

Assisted Migration as a Conservation Strategy for Rapid Climate Change:
Investigating Extended Photoperiod and Mycobiont Distributions for
Habenaria repens Nuttall (Orchidaceae) as a Case Study

By

Brian George Keel

A dissertation in partial fulfillment of the requirements for the degree of

Doctor of Philosophy
(Environmental Studies)

at

Antioch University New England

2007

“DEFINING MIGRATION” CHAPTER

Defining Migration

There does not seem to be a standard definition of migration in the literature. Some authors write of migration as movement both within and an expansion of a plant's range (Kirkpatrick & Barton 1997) as the individuals from populations throughout the plant's range establish at higher latitudes and altitudes in response to the movement of their climate optimum. Thus migration occurs in the form of both propagules and pollen dispersal throughout the plant's range and not just as a result of expansion and contraction at the range margins (Jump & Penuelas 2005). Davis (1983a) defines migration as an expansion or contraction of a plant's range. Hanski (1999) writes about movement within a species' range, especially in the case of movement within a metapopulation and metapopulation dynamics. Neilson et al. (2005) list four components of local spread and long-distance migration including fecundity (reproductive output), dispersal, establishment (germination and seedling survival) and growth to reproductive maturity. Reproductive output can take place without dispersal especially in the case of clonal species; therefore, regardless of reproductive output, dispersal only takes place when propagules move away from the immediate vicinity of the parent. I consider colonization to be successful only after seed germination, seedling survival, growth to maturity and production of offspring has taken place because colonization is only insured when young are produced, i.e., reproductive maturity does not guarantee propagation will take place. I propose the following explanation of the mechanism of plant migration. Migration as a process consists of two components: dispersal and colonization. Dispersal begins with the dissemination of propagules (seeds, spores or plant parts) from the parent

and ends when the propagule comes to rest at the site where it will either perish or grow. Colonization begins with germination of the seed or spore or initiation of vegetative propagation of the plant part and ends with the successful production of a propagule by the parent at the new site and growth of the offspring. Successful production of a propagule includes growth of a ramet for a clonal species. Migration requires both dispersal and colonization. Successful dispersal of a propagule to a new site beyond the parent plant's population can take place without colonization occurring but this does not constitute migration without successful colonization, and colonization can not take place without dispersal. The mechanics of dispersal and colonization can occur within the historic range of a plant, but this is only an increase or shift in the distribution of the plant within its range and is part of the natural extinction/colonization process. Movement driven by climate change does not automatically imply migration. The range of a plant is made up of a heterogeneous landscape with all sites not habitable at any point in time. Climate change could be a driving force in the colonization of new sites within the range of a plant by making sites habitable that previously were not, as can also occur with fire and other disturbances. Colonization of those sites would be within the range of a plant and would not constitute the expansion of a species' range. I suggest that migration is the colonization beyond the historic range of a plant either in a latitudinal, longitudinal or altitudinal direction.

A montane species has two range boundaries, an altitudinal boundary determined by the upper or lower elevational limits of where growth is possible and a latitudinal/longitudinal boundary defining the area encompassed by the mountains on which the plant is presently or historically found. Movement of the montane plant

upward or downward, or to a mountain outside of its latitudinal/longitudinal boundary, in response to climate change, would constitute a migration. For non-montane plants, expansion or contraction of their latitudinal/longitudinal boundary in response to climate change would constitute a migration. Movement within a plant's range, even if driven by climate change should not be considered a migration, and this includes movement between mountains within the latitudinal/longitudinal boundary of a montane plant. For movement within a plant's range, as outlined above, it would be difficult to tell if the movement was caused by climate change or was part of the normal process of extinction/colonization within the plant's range. Within a plant's range as within a metapopulation, plants are continually going locally extinct and establishing new populations. These shifts within the plant's range, other than from anthropogenic causes, can be in response to slight changes in climate or extreme weather events, or stochastic dispersal and colonization. The process of dispersal and colonization, as evidenced by the paleorecord, allowed plants to migrate in response to past climate change.