

Cerulean Warbler Response to changes in forest structure in Indiana

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➤ Thank you for the introduction.

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- Indiana Academy of Science
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I would like to first start off by acknowledging our funding sources for the last 5 years.

BSU CERULEAN WARBLER RESEARCH PROGRAM

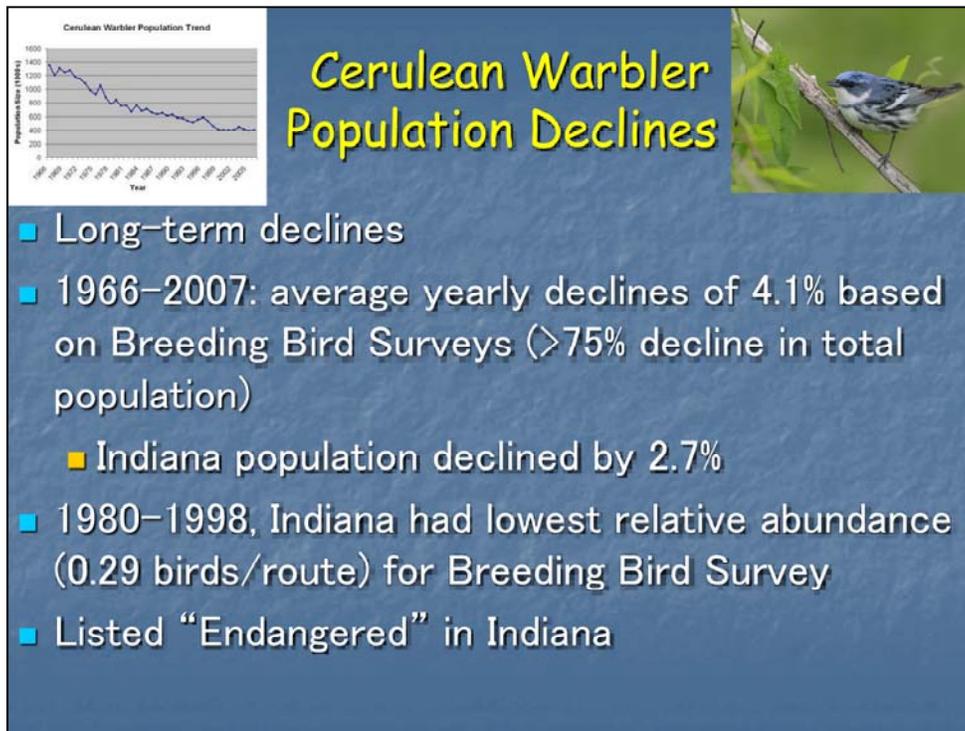
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I am fortunate to have had many dedicated and hardworking BSU graduate and undergraduate students tirelessly conducting Cerulean Warbler field research in southern Indiana.



Population declines

- The population has experienced long-term declines.
- Between 1966-2007 the population experienced an average yearly decline of 4.1% based on Breeding Bird Surveys (BBS) which is >75% decline in the last 40 years.
- During the same period in Indiana the population declined 2.7%.
- Between 1980-1998, Indiana had the lowest relative abundance (0.29 birds/route) for the BBS.
- Listed as Endangered in the state of Indiana.

Butler (1898) considered the Cerulean Warbler a common migrant and summer resident in Indiana, especially in the lower Wabash River Valley and other southern regions.

➤ And yet, a little over a century ago, Butler considered the Cerulean Warbler to be a common migrant and breeder in Indiana, primarily in the southern part of the state.

POSSIBLE FACTORS CONTRIBUTING TO DECLINE

- **Brown-headed Cowbird nest parasitism & predation**
- **Degradation of breeding habitat – loss & fragmentation**
- **Loss of migration (stopover) habitat**
- **Loss of winter habitat**

➤ Several factors have been attributed to the long-term decline in Cerulean Warbler populations. Some nests of Cerulean Warblers are parasitized by Brown-headed Cowbirds. For example, in Ontario, 7 of 39 nests or 18% were parasitized by cowbirds. However, another study in southeastern Ontario reported no instance of cowbird parasitism based on 27 nests. In our studies, we found only 2 cases of parasitism out of 50 nests monitored in southern Indiana.

➤ Other factors include loss of winter habitat and fragmentation of breeding habitat into smaller forested blocks. Based on studies conducted in Tennessee and the middle Atlantic states, Cerulean Warblers require large contiguous tracts of forests, at least 1000 ha in size, for successful reproduction. However, other studies in Ohio and Wisconsin contradict these findings and suggest that Cerulean Warblers can breed in much smaller tracts of forest.

➤ Some researchers have suggested that outbreaks of fungal and insect diseases on key nesting tree species such as oaks, elms, sycamores, and American chestnut, are responsible for the decline of Cerulean warblers. However, other researchers such as Paul Hamel, have refuted this hypothesis suggesting that these outbreaks occur on a local scale and should not affect the overall decline of Cerulean Warbler populations throughout its breeding distribution.

**Sustainably
Managing
Forests for
Our Future**



What will our forests
be like in 100 years?

**Hardwood Ecosystem
Experiment (HEE) - 100
year project**

Initiated in 2006

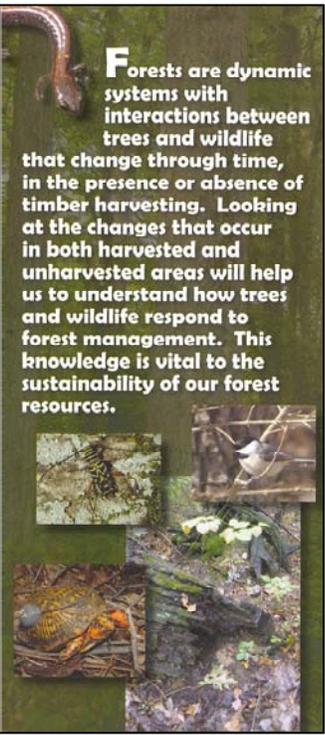
Goal - To understand social & ecological impacts of long-term forest management on public & private lands in Indiana and in the Central Hardwoods Region

Hardwood Ecosystem Experiment (HEE)

The Hardwood Ecosystem Experiment (HEE) is a 100 study examining the effects of silviculture on plant and animal populations. This project was initiated in 2006. **This is the brochure that was produced to advertise this study.**

Goal – To understand social & ecological impacts of long-term forest management on public & private lands in Indiana and in the Central Hardwoods Region.

**Primary Objective -
Develop even and un-even
aged silvicultural systems
that maintain oak
dominated forest
communities and
landscapes.**



Forests are dynamic systems with interactions between trees and wildlife that change through time, in the presence or absence of timber harvesting. Looking at the changes that occur in both harvested and unharvested areas will help us to understand how trees and wildlife respond to forest management. This knowledge is vital to the sustainability of our forest resources.

Hardwood Ecosystem Experiment (HEE)

Primary Objective – Develop even and un-even aged silvicultural systems that maintain oak dominated forest communities and landscapes.

Project Partners

Indiana Department of Natural Resources
Purdue University
Indiana Department of Forestry
Department of Entomology
Discovery • Learning • Engagement
Department of Entomology, Purdue University

INDIANA STATE UNIVERSITY
Center for North American
Bat Research and Conservation

Drake UNIVERSITY
The Nature Conservancy
Protecting nature. Preserving life.

BALL STATE UNIVERSITY
INDIANA DIVISION OF FISH & WILDLIFE
INDIANA STATE PARKS RESERVOIRS

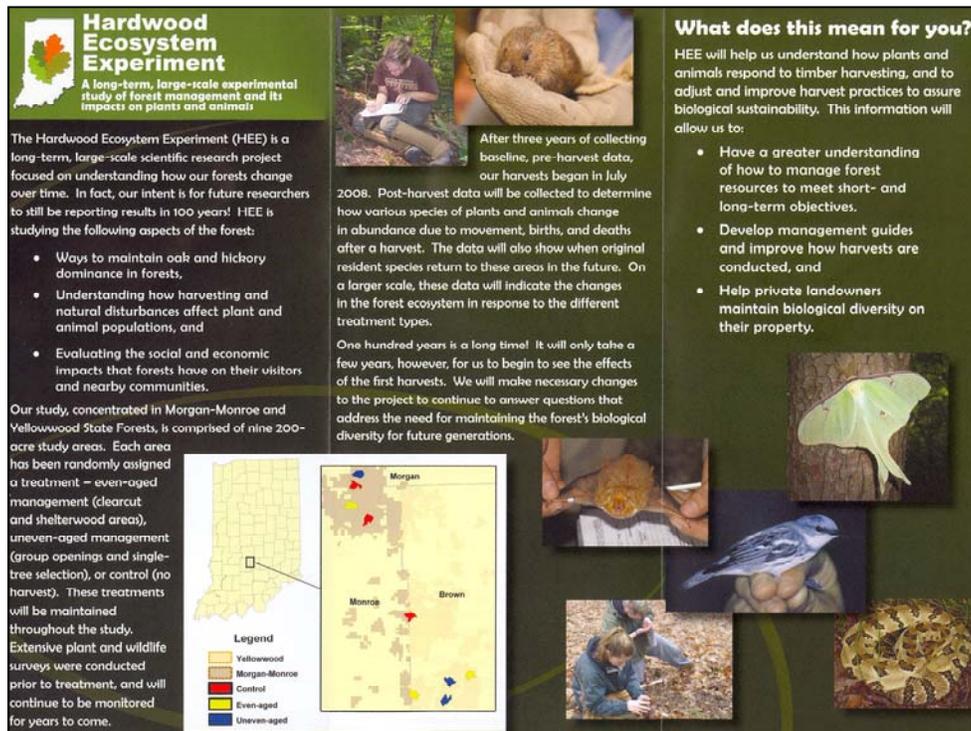
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Visit us on the web!
www.HEEForestStudy.org

Purdue University is an Affirmative Action,
equal access/equal opportunity institution.

Collaboration between Indiana Department of Forestry, Division of Wildlife and universities & agencies

Hardwood Ecosystem Experiment (HEE)

The Hardwood Ecosystem Experiment is a multi-disciplinary, collaborative project between the Indiana Department of Natural Resources, Division of Forestry, and scientists from Purdue University, Indiana State university, Ball State university, and Drake University. Other agencies include The Nature Conservancy and Indiana State Parks.

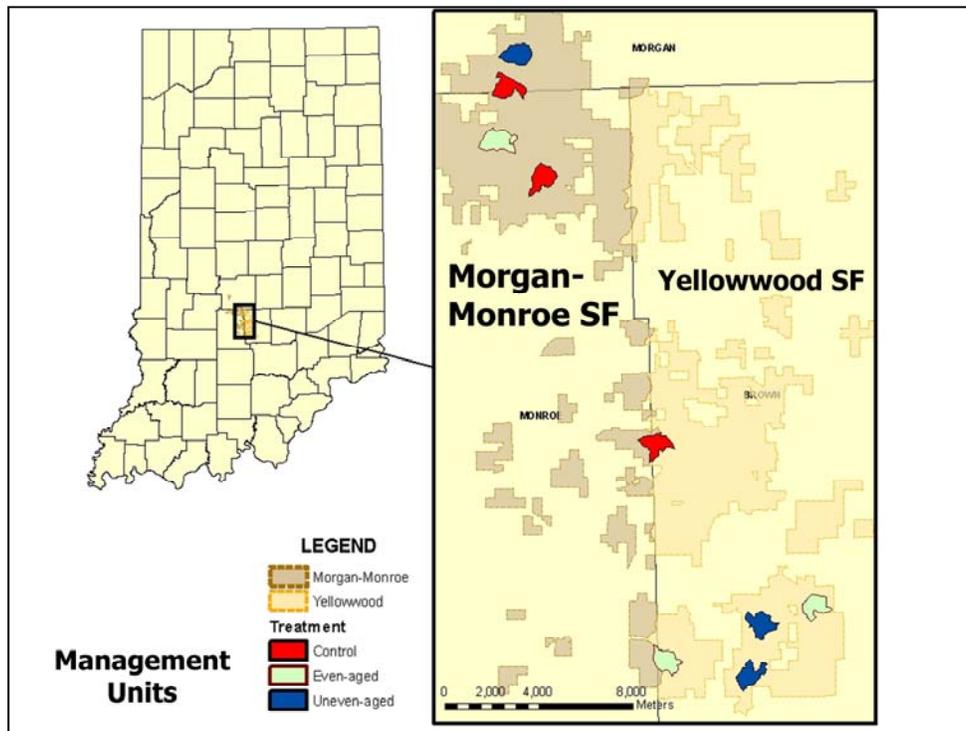


Hardwood Ecosystem Experiment (HEE)

The Hardwood Ecosystem Experiment (HEE) is a 100 study examining the effects of silviculture on plant and animal populations. This project was initiated in 2006. **This is the brochure that was produced to advertise this study.**

Examples of taxa included in this study are:

- Salamanders
- Lepidopteran & beetle communities
- Small mammals
- Eastern Box Turtle & Eastern Timber Rattlesnake
- Bird communities
- Indiana Bat
- Regeneration of oak seedlings AND
- Cerulean Warblers



Site Selection

A total of 9 management units, 4 in Morgan-Monroe State Forest (>9,712 ha; established in 1929) and 5 in Yellowwood State Forest (>9,439 ha; established in 1940) in Morgan, Monroe, & Brown counties in southern Indiana were selected for the Hardwood Ecosystem silvicultural Experiment.

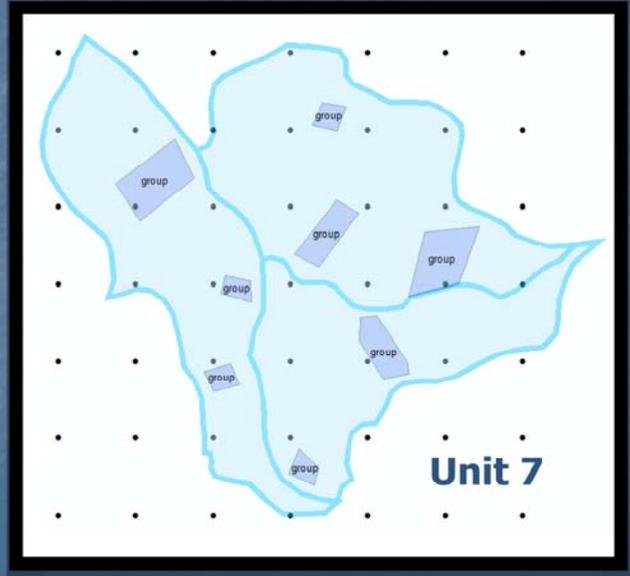
Each of the **9 management units**, ranging in size from **354-405 ha**, was **randomly assigned as a control, even-aged, or uneven-aged unit with 3 replicates of each**. **Red blocks** depict **control sites**, **light green blocks** **even-aged sites**, and **dark blue blocks** **uneven-aged sites**.

Single Tree Selection w/patch cutting

3 Units

Eight small openings 0.4 - 2 hectares

Produces uneven aged forests



Uneven-aged Management Units (Units 1,7,8)

- ✓ 8 randomly selected points (4 NE aspects & 4 SW aspects) were established.
- ✓ Harvest boundaries created around each point in 3 different sizes: two 2.02 ha, two 1.2 ha, and 4 0.4 ha harvest areas.
- ✓ Harvests are on a 20-year cycle – return interval for each opening will be 100 years.
- ✓ Single-tree selection with patch cutting in core area outside harvest boundaries with a target basal area of 16.1 – 23.0 m²/ha. This management type most closely resembles current silvicultural practices used by DOF at MM & YW state forests.

Single-tree selection w/patch cutting





Even-aged Management Units (Units 3,6,9)

✓ To determine harvest locations, 6 points randomly placed on DEM using Hawth's Tool in ArcGIS. Points stratified by aspect with 3 on north or east and 3 on south or west aspects.

✓ Two sites from each aspect selected.

✓ Of 4 selected areas, one NE aspect and one SW aspect were randomly assigned to shelterwood treatments. The remaining two were assigned to clearcut treatments.

✓ Harvests within units will occur on a 20-year schedule; the return interval for each opening will be 100 years.

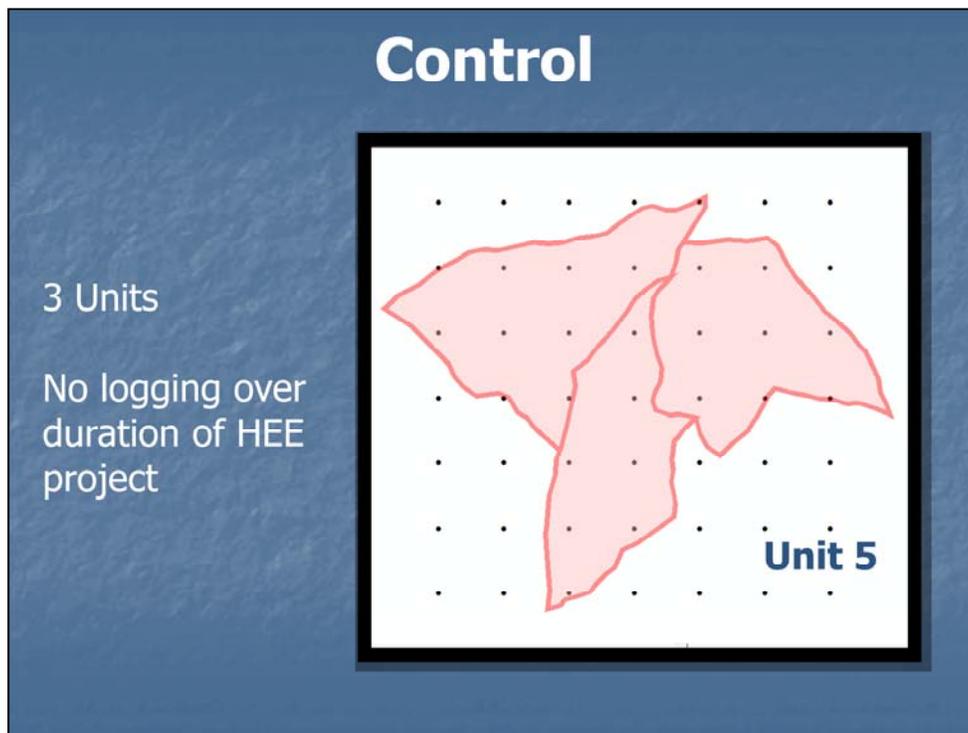
✓ Total harvest (for 3 replicates) is 48 ha or 16ha/replicate.

✓ **Clearcut** – 4.05 ha – All woody stems > 30.48 cm DBH harvested.

✓ **Shelterwood** – 3-stage system. 2008 harvest. A) **Preparatory cut** – overstory not removed – mid & understory removed with timber stand improvement (TSI); this removes most non-oak stems from stands that are 25.4 cm dbh & below. B) **Establishment cut** – 5-10 years after – removal will focus on poorly-formed canopy & subcanopy trees. C) **Final cut** – Overstory removed 5-10 years after establishment cut – Not to exceed 20 years from initial preparatory cut.







Control Management Units (Units 2,4,5)

✓Control sites selected same way as even-aged sites.



Objective

How do Cerulean Warblers respond to different silvicultural treatments?

Predictions

- a) Cerulean Warblers will benefit positively from uneven-aged treatments.
- b) Cerulean Warblers will be negatively impacted by even-aged treatments.

Objective

How do Cerulean Warblers respond to different silvicultural treatments?

Predictions

- 1) Cerulean Warblers will positively affected from uneven-aged treatments – **Uneven-aged stands will create a heterogeneous forest cover and Cerulean Warblers are known to be associated with forest openings** in our study areas as well as in other areas.
- 2) Cerulean Warblers will be negatively impacted from even-aged treatments from **immediate loss of habitat** and from **encroachment of brood parasites into open areas**.

Point Count Surveys

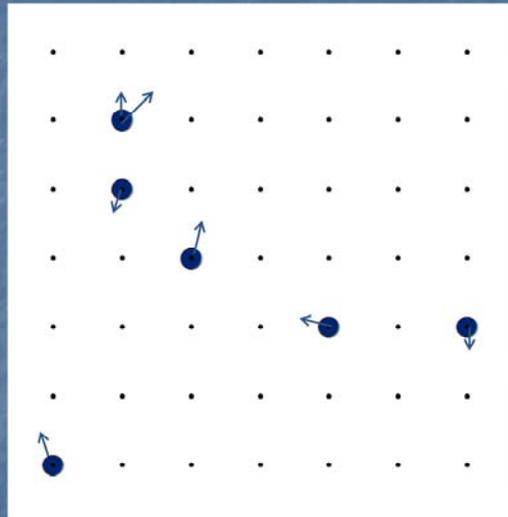
➤ May 2007-2011,
0530-1030 hrs

➤ **100-m fixed radius
point count**

➤ 49 points per site,
each point spaced
200 m apart

➤ **5 minute count
period**

➤ All plots 259 ha



Site 7

Methodology - Bird Surveys

➤ Surveys were conducted between 0530 & 1030 hr in May 2007-2010. We started our Cerulean Warbler study one year after the HEE study was initiated in 2006.

➤ Within each 259 ha plot or 1 square mile plot, 7 transects were established. Each survey point was 200m apart and we had approximately 49 survey points. At each survey point, we listened for the song of a Cerulean Warbler for two minutes followed by a recording of a conspecific male to elicit a response for one minute, followed another two minutes of listening.

➤ Once we obtained a response, the **distance and compass direction from the point was recorded.**

Territory Mapping

June – Mid July
2007-2011



Photos: Kyle Kaminski

Methodology – Territory Demarcation

➤ After surveys completed, we would go back to sites where we had detections on our surveys.

➤ If a male was not detected, we would play a recording of a conspecific male Cerulean to elicit a response. We used playbacks of conspecific Cerulean males to drive them to the edges of their territories. To delineate the boundaries of a male's territory, between 5-15 points were taken using a GPS or Global Positioning System Unit. Often more than one researcher worked to help delineate a male's boundary.

Point Count Results: Pre-treatment Data

Unit #	Detections 2007	Males/km ² 2007	Detections 2008	Males/km ² 2008	
Group					
1	0	0	5	2.55	
7	15	7.65	15	7.65	
8	40	20.41	47	23.98	
Shelterwood/ Clearcut					
3	9	4.59	20	10.2	One-way ANOVA P=0.110
6	8	4.08	4	2.04	
9	9	4.59	13	6.63	
Control					
2	1	0.51	4	2.04	
4	4	2.04	9	4.59	
5	8	4.08	7	3.57	
TOTAL	94	5.33	124	7.03	

Point Count Results: Pre-treatment Data

✓ A total of 218 male Cerulean Warblers were detected in 2007 (94) and in 2008 (124) in the nine sites surveyed.

✓ Cerulean Warblers were located in all nine units for the combined pre-treatment years with the number of individual birds identified per unit ranging from 0 to 47.

✓ Relative abundance estimates ranged from 0 to 23.98 males/km², averaging 6.18 males/km².

✓ Although there was an overall increase in the number of detections from 2007 to 2008, this trend was not consistent at each individual site. Sites 3 and 8 had the largest number of detections and sites 1 and 2 had the least number of detections over the two-year period.

✓ However, there was no significant difference (P=0.110) in the number of detections among the three groups for the two combined years.

Territory Size Results: Pre-treatment Data

<u>Harvest Type</u>	<u>Pre-Harvest Count</u>	<u>Pre-Harvest Mean (ha)</u>	
Group	60	0.27 ± 0.32	One-way ANOVA P=0.752
Shelterwood/ Clearcut	41	0.22 ± 0.18	
Control	19	0.34 ± 0.32	

Territory Size Results: Pre-treatment Data

✓ In **2007 and 2008**, a **total of 120** Cerulean Warbler **territories** were **demarcated**. The number of territories demarcated at each study site ranged from 0 to 24.

✓ Overall **territory sizes averaged from 0.11 ha to 0.86 ha**. We were unable to sample all territories in 2008 due to the initiation of the silvicultural treatments, which explains the apparent decrease in the number of territories for that year.

✓ There was **no significant difference (P=0.752)** in the **sizes of territories among the three groups for the two combined years**.

Harvest

- Completed between 14 July 2008 & 28 February 2009

Harvest

Harvest started on July 14 2008 & and was completed by February 28 2009.

Relative Abundance Changes

Site/Harvest	<i>PRE-HARVEST</i>		<i>POST-HARVEST</i>		
	<u>2007</u>	<u>2008</u>	<u>2009</u>	<u>2010</u>	<u>2011</u>
U n e v e n (single tree with patch cutting)					
1	0	2.6	0	0.5	0.5
7	7.7	7.7	3.1	4.1	4.6
8	20.4	23.9	20.4	9.2	14.8
Overall	9.4	11.4	8.8	4.6	6.6
Even (Shelterwood/Clearcut)					
3	4.6	10.2	18.4	11.2	9.7
6	4.1	2.0	5.1	6.6	13.3
9	4.6	6.6	6.1	9.5	5.6
Overall	4.4	6.3	9.9	9.1	9.5
Control					
2	0.5	2.0	4.1	2.6	3.6
4	2.0	4.6	5.1	1.5	4.1
5	4.1	3.6	4.6	3.6	9.7
Overall	2.2	3.4	4.6	2.6	5.8
TOTAL	5.33	7.03	7.43	5.41	7.31

Relative Abundance Estimates

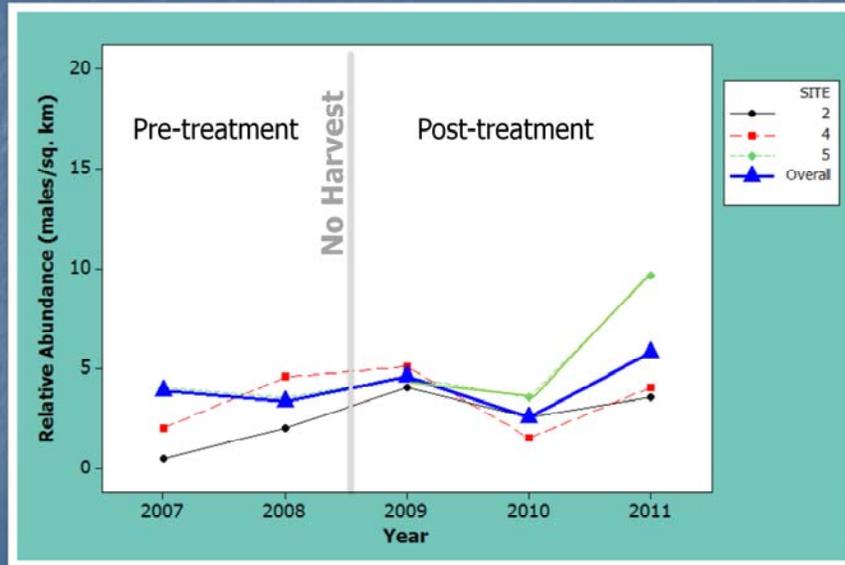
This table is a summary of relative abundance estimates for the five years of study.

Uneven – There was an overall decrease in the number of Cerulean Warbler detections in sites that received uneven-age treatments from pre- to post-harvest years.

Even – There was a significant increase in the number of Cerulean Warbler detections in treatment sites receiving shelterwood & clearcuts. AND

Control - There was a slight increase in the number of Cerulean Warblers detected in control sites between pre- and post-years.

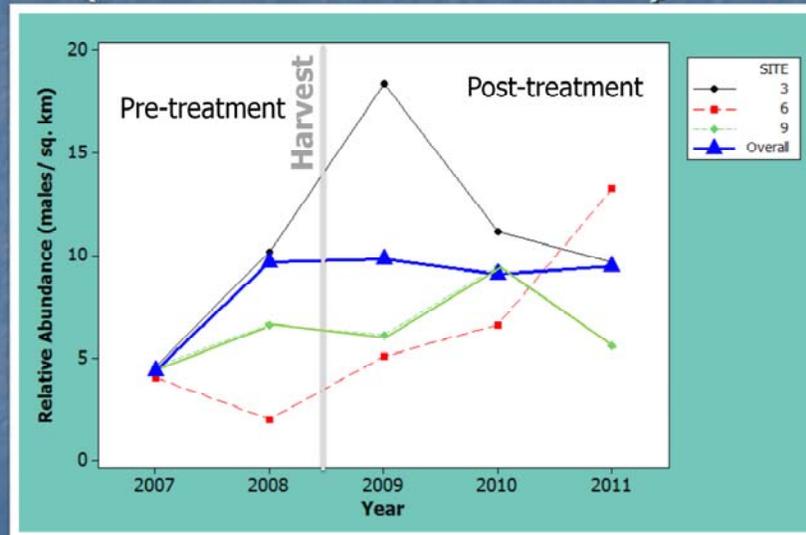
Relative Abundance at Control Sites



Relative Abundance – Control Sites

✓There was very **little change** in Relative abundance in the **3 control sites**.

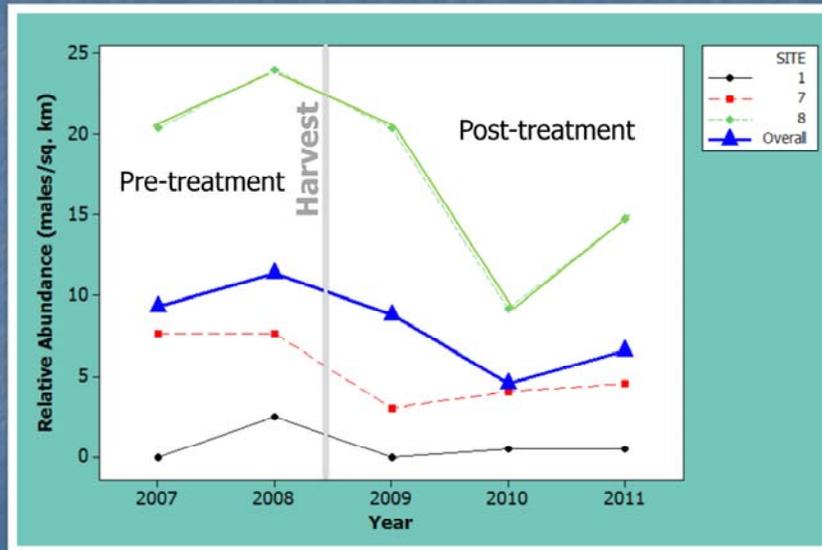
Relative Abundance at Even-Aged (Shelterwood and Clearcut) Sites



Relative Abundance – Even-aged Units

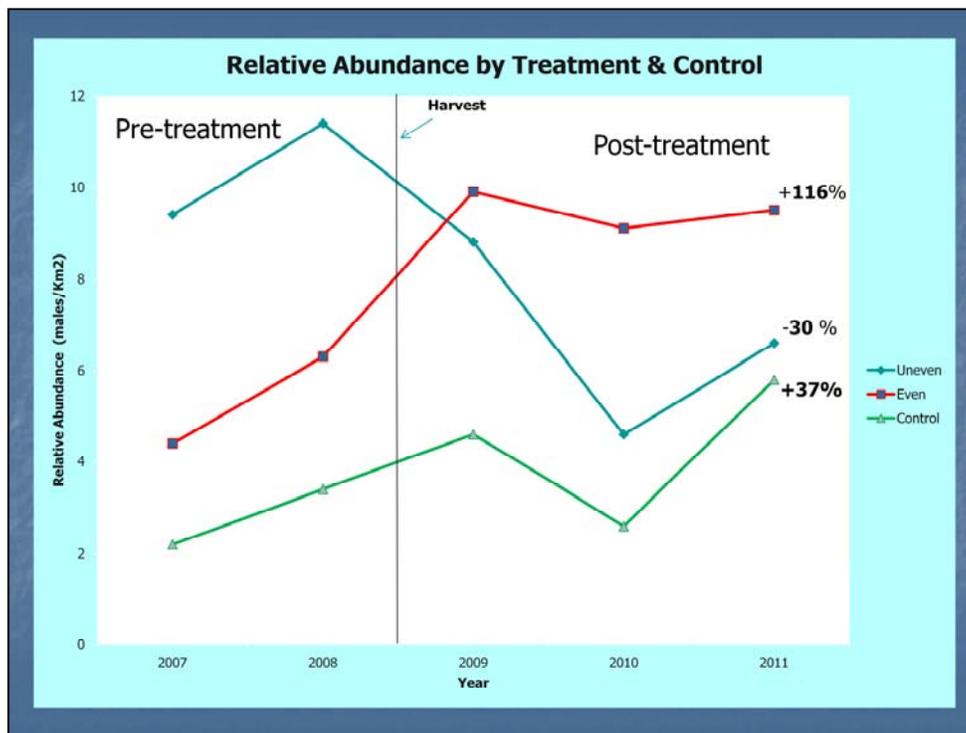
✓ Many more birds in Unit 3 after the harvest (10-18 males/km²), but then fell in 2010 & 2011.

Relative Abundance at Uneven-Aged (Single tree selection w/patch cutting) Sites



Relative Abundance – Even-aged Units

✓ Overall, averaging our totals for RA, we witnessed a 27.2% drop from 2009 to 2010 (lag effect?), but if we look all the way back to 2007 we have seen an overall increase in birds by 1.5%.



Relative Abundance Estimates – Pre-treatment vs. Post-treatment

✓ If we compare relative abundance estimates between pre-treatment and post-treatment **combined years**, the was a

- 1) **+37%** increase in the **control** sites,
- 2) **+116%** increase in the **even-aged** sites, and a
- 3) **-30%** decrease in the **uneven-aged** sites.

Number of Cerulean Warbler detections – 2007 (94), 2008 (124), 2009 (135), 2010 (98), & 2011 (130). Total = 581.

Nesting Success (2011)

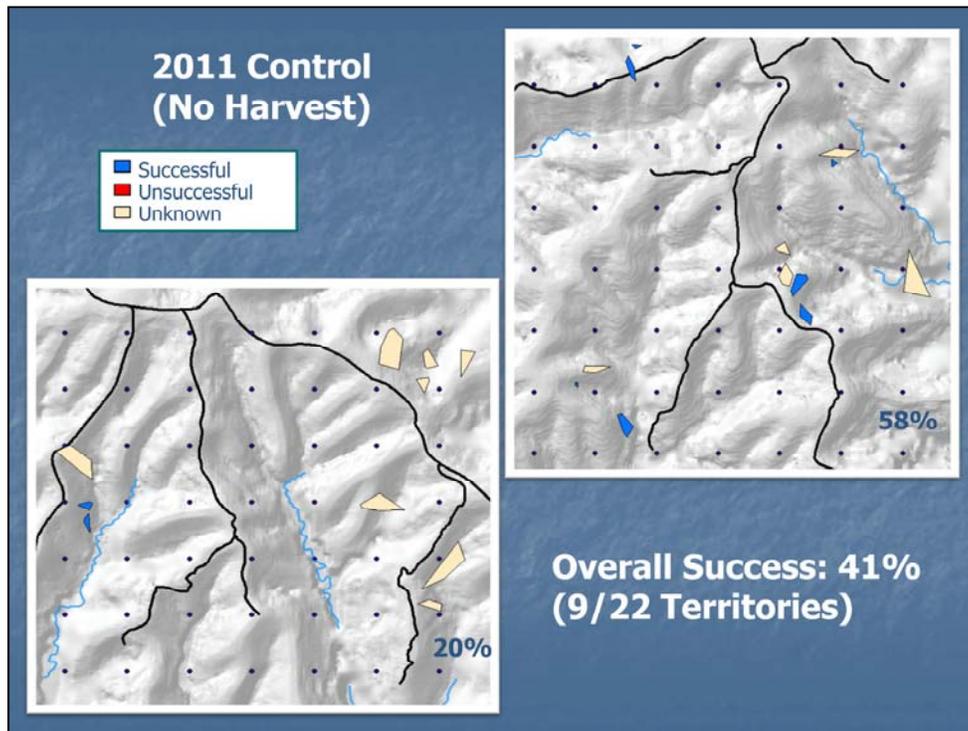
- What is success?
 - At least one conspecific fledged
- What is unsuccessful?
 - A nest was monitored and the nest failed
 - The pair reared a brown-headed cowbird
- What is unknown success?
 - No nest or fledgling was found
 - Territory was abandoned (presumably) early in the season

Nesting Success

We defined **success** as territories that fledged at least one conspecific

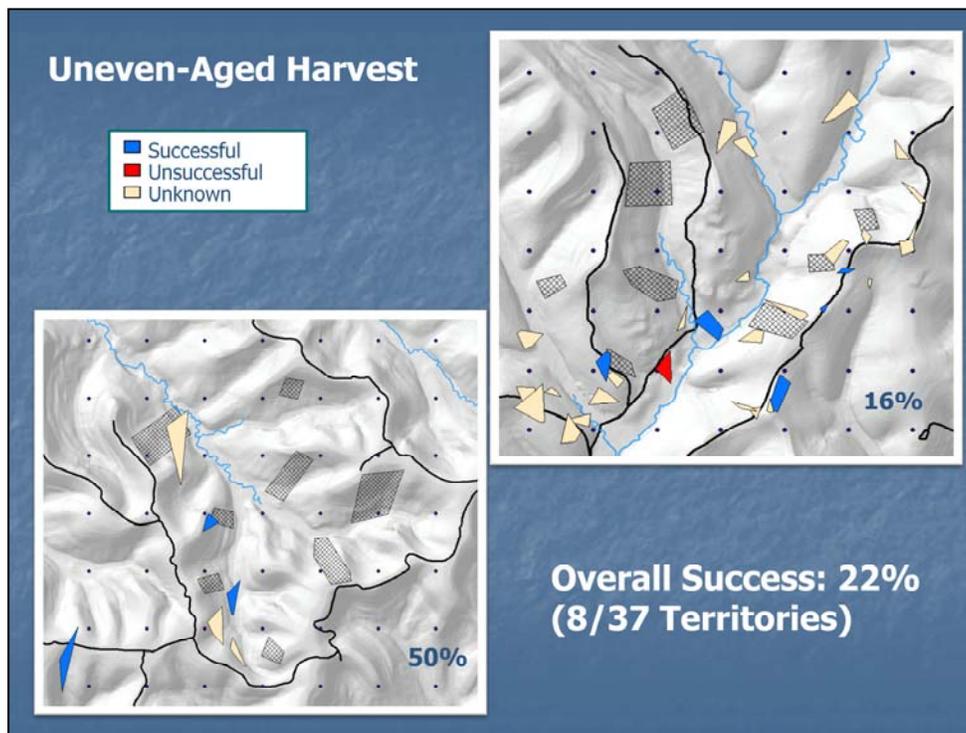
Unsuccessful territories were where a nest was monitored and the nest failed **OR** The pair reared a brown-headed cowbird chick.

Unknown success were those territories where either a) No nest or fledgling was found **OR** Territory was abandoned (presumably) early in the season.



Nesting Success - Control (No Harvest)

Of 22 territories that were monitored in 2 of 3 management units in 2011, 9 territories fledged young resulting in an overall success of 41%.



Nesting Success - Uneven-Aged Harvest

Of 37 territories that were monitored in 2 of 3 management units in 2011, 8 territories fledged young resulting in an overall success of 22%.

Summary

- Relative abundance estimates increased slightly in the control units (+37%), markedly in even-aged units (+116%), but declined 30% in uneven-aged units .
- **Control sites had higher nesting success (41%) than even-aged (33%) and uneven-aged (22%) sites.**

Summary

✓ Relative abundance estimates increased slightly in the control units (+ 37%), markedly in even-aged units (+116%), but declined by 30% in uneven-aged units.

Control sites had higher nesting success (41%) than even-aged (33%) and uneven-aged (22%) sites.

✓ Territory located significantly closer than random points to a) streams, b) roads, c) areas with greater slope, and d) SE direction of slope.

✓ In 2007, 82.8% of territories clustered, 2008, 51.8% clustered . However, unable to demarcate all territories because of harvest, and 2009, 85.5% of territories clustered.

Future Studies

- Continue monitoring population and territories
- **Intensive Nest Monitoring**
 - Are some territories in "better" habitat?
 - Successful vs. Unsuccessful breeding areas



Future Studies

- 1) Continue monitoring population and territories
- 2) Intensive Nest Monitoring
 - Are some territories better habitat?
 - Successful vs. Unsuccessful breeding areas

Future Studies

- Trophic Investigations
 - Do changes in Lepidopteran community affect Cerulean Warbler reproductive success?
 - Could the wide-range of territory sizes be a result of local prey fluctuations?



Future Studies

Trophic Investigations

- a) Do changes in the Lepidopteran community affect Cerulean Warbler success?
- b) Can the wide-range of territory sizes be a result of local prey fluctuations?



Any questions?