A U.S. Geological Survey report released in November 2006 indicated that the Beaufort Sea polar bear population has experienced a significant drop in cub survival. The study also determined that adult males weighed less and had smaller skulls than those captured and measured two decades ago. In recent years, winter sea ice has fallen by at least 600,000 square miles, double the size of Texas.
Conservationists hope — and Alaska business interests fear — that designating polar bears as threatened due to global warming will carry a huge economic cost, forcing federal agencies around the country to consider the affect on polar bears before granting permits that would increase greenhouse gas emissions.

Arizona Daily Star, 10 April 2007

New forecast: Two-thirds of polar bears could die off

THE ASSOCIATED PRESS

WASHINGTON — Two-thirds of the world's polar bears will be killed off by 2050 — and the entire population gone from Alaska — because of thinning sea ice from global warming in the Arctic, government scientists forecast Friday.

Only in northern Canada and northwestern Greenland are polar bears expected to survive through the end of the century, said the U.S. Geological Survey, which is the scientific arm of the Interior Department.

USGS projects that polar bears during the next half-century will lose 42 percent of the Arctic range they need to live in during summer in the Polar Basin when they hunt and breed. A polar bear's life usually lasts about 30 years.

Nothing in biology makes sense except in the light of evolution.

THEODOSIUS DODZHANSKY

Biodiversity (Biological Diversity)

"structural and functional variety of life forms at genetic, population, community, and ecosystem levels"
Hawaiian Endangered Species

Unfortunately, Hawai‘i has the highest number of listed threatened and endangered species in the nation. There are 394 threatened and endangered species in the State of Hawai‘i, of which 294 are plants, 57 invertebrates, and 43 vertebrates.

What is biodiversity?

Primack 2006, Fig 3.6
How many species on earth?

~12.4 million total species (50-90% in tropical forests)
~1.7 million identified

Most

Research Focus?

Biodiversity

1. Genetic (nat. sel.)
2. Species
3. Ecological: forests, deserts, lakes, wetlands, reefs etc.
4. Functional: energy flow, nutrient cycling etc.

Fig 2-13 Miller 2003

Levels of Biological Organization.
Scaling.

Miller 2003
Where is biodiversity?
One tree in Peru with same ant diversity as Britain

Species Richness and Latitude

Altitude?

Tropical Rainforests

Biodiversity
1. Genetic
2. Population/Species
3. Community/Ecosystem
4. Landscape

Composition
Structure
Function

Van Dyke 2003

Groom et al. 2006

Pimm and Jenkins 2005

Primack 2006
**Urodela families**

- Salamandridae
- Sirenidae
- Hynobiidae
- Salamandridae

**What factors correlated with high diversity?**

- Energy
- Precipitation
- Temperature
- Area
- Habitat heterogeneity (e.g., foliage height and birds)
- Stable environment
- Moderate (intermediate) disturbance level (shifting mosaic, no climax)
Terrestrial Biomes

(Forest, Desert, Grassland, Tundra, etc.)

Biotic (Vegetative) Communities

Climate
1. Temperature
2. Precipitation
3. Soil type

- Latitude
- Altitude

Threats to biodiversity – habitat loss

Species-Area Relationship
3 step loss of biodiversity

1. Endemics
2. Sink populations
3. Stochasticity

Therefore end up with lower steady state species richness and loss of biodiversity

\[ S = cA^2 \]

\( S \) = species richness
\( c \) = taxon-specific constant
\( A \) = area
\( Z \) = extinction coefficient for taxon

Species Focus ---> Biodiversity and Process Focus

(ESA)

What being lost vs. why...

Species = ?

Biological Species Concept (Mayr)
"a group of interbreeding populations that are reproductively isolated from other such groups"

2-morphological/taxonomic species concept
3-evolutionary species concept
4-genetic species concept
5-paleontological species concept
6-cladistic species concept
Biological Species Concept
1. Testable and operational
2. Definition compatible with established legal concepts
3. Focus on level of biodiversity that agrees with tradition of conservation

Conserve Species as
TYPES or as EVOLUTIONARY UNITS

Ernst Mayr (1904-2005)
Published papers for > 80 years

Galapagos Finches

Brassica oleracea

Aspidoscelis (Cnemidophorus)
Species vs. Parthenospecies...

1. Indicator Species - migratory birds - amphibians
2. Keystone Species - top predators - key pollinators

3. Umbrella Species
Native Species vs. Nonnative, exotic, alien
Measuring Biodiversity  
- alpha - beta - gamma

**Alpha**  
Species within a community  
- all populations occupying a given area at a given time  
- often broken into taxonomic groups or functional roles  

1) Species Richness (# of species)  
2) Species Evenness (how many of each type?)  

**Shannon Diversity Index** (richness and evenness)  
\[ H' = -\sum p_i \ln(p_i), \quad (i = 1, 2, 3 \ldots S) \]

\[ p_i = \text{proportion of total community abundance represented by } i \text{ species} \]

**Beta Diversity** 
1) quantitative measure of diversity of communities that experience changing environmental gradients  
2) are species sensitive, or not, to changing environments? are there associations of species that are interdependent (plants, pollinators, parasites, parasitoids)?  
3) how are species gained or lost across a TIME gradient?
**Measuring Biodiversity**

- **alpha**
  - Rarity with increased number of species (fewer of each type)

- **beta**
  - Rarity with habitat specialists

- **gamma**
  - Rarity if restricted to particular geographic areas

**Gamma**

Rate of change of species composition with distance (geography, rate of gain and loss of species)

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**Hawaiian Honeycreepers:**

- **Ko'olau Finch**
- **Makaaalaupuaea**
- **Niku’ai**
- **Makawahi**
- **Manu**
- **Kupa’au’au**

**Endemism...**
Desert pupfish declined due to the introduction and spread of exotic predatory and competitive fishes, water impoundment and diversion, water pollution, groundwater pumping, stream channelization, and habitat modification.
Cyprinodon macularius Quitobaquito pupfish  (Endangered since 1986)

This tiny fish was once part of a widespread population, the range of which included the Colorado, Gila, San Pedro, Salt and Santa Cruz rivers and their tributaries in Arizona and California. The ancestors of the Quitobaquito and Sonoyta river pupfish are believed to have been cut off from their relatives in the Colorado River drainage about one million years ago.

The warm, slightly brackish water at Quitobaquito is ideal habitat for pupfish. Pupfish can tolerate salinity levels ranging from normal tap water to water three times saltier than the ocean. Therefore, they are well suited to desert environments where high evaporation rates create water with high salinity levels.

Although the water temperature at the spring is a constant 74°F, the water temperature in the pond fluctuates greatly during the year, from about 40°F or cooler in January to almost 100°F in August, especially in shallow areas... very tolerant of rapid temperature change and low oxygen content due to summer heat.

Desert Pupfish
Family Cyprinodontidae

- 1 1/4 inches long
- max. age of three years
- females are gray and drab
- males are bluish, turning bright blue during spring breeding season.
- feed on insect larvae and other organic matter from pond bottom.
- prefer shallow pond depths, about 12 to 18 inches deep.

Rhynchocephalia
- evolved before dinosaurs
- world-wide distribution in Mesozoic
- most extinct at end Cretaceous (65mya)

Sphenodontidae
- 1 extant genus (Sphenodon)
- 2 extant species
- restricted to small islands of New Zealand
- long lived

Pricing Biodiversity

\[ R_i = (D_i + U_i)(\Delta P_i/C_i) \]

D = distinctiveness
U = utility
\( \Delta P_i \) = enhanced probability of survival
C = cost of strategy

Direct limited funds...
Ecological Contribution?