Modeling geographic uncertainty in current and future habitat for potential populations of *Ixodes pacificus* in Alaska

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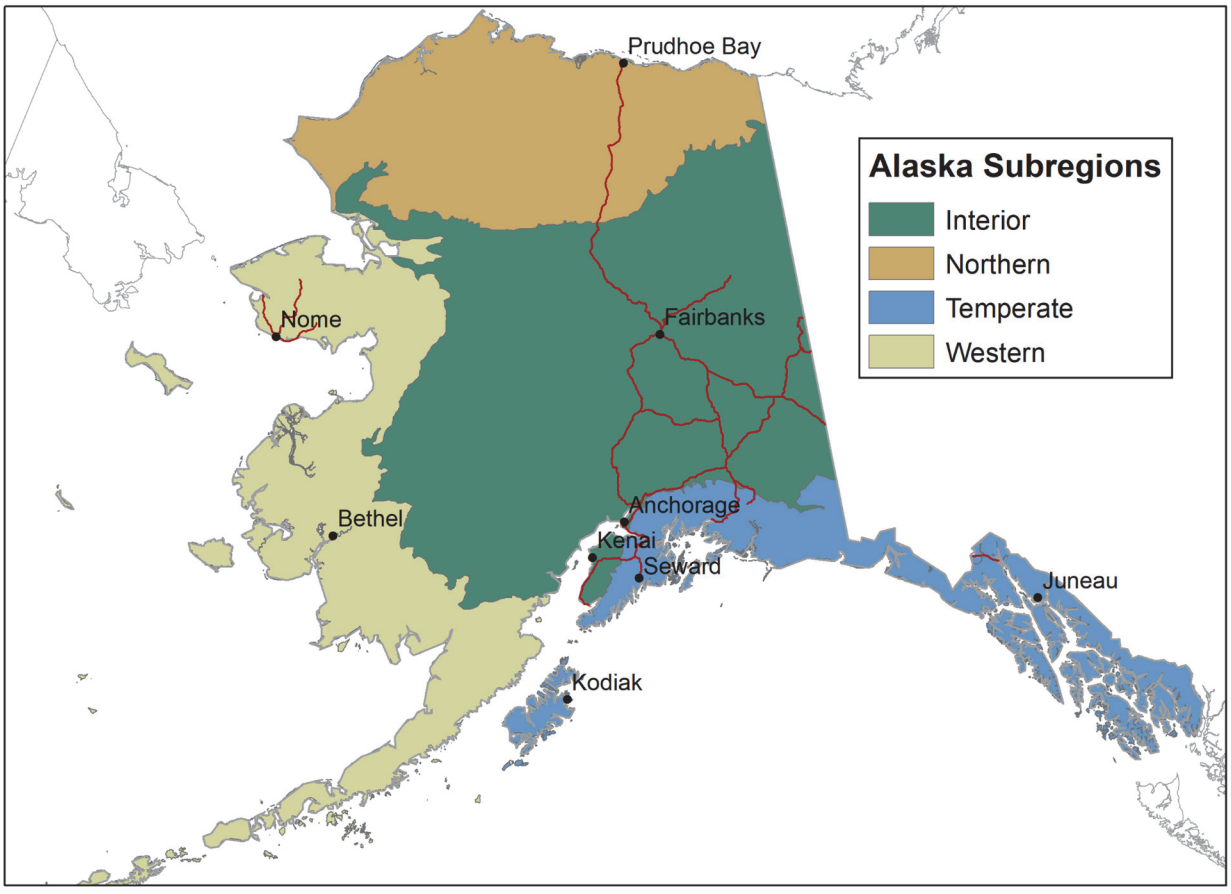
Supplementary Material

For the most dissimilar (MoD) maps (Supp. Fig. 5), we report here the published (Hahn et al. 2016, Eisen et al. 2018) relative contributions of the most problematic covariates for each model. By considering their model contributions, we can gain insight into their biological importance. For the CA 1 km models, summer day length and precipitation of the warmest quarter (Bio18) were most commonly out of range, though both had relatively small contributions to each model. For summer day length, the normalized contribution ranged from 1.2% for GLM to 7.9% for Maxent, while Bio18 ranged from 2.8% for Maxent to 5.7% for RF. For the Western county models, there were several variables out of range. Bio18 was the biggest offender for the GLM model (14.4%), but also in southern mountainous regions for Maxent (18.1%) and RF (6.0%). Isothermality (Bio3) was out of range for Maxent and RF, but contributed very little to the models (0.8%). Mean annual temp (Bio1) was out of range for most of the study area in the MARS model (8.8%). We elected to not constrain Bio3 or Bio1 because their impacts to the models were much smaller than those of summer day length and Bio18.

Supp. Table 1. Relative contributions of the most problematic covariates for each model.

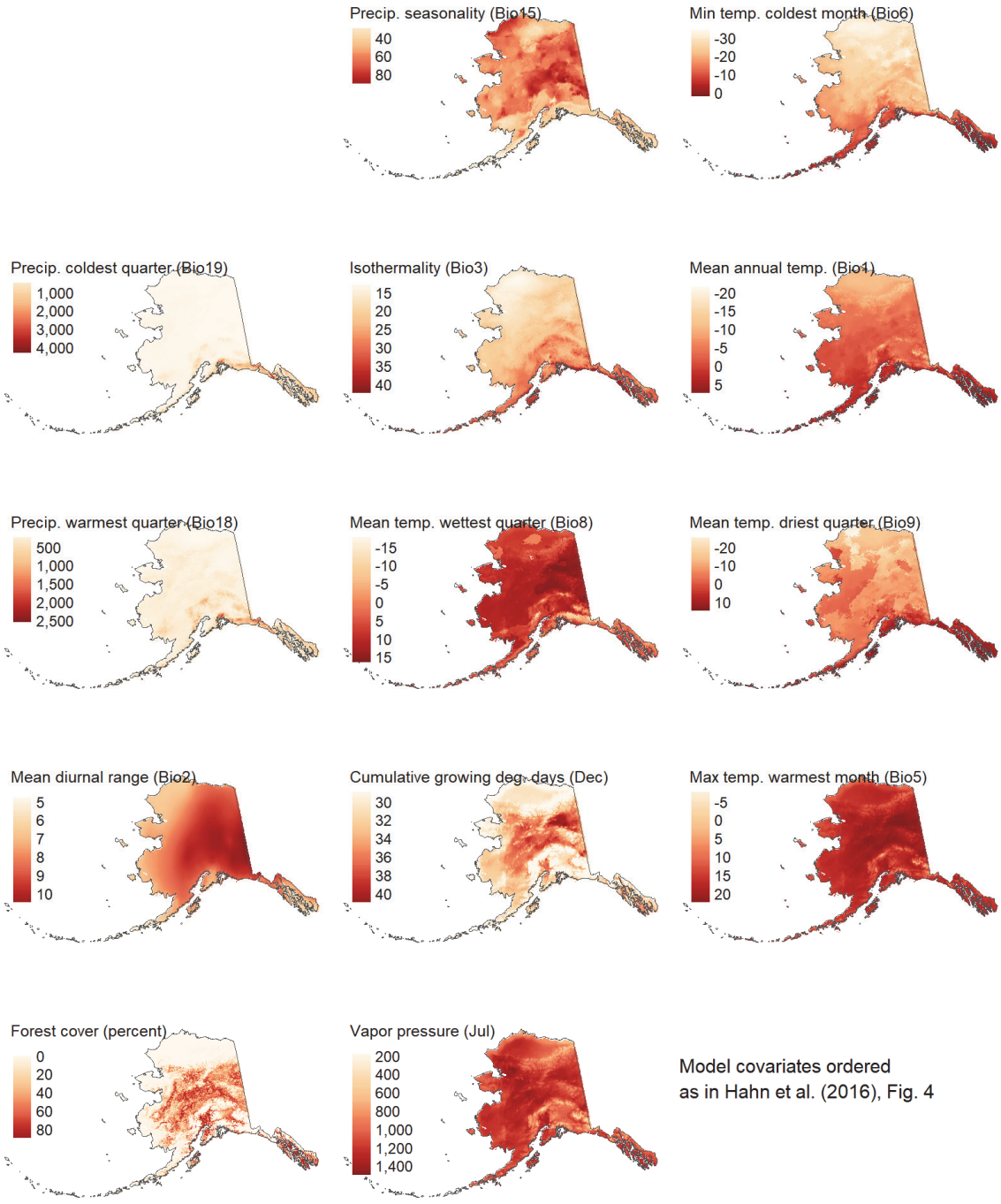
	CA 1km Models					Western County Models			
Predictor	**BRT**	**GLM**	**MARS**	**Maxent**	**RF**	**GLM**	**MARS**	**Maxent**	**RF**
Mean summer day length	-	1.2	3.6	7.9	7.6	-	-	-	-
Precip warmest quarter (Bio18)	-	-	3.4	2.8	5.7	14.4	-	18.1	6.0
Isothermality (Bio3)	Not visible on most of the MoD maps					-	-	0.8	0.8
Mean annual temp. (Bio1)	-	-	-	-	-	-	8.8	-	-

For our regional analysis, we use a modified version of the unified Alaska ecoregions (Supp. Fig. 1) developed by Nowacki et al. (2001). These data are available for download from the USGS Alaska Science Center, https://www.usgs.gov/centers/asc/science/alaska-ecoregions-mapping. In this modified version, we renamed the southern Maritime zone to Temperate and joined the Alaska Peninsula with the Western region. The Alaska Peninsula fits better in the Western region since i) there is not a discrete barrier between the Bristol Bay Lowlands and the Alaska Peninsula, which means that vegetation transitions are gradual, ii) forests are characteristic of the Temperate region but are almost totally lacking on the Alaska Peninsula, iii) the north side of the Aleutian Range has strong climatic and vegetation affinities to the rest of the subarctic adjacent to the Bering Sea and iv) the south side of the Aleutian Range is more different than similar to the Temperate region.

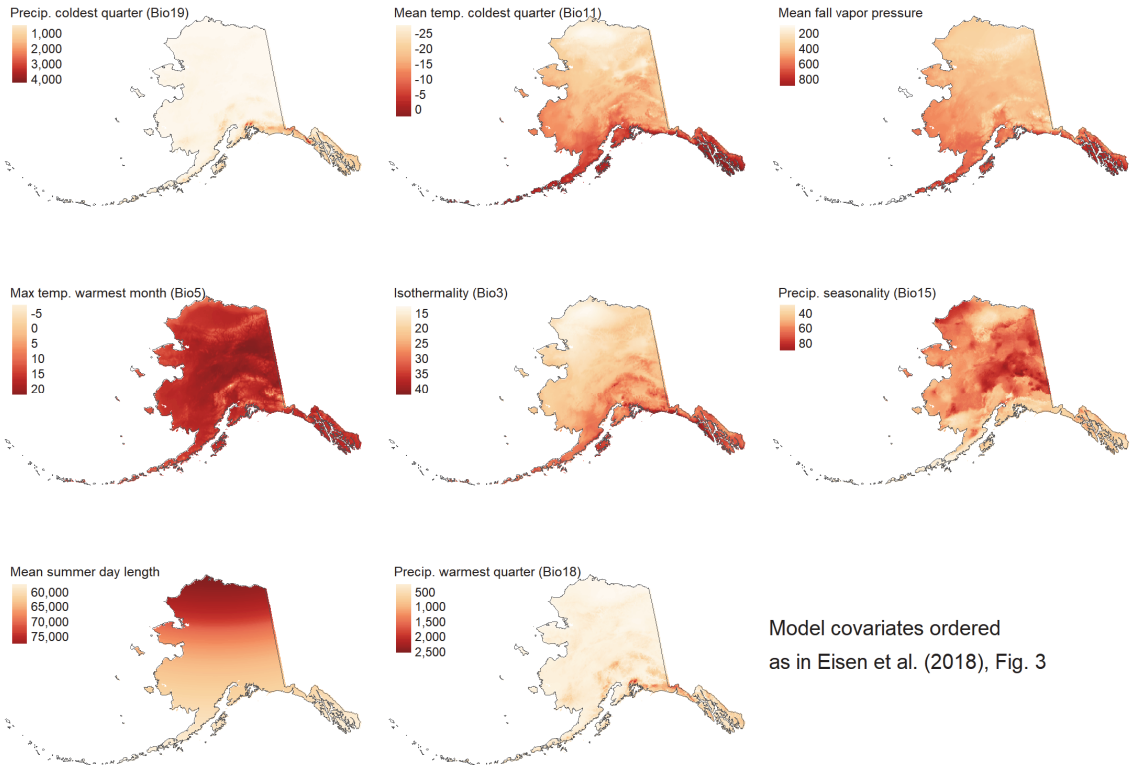


Supp. Fig. 1. Main Alaska subregions, modified from Nowacki et al. (2001).

The following maps show the range and spatial variation of the input covariates for the Western county (Supp. Fig. 2) and CA 1 km (Supp. Fig. 3) sets of models for the period 1980-2014. The maps for the 2070-2100 period exhibit similar spatial patterns, with warmer temperatures (5-10° C) the most noticeable difference for the future forecast.

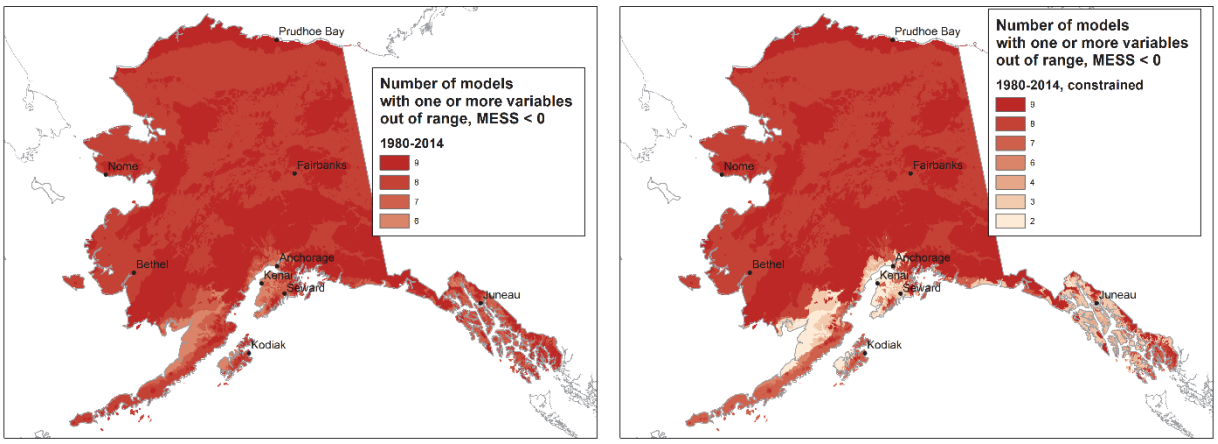


Supp. Fig. 2. Input covariates for *I. pacificus* for the Western county models, 1980-2014.

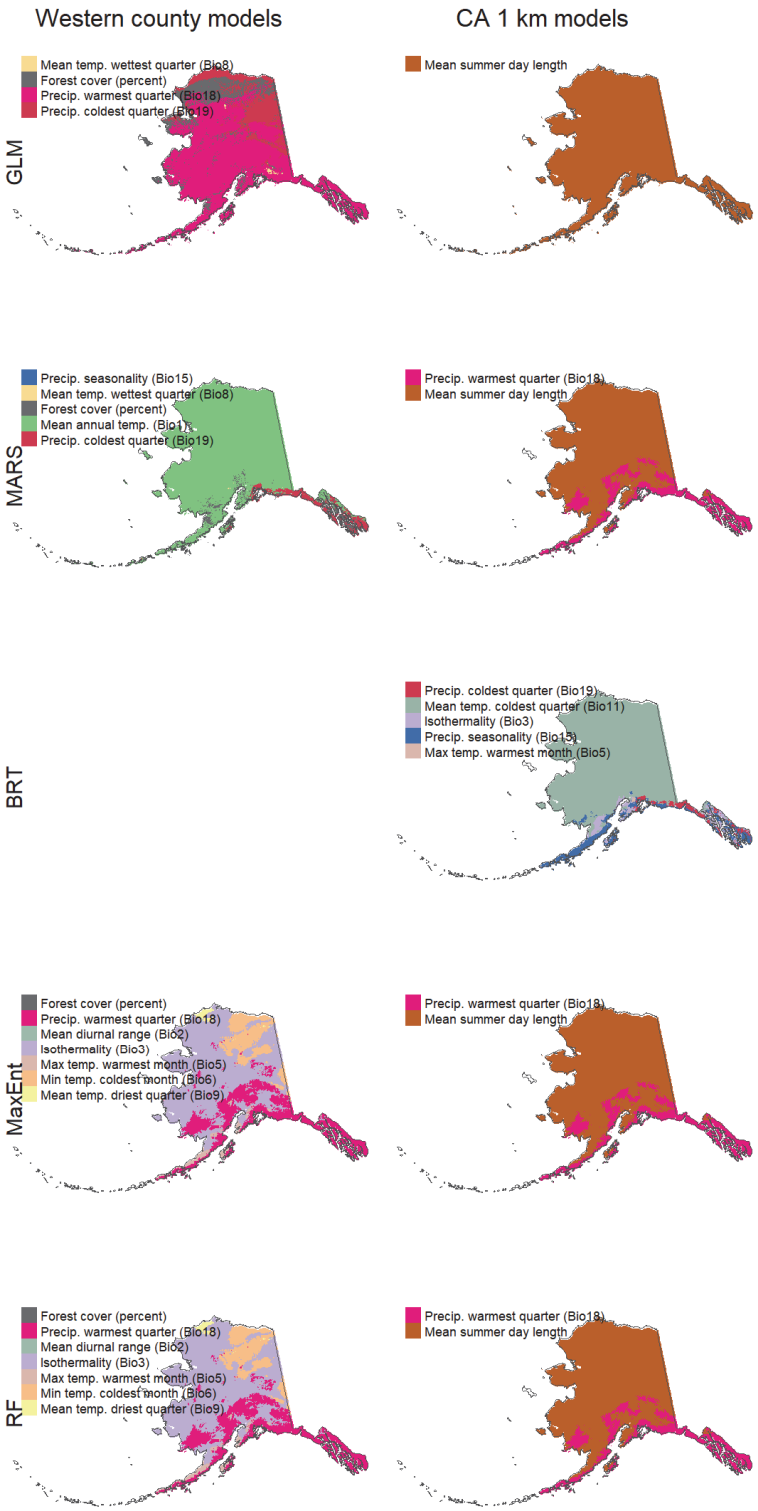


Supp. Fig. 3. Input covariates for *I. pacificus*, for the CA 1 km models, 1980-2014.

Supp. Fig. 4 shows the number of models with one or more variables out of range for a given pixel. Using the observed covariate values for Alaska, six or more models have at least one variable out of range for every pixel. After constraining warm precipitation and summer daylight, many areas in southern and Southeast Alaska have fewer than four models with variables beyond the calibration range. These count MESS maps show the extent and pervasiveness of extrapolation, see Fig. 3 in the main text to see the extrapolation magnitude.

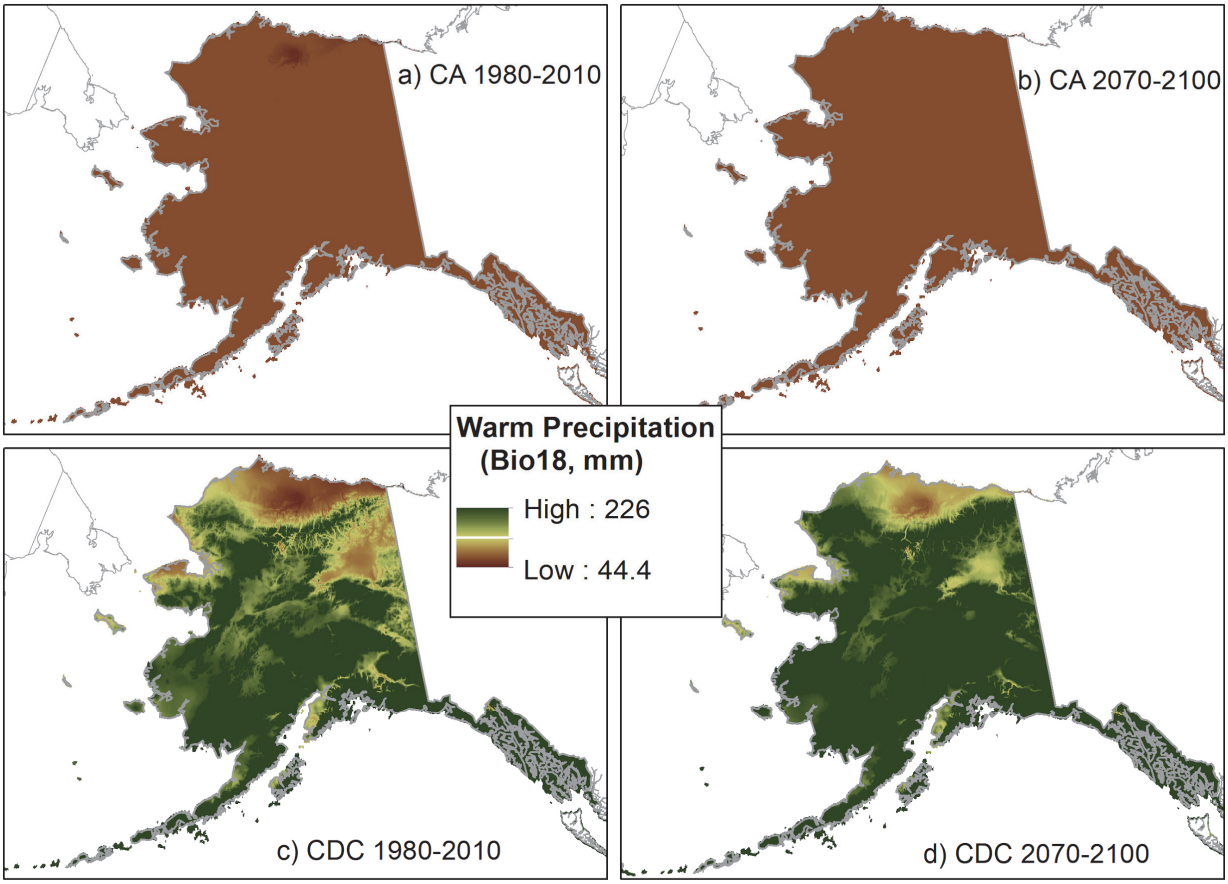


Supp. Fig. 4. Ensemble MESS map for *I. pacificus*, 1980-2014, showing the number of models with one or more variables that are beyond the input model range (MESS < 0). Original on left, summer daylight and precipitation constrained models at right.



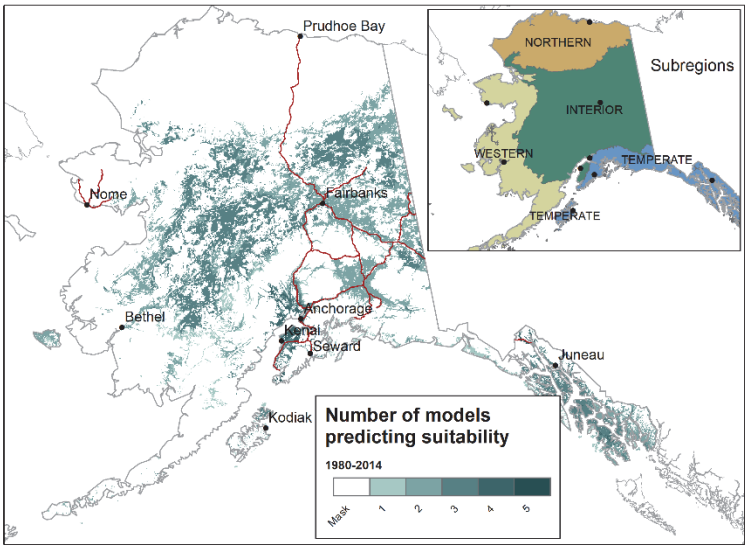
Supp. Fig. 5. Most dissimilar (MoD) variable maps showing which variable drives the MESS map values (i.e. which Alaska variable is most beyond the range of the training data). The summer daylight variable (in brown) and Bio18, warm precipitation (in pink), are most dissimilar for Alaska in many of the models.

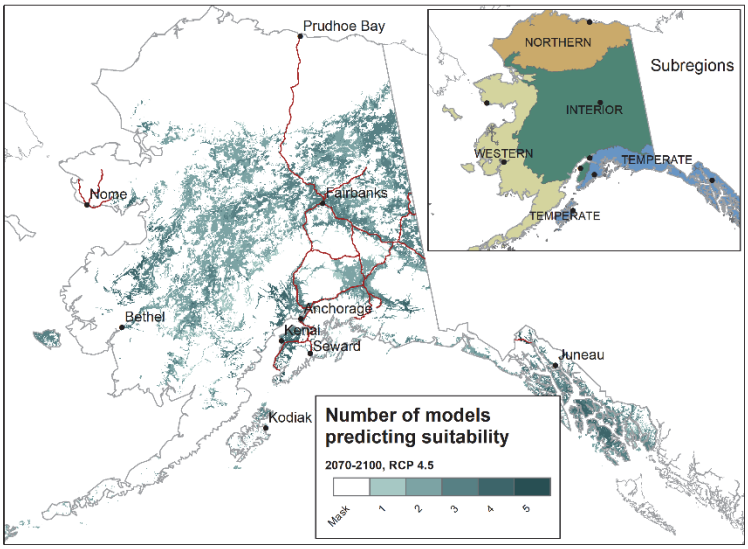
Supp. Fig. 7 shows the modified warm precipitation covariates that were used for the constrained version of the models.

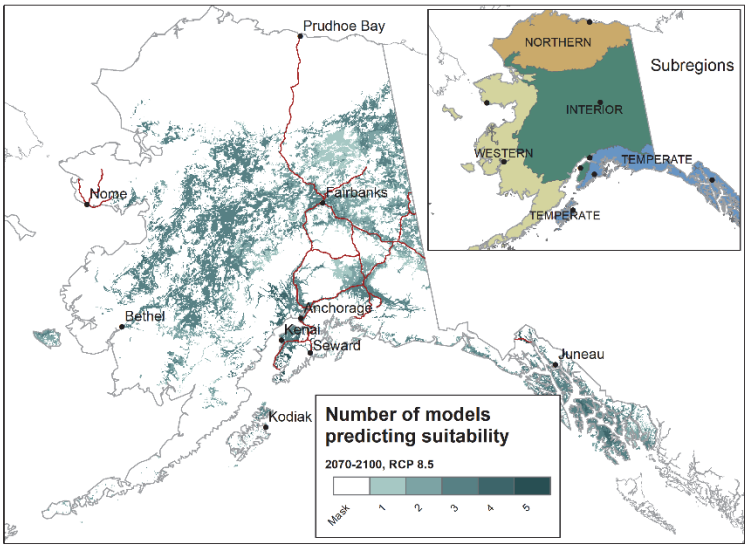


Supp. Fig. 6. Maps showing warm precipitation (bio18) constrained to a maximum of 73 mm based on the CA 1 km (panels a & b) models and 226 mm based on the Western county (panels c & d) models for current and future climatologies.

The ensemble habitat suitability results presented in the main text use a threshold of 3 models to increase confidence in our results and to simplify the visualization. Supp. Fig. 7 shows the full ensemble model counts for the unconstrained ensembles.

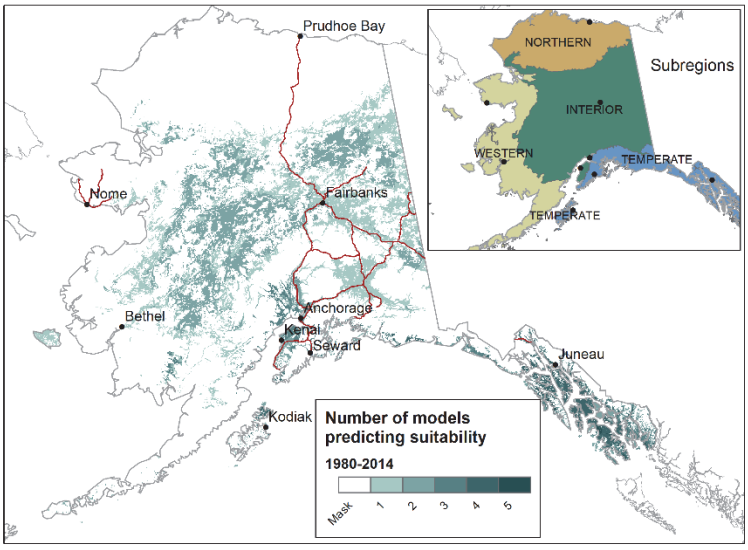






Supp. Fig. 7. Unconstrained ensemble map showing Alaska habitat suitability for *I. pacificus* for the period 1980-2014 (top) and 2070-2100 for RCP 4.5 (middle) and RCP 8.5 (bottom).

The ensemble habitat suitability results presented in the main text for the constrained version use a threshold of 3 models to increase confidence in our results and to simplify the visualization. Supp. Fig. 8 shows the full constrained ensemble model count results for both current and future climatologies.


Prudhoe Bay
Nome
Fairbanks
Bethel
Anchorage
Kenai
Seward
Juneau
Kodiak
Subregions
NORTHERN
INTERIOR
WESTERN
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Number of models predicting suitability
1980-2014
Mask
1
2
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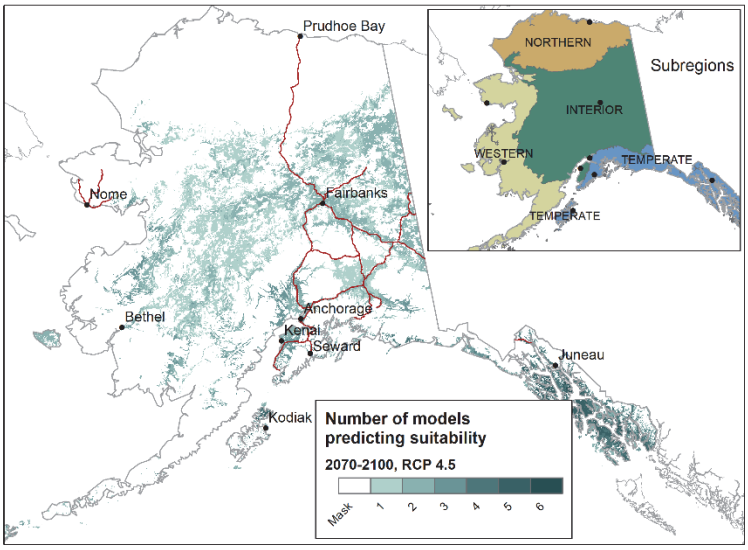
Prudhoe Bay
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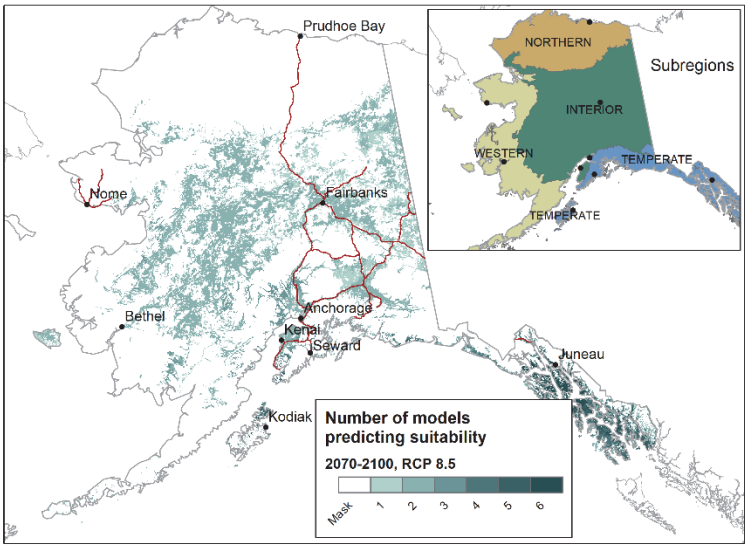

Supp. Fig. 8. Constrained ensemble model results showing Alaska habitat suitability for *I. pacificus* for the period 1980-2014 (top) and 2070-2100 for RCP 4.5 (middle) and RCP 8.5 (bottom).

References

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