

Ecos = "home"

Ecology: the study of

- ...where an organism lives.
 - Range
 - Habitat
 - Distribution
- ...how/why it lives there.
 - Environment: factors of the habitat that affect the organism
 - Niche: role of the organism affecting the environment

THE REALM OF ECOLOGY

• **Organismal Ecology:**
How an individual organism adjusts its physiology and/or behavior to respond to its environment.



Individuals

How do zebras regulate their internal water balance?

THE REALM OF ECOLOGY

• **Population Ecology:**
Interactions among members of the same species in a given habitat.



Population

What factors control zebra populations?

THE REALM OF ECOLOGY



Community

How does disturbance influence the number of mammal species in African grasslands?

• **Community Ecology:**
Interactions among members of all of the species in a given habitat.



Interactions

What evolutionary benefit do zebras gain by allowing birds to remove parasites?

THE REALM OF ECOLOGY



Ecosystem

How does fire affect nutrient availability in grassland ecosystems?

• **Ecosystem Ecology:**
Interactions between the species in a given habitat and their physical environment.

THE REALM OF ECOLOGY

- **Landscape (Regional) Ecology:** Interactions among adjacent and overlapping ecosystems.



Region

How has geologic history influenced regional diversity within certain groups of organisms?



Landscape

How do vegetated corridors affect the rate of movement by mammals among isolated forest fragments?

THE REALM OF ECOLOGY

- **Biosphere (Global) Ecology:** Interactions among all the ecosystems on the planet
- Earth as a living system.



Biosphere

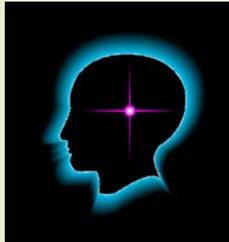
What role does concentration of atmospheric CO₂ play in the regulation of global temperature?

WHAT IS SCIENCE ?



- Attempts to discover the order in nature
- Makes predictions about what will happen
- Methodical process of discovery and understanding

WHAT IS SCIENCE ?



- Discrimination of what is true (reality) from what only appears to be true, (illusion, prejudice, & story-telling)

“Science as a way of knowing”

PROCESS SCIENTISTS USE TO ANSWER QUESTIONS ABOUT NATURE



- Hypothetico-deductive method

6A 6B 6C

- Observations
- Question
- Hypothesis
- Prediction
- Experiment
- Conclusions

It all starts with **OBSERVATIONS**

- Careful, meticulous, well-documented observations!



- Naturalists and explorers
 - Detailed descriptions, illustrations, maps, & anecdotes
- Published scientific reports
 - Peer-reviewed journals
- Personal experiences

The Hypothesis

- Hypotheses are possible, plausible explanations of an observation.
- Scientists formulate hypotheses based on:
 - 1) previous knowledge
 - 2) inference from similar situations
 - 3) common sense
- The more basic facts you know, the better your questions.

The Hypothesis

- Formulate a **specific prediction**
- Word it as **falsifiable** (testable)
- Formulate falsifiable alternative hypotheses
 - Including the null hypothesis
- Design *good* tests of the prediction
 - experiments and/or more thorough observations
- **If** the hypothesis is correct....
- **Then** we predict the following outcome from our tests

Test the Hypothesis

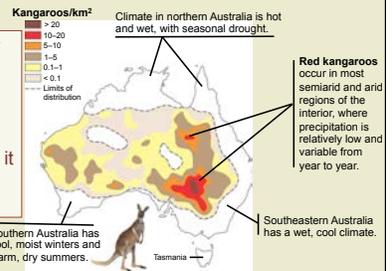
- Observations
- Questions
- Hypothesis/Predictions
- Tests (Experiments)
 - Control Group
 - Experimental Group
 - Standardized Variables
 - Independent Variable
- Data/Results
 - Dependent Variable
- Conclusion



Ecological Questions

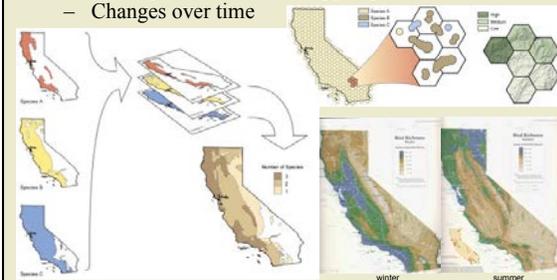
- **Biogeography**
 - Provides a good starting point for understanding what limits the geographic distribution of species

- Why is a particular organism found in some specific areas, and not in other areas?
- I.e., what prevents it from expanding its range?



Ecological Questions

- **Biogeography** in the computer age: **Geographical Information Systems (GIS)**
 - Overlay/Correlation of mapped parameters
 - Changes over time



Ecological Questions

- **Biogeography**
 - Provides a good starting point for understanding what **limits** the geographic distribution of species
 - “limiting factors”

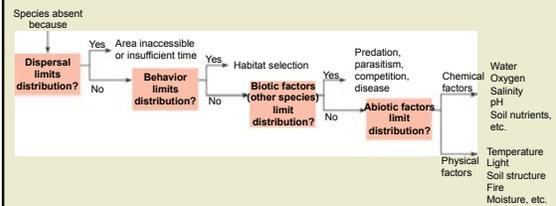
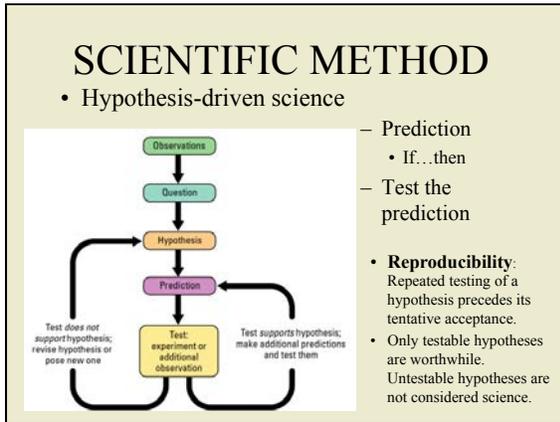


Figure 52.16



Evolution of Life History Traits in Caribbean Guppies

Observations:

- Guppies live in river pools.
- Some pools have large cichlid fish predators.
- Some pools have smaller killifish predators.
- Some pools have neither predator.

Predators: Killifish; preys mainly on small guppies

Guppies: Larger than those in "pike-cichlid" pools

More observations

Predators: Pike-cichlid; preys mainly on large guppies

Guppies: Smaller at sexual maturity than those in "killifish" pools

Question: Does the type of predator present alter the growth rate/ maturation of guppies?

Prediction: If guppies are exposed to a different predator, then they will alter their growth rate and maturation.

Experiment

Predators: Killifish; preys mainly on small guppies

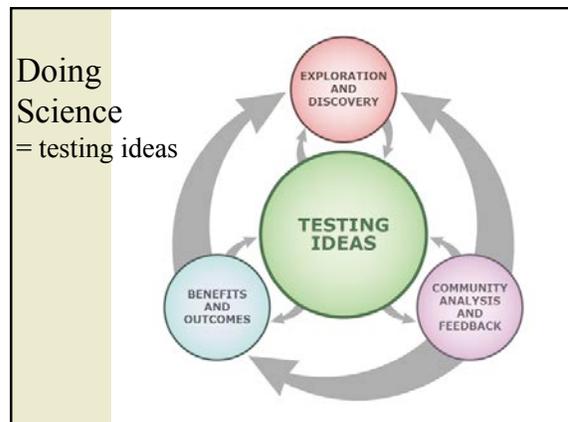
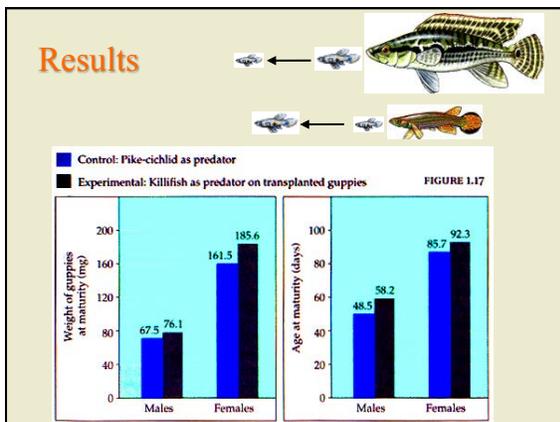
Guppies: Larger than those in "pike-cichlid" pools

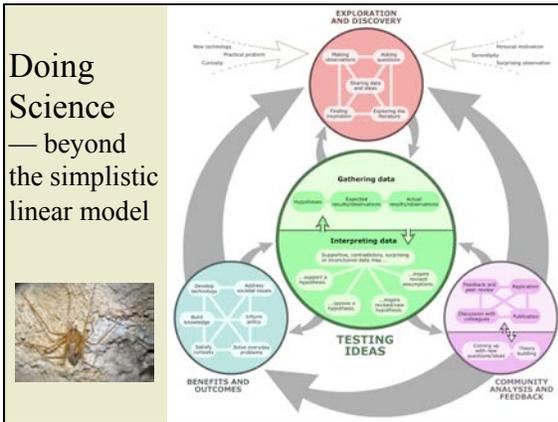
Experimental transplant of guppies

Pool with killifish, but no guppies prior to transplant

Predators: Pike-cichlid; preys mainly on large guppies

Guppies: Smaller at sexual maturity than those in "killifish" pools





Doing Science



- 1) Get all background information possible (lots of it normally)
- 2) Collect data (often several years of work)
- 3) Analyze data (can take months or years)
- 4) Write up results & submit for peer review and publication (often >1 year until publication)

Ecology and Environmentalism

- ***Silent Spring***, 1962, by Rachel Carson
 - Credited with starting the modern environmental movement
 - Specifically, alerted the public to the side impact of DDT use upon bird populations
 - Generally, publicized that human “control of nature” often came with severe retributions



Figure 56.26

Ecology and Environmentalism

- The **precautionary principle**
 - Current environmental policies do not do enough to *prevent* environmental disasters instead of controlling damage *after* an incident.
 - Must apply ancient medical principle of “first, do no harm” to environmental policies.
 - **“When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically.”**
 - “Wingspread Conference on the Precautionary Principle”, *The Science and Environmental Health Network*, January 26, 1998. <http://www.seltn.org/wing.html>




Ecology and Environmentalism

- The **precautionary principle**
 - Basically states that humans need to be concerned with how their actions affect the environment
 - It is a lot more plausible to prevent environmental degradation than to try to remediate it




Ecology and Environmentalism

- **Ecology** — Provides the scientific understanding underlying environmental issues
- **Sustainable Development**
 - Long-term prosperity of both humans and ecosystems
 - Commitment to protect and preserve biodiversity
 - “Stewards of the land”
 - Decisions that benefit future generations



Real and potential human insults to the integrity of the biosphere

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1. Global contamination (pollution)
2. Habitat destruction
 - Environmental homogenization
3. Climate change
 - Global warming (“weirding”)
4. Destruction of the ozone layer
5. Nuclear winter

Feeling the Effects of Climate Change
<http://video.pbs.org/video/1939995285/>

The Anthropocene:

A new geological epoch defined by global alteration of the biosphere resulting from human activity over the past 100 years

- Contamination of all ecosystems
 - Quantitative: redistribution, depletion, and accumulation
 - Qualitative: synthetic petroleum products, plastics, pharmaceuticals, radioisotopes
- Loss of biodiversity
 - Major extinction events
 - Global distribution of invasives
- Loss of ecosystem diversity
 - Global homogenization

The Anthropocene: Human Impact on the Environment

Defining the Anthropocene

Small text: Earth's geology is defined by a unique marker in the rock record. This marker is the Anthropocene, the period of human influence on the planet's geology and environment. It is defined by the presence of synthetic materials, such as plastics and nuclear isotopes, in the geological record. The Anthropocene is a new geological epoch that began around 1950, marked by the start of the nuclear age and the rapid increase in human population and industrial activity. It is characterized by significant changes in the Earth's climate, land use, and biodiversity. The Anthropocene is a period of rapid environmental change, and it is important to understand its impact on the planet and to take action to mitigate its effects.

The Miraculous Coincidences of Planet Earth

- Unique essential combination of factors compatible with life.
- Water in all three phases
- Size: smaller ⇒ lose oxygen
bigger ⇒ trap hydrogen
- Distance from sun:
 - 5% closer ⇒ too hot
 - 1% farther ⇒ too cold
- Speed of rotation, tilt of axis, speed & shape of solar orbit ⇒ prevent lethal extremes
- Gas giants in outer solar system deflect interstellar debris

Very likely unique in the universe!

Even our position in the galaxy is ideal!

You are here.

If you were here, the high stellar density would create radiation and gravitational disruption.

If you were out here, there would be insufficient heavy elements to form planets.

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Biophilia
 a love of life and its forms

Our innate sense of connection to nature may eventually motivate a realignment of our environmental priorities

Biologist Carlos Rivera Gonzales examining a tiny tree frog in Peru