6 Supplementary Materials

6.1 Target-netting methods

We recommend the following techniques for Olive-sided Flycatcher capture, two of which relate to distinct trapping periods during nesting. Although tagged birds (no longer "naive" to capture) were often more difficult to trap, these methods proved successful:

(1) **Early breeding/pre-incubation period (late May-mid June)**. Territory owners (especially naive males) are quite reactive to conspecific decoy and playback prior to incubation. Taxonomic skins make ideal decoys but are difficult to obtain. We purchased painted wooden species decoys from eBay (Hummingbird Studios, Seller: yaoqiangli1956), and augmented white flank patches with a paint pen (Fig. S1). White flank patches are conspicuous long-distance visual marks (Bent 1942), often visible on displaying or agitated individuals (Hagelin, pers. obs.). When available, we also glued a few flank feathers to each side of the decoy, to further exaggerate the flank region. We attached decoys to existing snags or mist-net poles and hid a remote-controlled Foxpro® Firestorm in the bushes below to play a loop of species-typical "Quick-Three-Beers" song, followed by a mix of chortles and bill-clapping (aggression), and twittering (a sexual vocalization [28, 42]). Vocalizations are available from the Macaulay Library www.macaulaylibrary.org and xeno-canto.org. Species-typical song appeared to entice birds over long-distances, but addition of

chortling and other conspecific sounds greatly enhanced adult reactivity (Hagelin, pers. obs). We avoided trapping during incubation to minimize risk of nest abandonment.

Figure S1: Wooden decoy (with white paint augmenting flank patches) used for target-netting Olive-sided Flycatchers.

(2) **Post-hatch period (June-early July)**. We targeted adults with chicks no older than 2 weeks of age, to avoid accidental forced fledging. Parents at this stage did not react to conspecific decoys but responded readily to decoys and playback of local predators. We used a taxonomic skin of a red squirrel (*Tamiasciurus hudsonicus*) in Fairbanks area sites, and a plastic model of a Black-billed Magpie (*Pica hudsonia*; purchased on Amazon [brand: GUGULUZA]) in Anchorage. Some nests in boreal Alaska are relatively accessible (2-10m high), making it possible to mimic a predator approaching the nest via the

following method. A camouflaged investigator stood at the base of the nest tree and slowly moved the predator decoy (e.g., squirrel round skin attached to the tip of a mist net pole with a zip-tie) closer to the nest by adding more net poles. The decoy was maneuvered to simulate irregular climbing or "hopping" movements, as it slowly ascended the trunk and branches toward the nest. This method, often combined with playback (e.g., squirrel chatter), incited adults to dive-bomb the predator decoy and usually hit a mist net, set up in a V-shaped or triangular arrangement around the nest tree.

(3) **Passive mist netting**. We employed passive netting only when the two methods above failed. Passive netting required knowledge of adult habits and nest location. We erected nets in preferred aerial paths used to enter/exit the nest and also in nearby foraging areas. As many as 12 mist nets, checked every 20-30 minutes for multiple hours, usually resulted in successful adult capture.

6.2 Harnessing method

The video at this site demonstrates how to create a synsacrum harness from Stretch Magic™ material for deploying archival light-level geolocators and archival GPS tags: https://sites.google.com/site/lukelpowell/research/rusty-blackbirds.

6.3 Pre-programmed schedules of archival GPS tags

Two types of archival GPS tags (10-point and 80-point) were used in our study (Table 1). We programmed 10-point tags to collect one fix per month over a 5-month period from 15 September to 15 January, and five remaining fixes once per week during spring, beginning on 15 March through 23 April. By contrast, schedules of 80-point "Swift fix" tags focused more on fall and spring movement periods. We acquired the first fix within 1 degree latitude/longitude of breeding deployment locations, per manufacturer instructions. Then, starting 1 August, fixes during fall migration occurred every 3-4 days through the first week of October (with a 2-day delay between fixes), yielding 32 points. For the stationary wintering period, fixes occurred twice monthly (with a 15-day delay) in the latter half of the month (e.g., 15th and 30th) from October through February, yielding 10 points. Beginning 1 March, points during spring were again taken 3-4 days per week (2-day delay) through the first week of May, with an additional point added during the last 3 weeks of April, prior to arrival in Alaska (6-day delay, starting on 12 April), yielding 37 points. Both 10- and 80-point GPS tags took fixes at 1800 GMT, which equated to 9am-2pm local time throughout the western breeding, migratory and winter range. Collecting data during these times of day aimed to increase the likelihood of securing a successful fix, since birds perched and foraged from treetops [28] during midday and would likely be in full view of satellites.

6.4 Re-sight protocol for tagged birds

We surveyed deployment sites annually for up to three summer seasons in an effort to recover tags. If birds were not detected immediately, we typically conducted surveys at least three times during peak singing (late May-early July [42]) at 5 or more points spaced ~300m apart in the vicinity of the nest location from the previous year.

We estimate that this provided a minimum 90% detection probability, given detection distances of ~400m (max. 654 m) and singing rates of 120 songs/hr, as quantified in [42]. Our specific re-sight protocol involved listening at a point for 10-minutes, before initiating 1-minute playback of conspecific calls, followed by 10-minutes more of listening. This level of playback did not result in nest abandonment or acclimation to recorded song prior to target netting. Olive-sided Flycatcher territories in boreal Alaska are typically oblong (e.g., ~625m long x ~300m wide) and follow contours of wet habitat features [42], allowing us to thoroughly search the original territory and other habitat adjacent to a wet habitat feature.

6.5 Zenith angle detail for geolocators

To calibrate zenith angle during the stationary non-breeding season (early October-early April), we attached 4 geolocators to perches at canopy height within known Olive-sided Flycatcher habitat in Latin America (Ecuador n = 2, Nicaragua n = 1, Guatemala n = 1). Attachment sites included known locations (e.g., GPS points) where wintering individuals had been spotted in previous years. Zenith angles calculated from these geolocators, however, did not produce results that differed notably from those collected on live birds at breeding sites in Alaska, prompting use of on-bird estimates from boreal habitat in our analysis (see Methods: 2.4 Light-level geolocation data).

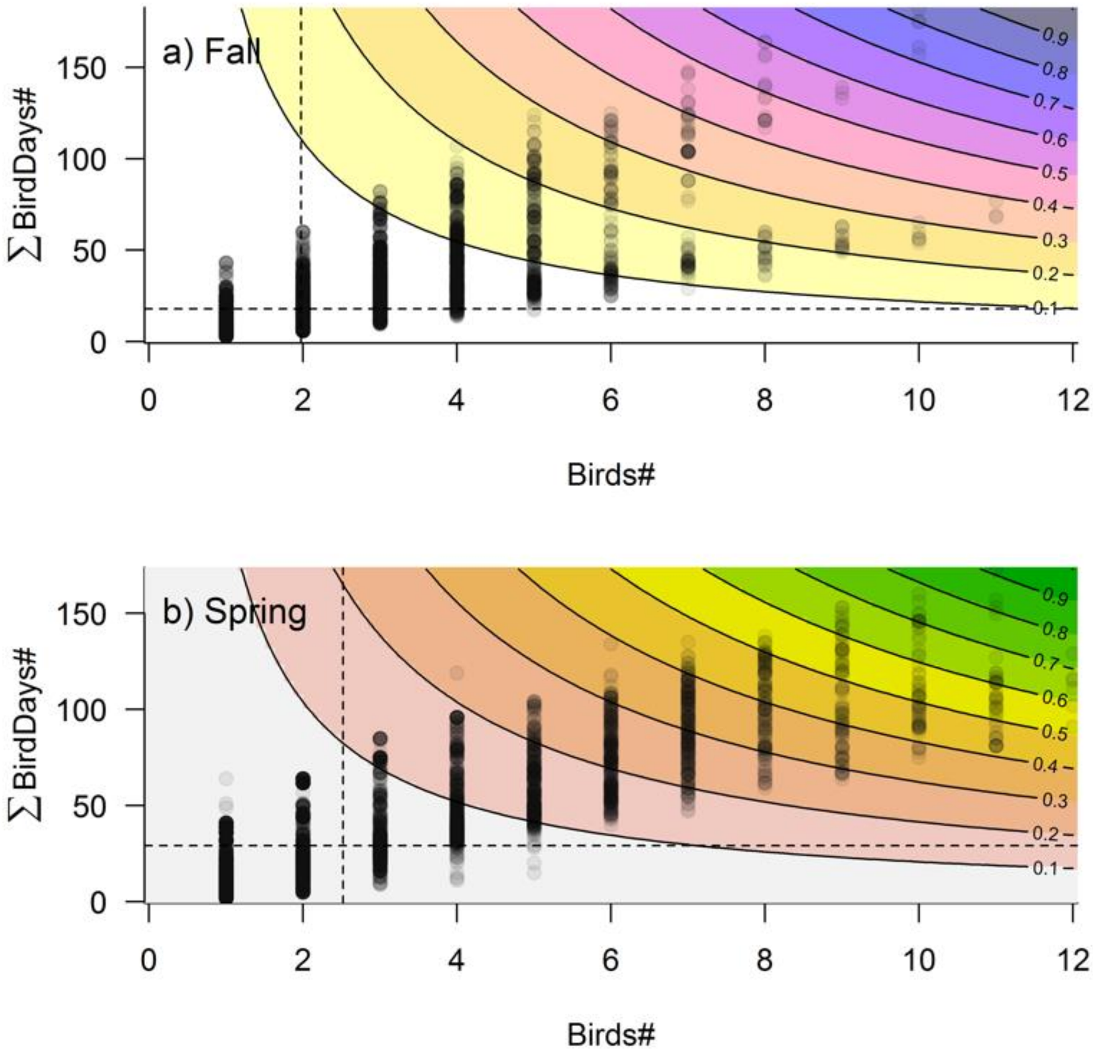

Figure S2: Relationship between two variables that comprise the importance score, which measures intensity of bird use, during a) fall and b) spring migration of Olive-sided Flycatchers (*Contopus cooperi*) from boreal Alaska. Each axis represents summed raw data generated by overlaying the seasonal migratory routes (and associated uncertainty) of 14 birds that carried light-level geolocators (see: Fig. 2a,b and 2d,f). Per pixel sums represent the estimated the number of birds (Birds#) and total bird-days (sum of individual stopover durations, or ΣBirdDays#) for each migratory period. Dashed lines indicate mean pixel values, and colored shading represents the value of the importance score. Importance scores ≥ 0.2 were used to delineate Important Stopovers (e.g., Fig. 3), because they were associated with above-average pixel values for both variables in both seasons, indicating high-intensity bird use. See also Methods: 2.6 Identification of “Important Stopovers”.

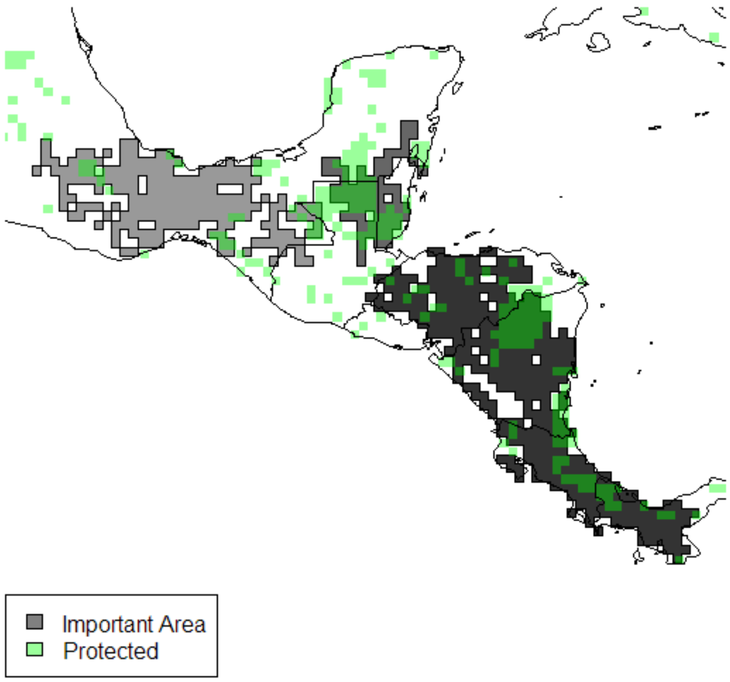

Figure S3: Example data from the World Database of Protected Areas (in green, www.protectedplanet.net) overlaid on the spatial extent of 3 Important Stopovers of Olive-sided Flycatchers (represented as 3 shades of gray) from Fig. 4. This illustrates the method used to calculate the percent land area currently "protected" for each Important Stopover provided in Table 3 (see also Methods: 2.7 Percent protection of Important Stopovers).

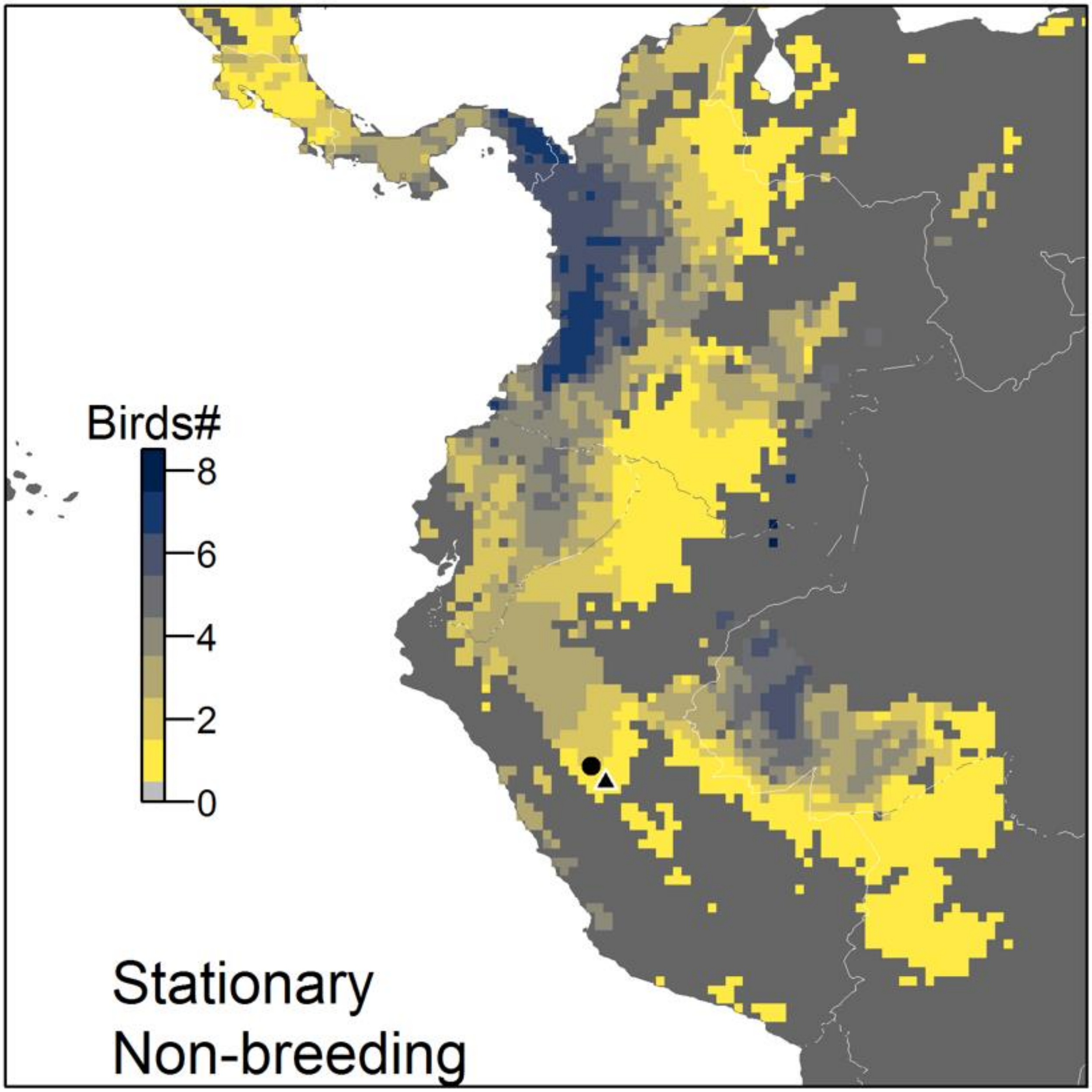

Figure S4: Enlarged version of Fig. 2g, representing the stationary non-breeding areas of 16 Olive-sided Flycatchers from boreal Alaska. The heatmap represents the relative number of individuals (Birds#) summed per pixel from 14 adults that carried light-level geolocators. The black circle and triangle indicate GPS locations of 2 additional birds obtained during stationary non-breeding months only. Spatial resolution of modeled geolocator data is 0.25° x 0.25°(or ~500 km^2).

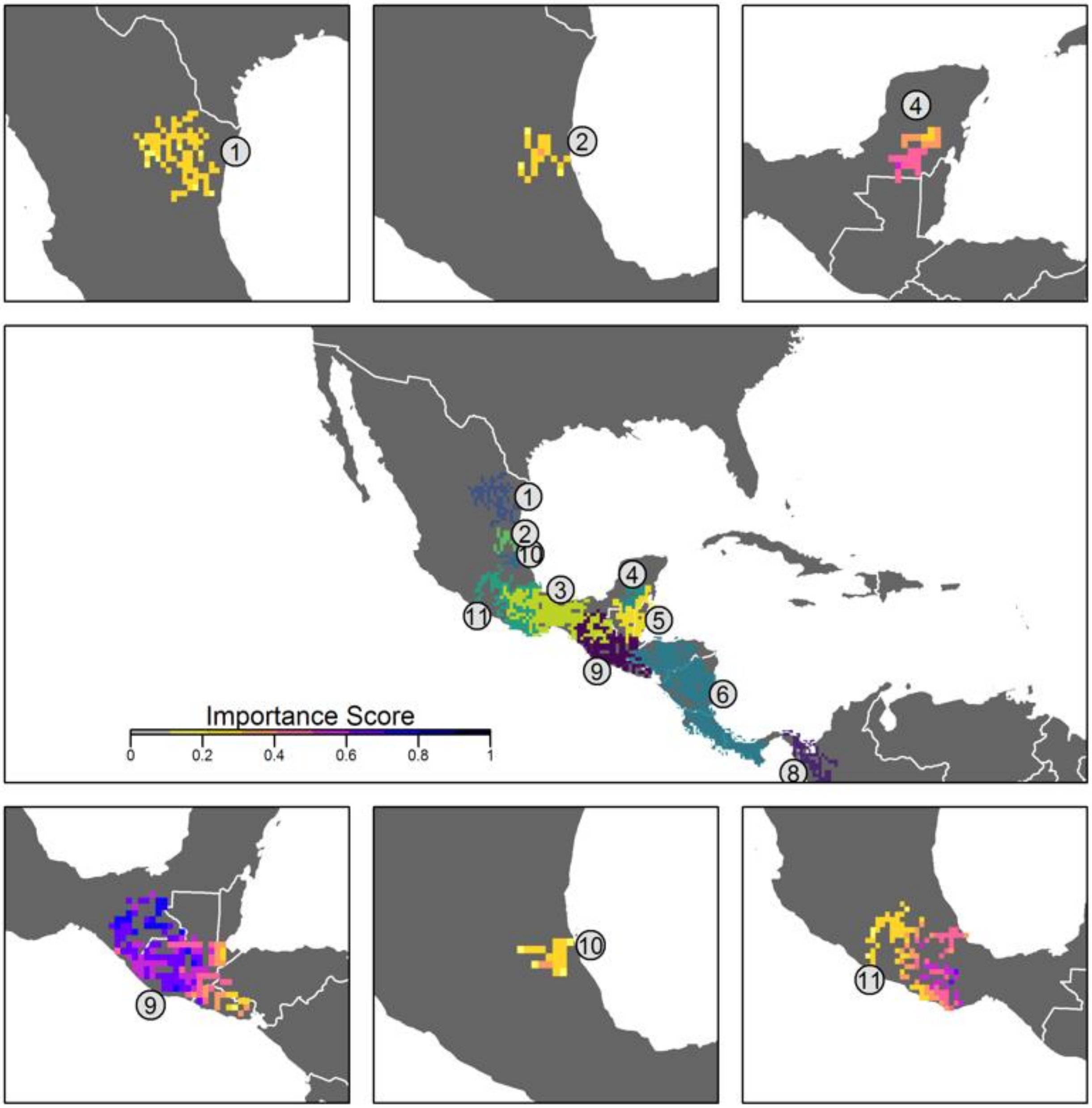

Figure S5: Important Stopovers used by Olive-sided Flycatchers (*Contopus cooperi*) from boreal Alaska primarily during fall migration (top panels) and spring migration (bottom panels), and the locations of each relative to all sites identified in the Mexico/Central America region (center panel). Three sites in the center panel used during both seasons are provided in Fig. 4. Heatmaps of the importance score within each Important Stopover provide detailed information on the intensity of bird use. Areas of high-intensity use can inform the location of future field studies aimed at quantifying habitat use and threats. Numbering cross-references with data in Table 3 and other Important Stopover figures. Pixel-level data for heatmaps are provided in Appendix 1. Spatial resolution of modeled geolocator data is 0.25° x 0.25°(or ~500 km^2).

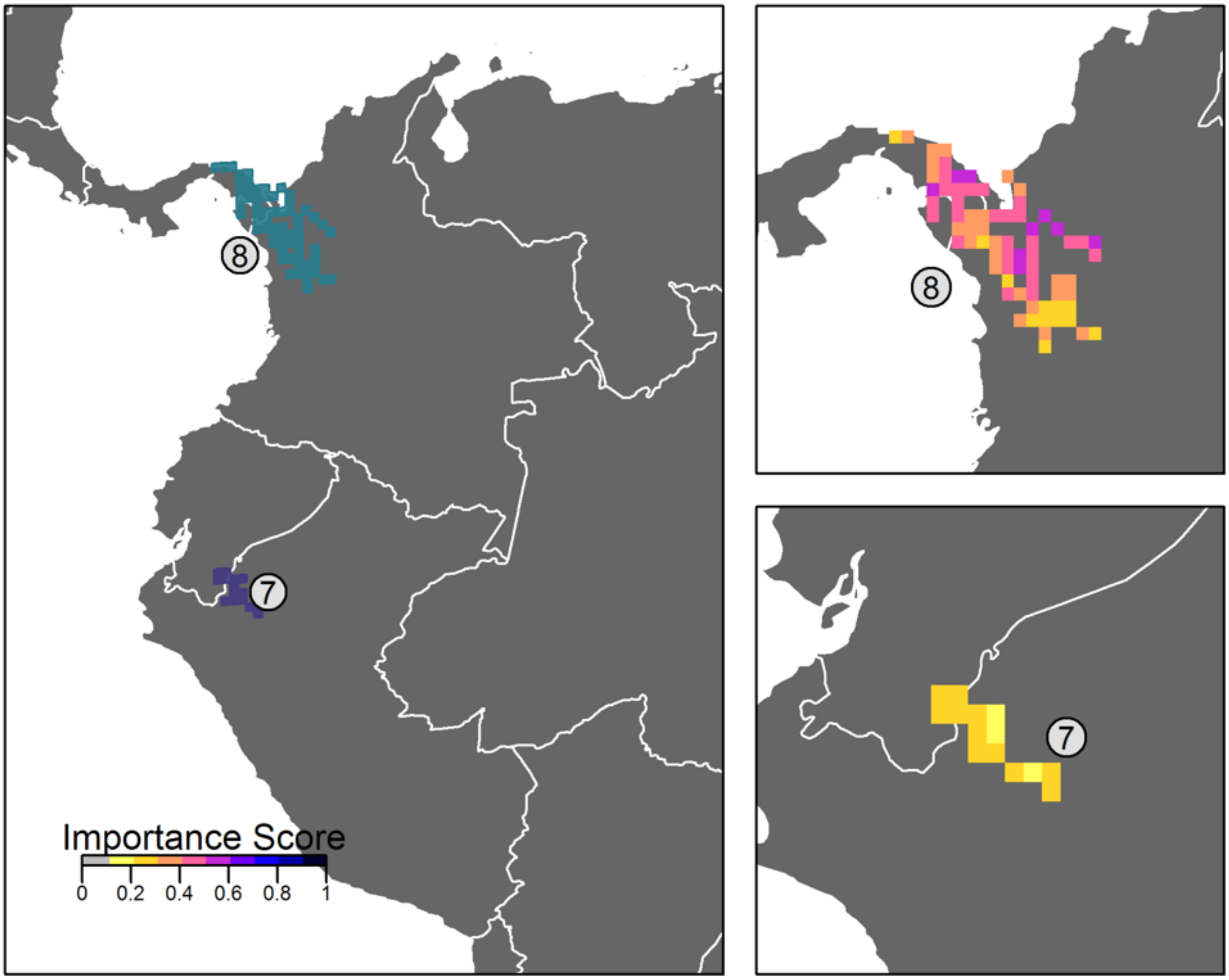

Figure S6: Important Stopovers in South America used by Olive-sided Flycatchers (*Contopus cooperi*) from boreal Alaska. Heatmaps of the importance score (right panels) provide detailed information on the intensity of bird use. Areas with high-intensity use can inform the location of future field studies aimed at quantifying habitat use and threats. Numbering cross-references with data in Table 3 and other Important Stopover figures. Pixel-level data for heatmaps are provided in Appendix 1. . Spatial resolution of modeled geolocator data is 0.25° x 0.25°(or ~500 km^2).

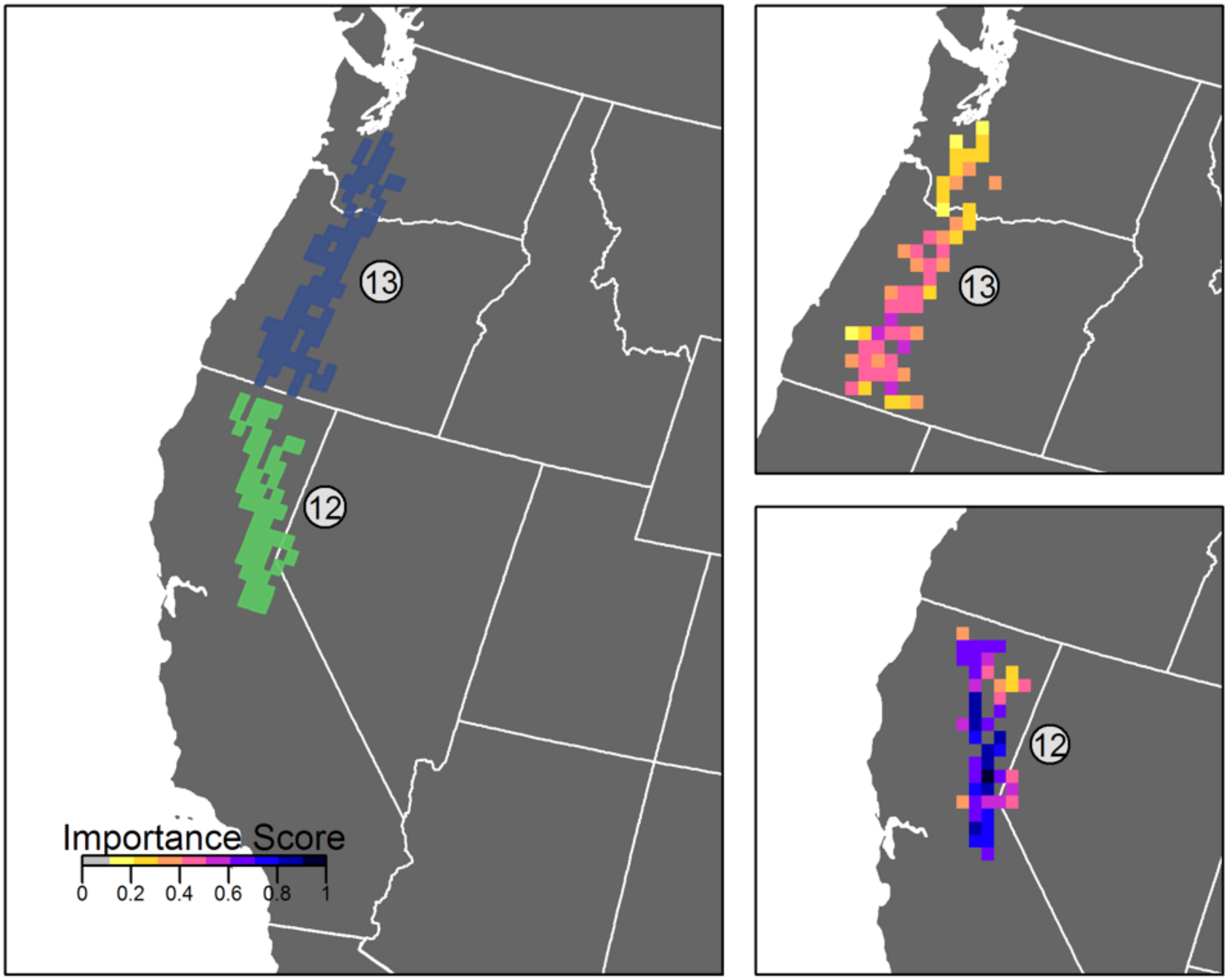

Figure S7: Important Stopovers in the western USA used by Olive-sided Flycatchers (*Contopus cooperi*) in spring enroute to breeding grounds in boreal Alaska. Heatmaps of the importance score (right panels) provide detailed information on the intensity of bird use. Areas with high-intensity use can inform the location of future field studies aimed at quantifying habitat and threats. Numbering cross-references with data in Table 3 and other Important Stopover figures. Pixel-level data for heatmaps are provided in Appendix 1. Spatial resolution of modeled geolocator data is 0.25° x 0.25°(or ~500 km^2).

Appendix 1: "Appendix 1" is a geoTiff (raster) file provided in Supplementary Materials. It contains the fall and spring importance scores illustrated in heatmaps (Fig. 4 and Fig. S5-S8). Importance scores were derived from light-level geolocator data to define the 13 Important Stopovers used by 14 Olive-sided Flycatchers (*Contopus cooperi*) from boreal Alaska. The first band in the geoTiff file is "fall" data and the second band is "spring." Note: GeoTiff files are intended for GIS applications (e.g., R, QGIS, ArcMap), not Google Earth.