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EXAMINING THE CONTRIBUTION OF REPRODUCTIVE TRAITS TO ARCTIC SHRUB EXPANSION PATTERNS USING SPATIALLY-EXPLICIT SIMULATION MODELLING

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Expansion of woody shrubs is a significant component of terrestrial Arctic change. While considerable research effort has focused on better understanding the processes driving this phenomenon, the contribution of shrub reproductive characteristics to spatial pattern is still poorly understood at broader spatial scales. Building upon our previous work[1] [2] in river valleys in northern Alaska, we developed a C#-based spatially-explicit model that simulates historic landscape-scale shrub establishment between the 1970s and the late 2000s on a yearly time-step while accounting for parameters relating to different reproduction modes (clonal development with and without the "mass effect" and short-distance dispersal). In addition, the model considers environmental heterogeneity represented by a topographic wetness index. We examined these treatments in three river valleys in northern Alaska. After simulating 30 landscape realizations using each parameter combination, we quantified the spatial characteristics (percent area, patch density, patch size variability, mean distance between patches) of the resulting shrub patches on the simulation end date using FRAGSTATS. We used Principal Components Analysis to determine which treatments produced spatial characteristics most similar to those observed in the late 2000s. Based upon our results, we hypothesize that historic shrub expansion in northern Alaska has been driven in part by clonal reproduction with the "mass effect" or short-distance dispersal (< 5 m). The interactive effect of environmental heterogeneity using a topographic wetness index, however, is less clear. These hypotheses may then be tested in future work involving field observations. Considering that climate change may facilitate a shift from a clonal to a sexual reproductive strategy, this model may facilitate predictions regarding future Arctic vegetation patterns.

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[1] Naito AT and Cairns DM (accepted) Patterns of shrub expansion in Alaskan Arctic river corridors suggest a phase transition. *Ecology and Evolution.*

[2] Naito AT and Cairns DM (2011) Relationships between arctic shrub expansion and topographically-derived hydrologic characteristics. *Environmental Research Letters* 6(4): 045506.