Ambystoma macrodactylum croceum

Santa Cruz long-toed salamander

California Department of Fish and Wildlife
Range and Distribution Mapping and Analysis Project (RADMAP)
Species Habitat Model (SHM) assessment metrics and metadata

Star Rating: 2 out of 5

Date: 2025-09-10

This metadata describes the SHM results for this one taxon. Methods were developed by the RADMAP team and implemented with Maxent. Evan Greenspan was the primary modeler for this species.

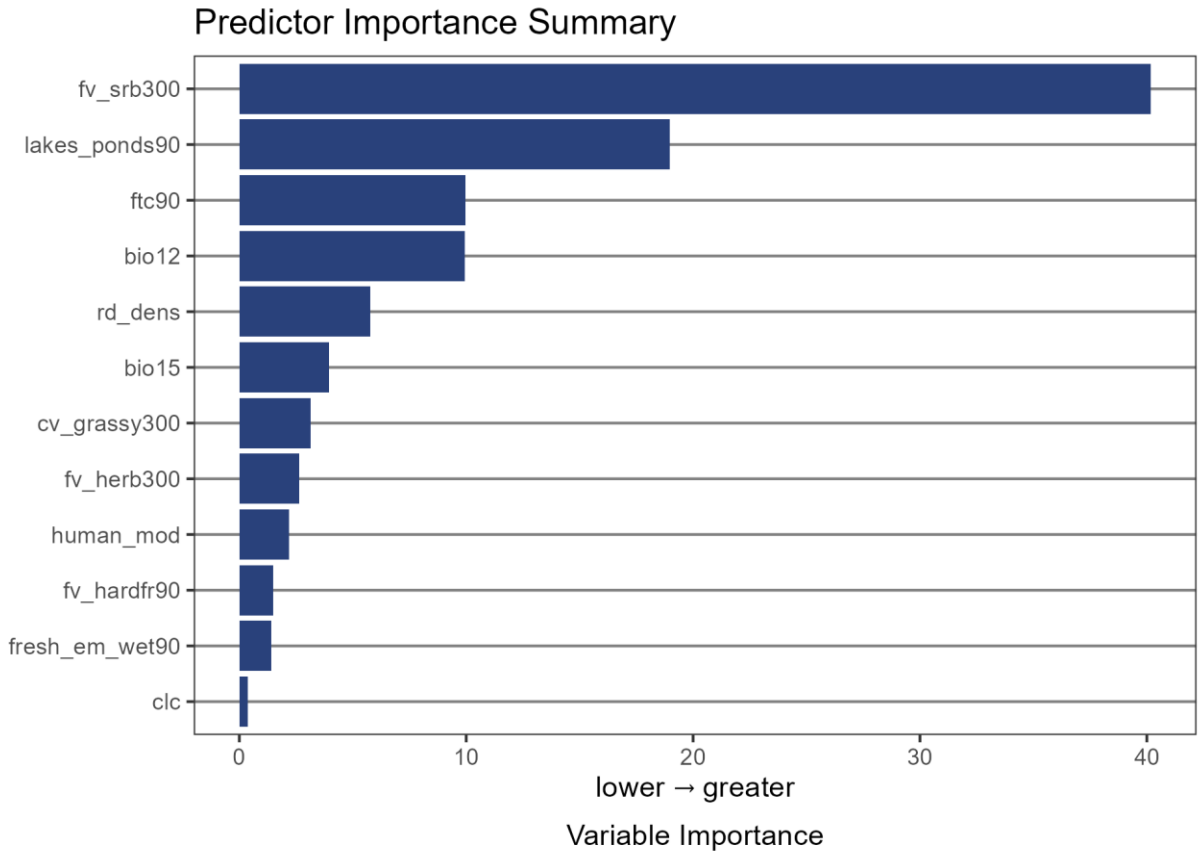
Model Results

Table 1. Maxent model testing results, including the number of filtered presence locations used (Presence), regularization multiplier (RM), feature class (FC), p0 test omission error rate (OER), test area under the curve (AUC), difference between AUC test and AUC training values (AUCdiff), p0 threshold (Threshold) distinguishing habitat from non-habitat, and max(se+sp) test True Skill Statistic (TSS).

Presence	RM	FC	AUC	AUCdiff	Threshold	TSS	OER
420	4	lpqht	0.816264	0.1108888	P0	0.5557667	0

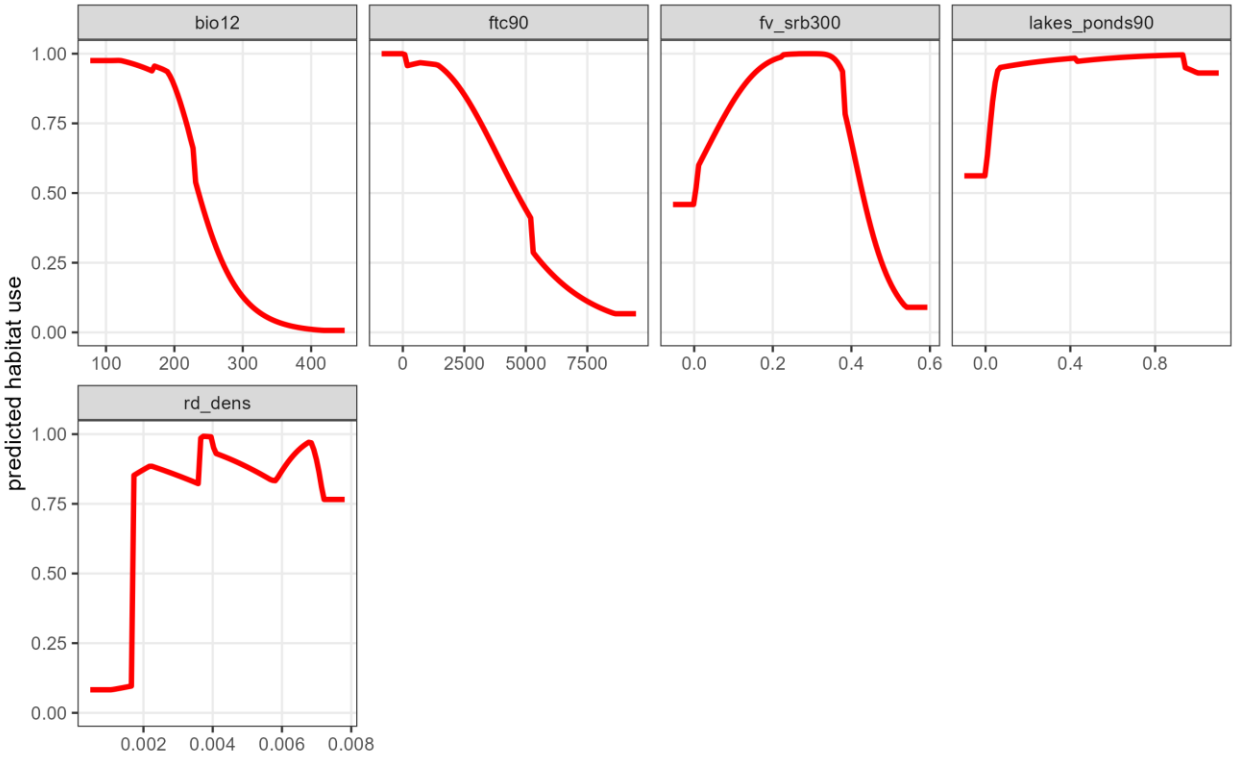
Percent Contribution of Covariates

Figure 1. Estimates of the relative percent of contributions (variable importance %) of covariate inputs to the top Maxent model. Covariates are defined in Table 4.



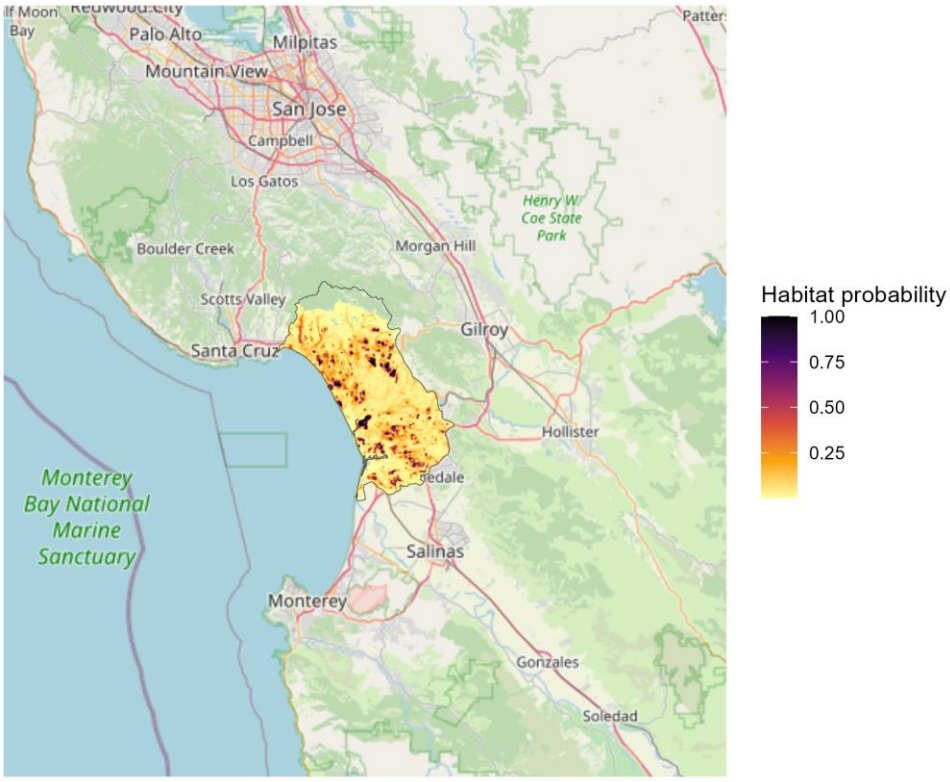
Response Curves

Figure 2. Response curves reveal how the predicted habitat use (0–1 on the y-axis) changes as each variable is altered while all other predictors remain constant. The x-axis represents the covariate's range of values while the y-axis represents the effect between the variable and the model response. Covariates are defined in Table 4.



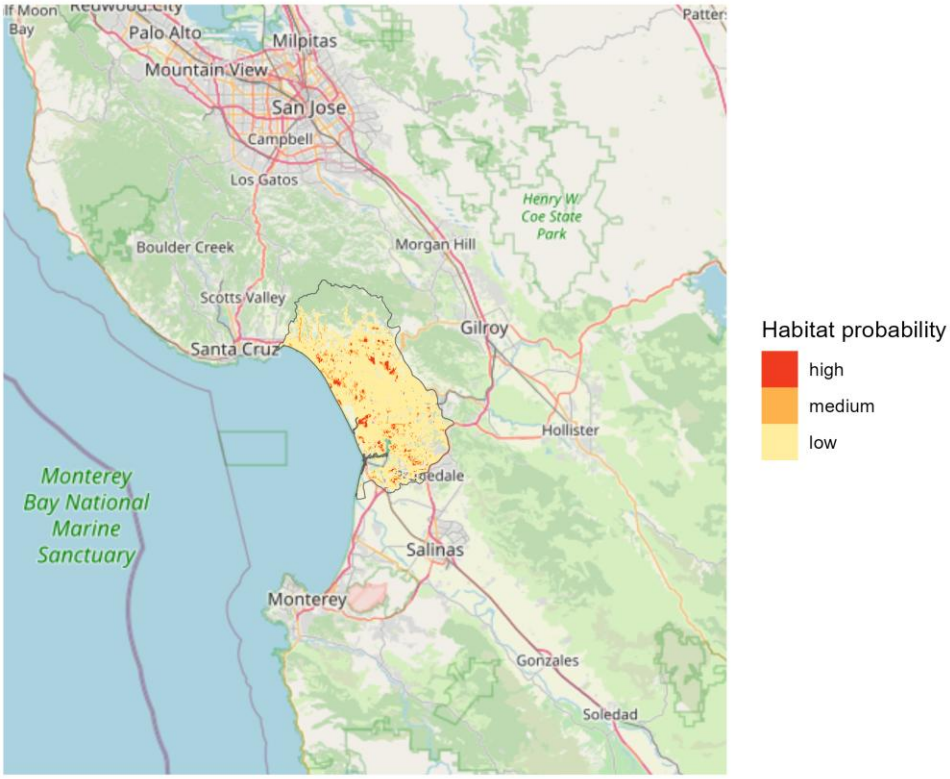
Model Output – Species Habitat Model (continuous)

Figure 3. SHMs depict a species' predicted habitat associations within each cell, represented as a continuous value between 0 and 1, and masked to the species' range. Values closer to 1 depict a higher relative probability of habitat use within that cell.



Model Output – Species Habitat Model (categorical)

Figure 4. The categorical SHM is based on the continuous SHM output. It splits the model output into predicted habitat and non-habitat based on a statistical threshold (p0). Within the area marked as predicted habitat in the output, this map displays the categories of high, medium, and low relative probability of habitat use. Medium and high relative probability of habitat use categories were distinguished based on expert chosen statistical thresholds.



Categorical SHM Thresholds

Table 2. Statistical thresholds chosen to represent the categorical SHM.

Category	Threshold Selected	Threshold Value
low	Minimum Training Presence	0.01408
medium	Maximum Sensitivity Plus Specificity	0.16302
high	Top 25% of habitat probability values above medium threshold	0.48752

Model Evaluation

Table 3. The final model evaluation score, represented as a star rating (1-5) is presented at the top of this metadata. Star ratings are comprised of three distinct components, including an expert review, a modeler review, and an AUC score. Experts review models based on predictor relevance and the overall accuracy of the continuous and categorical SHM outputs. Modelers provide a review of presence data, predictor relevance, performance evaluation, spatio-temporal data alignment, model review status, and the overall accuracy of the continuous and categorical SHM outputs. Along with the AUC score, these three inputs are normalized and given an equal weight before being converted into a categorical star rating. The table below provides a basic descriptive meaning of the star rating provided for this model, taking into account the subjective expert and modeler review scores as well as the objective AUC evaluation.

Star Rating	Brief Description
1	Poor representation of habitat. Habitat for this species is unlikely to be successfully mapped using standard habitat modeling approaches given unique species traits.
2	Significant concerns. A large proportion of the map shows habitat in areas where the species is unlikely to occur or does not predict habitat where the species is known. Revisions are needed before the model is used for any formal application or decision, with the possible exception of guiding inventory.
3	Some concerns about model performance in specific areas. The model would benefit from additional refinement, but the general pattern of mapped habitat is consistent with expert expectations
4	Model generally good. Potential for further improvement through additional iteration but provides a good approximation of likely habitat.
5	Modeled habitat is a very good representation of likely habitat. Further iteration is unlikely to result in significant improvements.

Covariate Descriptions

Table 4. Descriptions of environmental variables included in model. Covariates were chosen for inclusion in the model based on a literature review, their potential for ecological relevance to the focal taxon, and advice from applicable experts. Focal statistics were calculated for certain habitat covariates at the 90, 300, 900, 3,000, and 6,000-m radii scales to assess species' scale dependency. Only one covariate per set of scales were included in the covariate candidate set. Other covariates were extracted at the raster cell's resolution (30-m) unless otherwise specified.

The entire covariate library including full citations is available here: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=232517

Covariate Name	Covariate Description	Source
bio12	Annual precipitation	USGS Basin Characterization Model
bio15	Precipitation seasonality (coefficient of variation)	USGS Basin Characterization Model
rd_dens	Road density within a 3 km radius	US Census TIGER/Line data
ftc90	Fractional tree cover at a 90 m radius	Center for Ecosystem Climate Solutions
clc	Canopy layer count	California Forest Observatory
cv_grassy300	"CropVeg"- grassy (not orchards, rice, or low crop types) at a 300 m radius	Cal Fire FVEG 2022, CropScape 2022
fv_hardfr90	FVEG hardwood forest prevalence at a 90 m radius	Cal Fire FVEG 2022
fv_herb300	FVEG herbaceous prevalence at a 300 m radius	Cal Fire FVEG 2022
fv_srb300	FVEG shrub prevalence at a 300 m radius	Cal Fire FVEG 2022
human_mod	Human modification of terrestrial lands	Theobald et al., 2020
fresh_em_wet90	Freshwater emergent wetlands habitat prevalence at a 90 m radius	Cal Fire FVEG 2022, CDFW, USFWS National Wetlands

Covariate Name	Covariate Description	Source
		Inventory 2024, Cal Fire FRAP 2025
lakes_ponds90	Lakes and ponds at a 90 m radius	CDFW, USFWS National Wetlands Inventory 2024

Ambystoma macrodactylum sigillatum

Southern long-toed salamander

California Department of Fish and Wildlife
Range and Distribution Mapping and Analysis Project (RADMAP)
Species Habitat Model (SHM) assessment metrics and metadata Star Rating: 4 out of 5

Date: 2026-07-02

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Model Results

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Presence	RM	FC	AUC	AUCdiff	Threshold	TSS	OER
960	3	lq	0.9549705	0.00623892	P0	0.800075	0

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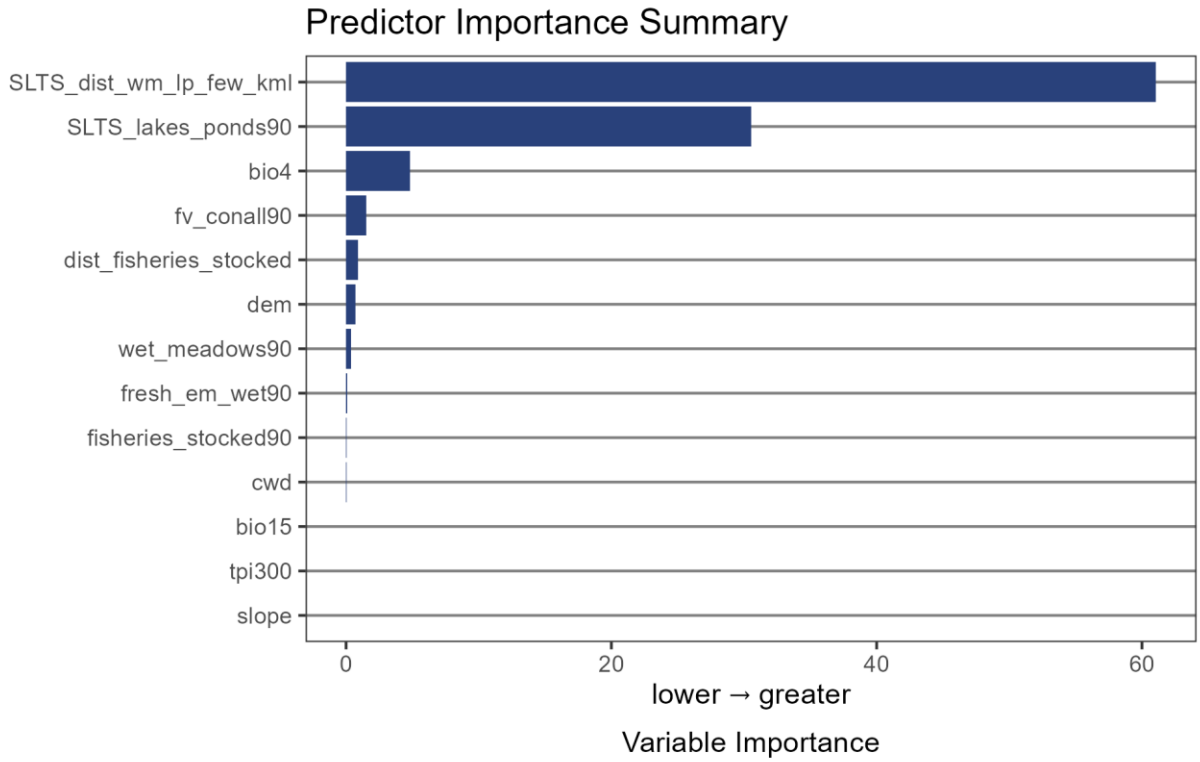

Response Curves

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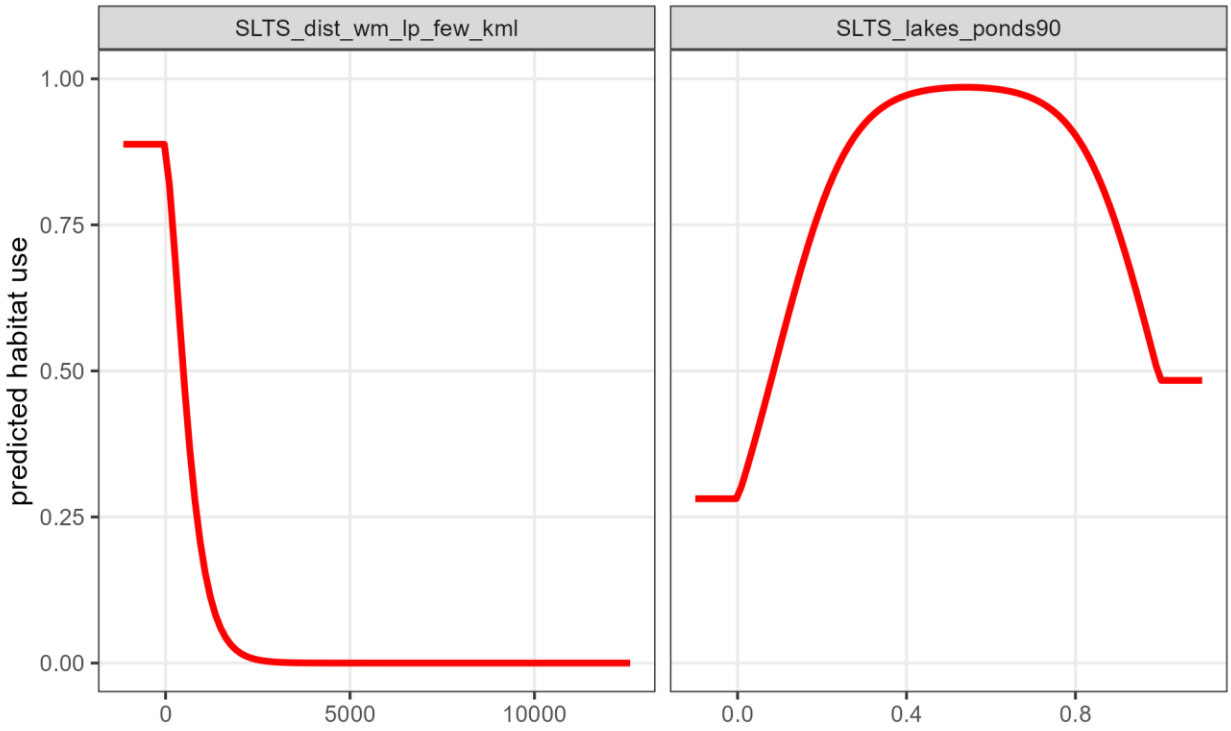

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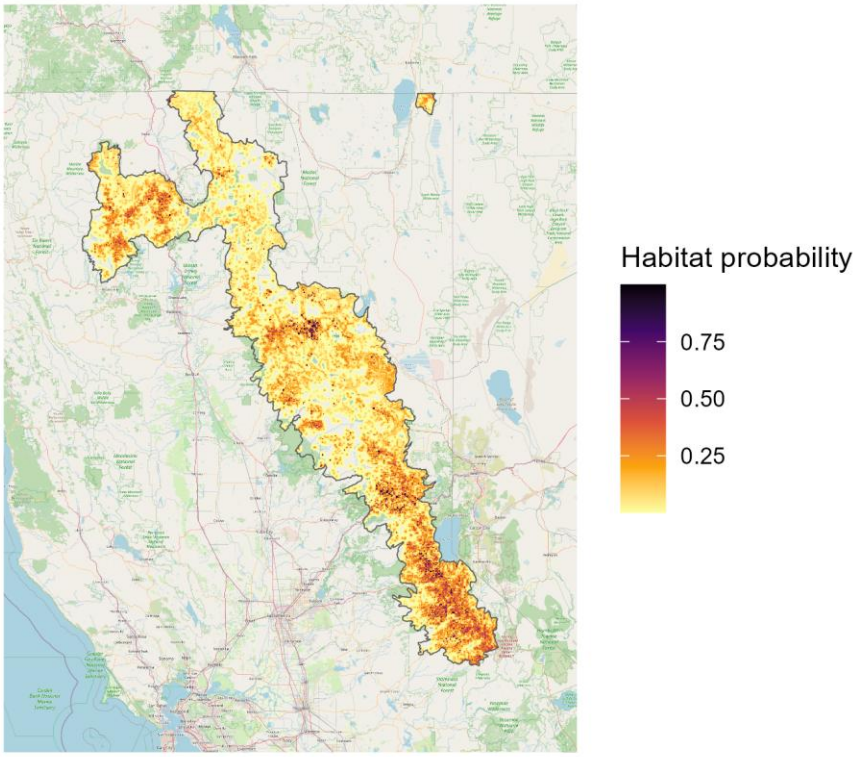

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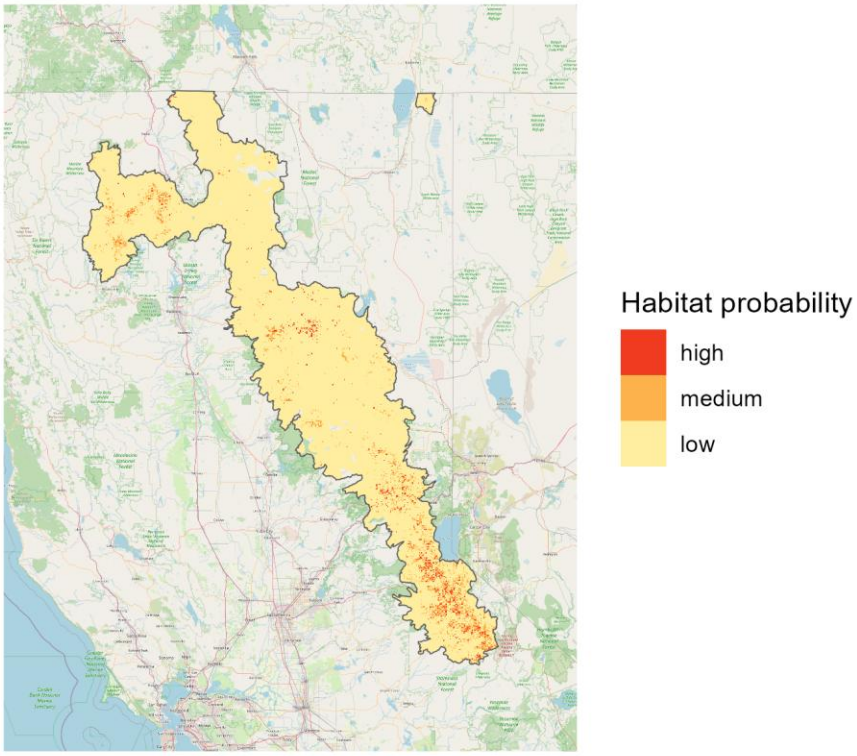

Categorical SHM Thresholds

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Category	Threshold Selected	Threshold Value
low	Minimum Training Presence	0.0000100
medium	Maximum Sensitivity Plus Specificity	0.2527000
high	Top 25% of habitat probability values above medium threshold	0.3995365

Model Evaluation

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bio4	Temperature seasonality	USGS Basin Characterization Model
bio15	Precipitation seasonality (coefficient of variation)	USGS Basin Characterization Model
dem	Digital elevation model	USGS Earth Explorer
slope	Slope	Digital Elevation Model, USGS Earth Explorer
cwd	Climatic water deficit	USGS Basin Characterization Model
tpi300	Topographic position index at a 300 m radius	USGS Earth Explorer
wet_meadows90	Wet meadow habitat prevalence at a 90 m radius	Cal Fire FVEG 2022, CDFW, Cal Fire FRAP 2025
fresh_em_wet90	Freshwater emergent wetlands habitat prevalence at a 90 m radius	Cal Fire FVEG 2022, CDFW, USFWS National Wetlands Inventory 2024, Cal Fire FRAP 2025
fv_conall90	FVEG all conifer prevalence at a 90 m radius	Cal Fire FVEG 2022
dist_fisheries_stocked	Euclidean distance to fish stocked water features	CDFW
fisheries_stocked90	Fish stocked water features at a 90 m radius	CDFW

Covariate Name	Covariate Description	Source
SLTS_lakes_ponds90	Lakes and ponds at a 90 m radius with stocked lakes removed	CDFW, USFWS National Wetlands Inventory 2024
SLTS_dist_wm_lp_few_kml	Distance to wet meadows, lakes and ponds, freshwater emergent wetlands, and Klamath mountain lakes with stocked lakes removed	CDFW Mountain Lakes and Wetlands Field Maps, Cal Fire FVEG 2022, CDFW, USFWS National Wetlands Inventory 2024, Cal Fire FRAP 2025