BIOB480/BIOE548 notes 11/05/2024

Introduction

- HW9 due Thursday—any questions?

Management Units

Conservation genetics encompasses usiong genetic tools to better understand the taxonomy and systematics of threatened species and popoulations. Per the Convention on Biological Diversity, Taxonomy is "the science of naming, describing and classifying organisms and includes all plants, animals and microorganisms of the world". Systematics is often used interchangeably with taxonomy, but adds an evolutionary dimension: what are the *relationships* among taxonomic units?

So why does taxonomy matter for conservation?

1. Unrecognized endangered species may be allowed to go extinct;
2. Endangered species may be denied protection if considered a population of a common species;
3. Incorrectly diagnosed species may be hybridized with other species, potentially reducing fitness;
4. Populations that could be used to ameoliorate inbreeding might be overlooked.

Familiarity with **species concepts** is important to this goal. Species concepts are famously abundant, with and counting at the time of a review in the mid-90s (Mayden 1997). Part of the reason for their proliferation is widespread confusion between conceptual basis and operational criteria (*definitions* versus *delimitation*).

A few important species concepts follow:

- *Biological species concept*: A species is a group of actively or potentially interbeeding individuals separated from other such groups by intrinsic or extrinsic reproductive isolation (not only geography)
- *Ecological species concept*: A species is a group of individuals that share the same ecological niche or adaptive zone.
- *Evolutionary species concept*: A species is a group of individuals with the same evolutionary role, tendencies, and historical fate.
- *Phylogenetic species concept*: A species is a group of individuals that conform to one or more phylogenetic criteria (reciprocal monophyly, coalescence of all gene trees).
- *Phenetic cluster species concept*: A species is a group of individuals that form a cluster in morphological space separated from other such groups (similar trait values for multiple features).
- *Genotypic cluster species concept*: A species is a group of individuals that form a cluster in genoptypic space separated from other such groups (similar allele frequencies at multiple loci).

These species concepts may conflict for several reasons:

- Alternate definitions

- Insufficient data
- Incomplete speciation

Understanding how speciation proceeds can help resolve ambiguities:

- Usually in *allopatry* (between geographically isolated populations) but sometimes in *sympatry* (populations with overlapping distributions) or *parapatry* (populations with non-overlapping but adjacent distributions)
- Predominantly driven by natural selection, not drift
- May involve changes in number of chromosomes
- Frequently takes a long time

Species delimitation is the process of identifying the boundaries of species and assigning individuals to groups:

- Requires "operational criteria" (which may or may not be independent from species concepts): how do we separate one species from another in practice?
- Most criteria require algorithims to assess genetic differences between populations

Many approaches to species delimitation with genetic data depend on Nei's Genetic Distance (D_N):

$$D_N = -ln(\frac{\sum_{i=1}^{m}(p_{ix}p_{iy})}{\sqrt{(\sum_{i=1}^{m}p_{ix}^2)(\sum_{i=1}^{m}p_{iy}^2)}})$$

- If the substitution rate is constant per generation, D_N will increase proportionally to divergence time (not true of F_{ST}, for example)
- When $p_{ix} = p_{iy}$, $D_N = 0$; when no alleles shared, $D_N = \infty$

In practice, species delimitation and taxonomy are important to conservation genetics because of the risk of **oubreeding depression**, or decreased fitness with increased genetic diversity.

Outbreeding depression may be caused for two primary reasons:

- Populations may be adapted to **different environmental conditions**
- Populations may have evolved **different coadapted gene complexes (positive epistasis)**

Species delimitation is also important because conservation law requires categories to which to apply. THe US Endangered Species Act permits listing of "any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbeeds when mature". Unfortunately, the ESA does not define DPS, but FWS offers guidance: "a population segment's DPS status is determined by the *discreetness* and *significance* of the population segment compared with the species as a whole".

Grizzlies in the Greater Yellowstone Ecosystem are a prime example of the difficulty of applying the ESA:

- 2007: FWS decides a valid DPS and sufficiently recovered, so delisted

- 2009: US District Court for District of Montana determines FWS has not adequately considered whitebark pine decline, relists

- 2017: FWS declares (after research) whitebark pine decline not an issue, again delists

- 2017: Crow Indian Tribe successfully sues on basis of FWS delisting not considering other grizzly populations—potentially a problem because DPSs should be species in their own right!