

Goals of Ecological Field Studies

- Test basic scientific hypotheses
- Assess environmental impacts
- Long-term monitoring
- Biodiversity inventory
- Population status/assessment

Testing Basic Scientific Hypotheses

- Role of species interactions
- Causes of population regulation
- Ecological significance of behavioral or morphological traits
- Determinants of biodiversity

Assess Environmental Impacts

- Development projects
- Restoration projects
- Policy or regulatory changes
- Cumulative effects of pollutants

Long-Term Monitoring

- Search for environmental trends
- Assess population status of rare or endangered species
- Establish ecological/environmental baseline
- Describe variance structure of ecological/environmental data

Biodiversity Inventory

- Determine presence or absence of a taxa at particular sites
- Map the geographical distribution of taxa
- Discover un-described species
- Map geographical variation within a species

Population Status/ Assessment

- Determine if species' populations are growing or declining
- Determine if significant exchange of individuals or genes occurs between populations
- Determine how to manage populations to prevent decline to extinction

What Methods do Ecologists Use to Achieve These Goals?

- Application of the *Statistical Principles of Experimental Design*
- Enormous and imaginative variety of largely *ad hoc* field and laboratory methods
- Some standardization of methods
- Analytical mathematical and computer simulation models

Experiment and Observation

- Un-controlled observations
- Controlled observations
- Mensurative experiments
- Manipulative experiments
- Microcosm/mesocosm experiments

Statistical Principles of Experimental Design (in a nutshell)

- Identifying the “population” of inference
- Designing an appropriate experiment or sampling program
- Using probability sampling correctly
- Estimating “population” parameters
- Testing a null hypothesis
- Assessing the “power” of the test
- Correctly interpreting the test results
- Entertaining alternative explanations

A Yardstick for Assessing Effects

- Control - the absence of the process or effect of interest
- Treatment - the presence of the process or “treatment” of interest
- The problem of confounded effects

The Population and the Sample

- Population is the group about which inferences are to be made
- Sample is a subset of the population collected in a manner that permits inferences about the population

Probability Sampling

- All members of the population are at equal risk of being sampled
- Achieved by sampling independently and at random

Error Elimination in Hypothesis Testing

Actual

True

False

True

Correct
Decision

Type II Error,
 β

Behavior

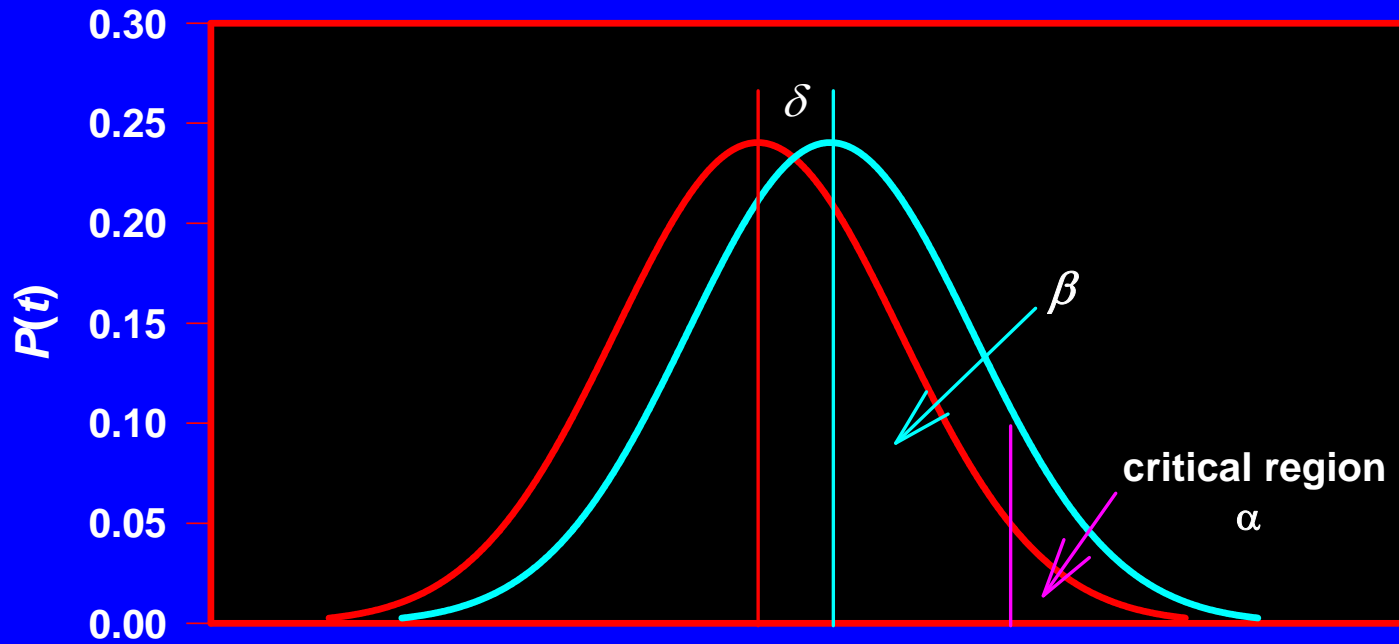
False

Type I Error,
p-value, α

Correct
Decision

True	Correct Decision	Type II Error, β
False	Type I Error, p-value, α	Correct Decision

Figure 1 - Distribution of t under H_0 and H_a



Power of a Statistical Test

$$\text{Power} = 1 - \beta$$

What Determines Power?

- **Sample size, n**
- α
- **Effect size**
- σ

Figure 3 - Power Curves

