Herding Rats: Fifteen Years of Appalachian Northern Flying Squirrels
Appalachian Northern Flying Squirrels

- Pleistocene relict
- *G.s.coloratus* inhabits high elevation forest islands in southern Appalachians; *G.s.fuscus* inhabits more connected landscape in central Appalachians
- Prefers red spruce or mixed red spruce-northern hardwood forests
- Cavity nester
- Mycophagus
- Parasite-mediated competition with *G. volans*
Pre-exploitation forest structure similar to Pacific Northwest?

Fig. 2—Red spruce trees dwarf the lumberjacks who are soon to cut them. Cheat Mountain, Pocahontas County on lands of the West Virginia Pulp and Paper Co., 1910. Courtesy Mrs. Emory P. Shaffer.
Just 12 of us documented prior to 1980's in the Virginia’s
The Blackwater Canyon: a private forest (forest management, surface mining, second-homes and wind energy) with public expectations.
Canaan Valley NWR
Snowshoe Resort
Kumbrabow SF and MeadWestvaco Ecosystem Research Forest

VA
WV

Glaucomys sabrinus fuscus captures through 2004
Figure 1. Location of Carolina northern flying squirrel nest box lines, 1996-2011.
Mixed Northern Hardwood - Red Spruce

Occupancy (Psi) vs Mean Percent of Habitat

Predicted Probability of Occurrence

- Red: > 75% Prob. of Occurrence
- Blue: 50-75% Prob. of Occurrence
Figure 3. Relationship of predicted occupancy of Carolina northern flying squirrels in North Carolina (80 lines), 1996-2011 with landform index of surrounding habitat.
Den Tree Results

• 41 cavity and 18 drey nests

• Yellow birch and Fraser’s magnolia chosen more than expected; Norway spruce, red spruce, American beech, black birch, red maple, sugar maple and black cherry used in proportion or less than expected.

• Trees on north facing slopes

• Larger and taller than surrounding trees

• Close to hiking and skidder trails

• Switched nest trees frequently

• High plasticity in nest tree selection
  – wide variety of characteristics

• No difference between male and female

Home Range and Habitat Use

* Male - 54.2 ha (summer), 25.8 ha (winter)
* Female - 15.3 ha (summer), 3.8 ha (winter)

(compare with 1-4 ha in Cascade and Coast Ranges in Pacific Northwest)

* Spruce > northern hwds. > mixed mesophytic
* Males will cross roads and ski slopes


Occupancy:

\[ \psi(\text{high}) = 0.95 \pm 0.17 \]
\[ \psi(\text{medium}) = 0.80 \pm 0.29 \]
\[ \psi(\text{low}) = 0.50 \pm 0.00 \]

Detection:

\[ \rho = 0.65 \pm 0.1 \]
\[ \rho (\text{high}) = 0.76 \pm 0.05 \]
\[ \rho (\text{medium}) = 0.64 \pm 0.05 \]


Figure 2. Linear relationship between cumulative captures of Carolina northern flying squirrels and site-specific POPAN population estimation, 2011.
Statewide Occupancy
(mixed northern hardwood-red spruce covariate)
Northern flying squirrel upsweep

Southern flying squirrel down-sweep
Would going from degraded and potential habitat to occupied and restored (semi-functioning) montane conifer habitat be a suitable management objective in West Virginia and Virginia - and perhaps now North Carolina and Tennessee?

- High % public ownership
- Geographically definable and compact
- Restoration and expansion of valuable forest type
- Endangered species recovery (northern flying squirrel, Cheat Mountain salamander, spruce-fir spider)
- Enhance status and outlook for sensitive or relict species (northern goshawk, saw-whet owl, snowshoe hare, fisher)
- Banking for the future - build resistance!
- Thin to increase structural heterogeneity (multi-size classes) and release residuals
- Target eastern hemlock and American beech


Hemlock adelgid
Balsam woolly adelgid
Acid deposition
Climate change
Surface mining
Wind energy
Second homes/recreation

Red oak or northern hardwood?

< 0.70 probability of Northern Hardwood

> 0.70 probability of Northern Hardwood

89.47% correct classification
“You’re a hell of a squirrel, but you’re still just a squirrel.”
Corinne Diggins
PhD Candidate
Virginia Polytechnic Institute and State University
USGS Virginia Cooperative Fish and Wildlife Research Unit
Steps in Restoration

• Time of reference
• Clearly state reference conditions used for restoration
  – Critical first step in the restoration process
  – Helps garner more public support
  – Without clearly stated and proper application of reference conditions, it is not restoration!!!
Steps in Restoration

• Time of reference
• Clearly state reference conditions used for restoration
• Define restoration treatments
  – Take into account site-to-site variability
  – Blanket prescriptions are inappropriate for promoting structurally diverse systems
• Carry out preliminary, small scale on-the-ground experiments prior to application on the landscape level
• Monitor restoration treatments
• Evaluate effectiveness of restoration treatments using Evidence-based Conservation
• Use adaptive management to perfect restoration treatments
Goals for Restoration in Southern Appalachians

- **Ecological Fidelity**
  - Main goal of restoration
  - Determined by time of reference
  - 3 principles
    - Structural/compositional replication
    - Functional success
    - Durability

- **Increase ecological health and integrity**
- **Methods of restoration should be effective and efficient**
Reference Conditions

- Old-growth stands
  - Gaudineer Knob Scenic Area
  - War Spur
  - Great Smoky Mountains
- Historic accounts of spruce in Central and Southern Appalachians
  - Photographs during logging era in 1880-1920s
- Early land surveys
- Soils and ectomycorrhizal fungi
- Dendrochronology studies
  - Determine second-growth hardwood forests (Schuler et al. 2002)
Getting it right

• Using clearly defined reference conditions, test several different methods to restore spruce on-the-ground using scientific methodology

  • Need to experiment on small scale to determine the best methods to efficiently restore spruce while considering the following:
    – Available resources
    – Easy of application on the ground
    – Translation to large scale application

• Benefits
  – Small scale equals little to no impact on wildlife (e.g., Carolina and Virginia northern flying squirrel, Cheat Mountain salamander, avifauna, etc.)
  – Gain support from public by producing research-based methods for restoration prior to applying them on a larger scale
Applying Landscape Scale Restoration

• After determining which restoration methods are the most effective on a small scale, apply them over a large contiguous area adjacent to an established spruce stand to study effects of restoration on a landscape scale using a before-after control-impact approach
  • Effects on wildlife populations and habitat dynamics
  • Nutrient cycling
  • Carbon sequestration
  • Ectomycorrhizal fungi associations
  • Herbaceous understory diversity
  • Insect communities
• Long term monitoring
• Evidence-based conservation to adjust restoration methods
Evidence-based conservation uses systematic reviews to evaluate the effectiveness of specific restoration treatments and present the likely outcomes of using such treatments.

- Formulate the management question with the relevant stakeholders
- Conduct a systematic review by performing an exhaustive, repeatable search of the literature; assessing the quality of the data; and objectively synthesizing and presenting the results
- Communicate the results in accessible forms to the relevant stakeholders, presenting management alternative and recommendations as well as directions for future research
- Reconvene the stakeholders to select a course of action based on the systematic review, and then monitor and evaluate the outcomes
Questions?