

Data and Measurement

- **variable**—an attribute that can take more than one form or value (it must vary)
- **measurement**—the process of assigning numbers to the variable

Characteristics of abstract number system are *identity, magnitude, equal intervals* and a *true zero*

Characteristics of variables do not always match characteristics of abstract number system

The Language of ‘Variables’

Variable: Any observation that can take on different *values*

Attribute: A specific *value* of a variable

Examples of Variables

EXAMPLES

Variable: Sex or gender

Attribute: Female; male

Variable: Agreement

Attribute:

1 = strongly disagree

2 = disagree

3 = neutral

4 = agree

5 = strongly agree

Types of Variables

Independent: Leads to or causes something else

Dependent: Is affected by other variable(s)

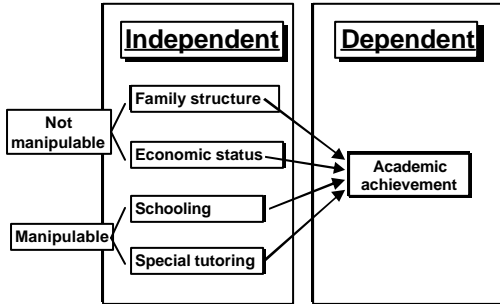
Discrete: No underlying continuum exists

examples: gender, place of residence, pregnancy, mortality

Continuous: Measured along a continuum

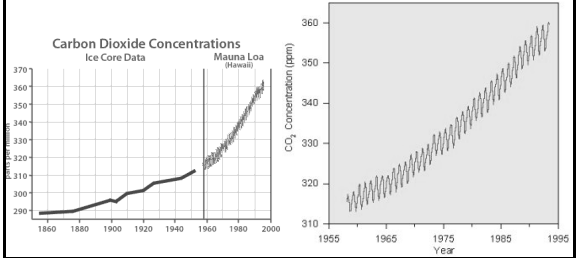
examples: age, pH, temperature, BAC

Types of Variables

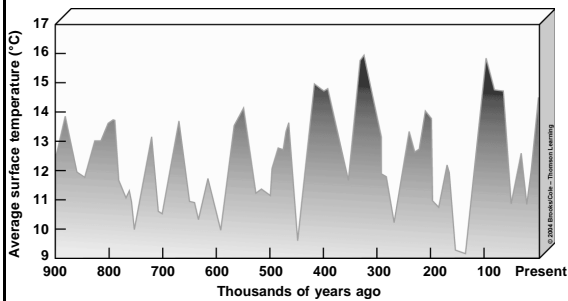


Changes in Atmospheric CO₂

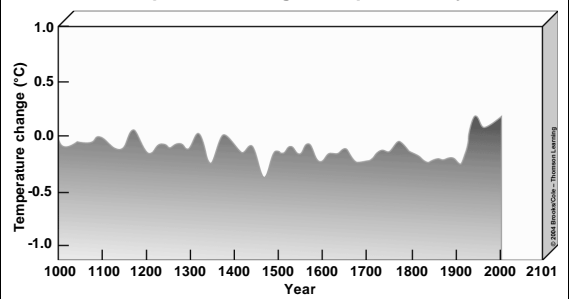
Data from Mauna Loa, Hawaii

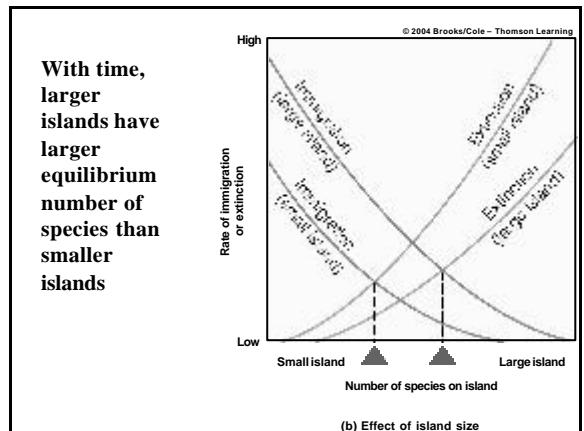
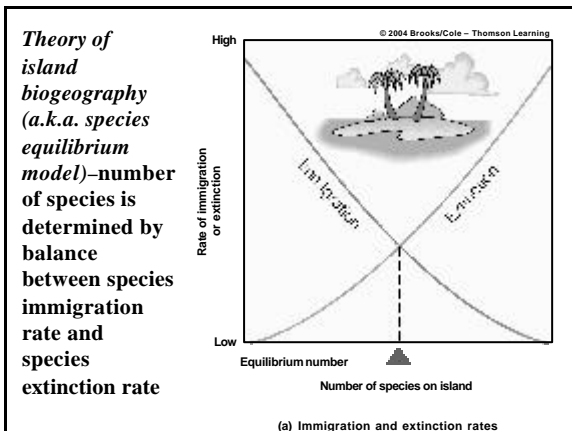
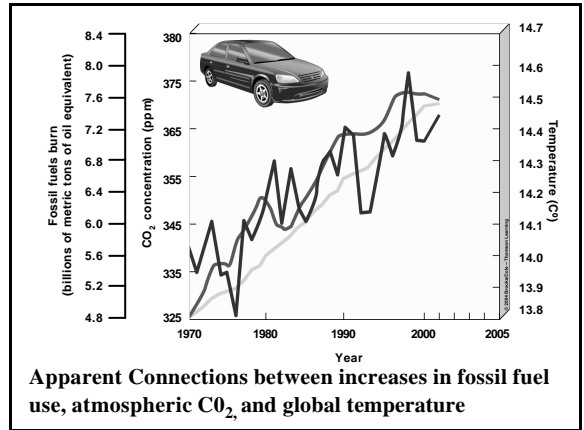
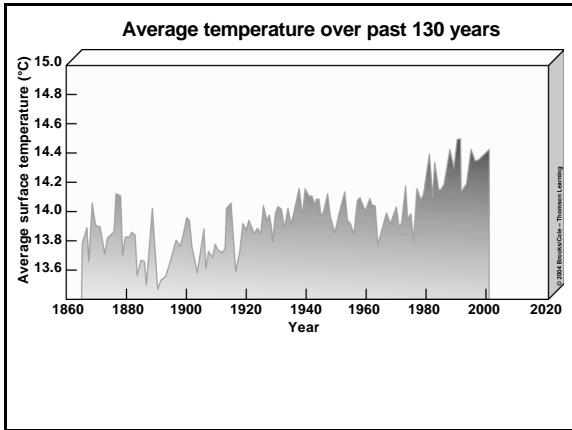


Average temperature over past 900,000 years

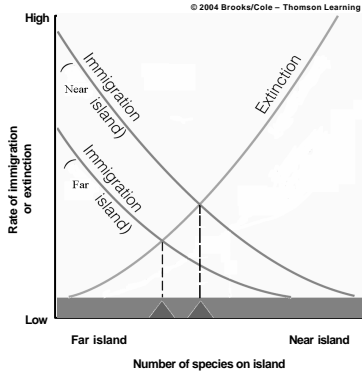


Temperature change over past 1,000 years

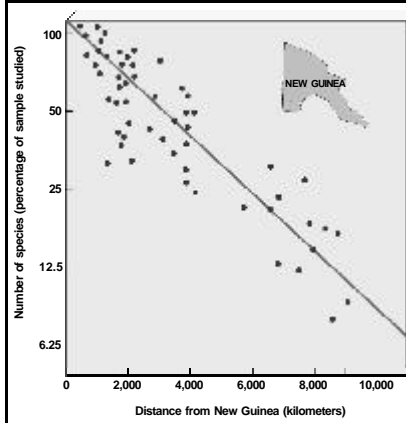




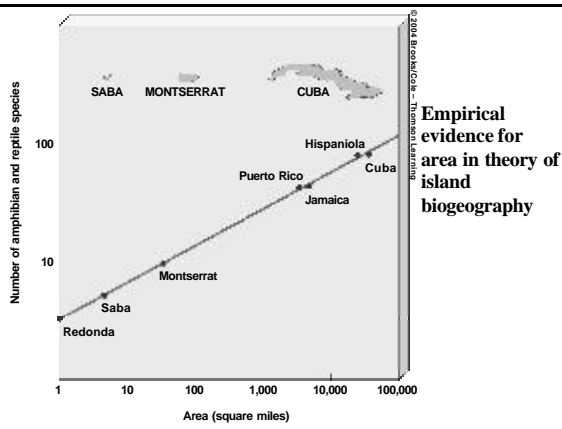
Assuming equal extinction rates, an island near a mainland will have a larger equilibrium number of species



(c) Effect of distance from mainland



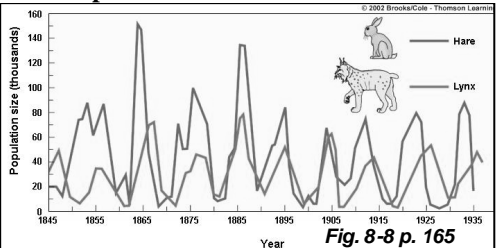
Empirical evidence for distance in theory of island biogeography



Empirical evidence for area in theory of island biogeography

The Role of Predation in Controlling Population Size

- **Predator-prey cycles**
- **Top-down control**—predators control prey numbers
- **Bottom-up control**—prey availability determines predator numbers

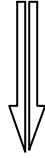


Operational Definition

Theory or idea

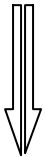
Operational Definition

Theory or idea



Operational Definition

Theory or idea

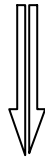


Reality

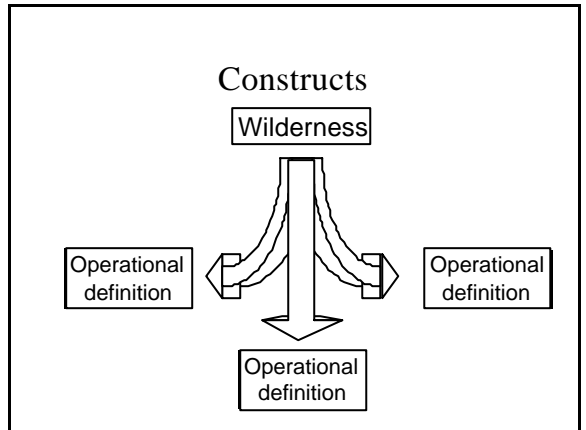
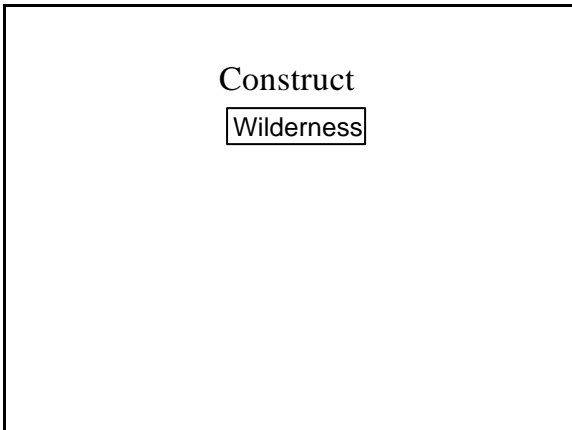
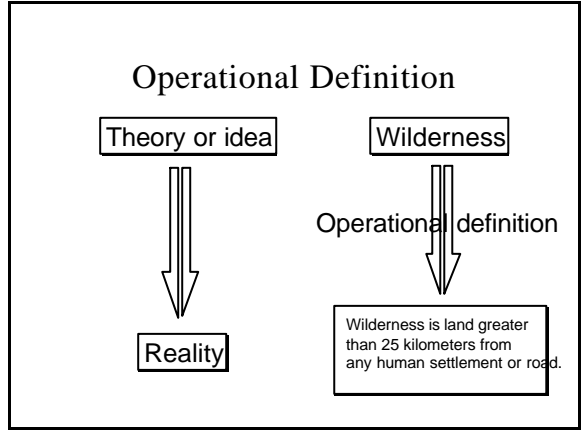
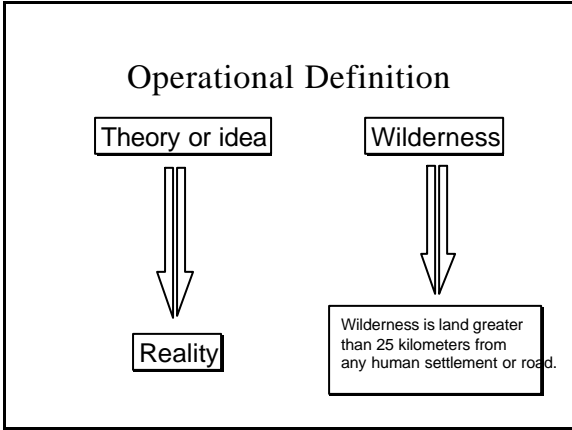
Operational Definition

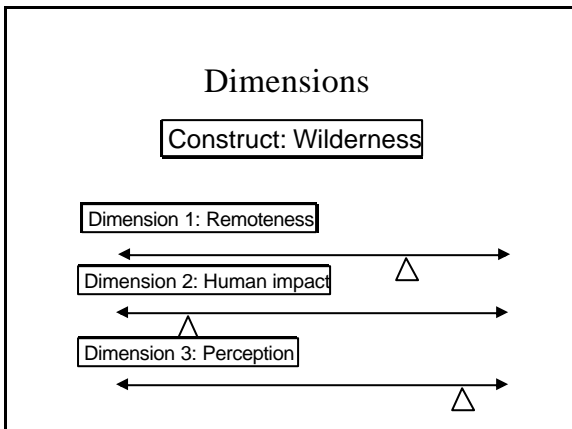
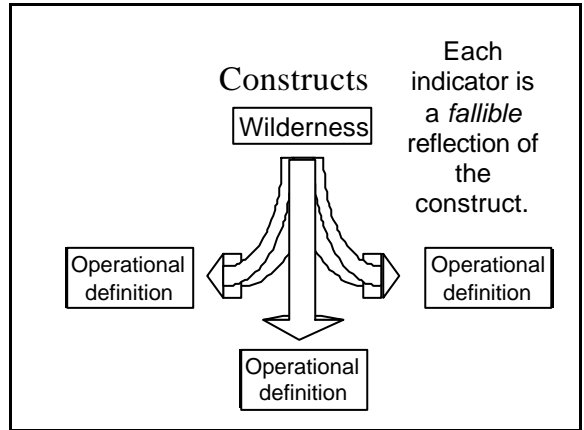
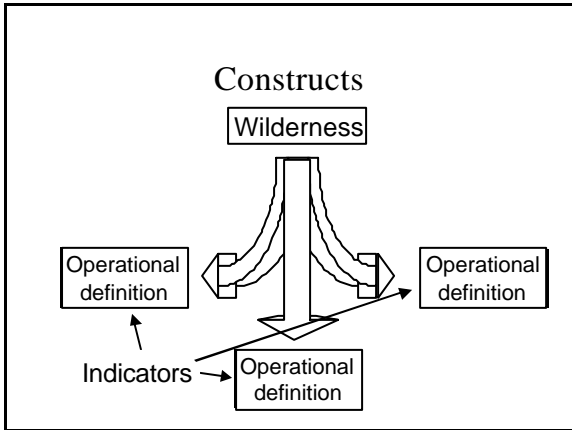
Theory or idea

Wilderness



Reality





Stevens classification of variables

4 levels or scales of measurement arranged from least to most matching real number system

- **nominal**—lowest level, naming scales, only property is identity, differences between categories are qualitative, not quantitative (chi-square statistical tests)
- **ordinal**—measures a variable in order of magnitude, properties of magnitude as well as identity, variables can be ranked from low to high, called ordered data (nonparametric tests such as Mann-Whitney U-test or Wilcoxon matched pairs signed rank test)
- **interval**—conveys information about the magnitude and the distance between values but lacks true zero, example (temperature), called score data
- **ratio**—have all properties of real number system, has true zero, also called score data, (t-tests, ANOVA, and product-moment correlations)

Your turn—classify the following...

- Weight (in kg)
- Height (in cm)
- Shape (e.g., oval, rectangle, square)
- Dosage (in cc)
- Time
- Income
- Sexiness
- Species
- Temperature
- Distance
- Concentration (e.g., ppm)
- Stage in life cycle (e.g., baby, toddler, adolescent, adult)
- Class rank
- Visitor Satisfaction
- Growth (e.g., in cm)
- Speed
- Obesity
- Sustainability
- Soil type
- Water quality
- Tourist experience
- Population size
- Sporting success
- Physical fitness
- Quality of service
- Mortality
- Aggression
- Wingspan

Reliability in Research

- **reliability** of measure—reproducibility of measure
 - inerrater reliability**—when two or more independent observers (blind to the others' ratings) agree with one another
 - test-retest reliability**—taking measurements at two different time intervals and having the results consistent
 - internal consistency reliability**—several observations are used to obtain a score for each subject—reliability is high if each of the observations correlates with the other observations—that is if all items are measuring the same thing
- the more observations we make to obtain a score for a person, the greater will be the reliability of the score

Factors that contribute to reliability

1. precision and clarity of operational definition
2. the care with which we carry out the measures and the precision with which we follow the procedures outlined in the operational definition
3. the number of independent observations on which the score is based

Measurement Reliability Concerns

- **effective range of scale**—the range of values for which the measurement instrument is likely to be accurate/reliable (ex. Scale to measure weight of mouse versus elephant)
- **scale attenuation effects**—problems associated with too much restriction in the range of values in a scale (can lead to floor (all high scores) and ceiling (all low scores)) both reduce the potential variability of the data

**sufficient variation is essential in research

Validity vs. Reliability

Validity of measure is not the same as
reliability

validity deals with accuracy—*reliability* deals
with consistency