Effects of light pollution on distributions of two species on southern California beaches

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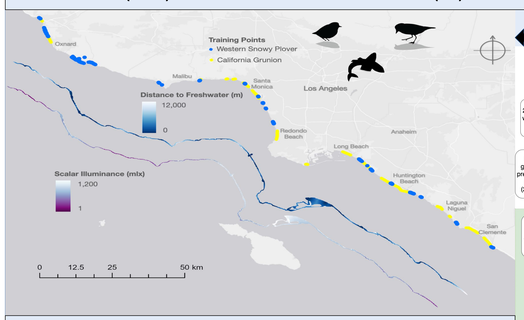
Abstract

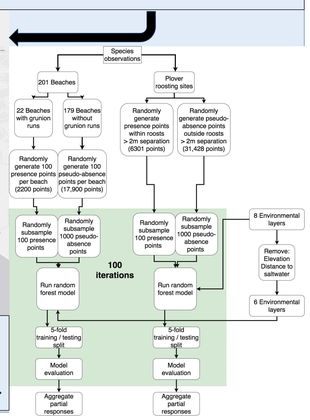
Studies of the influence of artificial light at night on the distribution of species have relied on remote sensing of its upwards radiance, rather than credible estimates of light exposure from the perspective of the organism. We demonstrate the use of exposure to nighttime lighting modeled from ground-level measurements within spatial distribution models for both roosting of Western Snowy Plovers and spawning of California Grunions. Exposure to artificial light at night (ALAN) was the most important environmental factor influencing distribution of grunion runs, and second most important factor for plover roosts. With evidence of ALAN providing significant ecological disturbances we recommend control of nighttime illumination to mitigate disturbances to coastal, and potentially other, environments.

Background & Methods

- Community science observations (Plover roosts & grunion runs)
- 8 Environmental layers
  - Log(SI) - Scalar illuminance of the hemispherically integrated exposure to ALAN (Simons et al., 2020)
  - Beach category: (1) Flat, undeveloped landscapes containing no buildings within 100 m of the shoreline, (2) Flat, developed landscapes containing buildings within 100 m inland of the coastline, (3) Elevated, undeveloped landscapes where land rises to more than 10 m of elevation within 100 m inland of the coastline, (4) Elevated, developed landscapes where land rises to more than 10 m of elevation within 100 m inland of the coastline, and contains buildings within 100 m of the shoreline, (5) Beaches backed by water where open water bodies are within 100 m inland of the coastline, and (6), Beaches backed by water that is developed into a marina or port.

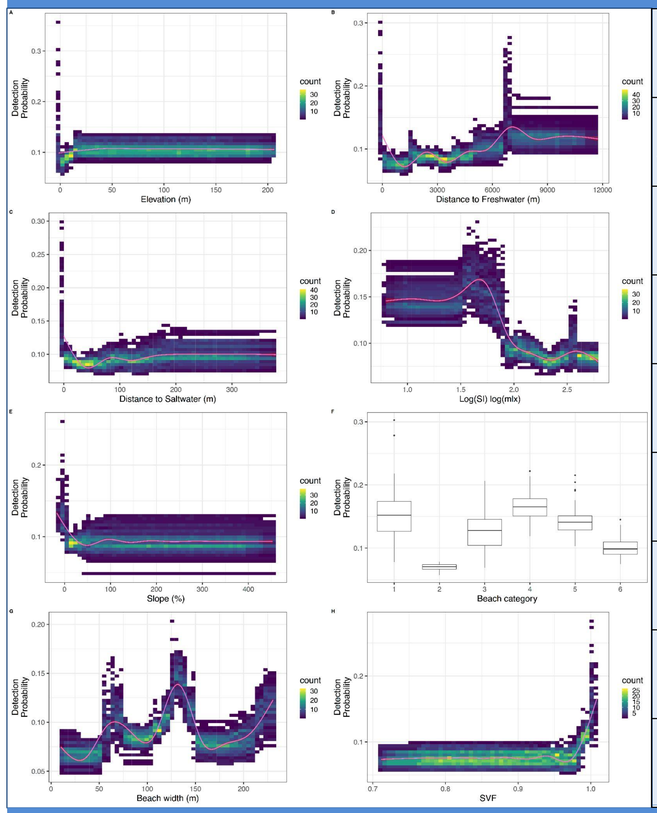
Distribution of training points for plover roosts and grunion run locations on sandy beaches. Study area: 1.5 km wide coastal strip of Ventura, Los Angeles, and Orange counties. Included are examples of environmental layers for hemispherical illuminance (mlx) and distance to freshwater (m).





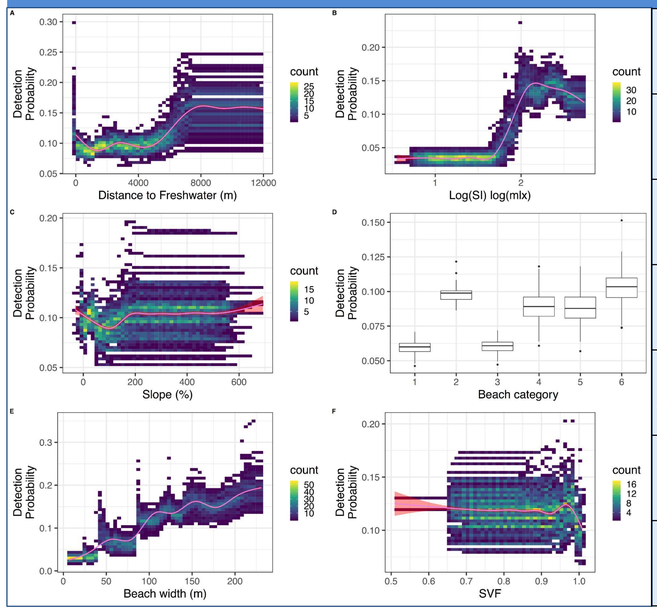
Flowchart describing our workflow using random forest models of grunion runs and plover roosts based on our environmental layers.

Results - Plover Roosts



Variable	Rank
Distance to freshwater	1
Log(SI)	2
Sky View Factor (SVF)	3
Beach width	4
Elevation	5
Distance to saltwater	6
Slope	7
Beach category	8

Results - Grunion Runs



Variable	Rank
Log(SI)	1
Beach width	2
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Distance to freshwater	4
Slope	5
Beach category	6

Conclusions

Of the environmental factors considered, we found exposure to ALAN to be important in influencing the distributions of both species.

- Grunion runs
  - The likelihood of grunion runs peaked near 100 mlx, the illumination from a full moon at mid latitudes (Kyba et al., 2017).
  - Grunion runs are more common along wide, flat beaches backed by illuminated bodies of water.
- Plover roosts
  - The likelihood of a roosting declined significantly above 50 mlx, falling to 50% of their peak above 100 mlx.
  - Plover roosts are more common in wide beaches near, but not immediately adjacent to, freshwater.

References

- Kyba, C., Mohar, A., & Posch, T. (2017). How bright is moonlight. Astron. Geophys, 58, 31-32.
- Simons, A. L., Yin, X., & Longcore, T. (2020). High correlation but high scale-dependent variance between satellite measured night lights and terrestrial exposure. Environmental Research Communications, 2(2), 021006.

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