Multiple effects of forest management on cerulean warblers in the Appalachian mountains

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Introduction – Appalachian Mts.

AMBCR - Covers 105 million hectares
Dominated by various forest types (esp. Oak-Hickory)
Mostly privately-owned land
234 bird spp. breed or winter
86 spp. in decline (Sauer et al. 2005)

Introduction – Cerulean Warbler

Dendroica cerulea is a small, canopy-dwelling, neotropical migrant

Breeds in hardwood forests of eastern North America- 80% in Appalachian mountains (Buehler et al. 2006)

Declined by ~4%/yr from 1966 to 2007 (Sauer et al. 2008)

Designated vulnerable or threatened by many organizations/agencies

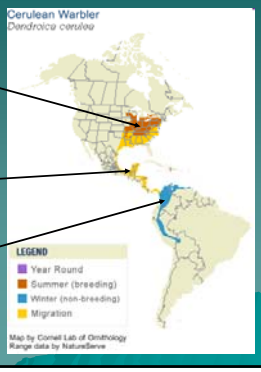
Petitioned for federal protection as a threatened species in 2000


Cerulean warblers - Range

Breeds: May-July

Migrates: Mar-May and July-Oct

Winters: Oct-Mar



Cerulean Warbler Habitat Associations

Mature forest, closed-canopy...

but also gaps/emergent trees

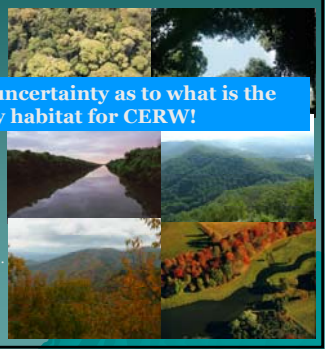
Much variability and uncertainty as to what is the highest quality habitat for CERW!

Bottomland...

Or ridge-top (but not in between)

Often require large tracts of forest...

but not always!



Cerulean Warblers and Forest Management

While CERW pops. have declined precipitously, total forest cover has only decreased slightly in past 40 years (Brown et al. 2005)

Forest Quantity ≠ Forest Quality

How may forest management affect CERW?

Can we improve quality of habitat using forest management?

Previous research

Density unaffected, or higher, in areas where certain silvicultural prescriptions applied
(Stoleson 2004, Rodewald 2004, Wood et al. 2005)

Lack: pre-treatment data, replication, metrics other than abundance, all examined less than three years of data

How may forest management affect CERW?

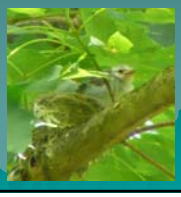
1) Abundance/Density

Abundance ≠ Quality
(Van Horne 1983, Marra and Holmes 2001, Battin 2004)

Could produce population sinks/ecological traps (Robertson and Hutto 2007)

2) Reproductive Success and Productivity

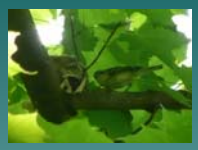
Decrease after natural disturbance
(Jones et al. 2001)



Forest management could also influence:

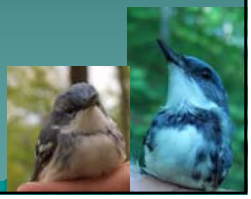
3) **Territory size and parental behavior**

Management may alter microclimate, predator risk, and food availability which may influence behavior
(Eggers et al. 2008)



4) **The distribution of individuals based on bird quality/plumage**

High quality, heavily ornamented birds may select high quality habitats (Wolfenberger 1999, Reudink et al. 2009)

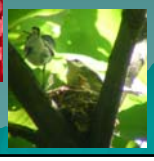


What is "quality"?

Any characteristic that is **directly** related to fitness (i.e., survival or reproduction)

Measures of individual quality:

- Size/Body Condition
- Provisioning rates
- Reproductive success
- Immune system function
- Age



Plumage and bird quality are often correlated (McGraw and Hill 2006)

American Redstarts

(Marra 2000, Reudink et al. 2009)

Winter in Caribbean in mangroves and secondary growth scrub

Individual quality is correlated with plumage

Birds w/ brighter tail spots obtain territories in mangroves; duller birds obtain territories in secondary growth

This suggests that the highest quality habitat is the mangrove habitat (which is supported by other studies as well)

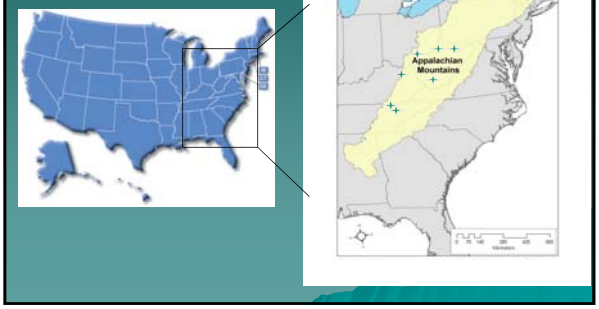
Goal

To assess how various forest management practices affect cerulean warblers

Objectives

1) To evaluate effects of various types of management on CERW abundance and reproductive success
2) To assess relationships among ornamentation, individual quality, and habitat of cerulean warblers
3) To measure relationships among habitat, territory size, and parental behavior of cerulean warblers

Methods- Study Sites



Experimental Design and Timeline

Seven sites replicated across Appalachian Mtns

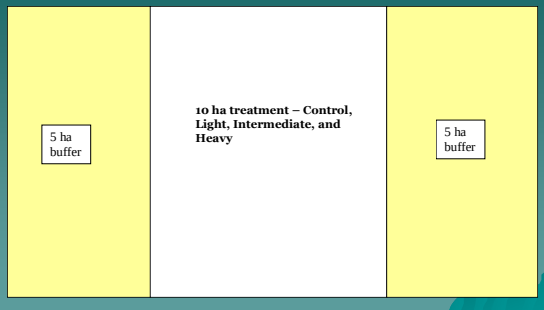
2005-06: Collect pre-harvest data

After summer of 2006: Experimentally manipulate forest stands by thinning at various levels

Three levels of harvest (plus control) at each site: light, intermediate, and heavy treatments (i.e., single tree selection, shelterwood cut, and modified clearcut)

2007-10: Collect post-harvest data

Treatment Plots

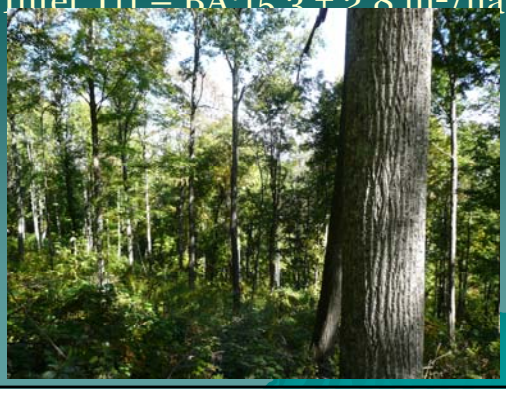


Plots embedded within forested landscape

Control – BA: 27.0 ± 5.1 m²/ha

Light Trt – BA: 20.9 ± 3.2 m²/ha

Inter Trt – BA: 15.3 ± 2.8 m²/ha



Heavy Trt – BA: 7.2 ± 3.3 m²/ha

Abundance/Density: Spot mapping

Following methods of Bibby (1992)

Eight visits to each plot

Record locations and territorial behavior of all male CERW

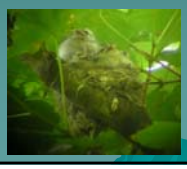
Delineate territories and determine density of CERW in each treatment

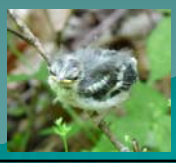
Reproductive Success: Nest-searching and monitoring

Most valuable if nest found in building stage- Find females early!

Monitor nest every 1-3 days (using spotting scope)

Determine outcome, fledgling #, male associated

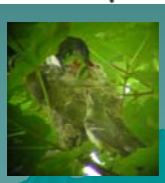




Parental Behavior: Nest Videotaping

Videotape all nests between day 6-9 of nestling stage (two hours)

Record all parental behavior data (time spent provisioning, brooding, fecal sack removal, etc.)



Territory Size: Territory mapping

- Map territories of all banded males
- Use burst sampling method following Barg et al. (2005)
- Record location of known male every 1 min for 30 min
- Flag locations and record with GPS later in day
- Map each bird at least 4 times
- Use 95% kernel method for determining territory size

From Barg et al. (2005)

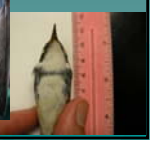
Plumage and Quality: Banding/Morphometrics

Target band male CERW using playback with decoy

Determine age (Pyle 2000)

Measure: Mass, wing length, exposed culmen, breast band width

Collect 10 rump, 10 crown, and 1st left rectrix feather

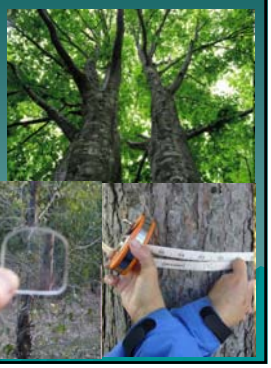


Take digital photos of tail spots, breast band, and crown

Habitat Measurements

At each nest, territory, and twenty random locations/plot

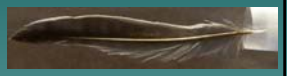
BA, canopy cover (at various forest levels), DBH of "in" trees, and other habitat variables



Lab Methods: Plumage and Quality

Quality:

L1 Rectrix length – digital calipers



Ptilochronology – Digital camera and various lights (analyzed using ImageJ from NIH)

Plumage:

Tail spot area – ImageJ

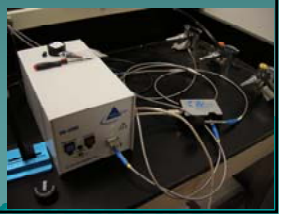
Feather color – Ocean Optics Spectrometer

Spectrometry Methods

Tape feathers on black paper, mimicking how they lie on the bird

Color Measurements:

- **Hue** (wavelength of highest reflectance)
- **UV Chroma** (% Reflectance from 320-400 nm)
- **Blue-Green Chroma** (% from 400-525 nm)
- **Brightness** (Total reflectance across all wavelengths)



Assess statistical relationships between:

Treatment and density: Regression

Treatment and reproductive success: Regression, Program MARK (AIC)

Plumage, bird quality, and habitat: PCA, correlation tests, and mixed linear models

Territory size, parental behavior, and habitat: Regression

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Questions?