

Gene Flow, Oil Flow and the Marbled Murrelet:

A Bird in the Bush Administration

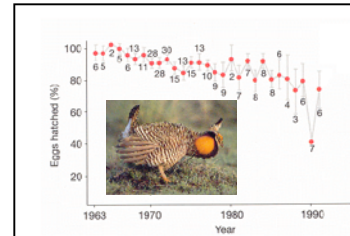
- The role of genetics in conservation
- Conservation genetics of marbled murrelets
- Murrelets and the U.S. Endangered Species Act



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The Role of Genetics in Conservation

- As populations decline, inbreeding and the potential for inbreeding depression increase.



- Loss of genetic variation may compromise a population's persistence.

Role of Genetics, cont'd

- If local populations differ genetically, loss of a population may result in
 - loss of genetic variation
 - loss of local adaptations
 - loss of cryptic species.
- The species also may not naturally repopulate an area following a decline.

Populations that differ genetically should be managed separately.

Conservation Genetics of Marbled Murrelets

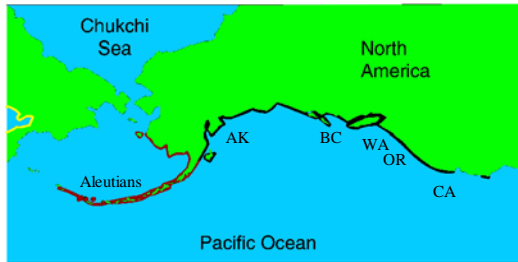
Introduction

Marbled murrelets

- are small alcids (seabirds)
- feed inshore on small fish and invertebrates
- have solitary nests, generally in large trees in coastal old-growth forest
- are "K-strategists"
- are monogamous, with biparental care

Introduction,cont'd

- nest from California through BC to the Aleutian Islands



black = tree-nesting; brown = ground-nesting; yellow = Asian murrelet

Introduction,cont'd

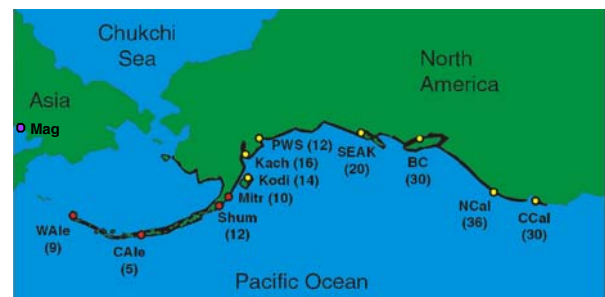
- are highly vulnerable to logging, oil pollution (e.g. *Exxon Valdez* Oil Spill), drowning in gill nets, and predation by corvids.

Introduction,

How is neutral genetic variation distributed within and among local populations of marbled murrelets?

(Friesen et al. 1996, 1997, submitted, Congdon et al. 2000)

Methods



Methods,

A 547 base pair fragment of mitochondrial DNA was amplified and sequenced:

- + high mutation rate;
- + maternally inherited and haploid;
- only provides information on matriline.

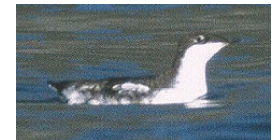
Sequence variation was screened for allozymes and nuclear introns:

- + biparentally inherited and diploid;
- lower mutation rates.

Results: Asian murrelets

'Marbled' murrelets from Asia represent a cryptic species:

- mitochondrial DNA sequences are 10% different;
- they have distinct alleles at several nuclear loci;
- ➔ they have probably been reproductively isolated for 5 my.



Results: North America, mCR

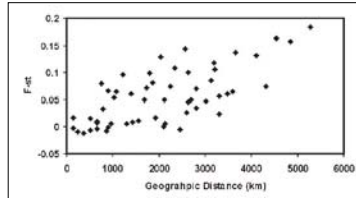
- high variation (75 haplotypes)
- several private haplotypes, esp. in Cal and the Aleutians
- global $\Phi_{ST} = 0.06$ ($P < 0.0001$)
- most pairwise Φ_{ST} not significant, but most estimates involving Cal significant (range = 0.00 - 0.49)

Results: mCR, cont'd

- in hierarchical AMOVAs, the 'best' results involved four groups:
 - (1) WAle
 - (2) CAle
 - (3) AK Peninsula to NCal
 - (4) CCal
- ($\Phi_{CT} = 0.10$, $P < 0.001$)

Results: North America, Introns

- 3-18 alleles
- several private alleles, esp. in Cal
- global $F_{ST} = 0.041$ ($P < 0.0001$)
- most pairwise F_{ST} not sig., but comparisons involving Cal and Aleutians significant (range = 0.00 - 0.18)
- significant isolation-by-distance (Mantel's test; $r = 0.70$, $P < 0.001$).



Results: Introns, cont'd

- 'Best' results in hierarchical AMOVAs involved five groups:
 - (1) WAle
 - (2) CAle
 - (3) AK Peninsula to BC
 - (4) NCal
 - (5) CCal
- ($F_{CT} = 0.064$, $P < 0.001$).

Summary for Population Genetics Study

Significant population genetic structure exists in marbled murrelets:

- main differences appear to involve populations in the Aleutians vs mainland AK/BC vs CCal
- structure is intermediate to other species of seabirds

The Five Year Listing Review

Marbled murrelets are

- declining in most (all?) parts of range
- listed as 'Threatened' in BC under the Species at Risk Act
- listed as 'Threatened' in WA, OR and CA under the US Endangered Species Act
- * WA, OR and CA murrelets are presently considered a 'Distinct Population Segment' under the US ESA.

What is a “Five Year Review”?

- US Fish & Wildlife Service is required to review the status of listed species every five years.
- The logging industry wants them de-listed.
- The logging industry sued the USFWS in 2003 for
 - not conducting reviews of the marbled murrelet and spotted owl,
 - not delineating DPSs properly.
- USFWS contracted reviews to expedite the process.

How Did the Murrelet Review Work?

- The contractor (EDAW Environmental)
 - assembled a team of ‘experts’;
 - submitted a request for literature to US federal archives (425 relevant documents from last 5 years);
- The “experts”
 - formally reviewed the 425 documents, plus many others
 - wrote a formal report
- USFWS reviewed the document, and decided listing.

What were the Findings of the Review?

- Methods for studying murrelets, and knowledge base have increased greatly over past 5 years.
- Demographic models indicate that populations in CA, OR and WA will be extinct within the next 50 years, even under a ‘best-case’ scenario.
- Populations in CA, BC/mainland AK and Aleutians are “distinct population segments” (genetic & ecological data).
- Populations in CA/OR/WA are “significant” (ecological data).

Findings, cont’d

- Current major threat is predation by corvids, whose populations are artificially high due to food subsidies in parks.
- Other threats include oil pollution, marine pollution, forest edge-effects, and disease.
- Murrelets in CA, OR and WA should be listed as ‘Threatened’ or ‘Endangered’.

The Listing Decision (drum roll, please....)

The State FWSs upheld the recommendations of the review panel.

The Federal FWS decreed that there is 'insufficient evidence' to conclude that murrelets in CA, OR and WA constitute a distinct population segment!

- A range-wide review of the species' status will now be conducted, to determine if the species should be de-listed.

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