Table 1. Predictor variables included in Dakota Skipper global habitat suitability model.

|  |  |  |
| --- | --- | --- |
| Dataset | Covariate | Description |
| Rangeland Analysis Platform Layers (RAP) | PFG | 2018-2021 median perennial forb and grass cover (%) |
| RAP | pfgNPP | 2018-2021 median perennial forb and grass net primary productivity (NPP; lbs/ac) |
| RAP |  AFG | 2018-2021 median annual forb and grass cover (%) |
| RAP | afgNPP | 2018-2021 median annual forb and grass NPP (lbs/ac) |
| RAP | SHR | 2018-2021 median shrub cover (%) |
| RAP | shrNPP | 2018-2021 median shrub NPP (lbs/ac) |
| RAP | TRE | 2018-2021 median tree cover (%) |
| RAP | treNPP | 2018-2021 median tree NPP (lbs/ac) |
| RAP | LTR | 2018-2021 median litter cover (%) |
| RAP |  BGR | 2018-2021 median bare ground (%) |
| Potentially Undisturbed Lands Layer (PUDL) | grs1\_PUDL | Percent cover grass classification that has spectral qualities associated with potentially undisturbed grasslands, and within a zone of potentially undisturbed lands  |
| PUDL | grs2\_PUDL | Percent cover grass classification that has spectral qualities associated with restored grasslands, but within a zone of potentially undisturbed lands |
| PUDL | shrb\_PUDL | Percent cover shrub classification within a zone of potentially undisturbed lands |
| PUDL | grs1\_DIST | Percent cover grass classification that has spectral qualities associated with potentially undisturbed grasslands, but within a zone of disturbed lands |
| PUDL | grs2\_DIST | Percent cover grass classification that has spectral qualities associated with restored grasslands, and within a zone of disturbed lands |
| PUDL | shrb\_DIST | Percent cover shrub classification within a zone of disturbed lands. |
| PUDL | All\_wtr | Percent cover open water classification |
| PUDL | All\_crop | Percent cover crop classification |
| PUDL | All\_fors | Percent cover forest classification |
| PUDL | All\_dist | Percent previously of currently disturbed cover |
| PUDL | All\_grs | Percent all grass classification |
| PUDL | All\_grsshrb | Percent all grass and shrub classification |
| PUDL | PUDL\_grs | Percent all grass classification within a zone of potentially undisturbed lands |
| PUDL | PUDL\_grsshrb | Percent all grass and shrub classification within a zone of potentially undisturbed lands |
| PUDL | DIST\_grs | Percent all grass classification within a zone of disturbed lands |
| PUDL | DIST\_grsshrb | Percent all grass and shrub classification with a zone of disturbed lands. |
| GeoMorpho90 (GM90) | Slope | Rate of change of elevation (degrees) |
| GM90 | Aspect | Angular direction slope face (degrees) |
| GM90 | Aspect\_cosine | Angular direction slope face (continuous) |
| GM90 | Aspect\_sine | Angular direction slope face (continuous) |
| GM90 | Eastness | Sine slope \* cosine aspect |
| GM90 | Northness | Sine slope \* cosine slope |
| GM90 | Convergence | Terrain variable with values ranging from -100 (valleys) to 100 (ridges) |
| GM90 | SPI | Stream power index; upstream catchment area/tangent local slope angle |
| GM90 | CTI | Compound topographic index (or wetness index) is the logarithm of upstream catchment area divided by the tangent of local slope angle and is a proxy for soil moisture availability. |
| GM90 | DX | Slope east-west direction |
| GM90 | DY | Slope north-south direction |
| GM90 | DXX | Derivative of slope east-west direction |
| GM90 | DYY | Derivative of slope north-south direction |
| GM90 | Pcurv | Profile curvature; rate of change of slope along a flow line. |
| GM90 | Tcurv | Tangental curvature; rate of change perpendicular to slope gradient. |
| GM90 | Elev\_Stdev | Standard deviation of elevation in a 3x3 moving window. |
| GM90 | VRM | Vector ruggedness measure; captures variability of slope and aspect by measuring the variation of sine and cosine slope in three dimensions (x,y,z) in 3x3 moving window. |
| GM90 | Roughness | Largest absolute difference in elevation between a focal cell and one of its eight neighboring cells. |
| GM90 | TRI | Terrain ruggedness index is the mean absolute difference between a focal cell and its eight neighboring cells. |
| GM90 | TPI | Topographic position index is the difference in elevation between a focal cell and the mean of its eight neighboring cells. |
| GM90 | Dev\_magnitude | Maximum deviation from mean elevation across multiple moving window sizes (3x3 to 4,001x4,001). Deviation is measured as difference of a focal cell elevation and mean elevation of the window, divided by the standard deviation of elevation. |
| GM90 | Dev\_scale | The window size at which the maximum deviation from mean elevation occurred across all window sizes (3x3 to 4,001x4,001). Deviation is measured as difference of a focal cell elevation and mean elevation of the window, divided by the standard deviation of elevation. |
| GM90 | Rough\_magnitude | Maximum rough value across all moving window sizes (3x3 to 4,001x4,0010). Rough is measured as the spherical standard deviation VRM components. |
| GM90 | Rough\_scale | The window size at which the maximum rough value occurred across all moving window sizes (3x3 to 4,001x4,0010). Rough is measured as the spherical standard deviation VRM components. |
| GM90 | DEM | Elevation (m) |
| SoilGrids250 (SG250) | Bdod | Mean bulk density of fine earth fraction (cg/cm3) |
| SG250 | Cec | Mean cation exchange capacity of the soil (mmol/kg) |
| SG250 | Cfvo | Mean volumetric fraction of coarse fragments (> 2 mm; cm3/dm3 (vol%)) |
| SG250 | Clay | Mean proportion of clay particle (< 0.002 mm) in the fine earth fraction (g/kg). |
| SG250 | Nitrogen | Mean total nitrogen (N; cg/kg) |
| SG250 | Phh20 | Mean soil ph (phX10) |
| SG250 | sand | Mean proportion of sand particles (> 0.05 mm) in the fine earth fraction (g/kg) |
| SG250 | silt | Mean proportion of silt particles (>= 0.002 mm and <= 0.05 mm) in the fine earth fraction (g/kg) |
| SG250 | Soc | Mean soil organic carbon content in the fine earth fraction (dg/kg) |
| SG250 | ocd | Mean organic carbon density (gh/dm3) |
| SG250 | ocs | Mean organic carbon stocks (t/ha) |
| AdaptWest Downscaled PRISM and CIMP6 Climate Data (CIMP6) | MAT | Mean annual temperature (°C) |
| CIMP6 | MWMT | Mean temperature of the warmest month (°C) |
| CIMP6 | MCMT | Mean temperature of the coldest month (°C) |
| CIMP6 | TD | Difference between MCMT and MWMT, as a measure of continentality (°C) |
| CIMP6 | MAP | Mean annual precipitation |
| CIMP6 | MSP | Mean summer (May-Sep) precipitation (mm) |
| CIMP6 | AHM | Annual heat moisture index, calculated as (MAT+1))/(MAP/1000) |
| CIMP6 | SHM | Summer heat moisture index, calculated as MWMT/(MSP/1000) |
| CIMP6 | DD\_0 | Degree-days below 0°C (chilling degree days) |
| CIMP6 | DD5 | Degree-days above 5°C (growing degree days) |
| CIMP6 | DD\_18 | Degree-days below 18°C |
| CIMP6 | DD18 | Degree-days above 18°C |
| CIMP6 | NFFD | Number of frost-free days |
| CIMP6 | FFP | Frost-free period |
| CIMP6 | bFFP | Julian date on which frost-free period begins |
| CIMP6 | eFFP | Julian date on which frost-free period ends |
| CIMP6 | PAS | Precipitation as snow (mm) |
| CIMP6 | EMT | Extreme minimum temperature over 30 years |
| CIMP6 | EXT | Extreme maximum temperature over 30 years |
| CIMP6 | Eref | Hargreave’s reference evaporation |
| CIMP6 | CMD | Hargreave’s climate moisture index |
| CIMP6 | MAR | Mean annual solar radiation (MJ m-2 d-1) |
| CIMP6 | RH | Mean annual relative humidity (%) |
| CIMP6 | CMI | Hogg’s climate moisture index (mm) |
| CIMP6 | DD1040 | Degree-days above 10°C and below 40°C |
| CIMP6 | Tave\_wt | Winter (Dec to Feb) mean temperature (°C) |
| CIMP6 | Tave\_sp | Spring (Mar to May) mean temperature (°C) |
| CIMP6 | Tave\_sm | Summer (June to Aug) mean temperature (°C) |
| CIMP6 | Tave\_at | Autumn (Sept. to Nov) mean temperature (°C) |
| CIMP6 | PPT\_wt | Winter (Dec to Feb) mean precipitation (mm) |
| CIMP6 | PPT\_sp | Spring (Mar to May) mean precipitation (mm) |
| CIMP6 | PPT\_sm | Summer (June to Aug) mean precipitation (mm) |
| CIMP6 | PPT\_at | Autumn (Sept. to Nov) mean precipitation (mm) |
| Sentinel-2 (S2) | TCg | Tasselled cap transformation for greenness (Shi and Xu 2019). (-0.3599 \* B) + (-0.3533 \* G) + (-0.4734 \* R) + (0.6633 \* N1) + (0.0087 \* S1) + (-0.2856 \* S2)  |
| S2 | TCb | Tasseled cap transformation for brightness (Shi and Xu 2019).(0.3510 \* B) + (0.3813 \* G) + (0.3437 \* R) + (0.7196 \* N1) + (0.2396 \* S1) + (0.1949 \* S2) |
| S2 | TCw | Tasseled cap transformation for wetness (Shi and Xu 2019).(0.2578 \* B) + (0.2305 \* G) + (0.0883 \* R) + (0.1071 \* N1) + (-0.7611 \* S1) + (-0.5308 \* S2) |
| S2 | NDVIr | Normalized difference vegetation index (Rouse et al. 1974).(N1 - R) / (N1 + R) |
| S2 | NDVIb | Normalized difference vegetation index (Wang et al. 2007). (N1 - B) / (N1 + B) |
| S2 | NDVIg | Normalized difference vegetation index (Wang et al. 2007).(N1 - G) / (N1 + G) |
| S2 | NDVIre | Normalized difference vegetation index (Gitelson and Merzlyak 1994).(N1 - RE1) / (N1 + RE1) |
| S2 | NDVIresw | Normalized difference vegetation index (Radoux et al. 2016).(RE2 - S2) / (RE2 + S2) |
| S2 | NBR | Normalized Burn Ratio (Coffelt and Livingston 2002).(N1 - S2) / (N1 + S2) |
| S2 | NDMI | Normalized difference moisture index (Wilson and Sader 2002).(N1 - S1) / (N1 + S1) |
| S2 | SAVI | Soil adjusted vegetation index (Huete 1988; L=0.5).(1.0 + L) \* (N - R) / (N + R + L) |
| S2 | MSAVI | Modified soil adjusted vegetation index (Qi et al. 1994).0.5 \* (2.0 \* N1 + 1 - (((2 \* N1 + 1) \*\* 2) - 8 \* (N1 - R)) \*\* 0.5) |
| S2 | EVI | Enhanced vegetation index (Huete et al. 1997; g=2.5, C1=6, C2=7.5, L=1).g \* (N1 - R) / (N1 + C1 \* R - C2 \* B + L) |
| S2 | CIg | Chlorophyll index green (Gitelson et al. 2003).(N1 / G) - 1.0 |
| S2 | Cire | Chlorophyll index red edge (Gitelson et al. 2003).(N1 / RE1) - 1.0 |
| S2 | BAIS2 | Sentinel-2 Burn area index (Filipponi 2018).(1.0 - ((RE2 \* RE3 \* N2) / R) \*\* 0.5) \* (((S2 - N2)/(S2 + N2) \*\* 0.5) + 1.0) |
| S2 | SeLI | Sentinel-2 LAI green index (Pasqualotto et al. 2019).(N2 - RE1) / (N2 + RE1) |
| S2 | S2REP | Sentinel-2 red edge position (Frampton et al. 2013).705.0 + 35.0 \* ((((RE3 + R) / 2.0) - RE1) / (RE2 - RE1)) |
| S2 | TTVI | Transformed triangular vegetation index (Xing et al. 2020).0.5 \* ((865.0 - 740.0) \* (RE3 - RE2) - (N2 - RE2) \* (783.0 - 740)) |

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