Green wave indices for predicting spring migration timing of geese

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Abstract

The green wave hypothesis predicts that herbivorous waterfowl follow the flush of spring growth of forage plants during their spring migration to the northern breeding grounds. Here, we compared two green wave indices for predicting the geese spring migration timing at stopover and breeding sites. The satellite-derived green wave index (GWI), and an index of the rate of acceleration in temperature (GDDjerk) that are direct and indirect measure of plant phenology, respectively. The GWI was calculated from MODIS NDVI time series imagery and GDDjerk was calculated from gridded temperature data using GLDAS re-analysis products. We used tracking data from 12 GPS-tagged barnacle geese from 2008-2011. The relations between date of arrival at stopover and breeding sites with the date of peak GDDjerk and 50% GWI were analyzed using mixed effect linear regression. The geese arrival dates at both stopover and breeding sites were predicted more accurately using GWI ($R^2_{cv} = 0.68$, $\text{RMSD}_{cv} = 5.9$ and $R^2_{cv} = 0.71$, $\text{RMSD}_{cv} = 3.9$ for stopover and breeding sites, respectively) than GDDjerk. We also found GDDjerk index is highly sensitive to latitude, since a positive correlation was found between the absolute residual values of the GDDjerk model and distance to the breeding sites. This study highlights the use and importance of remote sensing data and the indices derived from it for avian herbivores migration studies.