Evading the Inevitable

Rabies virus is a fatal disease that can be transmitted between mammals and humans through contact with an infected animal’s saliva, typically through a bite. Although rabies is preventable through vaccination, this virus remains endemic to much of the world, with some countries experiencing an increase in incidence of rabies in recent years. However, Australia is unique in its historical ability for successfully preventing the intrusion of rabies within its borders, which has been accomplished through extremely strict import, quarantine, and vaccine protocols involving domestic animals.

Unfortunately, these strict precautions may soon be in vain, as rabies continues to run rampant in countries surrounding Australia—the notoriously dangerous Indonesian Archipelago and Papua New Guinea; both of which participate in heavy trade with Australia and are within 300 km off the northern coast of the continent. Rabies can be contracted by any of the 30 wild-mammal species that inhabit Australia, spreading between domestic animals, livestock, and humans.

This is especially risky for wide-ranging endemic carnivore species such as the wild dingo and red fox, whom are ideal carriers and transmitters of the virus. The inherent and inevitable risk of rabies entering Australia could be less damaging if there is an understanding of the potential entry points, disease spread, and factors that play an important role in mitigating this deadly virus.

Methods

The final rabies risk analysis included a weighted risk analysis for humans, weighted risk analysis for wildlife, and combined unweighted risk analysis for humans and wildlife. These three maps were produced by running a variety of tools including geoprocessing methods, merge, polygon to raster, kernel density, and reclassify. Zonal statistics was applied to the human risk analysis to show risk per Australian county.

The five factors used in the analysis are mapped below in their raster form, and were weighted in raster calculator with the following weights: Human Risk Analysis: 10% At Risk Species Density + 15% Dingo Range + 20% Aviation and Ship Port Density + 20% Shipping Lane Density + 25% Human Population. Wildlife Risk Analysis: 30% At Risk Species Density + 35% Dingo Range + 20% Aviation and Ship Port Density + 10% Shipping Lane Density + 5% Human Population.

Results & Discussion

For the final analysis, the weighted human, weighted wildlife, and combined unweighted risk analysis showed the likelihood of rabies incidence and prevalence upon virus entry into the country, theorizing a highly concentrated risk along the eastern coast of the continent. Using this spatial analysis, the likely pathway and factors that would determine the proliferation of the disease can provide insight for public health officials, government officials, wildlife coordinators, and veterinarians. Ultimately, this analysis can be used as a tool to determine where to focus mitigation, surveillance, and vaccination programs.

There are some limitations to this analysis, as there are many other at risk species with far-reaching ranges that could be affected by and/or assist in the spread of rabies within Australia. Some additional useful data that could be included in a future study would be rabies vaccine use by county, which would impact the spread of the disease among domestic dogs and cats, also likely lessening the impacts on wildlife and humans in areas of high vaccination rates.

Dingo Range

The Australian Dingo would play a massive role in the spread of rabies across the country. These wild dogs consistently interact with humans, domestic animals, livestock, and wildlife, and are prevalent across most of Australia. The range was mapped from a georeferenced density map using GPS point data gathered via citizen science, and then processed from polygon to raster. The resulting raster was reclassified for final risk analysis.

Human Population

An important factor to consider for the surveillance, prevention, and spread of rabies is through the human population density. Australia’s human population is highly concentrated along the east coast, with the remainder of the continent being mostly uninhabited by humans. The human population density was reclassified for use in the final risk analysis, and is a predominant factor in the human weighted risk analysis.

Shipping Lane Density

Australia relies heavily on importation of food and goods, with over 54% of its products being imported, predominantly from Asia. The density of shipping lanes between countries via direct or indirect route to Australia shows the interconnectedness to other countries, but also shows the potential of how rabies could be introduced. For this analysis raster data was converted to point data, processed with kernel density, and reclassified to show low to high risk based on shipping lane density.