BASIC HYPOTHESES AND OBJECTIVES

Approved by the Third ITEX Workshop, Boulder, Colorado, March 10, 1992.

The goal of the International Tundra Experiment (ITEX) is **to understand the response of tundra plant species through simple manipulation and transplant experiments to be conducted at multiple arctic and alpine sites**. Objectives and hypotheses related to measurements and simple manipulations are defined as Level 1 within the ITEX hierarchy. Transplant and common garden experiments are considered to be Level 2. The objectives of the proposed research are:

(1) to quantify the change in the environment (i.e., temperature, moisture, and nutrient availability) broughr about by experimental warming,

(2) to quantify the change in the environment from the point of view of the plant by quantifying the shift in phenotypic selection,

(3) to understand the potential of tundra plant populations to adjust to climatic warming, either through acclimation or adaptation, and

(4) to partition the effect of global warming on key phenological, morphological, and physiological traits into environmental and genetic components.

Research Questions

ITEX has four primary research questions. Questions I–III are answerable with the basic manipulation (Level 1); question IV relates to the transplant and common garden experiments. Not all subquestions will be answered at all sites, depending on the particular level of environmental measurement made at the site.

I. How will the selective environment change as a result of experimental warming?
   (a) How will the soil temperature profile change in response to air temperature change? Specifically, will the depth of the active layer increase (in arctic sites)? (Level 1)
   (b) How will factors correlated with temperature change in response to experimental warming? Specifically, will nutrient or water availability change? (Level 2)
   (c) How will community composition change? Will there be a shift in dominance in the experimental plots? (Level 1)

II. Will experimental warming result in a shift in the selective regime?
   (a) Will new character states or combinations of states (i.e., morphological and phenological characters and tissue nutrient concentrations) be favored in a warmer climate? (Level 1)
   (b) Will the selective regime be similar across multiple arctic and alpine sites? (no level - multisite comparison)

III. Are populations of arctic and alpine species able to accommodate warmed climatic conditions over the long term?
   (a) Do measures of population-level response indicate population decline, maintenance, or increase? (Level 1)
   (b) Do phenologic shifts occur in a manner that increases or decreases population vigor? (Level 1)
   (c) Do tissue nutrient concentrations provide an index of population stress (or vigor) within the context of climatic-induced changes in selective regimes? (Level 2)

Questions based on experimental manipulation of natural populations (all Level 2):

IV. Is phenotypic variability in warmed and control plots due to environmental effects, genetic variability, or a combination of the two?
   (a) Is there significant variation among clones within extant populations for traits affecting fitness under warmed conditions? In other words, is there significant heritability (in the broad sense) for traits relevant to global warming?
   (b) Does the expression of genetic variability in relevant traits change as a function of the environment? Is the broad-sense heritability environment-dependent?
   (c) Is there significant genetic variation in response to warming treatments (i.e., genotype x environment interaction)?

Experimental Design

Number of species. The measurement of a single species is acceptable for Level 1, but this species should be selected from the highest priority (1a) species list. If two or more species are measured, then they may all be from the 1b list, and as long as at least one 1a species is included then other species may be added as needed or desired.

Siting: Treatment sites should be placed in areas with uniform soil, plant cover (vegetation), slope angle, and slope exposure.

Treatment period: Treatments should begin at the date of release from snow and continue until late August or the inception of the winter snow period, whichever comes first. Although the working group recognized the validity of using a physiological indicator, such as change in leaf coloration, as the ”best” indication of senescence for an individual species, interspecific and intersite differences indicated that a calendar date would be most consistently applied, and that August 15 was a reasonable compromise for most sites.

Extent of Experiment: A five-year commitment to an experimental site is suggested as a minimum. Sites with on-going long-term programs and personnel, such as field stations, reserves, and long-term ecological research sites, are considered optimum, so that the experiment may be expected to continue beyond the initial five-year period for these sites.