Science in Natural Resource Management

ESRM 304

Science in Natural Resource Management

I. The scientific approach to knowledge
II. Hypothesis testing and resource management
III. “Read This! Study Tips”

I. The scientific approach to knowledge

A. What is science?

1. Accumulating knowledge
2. Identifying interesting patterns in the knowledge
3. Justifying the theories/explanations – rejecting false ones

B. Why is the scientific approach needed in resource management?

A. What is science?

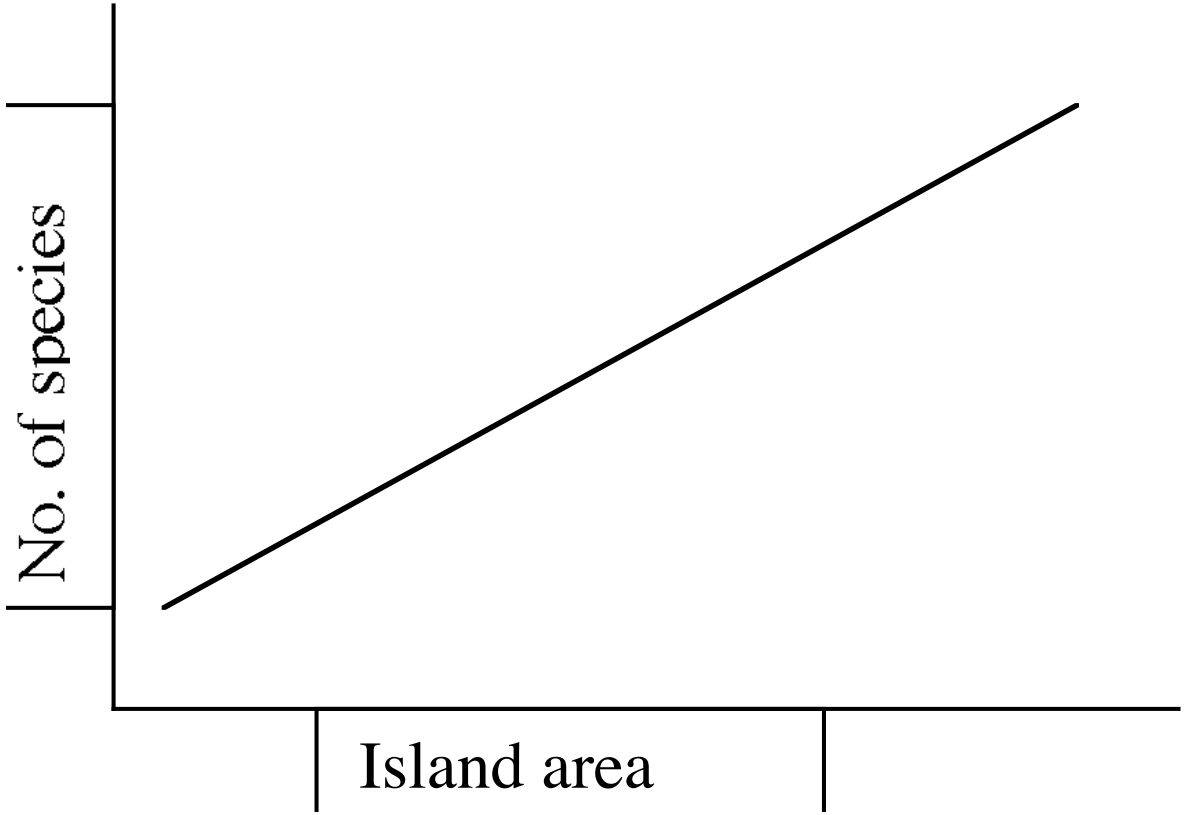
1. Accumulating knowledge (observation)
   - Common sense helps (often correct)
2. Identifying interesting patterns (model, working hypotheses, theories)
   - Concerned with establishing connections between phenomena
   - Integrates statements, theories into more comprehensive laws
   - Explanation of an observed pattern is called a *model* or *theory*

2. Identifying interesting patterns

- Models / theories
  - model development results from the interaction of the perceived problem with insight, existing theory, belief, and previous observations
  - start as verbal model, non-mathematical explanations of how nature works – then quantified into mathematical terms
  - models usually relate a response (dependent variable) to one or more factors (independent, or predictor variables)

2. Identifying interesting patterns

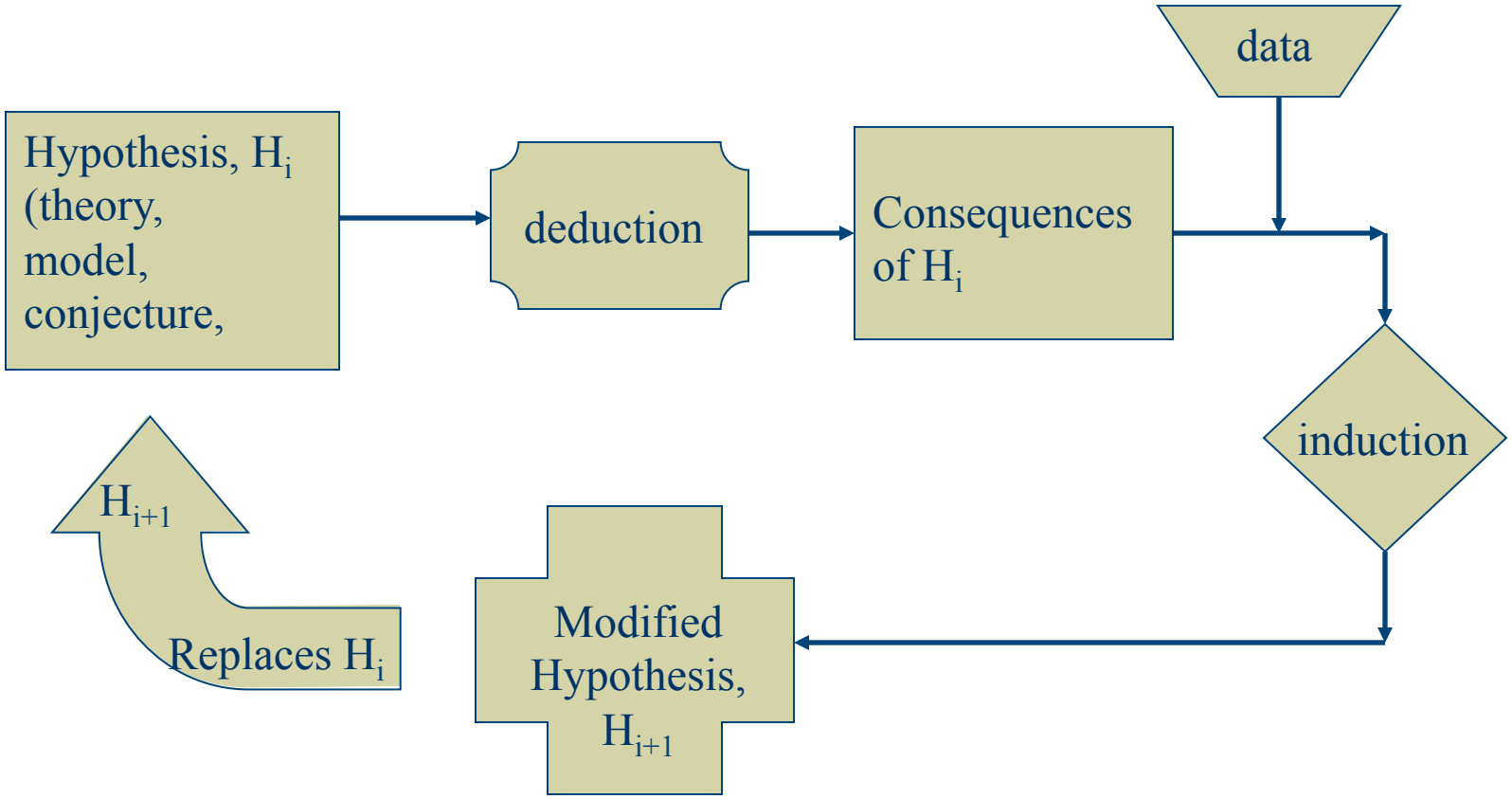
- A simple model



A. What is Science?

3. Appraising the explanation(s) - rejecting false ones (hypothesis testing)
    - Run experiment, observe result, interpret the data, draw conclusion
    - Ability to falsify a hypothesis is key

The Science Cycle



I. The scientific approach to knowledge

B. Why is scientific approach needed?

- Environmental scientists, foresters, biologists, etc., must contend with working across disciplines – statistical methods make up the "language" of research – common to all fields
- Publicly tests "private theories"
  - Confirmation bias
  - Theory tenacity

II. Hypothesis testing and resource management

A. Role of descriptive / exploratory studies

B. Role and nature of experiments

C. The hypothetico-deductive method

II. Hypothesis testing and resource management

A. Role of descriptive / exploratory studies

- Quantitative and robust description of pattern is crucial to the scientific process
- These are the ‘observational studies’ – bioassays, where we may just sample what is “out there” and find relationships
- Potential to reveal ‘correlation’

II. Hypothesis testing and resource management

B. Role and nature of experiments (5 parts)

- Hypothesis
- Experimental design
- Experiment execution
- Statistical analysis
- Interpretation / re-hypothesis

B. Role and nature of experiments

- Manipulative experiments
  - Always involve two or more treatments (factors); goal is making one or more comparisons
  - Experimenter directly applies the treatments, perturbing the system; factors are set to pre-determined levels at the outset of the trial
    - Typically, the hypothesis we seek to falsify is called the null
    - "null" and "research" (alternate) hypotheses must be complementary and exhaustive

B. Role and nature of experiments

- Manipulative experiments (cont'd)
  - Randomization
  - Representation
  - Replication
  - Have the potential to reveal causation
- Natural experiments
  - Large scale
  - No randomization
  - No replication
  - Capable of revealing association only

II. Hypothesis testing and resource management

C. The hypothetico-deductive method

- Asking the good question
  - Acquire knowledge
  - Suggests what to observe
  - Creative process
- Traits of good hypothesis
  - Internal consistency
  - Explanatory value
  - Advances knowledge
  - Is testable!

III. “Read This!”

- Emphasizes the “Three R’s of Experiments”
  - Randomization
  - Representation
  - Replication
- Keys to valid Statistical analysis
- Important for critiquing others’ work