Woodpeckers' spatial distribution through fragmented landscapes of boreal forests in Abitibi: a habitat connectivity analysis

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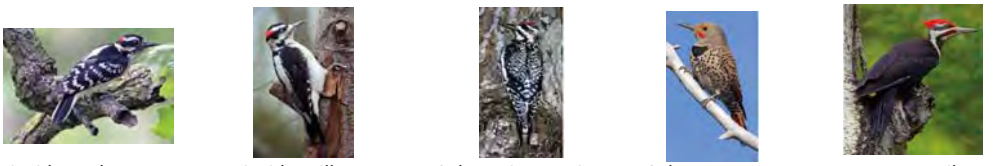
Woodpeckers require older forests for both foraging and nesting. More specifically, in boreal mixedwoods woodpeckers use primarily large trembling aspen in older stands. As the combined effect of natural (wildfire, insect outbreaks) and human-induced (agriculture and timber harvesting) disturbances rejuvenate and fragment the forest cover, the amount of mature trembling aspen available to woodpeckers is reduced

Objective: Evaluate how habitat loss and fragmentation affects woodpeckers' regional dispersal in managed boreal landscapes of north western Québec

WOODPECKERS UNDER STUDY

Images taken from Gordman., G 2014. Woodpeckers of the world.



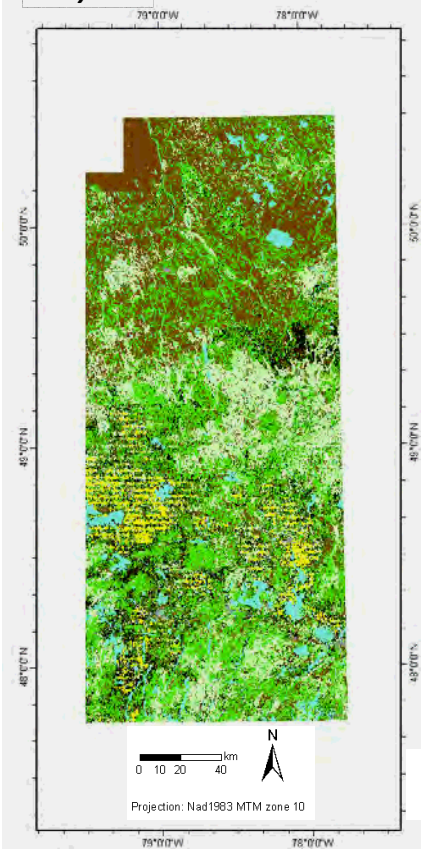
Picoides pubescens | *Picoides villosus* | *Sphyrapicus varius* | *Colaptes auratus* | *Dryocopus pileatus*

>25 cm — Minimum dbh of *Populus tremuloides* for feeding and nesting — >35 cm

10 ha — Forest area requirements — 50 ha

0.9 km — Dispersal capacity in daily movements — 4.7 km

Study area



HABITAT QUALITY MAP

Building process

Quebec's 3rd decennial forest cover map: species groups, type of forest cover, height classes → New type of forest cover (NTCO) with presence of Trembling aspen (TA) and certainty → Species groups in the Forest map & NTCO

3r decennial temporal plots (1/25) # TA with dbh > 25 & dbh >35 cm & NTCO → Cluster for NTCO with >5 plots considering height classes → K-means (*k*=4 to *k*=6) / Expert criteria

Results

Habitat

Forest categories (cluster results, k=4)
- Forest with large Trembling aspen
- Forest with Trembling aspen
- Forest without Trembling aspen
- Forest in regeneration

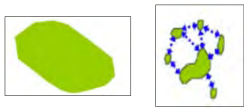
Non forest categories
- Semi-natural cover
- Agriculture
- Artificial lands
- Unproductive
- Water bodies and courses

HABITAT SIZE

>10 ha in green
>50 ha in dark green

CONNECTIVITY ANALYSIS

- Which landscape is more connected?



- Using the graph theory framework and planar graphs
- Software: Conefor and Graphab
- Tested scenarios:
  - Two thresholds of habitat size
  - Three distances of daily movements based on landscape configuration and empirical data
  - Accounting for landscape matrix resistance «*least-cost paths*»

Patch ranking as flux receivers

Connectivity indices

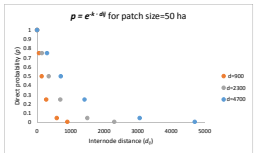
Flux

$$dF_k^* = 100 \times \frac{\sum_{i=1,i\neq k}^{n-1} p_{ik}^*}{\sum_{i=1}^{n}\sum_{j=1,i\neq j}^{n} p_{ij}^*}$$

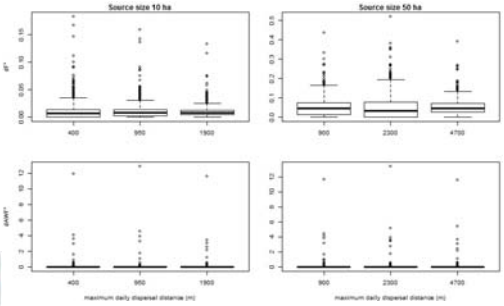
Area-weighted flux

$$dAWF_k^* = 100 \times \frac{\sum_{i=1,i\neq k}^{n-1} a_i \cdot a_k \cdot p_{ik}^*}{\sum_{i=1}^{n}\sum_{j=1,i\neq j}^{n} a_i \cdot a_j \cdot p_{ij}^*}$$

Based on *Saura and Rubio* 2010: Ecography 33: 523-537



Some preliminary results



Large habitat patches were highly ranked as area-weighted flux receivers (dAWF*) if they were reachable according to the dispersal capacity (rho≥0.55). dF* ranking was less correlated with source size (rho≥0.36).

FURTHER RESEARCH

Hierarchical modelling approach

Response variables
- Species occurrence
- Cavities
- Nesting success

- *Model 1:* habitat quality (source or not)
- *Model 2:* Model 1 + Size of habitat sources
- *Model 3:* Model 2 + Reachability of source patches
- *Model 4:* Model 3 + Reachability of large source patches

Analyses

- GLMs and Maxent modelling
- AICc model comparison

Hypotheses

- H0 (Null Model): Habitat connectivity does not affect woodpeckers occurrence, cavity localisation nor nesting success (Models 3 and 4 do not add a significant fit when compared with Models 1 and 2).
- H1: Connectivity is significantly associated with woodpeckers' occurrence
- H2: Connectivity exerts a significant influence only on woodpeckers' nesting parameters (cavity trees, nesting success).

CONCLUSIONS

- We set a methodology to develop a habitat quality map for woodpeckers based on fine scale empirical data.
- Connectivity analysis allowed us to detect which patches are key as flux receivers according to different habitat requirements and dispersal capacities.
- Further steps are needed to detect if and how the amount of reachable habitat influence species distribution and breeding success depending on the species.

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