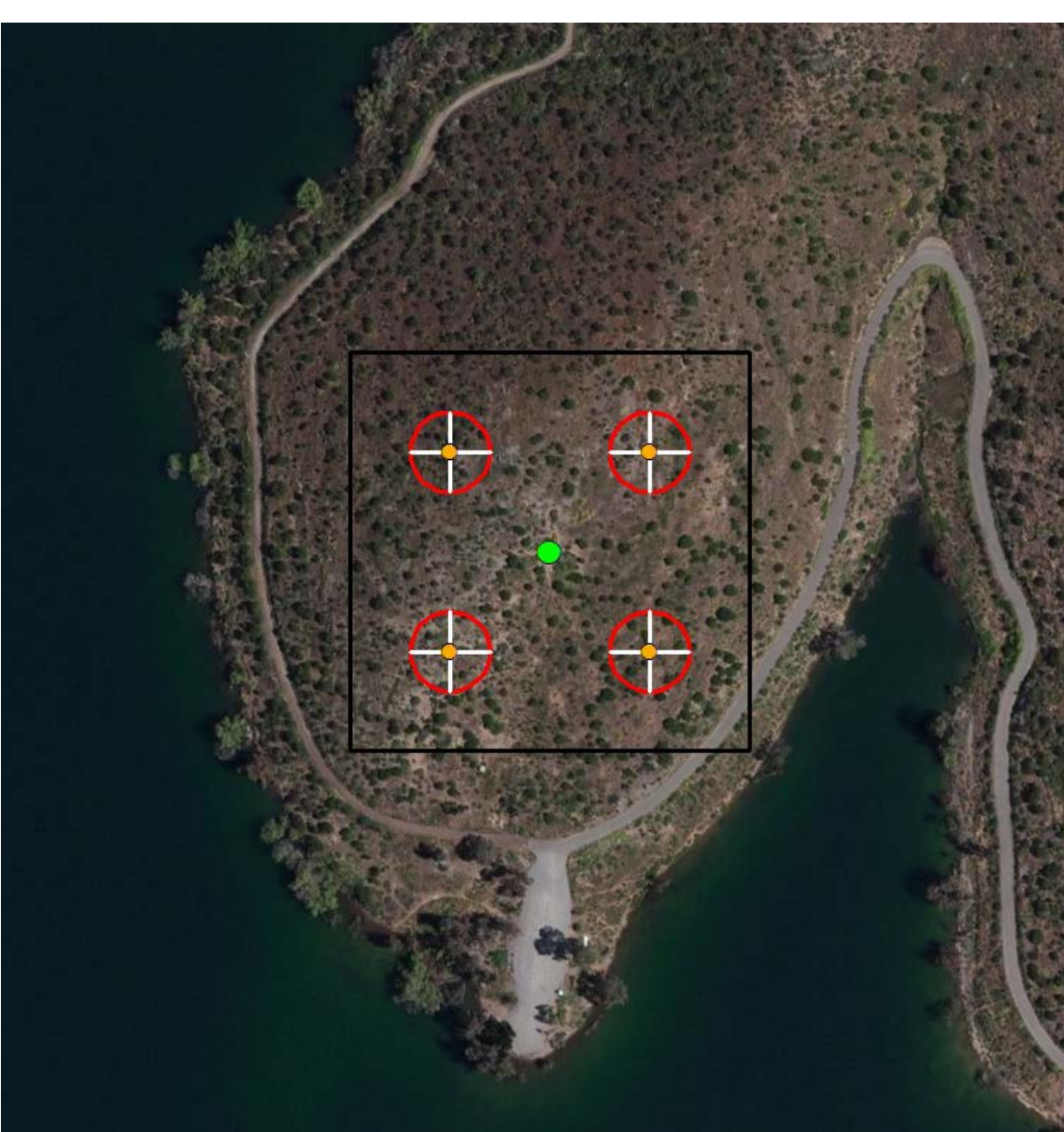
Eighteen models were developed with different combinations of variables and their performance was evaluated to select the top-performing model identifying high and very high habitat suitability. We evaluated the top model's performance using a Receiver Operating Curve (ROC) to determine the Area Under the Curve (AUC) value. An AUC value of ≥ 0.70 is considered acceptable in terms of model performance, with higher AUC values representing greater model performance. To conduct the ROC analysis, we randomly selected 3,073 “pseudo absence” locations from throughout the southern California study area to represent background HSI values and combined these with HSI values for the validation dataset of occupied gnatcatcher habitat. The model performed well with an AUC of 0.95.

Spatially Balanced Sample Design

Using the high and very high suitability areas on conserved lands as the sampling frame, sample plots (150m²) centered on the grid points were selected for regional monitoring in a spatially balanced manner for even distribution across suitable conserved habitat. This is more efficient than random sampling in gathering data on trends in population abundance and is statistically sound. Sample plots were selected in ArcGIS using the Spatially Balanced Sampling tool. Using the advanced options, the seed number was set to 2 so that plots could be added or subtracted as partners joined the survey effort. Three hundred thirty sample plots were selected with an additional 35 plots selected to use as backup where access to the original plot was prohibited. Additional plots were added throughout the partner evaluation process (see “Coordination Using ArcGIS Online” below)

Vegetation Monitoring

The CAGN Regional Sampling Program includes a collection of vegetation covariate data to better understand gnatcatcher habitat relationships and management needs. Each CAGN survey plot is subdivided into four 75m x 75m (0.56 ha or 1.38 acres) quadrats. A 15-m radius circular plot is centered in each quadrat. Vegetation was collected using a modified point-intercept method along 30 m perpendicular transects bisecting the circular plots. Transects are oriented north-south and east-west.



These plots and transects were created using a combination of Microsoft Excel and ArcGIS. We set the coordinate system to UTM Zone 11 North so that on the ground distances corresponded to a specific coordinate. In Excel, we used the coordinates of the spatially balanced points (X, Y) and the Pythagorean theorem to calculate the quadrat center point and the maximum and minimum coordinates for the circular plots. The quadrat center coordinate was used in ArcGIS with the buffer tool to create the boundary of the circular plot. The maximum and minimum coordinates were used in ArcGIS with the XY to line tool to create transects. Center points and transects were joined back to the survey quadrats using a permanent ID.

Coordination Using ArcGIS Online

An online map was created using ArcGIS Web AppBuilder. The maps contains a raster feature service displaying High and Very High suitable habitat. In addition, the first draft of potential plots was included for land managers to assess access. Plots were not thrown out due to the appearance of unsuitable habitat on the ground. However, if access was not possible due to a legal restriction or extreme environmental factors (e.g. cliff), the plot was removed and a back up plot was chosen. SDMMMP worked with land managers to select new plots whenever necessary. The final survey plots replaced the draft plots on the online map. The online map can be viewed at: <http://usgs.maps.arcgis.com/apps/webappviewer/index.html?id=744d260a1ffb4fa380e1a66e9aad6b5c> or by using the QR code below.

Results

The model identified over 470,000 acres of high and very high suitable habitat throughout southern California. Regionally, 330 plots were selected in a spatially balanced manner, in a total of 10 sub-regions. The percent of potential and chosen sampling plots in each subarea are listed in the table to the right. Approximately 25 partner agencies and consulting firms participated in evaluating survey access, survey method revisions, and conducting CAGN and vegetation surveys.

Each plot was surveyed for CAGN 3 times from March 15 to April of 2016. Vegetation surveys were initiated in May and completed June 15, 2016. Final analysis of trends will be prepared in fall 2016.

For a list of sources, see http://portal.sdmmp.com/view_article.php?cid=CID_eperkins@usgs.gov_573122a62e3ba

Subarea	Total Number of Potential Sampling Pts	% of Potential Sampling Pts	Total Number of Sampling Pts	% of All Sampling Pts
San Diego- Non Military	13,317	32.56	147 (all of SD)	44.55 (all of SD)
NWS Fallbrook	1,273	3.11	NA	NA
MCB Camp Pendleton	7,960	19.46	NA	NA
MCAS Miramar	1,767	4.32	NA	NA
NROC	4,278	10.46	42	12.73
Orange County Other	2,436	5.96	28	8.48
Los Angeles	1,141	2.79	12	3.64
Ventura	1,739	4.25	19	5.76
San Bernardino	630	1.54	7	2.12
Riverside	6,357	15.54	75	22.73

