Potential impacts of climate change on habitat supply & demographic outcomes for the Northern Spotted Owl

G. D. Sutherland[1] , F. L. Waterhouse[2], J. Smith[1], A. Hamann[3], A. S. Harestad[4], D. T. O'Brien[1], and M. Hafer[1]

Photo Credit: Glenn Sutherland

[1] Cortex Consultants Inc.

[2] BC Ministry of Forests and Range
Coast Forest Region

[3] University of Alberta

[4] Simon Fraser University

Introduction

We explored potential climate change (CC) effects on conservation strategies for species by testing hypotheses about how CC may induce shifts in habitat supply and distribution.
As a case study, we used Northern Spotted Owls (*Strix occidentalis caurina*; SPOW).
Long-term habitat & population recovery strategies for this endangered species are critical in B.C.

We used a strategic spatio-temporal landscape dynamics and habitat supply modelling framework (Sutherland et al. 2007). Effects of CC on habitat and potential supply of breeding territories were simulated replacing the biogeoclimatic sub-zone / variant component of habitat for Spotted Owls with projected shifts in climatic suitability envelopes of current BEC zones by Hamann and Wang (2006).

Our comparisons are preliminary and are limited to the period between 2004 and 2080. Habitat supply is shifted based on assumed changes in climate. Associated changes in forest ecosystem structures are assumed to lag behind climatic changes over the interval we studied (unless it is removed by harvest or fire).

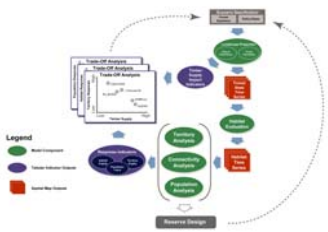
Model Framework

The framework concurrently integrates information about both ecological processes and predicted consequences of forest management activities.
We used components of the overall model framework (at right)
The specific models used in analyses were:

- scenario specification
- landscape dynamics (G&Y, harvesting, fires)
- habitat classification (life requisite function)
- connectivity among habitat types
- breeding territory creation and placement

Not used in this preliminary study:

- population model
- ranking of potential reserves model



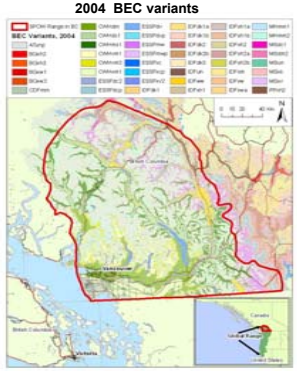
Bioclimate Projection Envelopes

Simulating Climate Change Effects

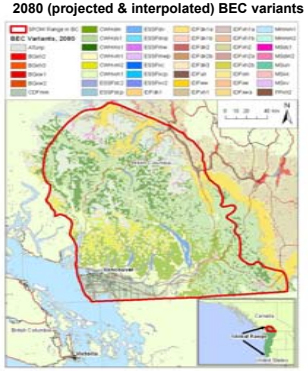
We projected shifts in habitat suitability & connectivity and inferred population effects using shifts in "bioclimate envelopes" translated into potential biogeoclimatic variants (BEC) at each location (Hamann and Wang 2006):

- average climate envelopes for plant species are defined using current climatic conditions and species distribution mapping.
- spatial scenarios of trends in climate variables - based on projected temperature changes of 3-5 ºC within the next 80 years.
- shifts in the "climatic suitability" envelope of current BEC zones - modeled by statistically relating ecological requirements of indicator plants of BEC variants to climatic variables for each 4 km^2 location within the SPOW range for the period 2004-2080.
- we assumed: (1) no climate change=no change in BEC variant; (2) climate change= projected change in BEC variant

2004 BEC variants



2080 (projected & interpolated) BEC variants



Habitat Types – Modelling effects of CC on supply & distribution

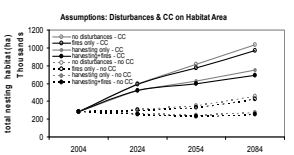
Potential habitat is classed as: (1) Nesting & Foraging; (2) Foraging Only; (3) Non-Habitat.
Habitat Type for each ha = f(acceptable BEC variant, max. elevation (only Nesting & Foraging habitat), min. stand age and min. tree height).
BEC and elevation are assumed to influence habitat suitability through temperature & precipitation controls on prey availability & owl energetics. Stand age & height determine suitable stand structure for supporting nesting, foraging, & cover.

Under shifting climate envelopes we hypothesized 4 possible climate + structure states at each cell:

1. No change in BEC envelope from current (2004) -> future (2080)
   - structural & climatic controls on habitat type are unmodified.
2. BEC envelope changes from current (2004) -> future (2080)
   - If both BEC_{t-1} & BEC_t are acceptable: use stand age/height criteria from BEC_{t-1}, & use elevation limit from BEC_t (structure & climate constraints may both apply)
   - If BEC_{t-1} = unacceptable; BEC_t = acceptable: use age/height criteria from BEC_t & remove elevation limits on Nesting habitat (structure constraints > climate constraints)
   - If BEC_{t-1} = acceptable; BEC_t = unacceptable: no change in habitat criteria (climate constraints may be greater than structural constraints)

Results – Changing Habitat Supply -> 2080 (with/without CC)

- Δ in Nesting & Foraging habitat due to CC: +246% to +366%
- Δ in Foraging Only habitat due to CC: -8% to +6%
- with CC, connectivity increases in major valley systems & in E & S directions of present range
- rates of habitat change marginally higher in near-term (2020-2050)



% of ∑ uncertainty

- 74% - CC
- 21% - harvesting
- 4% - fires

Zones of Uncertainty

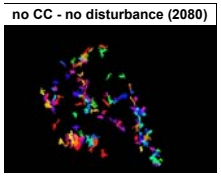
contribution by type of habitat variable

- 57% - climate variables only
- 30% - structural variables only
- 13% - both climate & structure

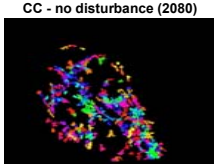
NB: disperse conservation areas among zones of uncertainty

Potential Territories (Reserves) & CC

no CC - no disturbance (2080)



CC - no disturbance (2080)



- disturbances reduce # potential territories by 13% to 34%
- depends on disturbance type

Conclusions

Modelling CC enables conservation planners to anticipate:

1. Zones of management uncertainty where projected habitat futures differ
2. Differing conservation area allocation opportunities
3. Potential changes in population response with habitat evolution

Further Work

1. Directly test conceptual model for CC effects on demography
2. Test assumptions – esp. lags between climate shifts & structural attributes
3. Examine alternate climate projections
4. Explore natural disturbance regime parameters

References

Hamann, A. and Wang, T. 2006. Effects of climate and climate change on ecosystem and tree species distribution in British Columbia. *Ecology* 87: 2773-2786.

Sutherland, G.D., D.T. O'Brien, S.A. Fall, F.L. Waterhouse, A.S. Harestad, J. B. Buchanan (editors). 2007. A Framework to Support Landscape Analyses of Habitat Supply and Effects on Populations of Forest-Dwelling Species: A case study based on the Northern Spotted Owl. B.C.. Min. For. Range, Res. Br., Victoria, B.C. Tech. Rep. 038. <http://www.for.gov.bc.ca/hfd/pubs/Docs/Tr/Tro38.htm>