**Can Land Tortoises also Surf the Green Wave?**

Nan Nourn

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**Background**

Resource landscapes have been suggested to strongly influence the behavioral strategies of mobile organisms. Natural gradients, such as elevation or temperature, can be characterized as resource waves within these landscapes, naturally creating highly favorable pulses of resources for mobile organisms to utilize through varying space and time (Aikens et al. 2017). Ideally, terrestrial mobile species on the landscape should prioritize their movement strategies in order to best utilize these resources as areas of high-quality appear across the landscape (Armstrong et al. 2016).

Specifically, for terrestrial herbivores, plant phenology plays a key role in determining the resource landscape, as herbivores must make inherent trade-offs in movement decisions due to selecting the best forage quality available against other behavioral states, such as allocating resources and energy expenditure through avoiding potential predation and parental care. The Green Wave Hypothesis (GWH) proposes that large-scale movement of herbivores should track new areas (waves) of green-up that appear on the landscape through time; Aikens et al. (2017) and Jessmer et al. (2018) have recently shown empirically that large ungulates track green waves of vegetation across the continental western United States during annual migrations, also known as “surfing the green wave.”

Identification of important migration routes and suitable habitat patches for various taxa of concern often serve as important strategies and prioritization for wildlife conservation projects with the establishment of travel corridors to preserve genetic flow and connectivity with metapopulations and conspecifics (Crooks & Sanjayan 2006). Recent advances in obtaining high resolution data to investigate inferences on the movement and migration ecology of animals have been made readily available for ecologists, especially with the proliferation of large datasets consisting of recorded fixed GPS animal locations and high-resolution imagery acquired from remote-sensing sensors and satellites. In accordance to further pursuing ecological and conservation questions related to connectivity, it is now imperative to link connectivity studies with dynamic landscapes that change through space and time (Zeller et al. 2020; Jennings et al 2020).

**Proposal**

While the GWH has been readily identified to be used by large, migrating ungulates (Aikens et al. 2017; Jessmer et al. 2018), it could further be tested with different species of large herbivores. Unlike ungulates who face a bevy of biological and life-history trade-offs within their respective landscapes (i.e. foraging versus predation risk and parental care), Galápagos tortoises are large ectotherms that lack natural predators after maturation from the juvenile stage and do not exhibit parental care for offspring; thus, comparisons of Galápagos tortoises exhibiting priority of foraging strategies over other state-dependent behaviors could further elucidate patterns of the GWH.

While there have been recent studies focused on the movement ecology of Galápagos, most studies have focused on inter-species variation in movement patterns at fine temporal scales while not attempting to identify established movement corridors for tortoises (Bastille-Rosseau et al. 2019; 2017; 2016). Under the GWH framework, I will attempt identify new waves of vegetation as important tortoise foraging habitat patches using the landscapemetrics package (Hesselbarth et al. 2019) and a combination of remote sensing data depicting land-cover on the Galápagos Islands. I will then create a resistance surface as a function of tortoise resource selection and land-cover for each island to assess and potentially identify important corridors for Galápagos tortoises with the grainscape package (Chubaty et al. 2020) and test whether tortoises “surf the green wave” through spatially explicit analyses. By obtaining fixed-GPS locations, I will examine whether tortoise locations can be used towards inferring selection of green wave of patches, and whether identifying selection of green waves is an appropriate use of identifying important tortoise migration corridors. I will explore if there are different movement strategies for tortoise species and sex, and whether inhabiting different islands yield any variability in the effect of the GWH.

**Hypothesis**

I predict that if Galápagos tortoises choose to select new green forage and surf the green wave, tortoise movement patterns will follow locations of green patches on the landscape (e.g. resource selection of tortoises will be heavily weight towards green patches) with tortoise migration following the green wave as the most least resisted path on the landscape. I also predict that tortoises inhabiting different islands will have different migration strategies, as the vegetation gradients vary highly in each island.

**Dataset**

The Galápagos Tortoise Movement Ecology Programme is a published long-term dataset that is stored in the Movebank Data Repository (Bastille-Rosseau et al. 2019). The dataset contains morphometric information on individual attributes of study tortoises and contains spatially explicit information of hourly recorded fixed locations obtained from GPS-satellite tagged animals starting from 2009 until 2018.

To develop landscape metrics and the resistance surface, I will use satellite imagery derived from Normalized Difference Vegetation Index (NDVI) sensors to assess green wave progress across the landscape and to assign resistance values for the landscape for 2009 to 2019, and will follow a similar protocol in developing “greenscape” metrics following Aikens et al. (2017) and Merkle et al. (2016).

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