FIRE-BAT User Manual

Brent R. Campos¹, Zachary Steel²

¹Point Blue Conservation Science, Petaluma, CA, 94954

²Department of Environmental Science and Policy, University of California, Davis, CA 95616



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INTRODUCTION

Land managers are often tasked with competing objectives, and lacking sufficient information to understand the complexity of synergistic effects on ecosystems, leaving them without clear-cut solutions (DeFries & Nagendra 2017). Habitat suitability models (a.k.a. species distribution models) can inform management decisions by describing key habitat requirements and predicting species distributions (e.g. Maiorano et al. 2006, Bellamy et al. 2013). Habitat suitability models quantify statistical relationships between environmental features and known species occurrences. With this information, managers can then restrict potentially detrimental activities (e.g., salvage logging) to areas of lower habitat suitability, or limit those activities where habitat suitability is high, to meet conservation targets. Such information can enhance planning effectiveness. However, despite numerous publications describing new models, few are applied (reviewed by Guisan et al. 2013). Application of species distribution models and resulting maps are computationally intensive, requiring time and resources not available to most natural resource specialists at land management agencies.

We developed an ArcGIS toolbox that is designed to streamline the application of habitat suitability models for bats to inform forest management in burned landscapes in California's Sierra Nevada Mountains. The toolbox and the underlying data target burned habitats, and is intended to facilitate rapid identification of suitable habitat for bat species in previously burned habitats and as new fires occur. In this manual, we summarize the basis and applicability of the underlying occupancy models (a form of habitat suitability model) in the FIRE-BAT ArcGIS application toolbox. We then detail step-by-step instructions for implementing these tools, which currently quantify post-wildfire occupancy for seven bats species.

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OCCUPANCY MODELS

Here we detail the methods used to build the occupancy models that are the basis for the spatially explicit occupancy models in FIRE-BAT. A companion report titled *Bat occupancy in Sierra Nevada wildfire areas and implications for post-fire forest management* contains additional information regarding the collection of bat occurrence data as well as additional analyses informing post-fire management in the Sierra Nevada Mountains (Steel et al. 2018).

Bat Acoustics Data

Automated recording units (ARUs; SM3BAT model, Wildlife Acoustics Inc.) and ultrasonic microphones (SMM-U1 model, Wildlife Acoustics Inc.) were deployed in and around three wildfire areas in the northern and central Sierra Nevada Mountains to conduct nightly bat surveys from May–September in 2014–2017. Recorded bat passes were subsequently classified using specialized software (SonoBat version 3.2.1). The three fires include the 2004 Power Fire, the 2012 Chips Fire (sample locations also included areas previously burned by the 2000 Storrie Fire), and the 2013 Rim Fire. In total 328 survey periods (unique location–year combinations) and 2057 survey nights from the 2014–2017 sampling seasons were used to build predictive models. Additional details on sample design, sampling effort and data processing can be found in previous and concurrent reports (Campos & Burnett 2016; Campos et al. 2017; Steel et al. 2018).

Environmental Variables

The environmental variables we considered when building landscape-level bat occupancy models are summarized in Table 1. Burn severity, density class, and size class were measured at multiple scales. For distance to water, distance to perennial water and distance to intermittent or perennial water (whichever was closer) served as two alternative scales.

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Table 1. Descriptions of environmental variables used to develop occupancy models for bats in burned and green forests. Local, middle, and landscape scales were calculated at 50 m, 500 m, and 2 km radii, respectively.

Variable (abbrev.)	Description	Scale
Burn severity (severity)	mean Relative differenced Normalized Burn Ratio (RdNBR) ¹	local, middle, landscape
Distance to water (distance)	meters to the nearest perennial or intermittent stream, river, or waterbody	intermittent, perennial
Temperature (max temp)	mean daily maximum temperature (1981-2010)	270-m pixel
Solar radiation (sol rad)	total annual solar energy exposure (watt-hours / m ²)	30-m pixel
Density class (density)	percent area composed of CWHR ² density class D (dense forest)	local, middle, landscape
Size class (size)	percent area composed of CWHR ² size classes 5 & 6 (medium or large, and multi-layered trees)	local, middle, landscape
Burned (burned)	boolean indicator of whether a survey location was within a burned area	NA
Old fire (old fire)	boolean indicator of whether the burn is "old" (i.e. 10-13 years post-fire; input value of one) vs. recent (i.e. 1-4 years post-fire; input value of zero)	NA
Salvaged (salvaged)	boolean indicator of whether a location was previously salvage logged	NA
National forest (plas, enf, snf)	three-level categorical variable indicating whether the survey location was within the Plumas/Lassen NFs, Eldorado NF or Stanislaus NF	NA
Survey length (length)	hours of recording during a survey night	NA
Julian Day (day)	julian day of the year	NA
Canopy cover (canopy)	% canopy cover around ARU	15-m radius

¹RdNBR data were obtained from the US Forest Service Region 5 Remote Sensing Lab and represented the data from the image classified as the "best assessment" of the initial and extended post-fire burn severity assessments.

²California Wildlife Habitat Relationships data from US Forest Service Existing Vegetation data

Model Selection

We developed occupancy models for twelve Sierra Nevada bat species (Table 2). Occupancy

models could not be fit for five additional species known to occur in the region either due to

insufficient presence data (i.e. rare species) or insufficient absence data (i.e. one near-ubiquitous

species; Table 2). Models were built using the R statistical environment (R Core Team 2016) and the unmarked package (Fiske & Chandler 2011). To identify the best predictive model for each species we compared candidate models using the area under the curve (AUC) metric. AUC is a measure of model goodness of fit where values close to 1 indicate a model consistently identifies true presences (here true detections) whereas values near 0.5 indicate model predictions are no better than random (Fawcett 2006). Due to imperfect detection occupancy cannot be observed directly. Thus, in order to calculated AUC values we compared model estimates of naïve occupancy (i.e. uncorrected for rates of detection) against observed presence/non-detections.

Species Code	Common Name	Scientific Name	Naïve Occupancy (%)
anpa	pallid bat	Antrozous pallidus	37
coto*	Townsend's big-eared bat	Corynorhinus townsendii	6
epfu	big brown bat	Eptesicus fuscus	61
euma*	spotted bat	Euderma maculatum	2
eupe*	western mastiff bat	Eumops perotis	8
labl	western red bat	Lasiurus blossevillii	19
laci	hoary bat	Lasiurus cinereus	58
lano	silver-haired bat	Lasionycteris noctivagans	74
туса	California myotis	Myotis californicus	91
myci	small-footed myotis	Myotis ciliolabrum	21
myev	long-eared myotis	Myotis evotis	73
mylu	little brown bat	Myotis lucifugus	55
myth	fringed myotis	Myotis thysanodes	48
myvo*	long-legged myotis	Myotis volans	8
тууи	Yuma myotis	Myotis yumanensis	36
pahe	western pipistrelle	Parastrellus hesperus	31
tabr*	Mexican free-tailed bat	Tadarida brasiliensis	94

Table 2. Species recorded during acoustic surveys. Naïve occupancy is the percentage of survey and year combinations that a species was observed at least once.

* Species for which occupancy models were not fit either due to too few detections or too few non-detections.

We used a two-stage model selection process to identify the predictor variables and spatial scales most relevant to bat occupancy:

For each of the twelve species, a near-global model was fit with all single-scale predictors

 (e.g. temperature max) and one multiple-scale predictor (severity, density, size, distance) at
 a time. For each varying-scale predictor, a 5-fold cross-validation procedure was conducted
 to calculate mean AUC values¹. The scale of each multiple-scale predictor that produced the
 highest mean AUC of these models was used in the second phase of the model selection
 process (Table 3).

Species	Density	Severity	Size	Distance
anpa	Landscape	Middle	Landscape	Perennial
epfu	Local	Local	Landscape	Perennial
labl	Local	Landscape	Middle	Intermittent
laci	Middle	Landscape	Local	Intermittent
lano	Landscape	Local	Landscape	Intermittent
туса	Landscape	Landscape	Landscape	Intermittent
myci	Middle	Local	Local	Perennial
myev	Middle	Local	Middle	Intermittent
mylu	Local	Local	Middle	Perennial
myth	Middle	Local	Middle	Perennial
тууи	Landscape	Landscape	Local	Perennial
pahe	Landscape	Local	Landscape	Perennial

Table 3. Scales selected during stage one of the model selection process for multiple-scale predictors.

2) The following global model was considered in the second stage of model selection with a

set of fixed and candidate variables:

¹ Cross-validation is a procedure where part of the data (in this case $1/5^{\text{th}}$) is held out of the model-building processes to be used as testing data in order to generate a fit statistic (e.g. AUC). This is repeated with different subsets of the data (e.g. 5) to generate a mean fit statistic.

$$logit(\psi_i) = \beta_{for} * forest_i +$$

 $(\beta_{burn} + \beta_{old} * OldBurn_i + \beta_{sal} * salvage_i + \beta_{sev} * severity_i) * burn_i + \beta_{sav} * salvage_i + \beta_{sev} * severity_i) * burn_i + \beta_{sav} * salvage_i + \beta_{sev} * salvage_i + \beta_{sav} * salvage_i + \beta_{sev} * salvage_i$

 $\beta_{distw} * DistWater_i + \beta_{mtmp} * MaxTemp_i + \beta_{solrad} * SolRad +$

$$\beta_{dens} * density_i + \beta_{size} * size_i$$

where β_{for} , β_{burn} , and β_{sev} are parameters estimated for fixed variables, and β_{old} , β_{sal} , β_{distw} , β_{mtmp} , β_{solrad} , β_{dens} , and β_{size} represent parameters for candidate variables. For each species, models were fit using all combinations of candidate variables. Each candidate model included all fixed variables. Parameters for old burn/recent burn (i.e. Power vs. Chips and Rim), salvaged/not salvaged, and severity were estimated using data for burned points only (i.e. only when $burn_i =$ 1). Site was indexed by *i*. Selection between models of different combinations of candidate variables was done using mean AUC calculated from 5-fold cross-validation, resulting in a final best predictive model for each species.

All occupancy models were fit with the following detection model to estimate rates of false absences:

$$logit(p_{ij}) = \alpha_0 + \alpha_{length} * length_{ij} + \alpha_{jday} * jday_{ij} + \alpha_{cc} * cancov_i$$

Length and jday are the survey length in hours and julian day for each site i and survey night j, and cancov is the percent canopy cover within 15m of the bat detector at each site i.

Mean parameter estimates used in the GIS tools are listed in Table 4. Additional discussion of model estimates including parameter uncertainty measures can be found in the accompanying report (Steel et al. 2018).

Predictor	Туре	anpa	epfu	labl	laci	lano	myca	myci	myev	mylu	myth	myyu	pahe
ENF	Occ	-0.50	-0.19	-2.38	0.60	1.26	1.75	-0.64	0.93	-0.69	-0.57	0.00	-0.34
PLAS	Occ	-2.08	0.30	0.42	-0.27	1.38	0.29	-1.86	1.75	1.80	-1.23	-0.78	-2.68
SNF	Occ	-0.31	0.14	-3.60	0.08	-0.44	11.19	-1.17	0.05	-1.21	0.33	-0.58	1.30
Density	Occ	-1.21	0.19	NA	-0.41	-0.43	-0.38	NA	NA	-0.23	NA	-0.16	-1.05
Size	Occ	0.48	NA	NA	NA	0.97	NA	0.21	0.47	0.66	0.29	NA	-0.29
Distance	Occ	0.19	NA	NA	NA	0.20	0.53	NA	-0.16	-0.16	NA	0.10	0.33
MaxTemp	Occ	0.53	-0.66	NA	0.25	NA	0.00	NA	-0.26	NA	NA	0.18	0.79
SolRad	Occ	NA	NA	0.24	-0.44	-0.40	NA	0.04	NA	0.32	0.31	0.05	NA
Burned	Occ	0.77	0.64	0.13	0.38	1.14	2.20	0.39	0.88	0.54	0.46	0.68	0.51
Severity	Occ	0.39	-0.26	0.80	-0.02	0.73	0.37	-0.72	-0.45	0.18	-0.29	0.49	-0.47
Old Fire	Occ	NA	1.00	NA	0.54	NA	-1.93	-0.43	NA	NA	1.43	-0.95	NA
Salvaged	Occ	NA	NA	NA	0.73	NA	1.23	0.80	NA	0.32	NA	NA	NA
Intercept	Det	-0.82	-0.37	-1.40	-0.60	0.24	0.99	-1.26	-0.19	-0.18	-0.61	-1.31	-1.29
Day	Det	0.18	0.41	0.38	-0.07	-0.08	0.36	0.45	0.20	0.02	-0.01	0.02	0.29
Length	Det	0.13	-0.01	-0.07	0.14	-0.13	0.15	0.18	0.05	-0.15	0.20	0.16	0.12
Canopy	Det	-0.05	-0.26	-0.46	-0.30	-0.61	0.06	0.00	0.03	-0.14	-0.08	-0.05	-0.20

Table 4. Mean parameter estimates for all final models. NA values indicate a variable was not included in the final model for that species. Detection (Det) variables were used to fit the full hierarchical model, but only the variables include in the occupancy submodel (Occ) are used to make spatial prediction.

Model Validation

In addition to calculating AUC as a measure of predictive ability, we ran the Mackenzie and Bailey goodness of fit test (MacKenzie & Bailey 2004) for each of the final models. A significant result from this test (P < 0.05) indicates model lack of fit, and c-hat values > 1 indicate overdispersion, with c-hat values > 4 indicating high levels of lack of fit. The Mackenzie Bailey test identified final models for three species (Pahe, Myth, and Myev) were poorly fit, indicating model estimates of uncertainty may be low. For the other nine species, final models had reliable uncertainty estimates. Of these, Labl, Myca, Lano, and Mylu exhibited the best predictive performance (AUC > 0.8; Table 5).

	Cross-vali	dation AUC	Mackenzie & I	Bailey Test
Species	Mean	Std. Dev.	p-val	c-hat
labl	0.8431	0.0559	0.76	0.03
myca	0.8213	0.1097	0.37	0.94
lano	0.8137	0.0114	0.43	0.48
mylu	0.8048	0.0480	0.43	1.11
pahe	0.8012	0.0361	0.00	815.52
myth	0.7279	0.0398	0.00	20.14
myev	0.7198	0.0106	0.01	8.14
anpa	0.7184	0.0634	0.24	0.91
laci	0.6962	0.0408	0.57	0.90
epfu	0.6649	0.0423	0.69	0.10
myci	0.6527	0.0271	0.09	2.76
myyu	0.6321	0.0839	0.21	0.24

Table 5. Model validation metrics. AUC mean and standard deviations values were calculated using 5-fold cross-validation. Models identified as showing significant lack of fit (p > 0.05 and c-hat > 4) are in italics.

MODEL APPLICABILITY

Models are restricted in applicability by the range of conditions within which they were developed. Applicability should ideally be tested with independent data before managers use model predictions to inform their decisions and planning (Wenger & Olden 2012; Bahn & McGill 2013). Such testing is particularly critical when applying models beyond the environmental range where originally developed. In light of these principles and where models have been tested, we offer guidelines for model applicability here.

The bat occupancy models within the FIRE-BAT toolset should only be applied within the regions, habitats, and timing relative to wildfire ignition in our study. Bat occupancy models were developed and are applicable to burned forests in three regions: Lassen/Plumas, Eldorado, and Stanislaus National Forests. We recommend the models only be applied to fires within or very near these forests (e.g. Tahoe National Forest). These burned areas are primarily within the Sierra mixed conifer and yellow pine forest zone, but also included significant pre-fire areas of

white fir, montane chaparral, and red fir habitat types, as designated by California Wildlife Habitat Relationship System (Mayer & Laudenslayer 1988). Lastly, our models are applicable to bat occupancy from May-September within 13 years following wildfire.

Sampled landscapes were affected by selective harvest salvage logging on USFS lands and often more intensive salvage logging on private lands, though sample locations were entirely on USFS land. Our models quantified relationships with salvage logging at a single, local scale on USFS land; we did not include larger scale effects of salvage logging, including those on private lands. Predictive performance may decline in extensively logged post-fire areas, especially for recent burns where much of the snag basal area on unsalvaged lands still stands.

INSTRUCTIONS FOR TOOL IMPLEMENTATION

Application tools described in this manual are operated within an ArcGIS environment. Users must have access to ArcGIS 10, a basic understanding of how to operate this software, and spatial data layers for clearly defined study areas. Steps provided here detail how to retrieve and compile environmental data into GIS layers required as model inputs, and how to access and implement the model application tools.

Users can obtain the FIRE-BAT toolset by emailing Brent Campos (bcampos@pointblue.org) or Zachary Steel (zsteel@ucdavis.edu). Two versions of the FIRE-BAT toolset are available: one with many of the input data layers included, the other without these layers. The version of the toolset with the data layers is quite large (~0.9 GB), but can save time by skipping some of the data download steps detailed below.

Once the user has extracted the toolset to a personal workstation, they can follow the steps below. Hereafter, the location "TOOLBOX" refers to the folder extracted from the FIRE-

BAT.zip file to a personal workstation. We provide one model application tool for each of seven bat species for four Sierra Nevada forests. Outputs generated by these tools are 30 m raster layers with occupancy values ranging from 0 to 1. We recommend using ".tif" or ".img" extensions for output layers for flexibility in filename length. The study area must have been burned by sufficiently large wildfires (>1000 acres) for the necessary data to be retrievable.

Steps to Implement Tool

- I. Retrieve and compile environmental data layers. In this step you will retrieve remotely sensed data from USFS and, optionally, other websites, and input them into the Input Generation tool to compile many of the variables listed in Table 1. None of the files you download will need to be altered from their downloaded form. The pathnames for data files used in these tools cannot have spaces, so when saving the environmental data layers to your workstation, ensure that no parent folders in the file path names have spaces. For example, "C:\GIS\Data\Sierra Bats\rdnbr_cc.tif" is an invalid path name; the folder named "Sierra Bats" needs to renamed to "SierraBats" or "Sierra_Bats".
 - A. Retrieve burn severity data. The version of FIRE-BAT that includes some input data layers in the ZIP file does not include burn severity data. For fires ignited in 2008 or after, the user may download the data via the following steps. For fires ignited prior to 2008, you may contact the Region 5 Remote Sensing Lab for burn severity data for your fire of interest.
 - 1. Go to the USFS Post-Fire Vegetation Conditions website

https://www.fs.fed.us/postfirevegcondition/index.shtml and enter the necessary information for your fire in the query builder. In this example, we are looking for the 2013 Rim Fire in California. If a window like the one below is not visible in your web browser at the webpage linked to above, ensure that Adobe Flash Player is enabled in your web browser then refresh the webpage.

Remote Sensing Applications Center - F	(SAC) at telephone number (801) 975-3750					
RAVG Data Access & Summaries						
Step 1. Introduction						
Step 2. Query Builder						
Please select the alpha-numeric group below fire name. If you know only part of the fire name and I word, please start to type it in the Advanced will try to match it with any word in the fire Example: User knows fire name contains with this word, so when user starts to type will filter out only fires containing "creek" in Creek WFU Complex", "Otter Creek", etc. All A - E F - J K - O P - T rim Advanced Set	v that contains the first letter of the desired he fire name does not start with this d Search input field. The search engine name. ord "creek", but fire name does not start word "creek", he Available First below them such as: "Horse Creek", "Moose U-Z 0-9 arch					
Available Fires	Selected Fires					
Rim Ad < Re <<< Rer	All Rim					
Step 3. Results & Analysis						

2. Click on the compressed file icon under the Download Data column to download the GIS data packet for your fire, then unzip the contents into your GIS workspace.

3. See the metadata document in the extracted file folder for explanation of the files associated with your download. In general, the fire perimeter polygon shapefile will end in "...burn_bndy..." and the burn severity raster will end in "_rdnbr.tif" or "_rdnbr_alb.tif" (hereafter "fire perimeter" and "burn severity" layers, respectively).

- B. Retrieve pre-fire forest structure data. The version of FIRE-BAT that includes some input data layers in the ZIP file does not include pre-fire forest structure data. This must be supplied by the user by downloading via the following steps. (NOTE: If the data available from sources in the following steps do not contain pre-fire data, such as when applying this tool to an old fire rather than a new fire, you may contact the Region 5 Remote Sensing Lab for the appropriate Existing Vegetation [Eveg] tiles that provide complete coverage of the fire perimeter and a 2-km buffer area outside the perimeter. To ensure the data reflects pre-fire conditions, request tiles that have all image source dates prior to the ignition date for your fire of interest).
 - Navigate to the Region 5 Vegetation Classification and Mapping webpage
 <u>https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprd</u>

 <u>b5347192</u>. Identify the Zone containing your fire of interest using the CALVEG
 Mapping Zones map on the webpage. If your fire of interest is near the border of a

Zone, you may also need vegetation data from an adjacent Zone to get complete coverage of the fire perimeter and a 2-km buffer area outside the perimeter. Once you have identified your Zone(s), click on "Download Existing Vegetation Zones, Keys and Descriptions."



 A table of available spatial data will appear. Click on the Zone containing your fire of interest under the Spatial Data column of the table. Doing this will take you to the National FSGeodata Clearinghouse at

https://data.fs.usda.gov/geodata/edw/datasets.php.

• Resource Management	program does not serve as an endo specific product.	rsement by the USDA Forest Service for a	
• Geospatial Data	Citing Geospatial Data		
Forest & Grassland Health	Spatial Data	Keys, Descriptions	
State, Private & Community Forests	Zone 1, North Coast - West	Keys	
Plants & Animals Learning Center	Zono 1. North Const. Mid	Keys	
Working Together	zone 1, North Coast - Mid	Descriptions	-
About the Region	Zone 1, North Coast - East	Descriptions	
News & Events ontact Information	Zone 2, North Interior	Keys Descriptions	
acific Southwest Region Google map) 123 Club Drive	Zone 3, North Sierra	Keys Descriptions	
Illejo, CA 94592 vice: 707.562.8737 Y: 707.562.9240 x: 707.562.9130	Zone 4, South Sierra	Keys Descriptions	
ffice hours: 7:30 a.m. – 00 p.m.	Zone 5, Central Valley	Keys Descriptions	
	Zone 6, Central Coast	Keys Descriptions	
	Zone 7, South Coast	Keys Descriptions	
	Zone 8, South Interior	Keys Descriptions	
an to add this information	Zone 9, Great Basin	Keys Descriptions	
ir mission is to sustain the alth, diversity, and			

3. On the FSGeodata Clearinghouse webpage, there is a "Search by keyword" option above the table of feature classes. Type "Existing Vegetation" into the "Search by keyword" text box and click the "go" button.

USDA United States Department Forest Service	of Agriculture		FSGeodata Clearinghouse
Al allerti	St all		A DECKER
			Clearinghouse Home Help Contact
Enterprise Data	Download National Datasets		
 Biota (23) Boundaries (43) Environment (30) Geoscientific Information (8) Imagery & Basemaps (43) Inland Waters (13) Planning Cadastre (14) Structure (1) Transportation (4) 	Data collected and managed by Fore downloadable file formats – in a sha describes the content, source, and co the menu at the left to help you find a single dataset by clicking on the na More FS map services are available in Topic Category Descriptions	st Service pro pe file and an urrency of the information y ame of the par n ArcGIS Online	grams is available in a map service and two ESRI file geodatabase. Metadata is available that data. You can filter the list by the topic categories in ou are interested in. You can view the feature classes in rent dataset at the bottom of the abstract.
Data Extract Tool	Search by Reyword: Existing Vegetatio	n go	
Map Services	Feature Classes		Abstract
Maps FSTopo Standard Map Products Other Map Products Raster Data	Activity Silviculture Timber Stand Improvement ESRI geodatabase (176MB) shape file (319MB) Date of last refresh: Apr 23, 2018	metadata map service	The SilvTSI (Silviculture Timber Stand Improvement) feature class represents activities associated with the following performance measure: Forest Vegetation Improved (Release, Weeding, and Cleaning, Precommercial Thinning, Pruning and Fertilization). The Activities data set portrays the areas where activities are accomplished [see more] parent dataset: Activities

4. Scroll down to your Zone of interest. In the example below, we are looking for the "South Sierra" Zone in Region 5. Once you have found your Zone, click the "ESRI geodatabase" hyperlink below the Zone name to download the Zone data. Unzip the file and place the geodatabase into your GIS workspace.

metadata map service	This Existing Vegetation (Eveg) polygon feature class is a CALVEG (Classification and Assessment with LANDSAT of Visible Ecological Groupings) map product from a scale of 1:24,000 to 1:100,000 for CALVEG Zone 8, the South Interior. Source imagery for this layer ranges from the year 2000 to 2008. The CALVEG classification system was used for vegetation typing and crosswalked to other classification systems in this database including the California Wildlife Habitat Relationship System (CWHR). Purpose: Existing vegetation is a foundational layer applicable to many business needs of the Forest Service. Mid-level products are intended to support regional and multi-unit information needs. Products at this level are typically developed programmatically from remotely sensed data but should integrate standard base level maps where they exist.
metadata map service	This Existing Vegetation (Eveg) polygon feature class is a CALVEG (Classification and Assessment with LANDSAT of Visible Ecological Groupings) map product from a scale of 1:24,000 to 1:100,000 for CALVEG Zone 4, the South Sierra. Source imagery for this layer ranges from the year 1995 - 2016. The CALVEG classification system was used for vegetation typing and crosswalked to other classification systems in this database including the California Wildlife Habitat Relationship System (CWHR). Purpose: Existing vegetation is a foundational layer applicable to many business needs of the Forest Service. Mid-level products are intended to support regional and multi-unit information needs. Products at this level are typically developed programmatically from remotely sensed data but should integrate standard base level maps where they exist.
	metadata map service

- C. Retrieve water source data
 - Option 1 for water source data: Use the water source data layer supplied in the FIRE-BAT Toolbox.
 - a. Navigate to "TOOLBOX → Input_Layers → NHDFlowline" and locate the
 "NHDFlowline.shp" file (hereafter referred to as the "water source" layer). You can leave the file here, or copy it to your workspace.
 - Option 2 for water source data: Download the water source data layer from a USGS website.
 - Go to <u>https://nhd.usgs.gov/data.html</u>. Under the section titled "Download by Map Viewer" click on the hyperlink for "National Map Download Viewer," or visit the link directly here:

https://viewer.nationalmap.gov/basic/?basemap=b1&category=nhd&title=NHD

%20View

U.S. Geological Survey - >			00000 0 0
← → C · Secure ht	sc//nhd.usgs.gov/data.html		***
🔢 Apps 🛊 Bookmarks 🗅	Point Blue High Peri () CADC Applications 🔯 Google Scholar () RefBase Database 🖬 Point Blue Leaders 8 NW	S Woodland For 💩 NWS Chester Forect 🌫 Califopo 🧯 AOU Birds of Nort 📒 Califed 📒 Aspen 🚺 Distance 🧻 Meadow	Habitat # NDVI #
Science for a changing world	The National Map		USGS Home Contact USGS Search USGS
Hydrography			
Home	Links to Data Products and Map Servi	ces	
News and Events			(1) (1)
About Data Products	The NHDPlus High Resolution (NHDPlus HR), National Hydrography Dataset (NHD), and Watershed Boundar WBD datasets used to create the the NHDPlus HR. The copies are current only to the date the NHDPlus HR dataset was created.	<u>px_Dataset</u> (WBD) are available for download and as map services. All RHOPIus HR downloads contain a copy of the NHD is created. All NHD downloads contain a copy of the corresponding WBD dataset that is current only to the date the NH and the NHD downloads contain a copy of the corresponding WBD dataset that is current only to the date the NHD dataset.	ond D
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	Please note: The NHDPlus High Resolution is being released for download in Beta version (NHDPlus HR Beta information about this building process, to find out the current availability by 2-digit Hydrologic Unit (HU2).	a) by 4-digit Hydrologic Unit (HU4) as it is built. Please see the <u>NHDPlus Hydr Resolution (NHDPlus HB)</u> page for more and to learn about participating in reviews of the Beta version data.	
	The NHDPlus HR data includes both vector and raster components for each geographic area mapped. NHDP raster data files are available for download as zipped (.72) files.	Plus HR Beta vector data is available in file geodatabase (GDB) format, zipped (.zip) to reduce the file size. NHDPlus HR	
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b. On the left side of the website will be series of options under the Product Search
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c. Click the blue "Find Products" button and the Products pane will appear on the left side of the webpage. Click on the "cart +" button to add this dataset to your cart, then click the blue "View Cart" button.



d. The Cart pane will appear with the data you selected. Click the "Download" hyperlink to download the data.

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- e. Place the downloaded ZIP file into your GIS workspace and extract the file.
 You will now have a folder called "NHD_H_California_Shape" in your workspace, with a subfolder called "Shape," within which is the water source shapefile called "NHDFlowline.shp" (hereafter referred to as the "water source" layer).
- D. Retrieve temperature data
 - 1. Option 1: Use the temperature data layer supplied in the FIRE-BAT Toolbox.
 - a. Navigate to "TOOLBOX → Input_Layers → temperature" and locate the
 "tmx1981_2010jja_ave_HST_1507159793.tif" file (hereafter referred to as the
 "temperature" layer). You can leave the file here, or copy it to your workspace.
 - 2. Option 2: Download the temperature data layer from a Point Blue website.

a. Navigate to <u>http://climate.calcommons.org/dataset/2014-CA-BCM</u>. If you do

not already have a CA Climate Commons account, click the "Request one now"

hyperlink, or click the "Log in" hyperlink if you have an account.

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b. After logging in, navigate back to <u>http://climate.calcommons.org/dataset/2014-</u>

<u>CA-BCM</u> and click "View Map and Download GeoData" hyperlink (you may

need to refresh the webpage to see this hyperlink).



c. You will now be at a map interface where you will download the temperature data. On the top left of the webpage will be a gray dialogue box with a number of drop-down boxes for different options of data to view and download. Feel free to review the instructions by clicking the green "Instructions" button.



d. First you will need to select a region of interest that encompasses your fire of interest plus a 3-km buffer. Hold down the shift button and left-click with your mouse the select your region of interest, erring on the side of being too large. In the example below, we are selecting an area around the Rim Fire.



e. For the first drop-down menu, select "Maximum Temperature (deg. C)." The

map will display the data after the selection is made.



f. For the second and third drop-down menus, "HST" and "1981-2010" should be selected as default. If not, select them.



g. For the fourth drop-down menu, select "Jun/Jul/Aug."



h. For the fifth drop-down menu, "Average" should be selected as default. If not,



select it. Click the green Download Data button.

- Place the downloaded ZIP file into your GIS workspace and extract the file.
 You will now have a folder called "tmx1981_2010jja_ave_HST_…" in your workspace (there is a timestamp at the end of the folder name). Within this folder is file called "tmx1981_2010jja_ave_HST_ … .tif" (hereafter referred to as the "temperature" layer).
- E. Retrieve elevation data
 - Option 1: Use the digital elevation model (DEM) data layer supplied in the FIRE-BAT Toolbox.
 - a. Navigate to "TOOLBOX → Input_Layers → dem → US_DEM2010" and
 locate the "us_dem2010" ArcGrid file (hereafter referred to as the "elevation"
 layer). You can leave the file here, or copy it to your workspace.

- Option 2: Provide your own DEM. We highly recommend a DEM resolution of 30m

 higher resolutions will result in prohibitively long computation times when the
 Generate Model Inputs tool calculates solar radiation (see following steps). The DEM layer's extent must cover the entire footprint of the fire of interest.
- F. Now you will compile many of the input variables needed to apply any of the habitat models for bats (Table 1) using the associated Generate Model Inputs tool. The following subtasks are best preformed entirely from ArcCatalog.
 - From ArcCatalog, navigate to the "TOOLBOX → Habitat Suitability Modeling.tbx
 → Generate Model Inputs" and open the "Generate Model Inputs" tool by doubleclicking it.

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- Identify or create a folder where you want the layers generated from this tool to be stored. Under "workspace", navigate to this folder. Then click "Add". Alternatively, you can drag and drop the desired folder to this window from ArcCatalog.
- 3. For "fire perimeter", navigate to the fire perimeter shapefile downloaded along with RAVG data (Step I.A). You can either navigate from outside the tool interface and drag and drop the perimeter shapefile into the "Fire Perimeter" box from ArcCatalog, or navigate from within the tool and click "Add".
- 4. If the user desires the output file to be in a different coordinate system from RAVG data (i.e., the fire perimeter shapefile), provide a spatial layer (shapefile or raster) that represents the desired coordinate system (drag and drop or navigate from within the tool). Otherwise, leave blank.
- 5. For "burn severity", use the relativized delta-normalized burn ratio (RdNBR) layer downloaded with RAVG data (Step I.A; drag and drop or navigate from within the tool). The filename for this layer may vary but should end in "rdnbr.tif" and not, for example, "rdnbr_ba.tif" or "rdnbr_cbi.tif". The user may need to review metadata for downloaded layers (click on the "Description" tab when previewing in ArcCatalog) to identify the right layer. If no such layer exists, the user may contact the Region 5 Remote Sensing Laboratory for an appropriate file.
- 6. For "CWHR polygons", provide the Existing Vegetation polygon file(s) retrieved in Step I.B (drag and drop or navigate from within the tool). The attribute table for each polygon file should contain "CWHR_DENSITY" and "CWHR_SIZE" fields, from which the input layers are derived. Users can verify existence of these fields by previewing the attribute table for each polygon file in ArcCatalog (go to "Preview"

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tab at the top and select "Table" in the drop down menu at the bottom and scroll to

the right, e.g., see screen shot below). If the attribute table(s) contains

"WHRDENSITY" and "WHRSIZE" fields, see the next step.

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- 7. If you provided older USFS Existing Vegetation data in the previous step, your attribute table will contain "WHRDENSITY" and "WHRSIZE" fields. In this case, click the box next to the "Click here if providing Eveg data (CWHR polygons) in the old format"
- For "water sources", provide the water source layer located in the Input_Layers folder under Step I.C.1 or download under Step 1.C.2 (drag and drop or navigate from within the tool).

- For "temperature Jun-Aug", provide the temperature layer located in the Input_Layers folder under Step I.D.1 or download under Step 1.D.2 (drag and drop or navigate from within the tool).
- 10. For "salvage polygons", you have the option of providing salvage units within the fire perimeter. The salvage data must be vector data in a single feature class.
- 11. Click OK. The tool will take 2-10 minutes to complete depending on the size of the burned area of interest. All outputs will be stored under "predictors" in your designated workspace. Open this folder and verify presence of the following layers (see the transparent yellow polygon in the screen shot below): "burnsev_lnd.tif", "burnsev_loc.tif", "burnsev_mid.tif", "burned_area_raster.tif", "canhi_lnd.tif", "canhi_loc.tif", "canhi_mid.tif", "dist_water_per.tif", "dist_water_int_per.tif", "fire_perim.tif", "radiation.tif", "salvage_raster.tif" (in predictors folder only if salvage polygons were supplied), "sizelrg_lnd.tif", "sizelrg_loc.tif", "sizelrg_mid.tif", "tmx_jja.tif".

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- 12. Optional: The "_scratch" directory generated in the designated workspace when implementing this tool can be deleted upon successful completion.
- II. Run any or all model application tools as desired. Now you will use the layers in the predictors file above as inputs for the species-specific occupancy suitability models for Sierra bats. The following tasks are best preformed entirely from ArcCatalog.
 - A. From ArcCatalog, navigate to "TOOLBOX → Habitat Suitability Modeling.tbx", open the "Occupancy Models" toolbox, and then open the tool for your species of interest by double-clicking it.



- B. For the variables listed in Table 4 use the associated layers generated in Step I.E. Either navigate to the "predictors" folder in ArcCatalog and drag and drop each input layer, or navigate from within the dialog box and click "Add" to designate each layer. A subset of 2-7 of these input layers will be required for any one tool. The "Salvaged area" parameter is only applicable to users who supplied a salvage polygon layer in Step I.E.9.
- C. Select the region your fire of interest is located in: Lassen/Plumas NF, Eldorado NF, or Stanislaus NF. (**IMPORTANT**: *If no region is selected, the tool will run and output will be generated, but the output will be wrong*!)
- D. For the "Output" parameter, designate an appropriate location and filename for the output occupancy raster. Click the button with the folder icon to the right, locate your workspace or any other desired location, and create a meaningful name, e.g., "AnpaOccu.tif". Again, we recommend ".img" or ".tif" file extensions to allow longer filenames.

E. Click on OK to run the model. A series of progress bars will flash. If necessary, close the results window once "succeeded" is displayed. To view the model output, navigate to the file named in step II.D (e.g., "AnpaOccu.tif"), and then select preview pane to preview the HSI map.



REFERENCES

- Bahn V, McGill BJ. 2013. Testing the predictive performance of distribution models. Oikos **122**:321–331.
- Bellamy C, Scott C, Altringham J. 2013. Multiscale, presence-only habitat suitability models: fine-resolution maps for eight bat species. Journal of Applied Ecology **50**:892–901.
- Campos BR, Burnett RD. 2016. Bird and bat inventories in the Moonlight, Storrie, and Chips fire areas: 2015 report to the Lassen and Plumas National Forest. Point Blue Contribution No. 2071. Point Blue Conservation Science, Petaluma, CA.
- Campos BR, Burnett RD, Steel ZL. 2017. Bird and bat inventories in the Storrie and Chips fire areas 2015-2016: final report to the Lassen National Forest. Point Blue Contribution No. 2142. Point Blue Conservation Science, Petaluma, CA.
- DeFries R, Nagendra H. 2017. Ecosystem management as a wicked problem. Science **356**:265–270.
- Fawcett T. 2006. An introduction to ROC analysis. Pattern Recognition Letters 27:861-874.
- Fiske I, Chandler R. 2011. unmarked: An R Package for Fitting Hierarchical Models of Wildlife Occurrence and Abundance. Journal of Statistical Software **43**:1–23.
- Guisan A et al. 2013. Predicting species distributions for conservation decisions. Ecology Letters **16**:1424–1435.
- MacKenzie DI, Bailey LL. 2004. Assessing the fit of site-occupancy models. Journal of Agricultural, Biological, and Environmental Statistics **9**:300–318.
- Maiorano L, Falcucci A, Boitani L. 2006. Gap analysis of terrestrial vertebrates in Italy: Priorities for conservation planning in a human dominated landscape. Biological Conservation **133**:455–473.
- Mayer KE, Laudenslayer WF, editors. 1988. A guide to wildlife habitats of California. State of California, Resources Agency, Department of Fish and Game, Sacramento.
- R Core Team. 2016. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. Available from https://www.R-project.org/.
- Steel ZL, Campos BR, Safford HD. 2018. Bat occupancy in Sierra Nevada wildfire areas and implications for post-fire forest management.
- Steel ZL, Safford HD. 2017. Acoustic Inventory and Monitoring of Bat Species in the Power Fire Burn Area: 2014, 2015, & 2016 Field Seasons.
- Wenger SJ, Olden JD. 2012. Assessing transferability of ecological models: an underappreciated aspect of statistical validation. Methods in Ecology and Evolution **3**:260–267.

APPENDICES

Appendix A – Troubleshooting guide

Problem 1. – When attempting to retrieve RAVG burn severity data for my project area, the data retrieval window is not visible on the website as shown in the instructions (Section 4.4).

Solution 1. – You may not have Adobe Flash Player installed or enabled. Search for "install or enable Adobe Flash Player" on the internet to find instructions to install, enable, and check the status of Adobe Flash Player. If Adobe Flash Player is enabled but the online data retrieval tool remains unavailable, you can contact the RAVG program directly via <u>email</u> or their <u>website</u>.

Problem 2. – When attempting to operate the Generate Model Inputs tool, I receive errors that resemble the following:

Error: "000732: <value>: Dataset <value> does not exist or is not supported." ExecuteError: Failed to execute. Parameters are not valid. ERROR 000732: Input Features: Dataset `...' does not exist or is not supported Failed to execute (PolygonToRaster).

Solution 2. – Check the folder names and pathways for input files. Filenames and pathways should contain no spaces. In particular, the most likely reason for this error is an invalid path name for Existing Vegetation polygons downloaded from the Region 5 website. If the file

geodatabase containing the polygons is embedded within a file of the same name, you will receive this error. For example, these paths result in an error:

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C:\GIS\vegetation\eveg\ExistingVegR5_SouthSierra1995_2016_v1.gdb\ExistingVegR5_ SouthSierra1995_2016_v1