B242 – Evolutionary Genetics

Conservation Genetics

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What is conservation genetics?

Conservation genetics is the application of genetics to preserve species as dynamic entities capable of coping with environmental change.

(Frankham et al. 2002. An Introduction to Conservation Genetics)

Are genetics important in conservation?

- Human factors – habitat destruction and hunting
- Environmental stochasticity – fires, harsh winters, climate change (non-anthropogenic)

Areas we will look at....

1. Inbreeding and loss of genetic diversity
2. Genetics and taxonomy in conservation

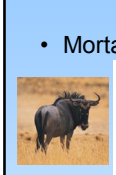
Inbreeding and loss of genetic diversity

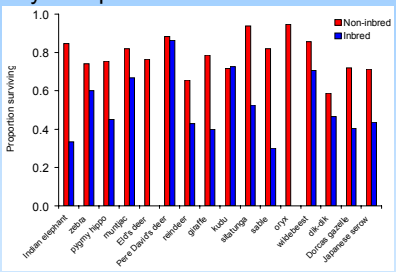
Inbreeding depression

- Inbreeding depression is the reduced fitness in offspring produced by incestuous matings.
- Examples of inbreeding depression
  - mostly from laboratory situations
  - inbreeding depression in species of conservation interest from zoos

Inbreeding depression in zoos

- Mortality in captive bred animals.



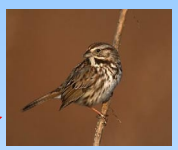


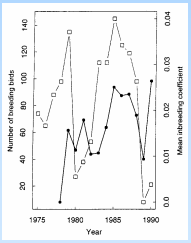
(Ralls et al. 1979. Science 206:1101-1103)

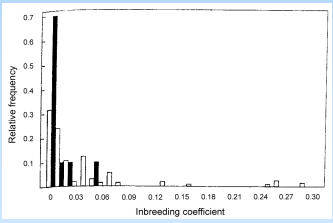
Inbreeding depression in the wild

- Very few good examples coz....
- Mandarte Island song sparrow

(Keller, L. F. et al 1994. *Nature* 372: 356-357)







Genetic diversity, population size and inbreeding

Low genetic diversity caused by

Inbreeding AND/OR Genetic drift in a small population

Drift in small populations

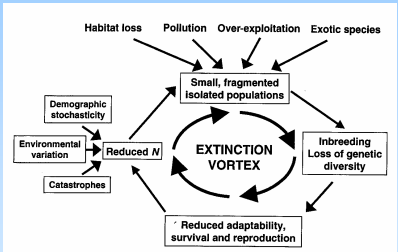
$$H_t = H_0\left(1-\frac{1}{2N_E}\right)^t$$

H_t = heterozygosity after t generations
H_0 = initial heterozygosity
N_E = effective population size

N_E usually much smaller than actual population size

fluctuating population size
skewed sex ratio
reproductive skew
age structure

The extinction vortex



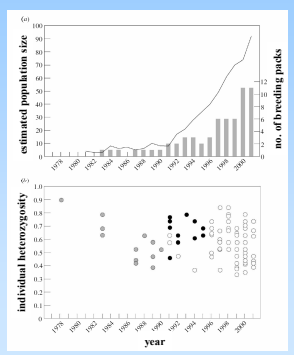
Genetic diversity and fitness

- Glanville fritillary

- Wolves

Wolf population recovery

Vila, C. et al. 2003.
Proc. R. Soc. Lond. B 270:91-97.



Florida panther

- In 1991 population was only 30 individuals
- Kinked tails, cardiac defects, poor semen quality, undescended testis, many infectious diseases
- 8 females introduced from Texas
- In 2004 population had increased to 87 and distribution had increased
- Hybrid kittens show 3 time higher survivorship

Genetic diversity and fitness

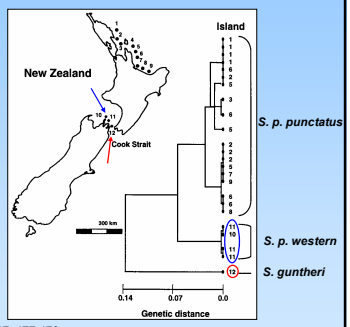
- Glanville fritillary
- Wolves
- Florida panther
- The cheetah story

Genetics and taxonomy in conservation

Species, subspecies and genetic distances

	Genetic Distance
Subspecies	
Red deer	0.016
Ground squirrels	0.103
Drosophilia willistoni	0.228
Species	
Galapagos finches	0.004 – 0.065
Ground squirrels	0.56
Anolis lizards	1.32 – 1.75
Genera	
Galapagos finches	0.04 – 0.14
Birds (Parulidae)	0.05 – 0.69
Fish (Scaenidae)	1.1 – 2.8

Tuataras



Daugherty, C. M. et al. 1990. *Nature* 347: 177-179.

DNA barcoding

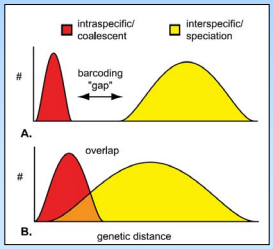
- What is DNA barcoding?
  - Identification of species using DNA sequences
  - Specifically using ~650bp of mitochondrial *cytochrome oxidase I* gene

Consortium for the Barcode of Life
http://barcoding.si.edu

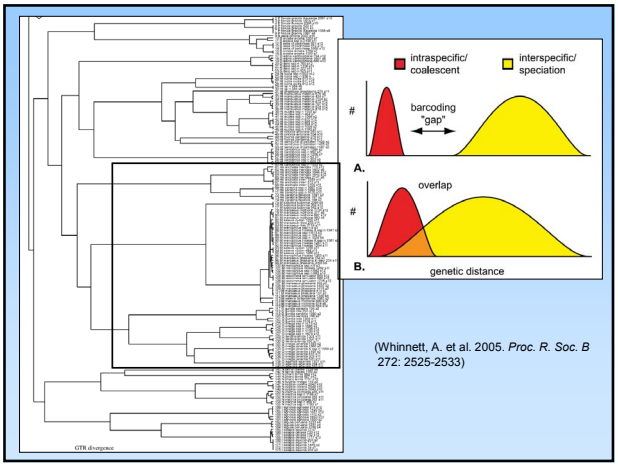
DNA barcoding

Relies on

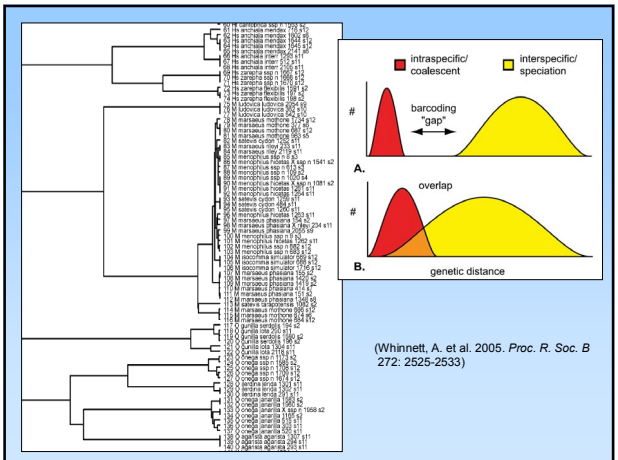
Interspecific variation >> intraspecific variation



Hebert, P. D. N. et al. 2004. *Nature* 347: 177-179.



(Whinnett, A. et al. 2005. *Proc. R. Soc. B* 272: 2525-2533)



(Whinnett, A. et al. 2005. *Proc. R. Soc. B* 272: 2525-2533)

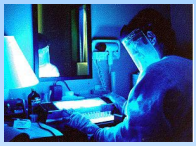
DNA barcoding – the good and the bad

- Advantages
  - No taxonomic knowledge required
  - Discovery of cryptic species
  - Potentially very fast
- Disadvantages
  - Based on mitochondrial DNA not nuclear DNA
  - Need laboratory equipment
  - Can't distinguish species in rapidly evolving taxa
  - May be little or no difference between intra and interspecific genetic variation

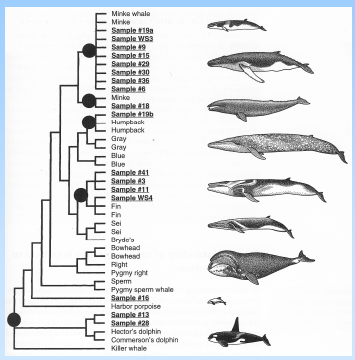
Forensic applications

- DNA can be amplified from tiny bits of tissue
  - hair, faeces, museum samples
- Tracking individuals
- Identifying species

Detecting illegal whaling



(Baker, C. S. et al. 1996. *Mol. Ecol.* 5: 671-685)



Major areas in conservation genetics

Inbreeding depression	Resolving taxonomic uncertainties
Loss of genetic diversity	Defining management units
Population fragmentation	Forensic applications
Genetic drift	Understanding species biology
Deleterious mutations	Outbreeding depression
Genetic adaptation to captivity	

Points to take away

- Some controversy over the importance of genetic factors in conservation
- Genetic factors important in small populations
- REMEMBER that human factors are by far more important
- Many uses of molecular tools in conservation
  - taxonomic uses
  - understanding species biology
  - population structure etc.