Designing Sustainable Landscapes: Traffic metric

A project of the University of Massachusetts Landscape Ecology Lab

Principals:

- Kevin McGarigal, Professor
- Brad Compton, Research Associate
- Ethan Plunkett, Research Associate
- Bill DeLuca, Research Associate
- Joanna Grand, Research Associate

With support from:

- North Atlantic Landscape Conservation Cooperative (US Fish and Wildlife Service, Northeast Region)
- Northeast Climate Science Center (USGS)
- University of Massachusetts, Amherst

Reference:

McGarigal K, Compton BW, Plunkett EB, DeLuca WV, and Grand J. 2018. Designing sustainable landscapes: traffic metric. Report to the North Atlantic Conservation Cooperative, US Fish and Wildlife Service, Northeast Region.

General description

The traffic metric assesses the effect of road (and railroad) traffic on animal populations due to road mortality. It integrates the distance to and traffic intensity of roads in the neighborhood of the focal cell. The traffic metric (**Fig. 1**) is an element of the ecological integrity analysis of the Designing Sustainable Landscapes (DSL) project (see technical document on integrity, McGarigal et al 2017). Consisting of a composite of 21 stressor and resiliency metrics, the index of ecological integrity (IEI) assesses the relative intactness and resiliency to environmental change of ecological systems throughout the northeast. As a stressor metric, Traffic values range from 0 (no effect from road traffic) to 1 (severe effect; although in real landscapes, the metric never reaches 1).

Use and interpretation of this layer

This metric relies on several assumptions:

- The road and traffic data are correct. See Traffic settings variable (McGarigal et al 2017) for assumptions in the traffic estimates.

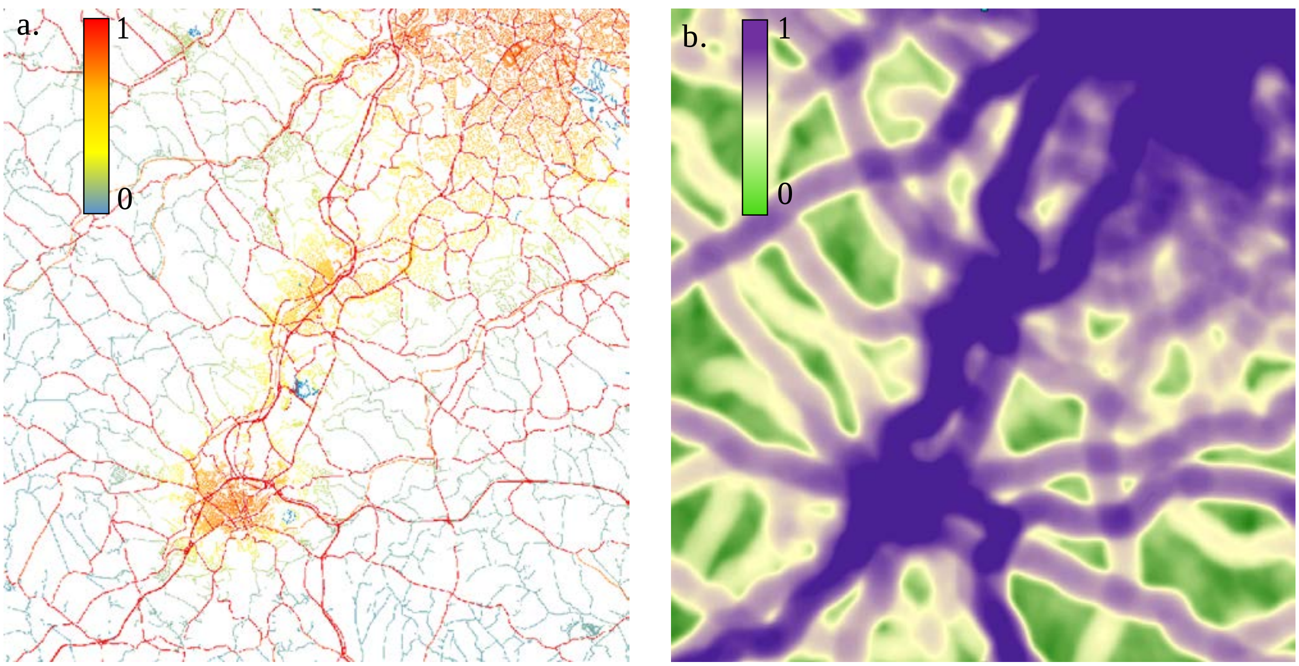

Figure 1. An example of the traffic metric in southwestern Pittsburgh and Washington, Pennsylvania. (a) Gibbs-transformed traffic rate (probability of mortality), (b) results of the traffic metric.

- Traffic is a generic metric, not parameterized to any particular species. Data on homerange sizes and migration and dispersal distances as well as habitat selection would be required to parameterize traffic for a particular species; in the integrity metric, we use a generic parameterization, which should, in general, be monotonically related to the risk of traffic mortality for any particular species.

- Traffic patterns vary by time of day, day of week, and time of year, and animal movements vary by season and time of day. Here, we use average traffic rates.

Derivation of this layer

Data sources

- Traffic rate. Traffic rates were estimated from road size and development intensity based on a model described in Traffic settings variable (McGarigal et al 2017). Raw traffic rates are Gibbs-transformed to an estimate of the probability of mortality for an animal crossing each road.

Algorithm

The traffic metric is the sum of Gibbs-transformed traffic rates (probability of mortality) within a logistic kernel centered on each focal cell (inflection point = 800, scaling factor = 100; **Fig. 2**), normalized by the maximum possible sum:

$$\frac{\sum_{ij} R_{ij} K_{ij}}{\sum_{ij} \lceil R \rceil K_{ij}}$$

where *ij* = cells in the neighborhood of the focal cell, *R* = Gibbs-transformed traffic rate for cell *ij*, L_{ij} = landcover class at cell *ij*, and K_{ij} = logistic kernel weight at cell *ij*.

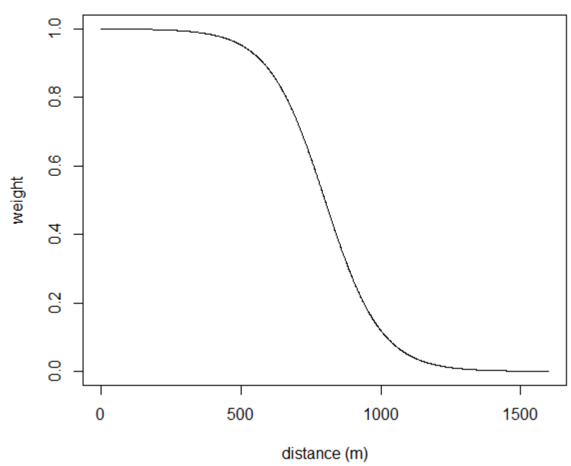

Figure 2. The logistic kernel used for the traffic metric.

Thus, traffic will be higher for points closer to more high-traffic roads. A cell with no traffic within about 2 km will get a value of zero; a cell in a highly urbanized center where most cells a roads with high traffic rates that result in a probability of mortality close to 1 will get a high value (approaching 1, theoretically, though this never happens in a real landscape).

GIS metadata

This data product is distributed as a geoTIFF raster (30 m cells). The cell values are continuous, representing the intensity of traffic in the neighborhood. This data product can be found at McGarigal et al (2017):

Literature Cited

McGarigal K, Compton BW, Plunkett EB, DeLuca WV, and Grand J. 2017. Designing sustainable landscapes products, including technical documentation and data products. https://scholarworks.umass.edu/designing_sustainable_landscapes/