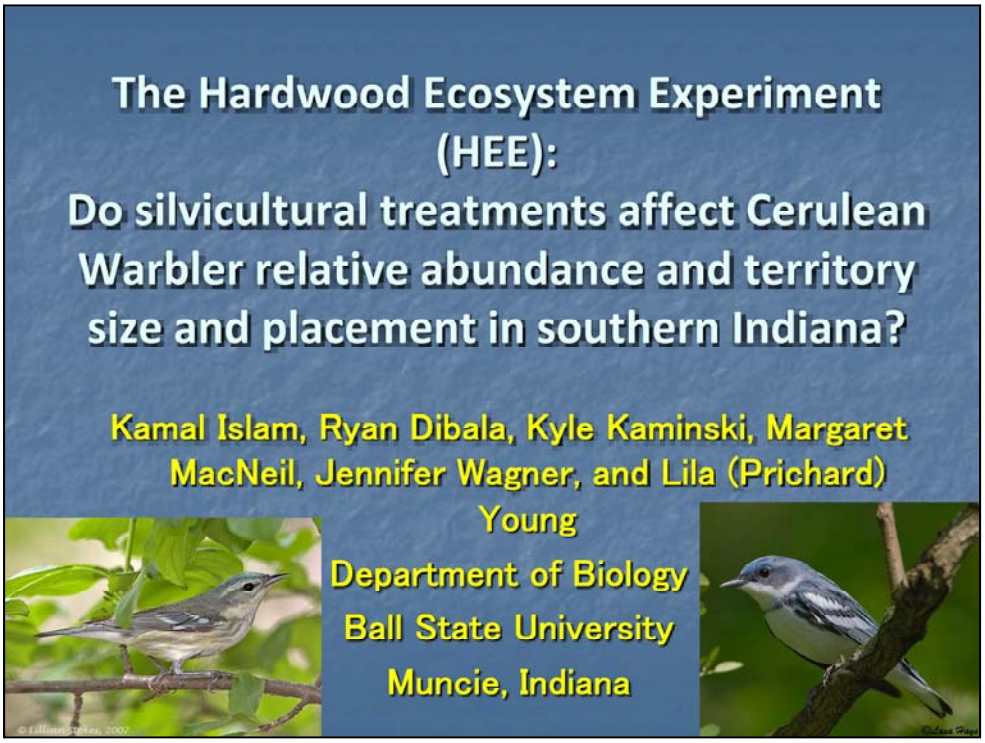
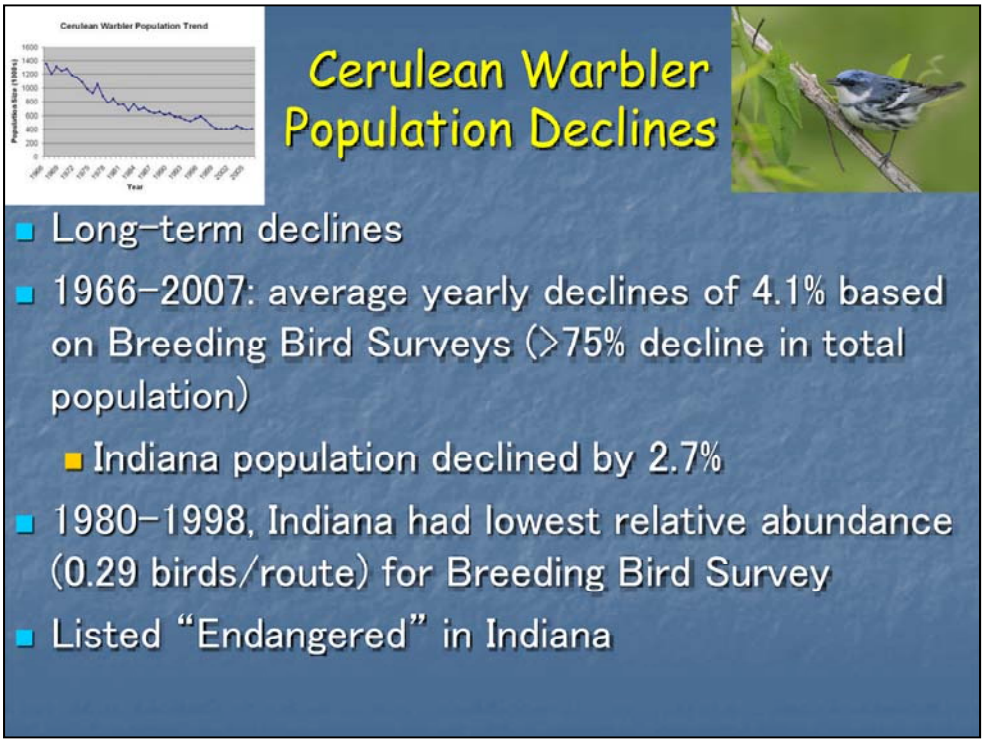


➢Thank you for the introduction.

I would like to first start off by acknowledging our funding sources for the last 4 years.

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

ReachOut
FLORIDA
Carroll



Population declines

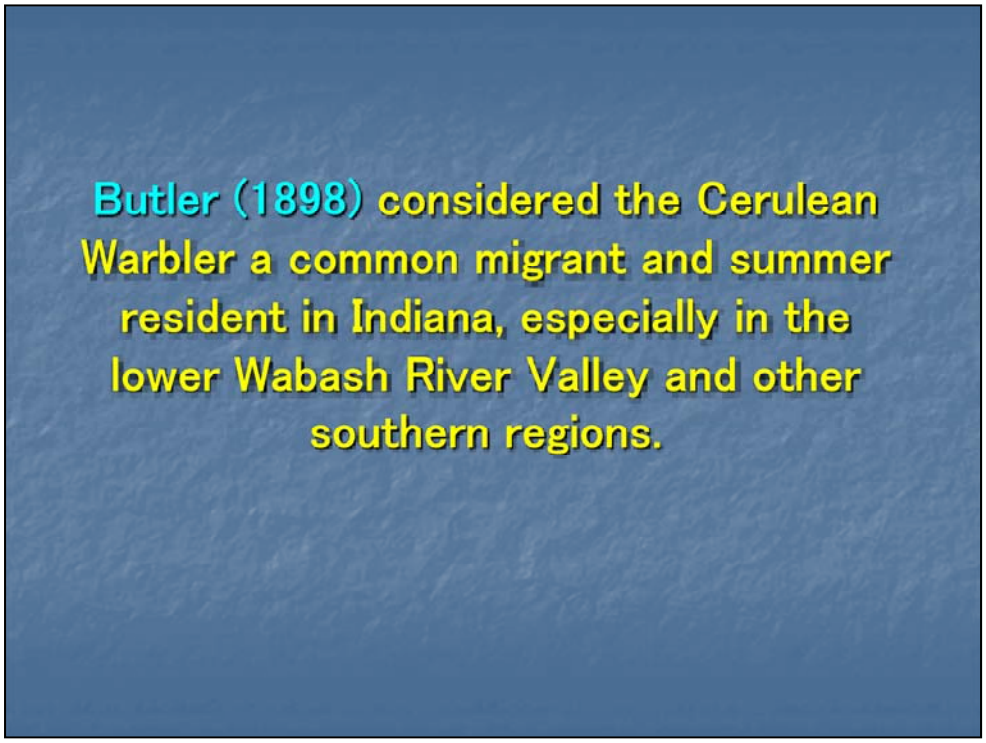
➢The population has experienced long-term declines.

➢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.

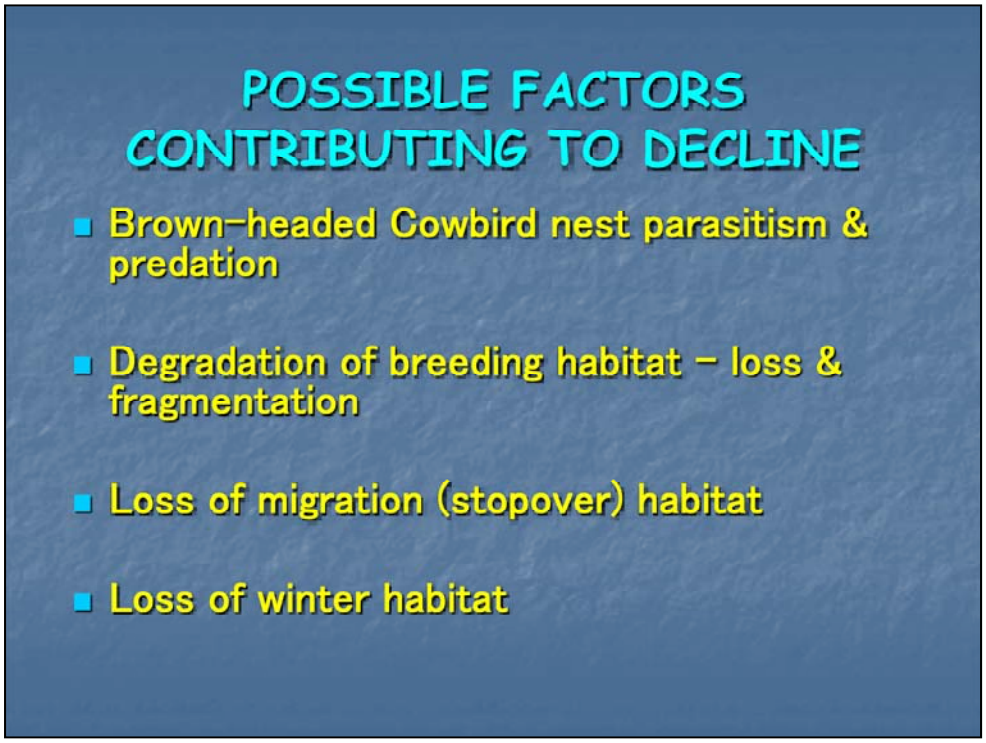
➢During the same period in Indiana the population declined 2.7%.

➢Between 1980-1998, Indiana had the lowest relative abundance (0.29 birds/route) for the BBS.

➢Listed as Endangered in the state of Indiana.



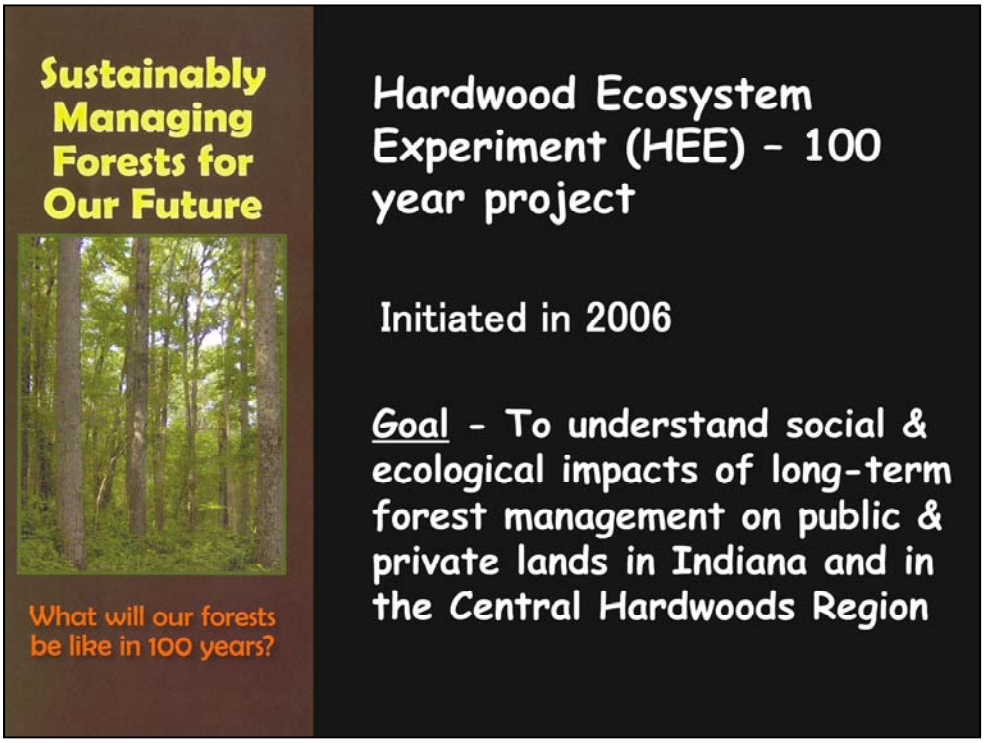
➢And yet, a little over a century ago, Butler considered the Cerulean Warbler to be a common migrant and breeder in Indiana, primarily in the southern part of the state.



➢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.

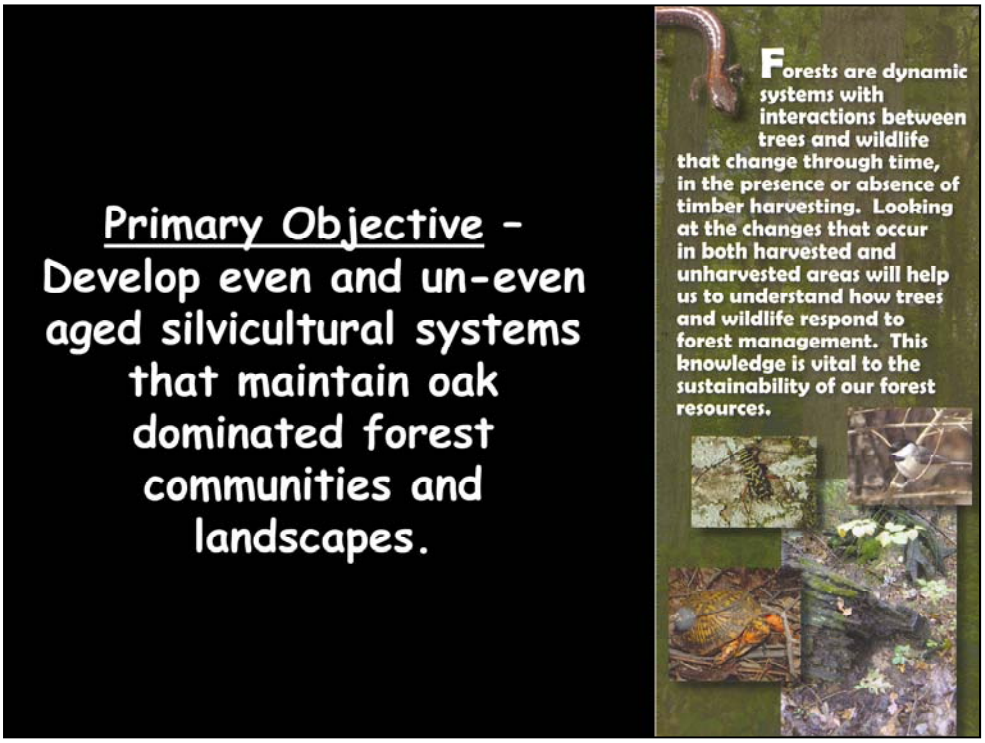
➢Some researchers have suggested that outbreaks of fungal and insect diseases on key nesting tree species such as oaks, elms, sycamores, and American chestnut, are responsible for the decline of Cerulean warblers. However, other researchers such as Paul Hamel, have refuted this hypothesis suggesting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



Hardwood Ecosytem 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.



Hardwood Ecosytem Experiment (HEE)

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

Hardwood Ecosytem 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 Ecosytem 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

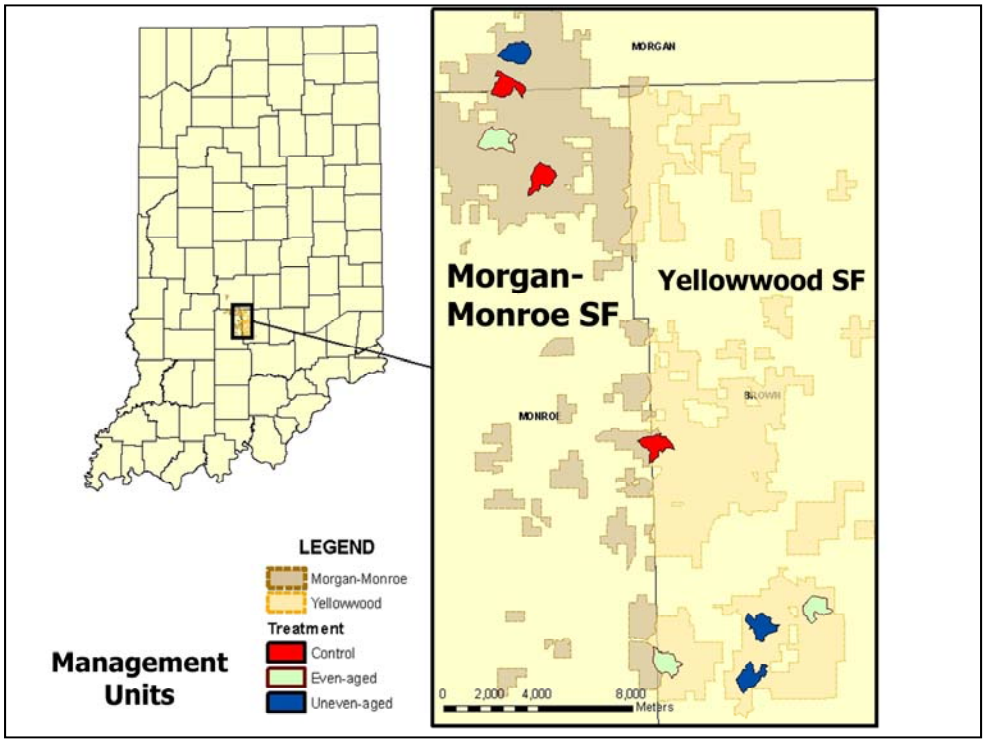
Eastern Box Turtle & Eastern Timber Rattlesnake

Bird communities

Indiana Bat

Regeneration of oak seedlings AND

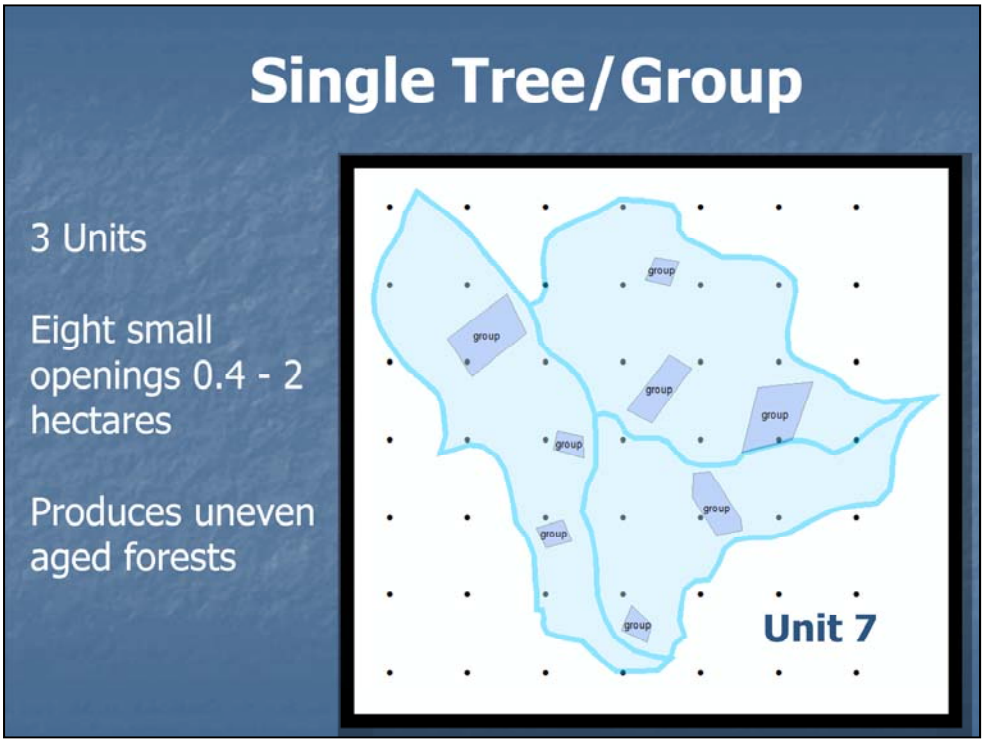
Cerulean Warblers



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**.



<u>Uneven-aged Management Units (Units 1,7,8)</u>

✓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 in core area outside harvest boundaries with a target basal area of 16.1 – 23.0 m^2/ha. This management type most closely resembles current silvicultural practices used by DOF at MM & YW state forests.

Group Harvest

<u>Even-aged Management Units (Units 3,6,9)</u>

✓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.

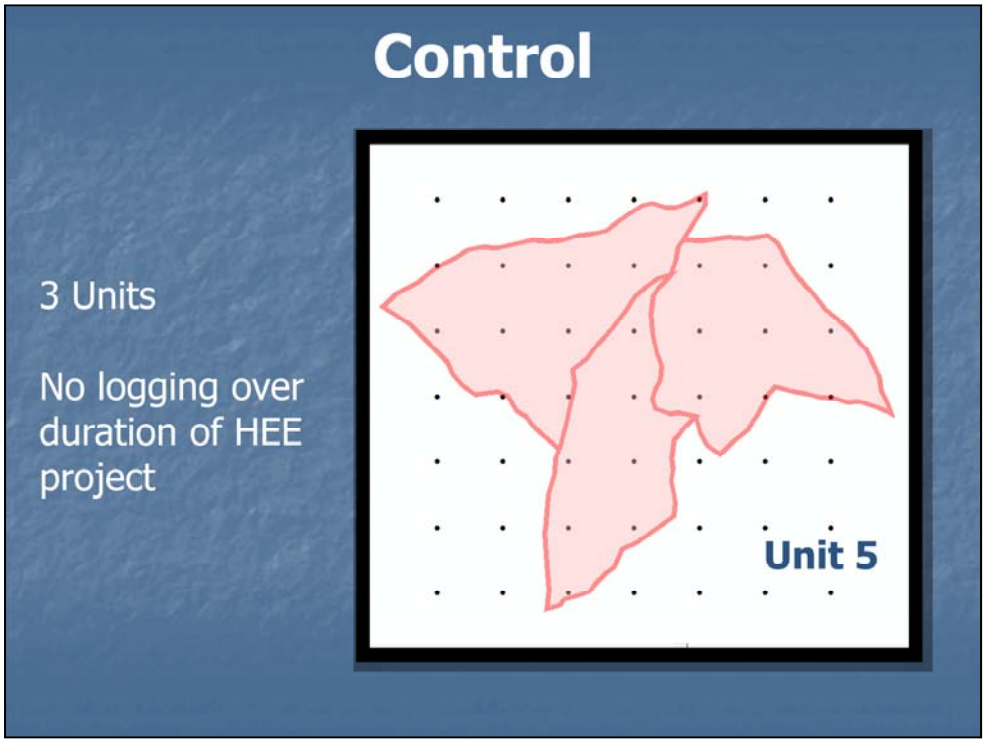
✓Total harvest (for 3 replicates) is 48 ha or 16ha/replicate.

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

✓**<u>Shelterwood</u>** – 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.

Shelterwood

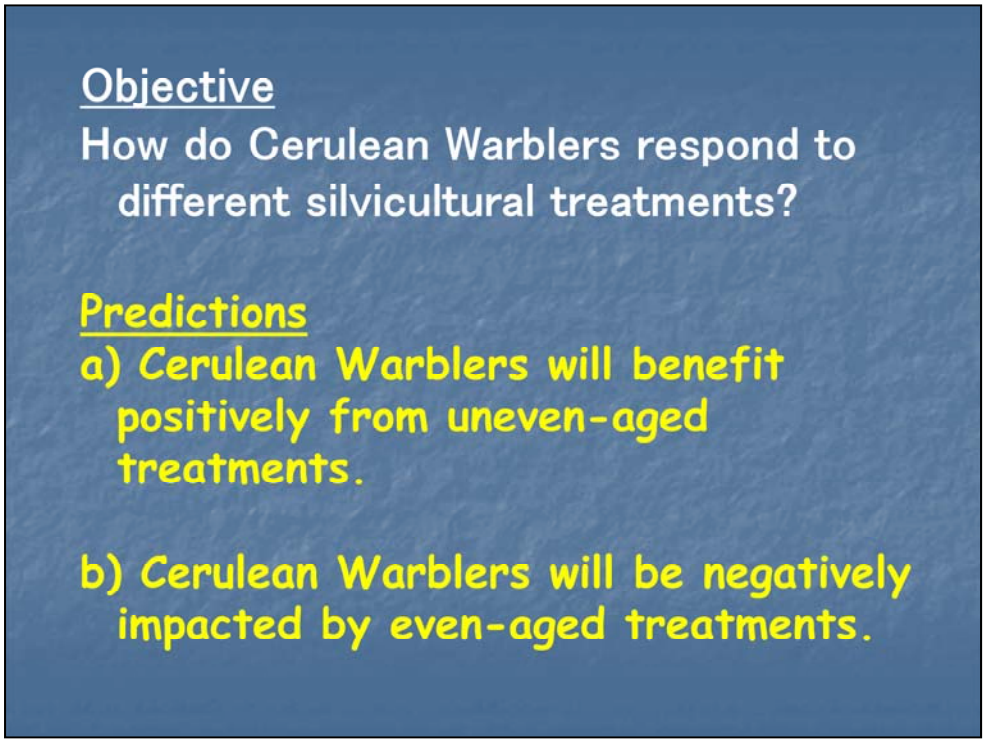
Clearcut



Control Management Units (Units 2,4,5)

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

Control



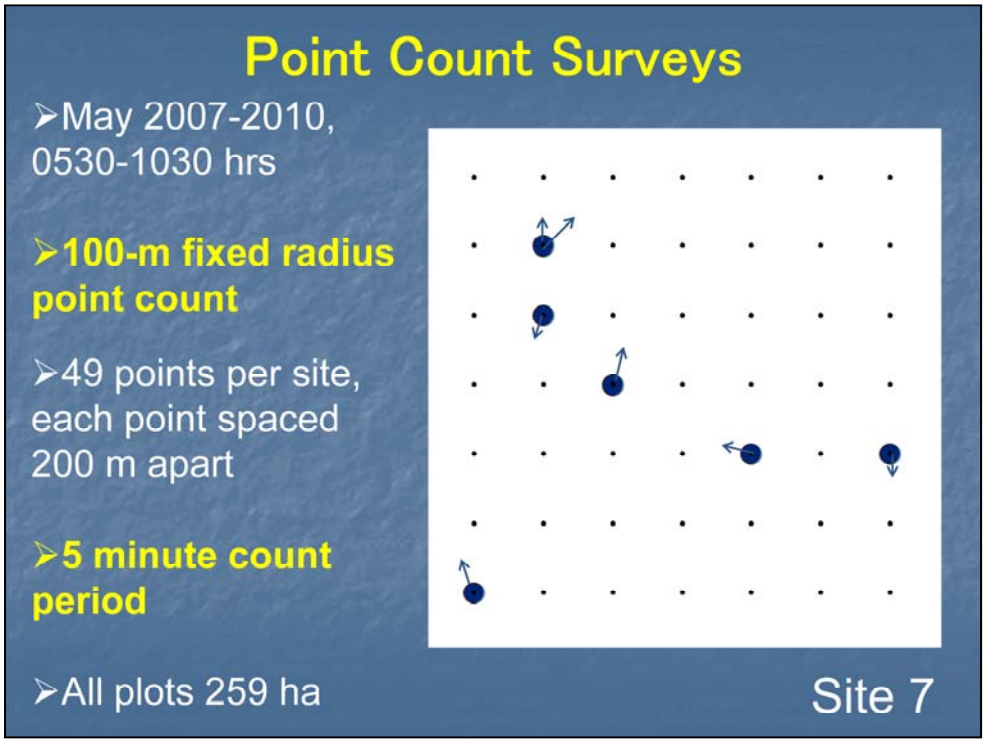
Objective

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**.

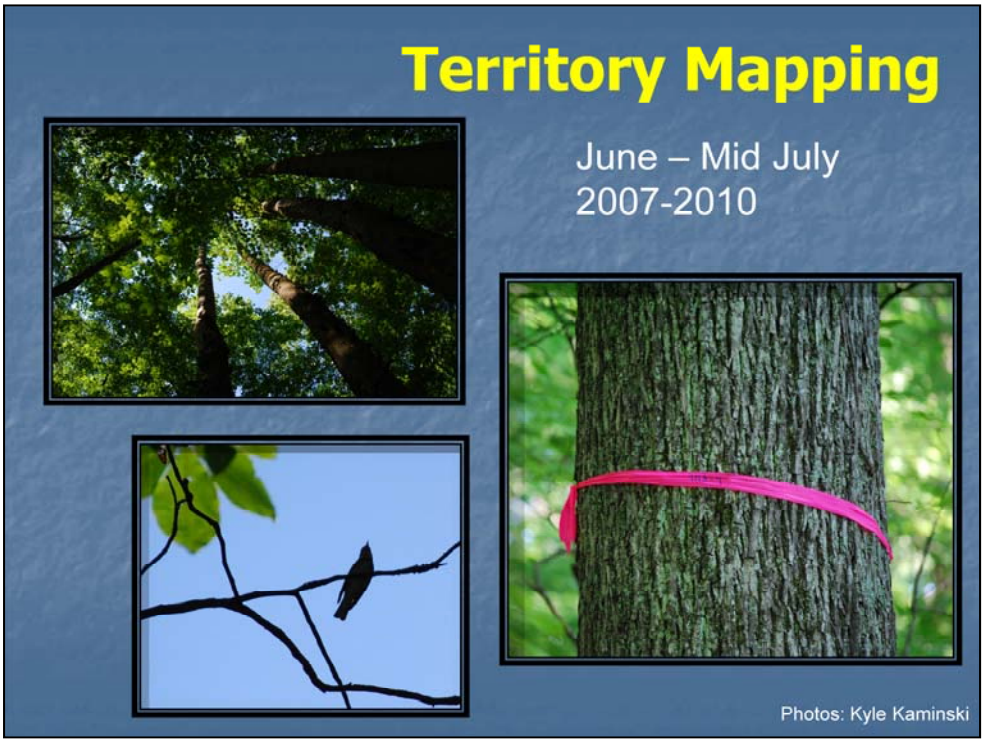


Methodology - Bird Surveys

➢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.

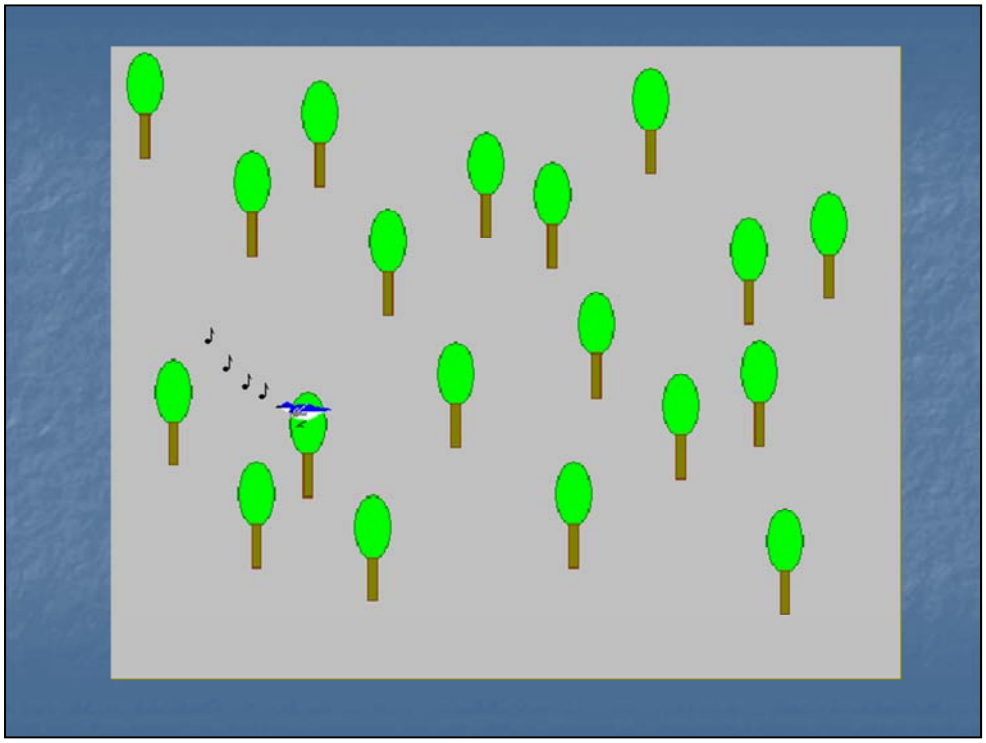
➢Once we obtained a response, the distance and compass direction from the point was recorded.

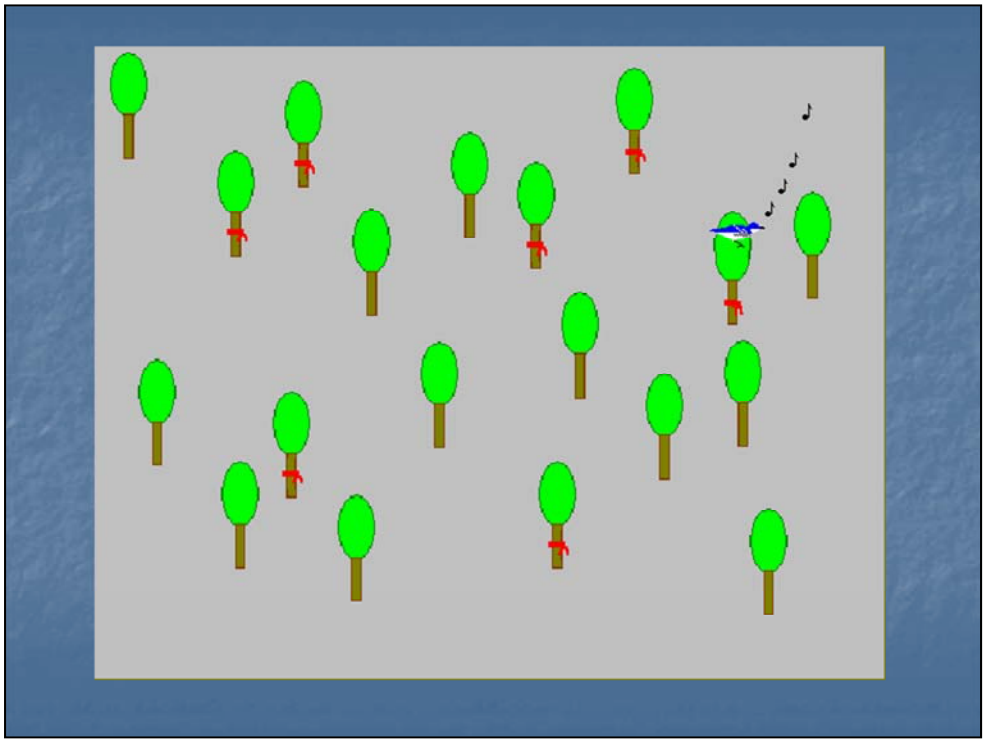


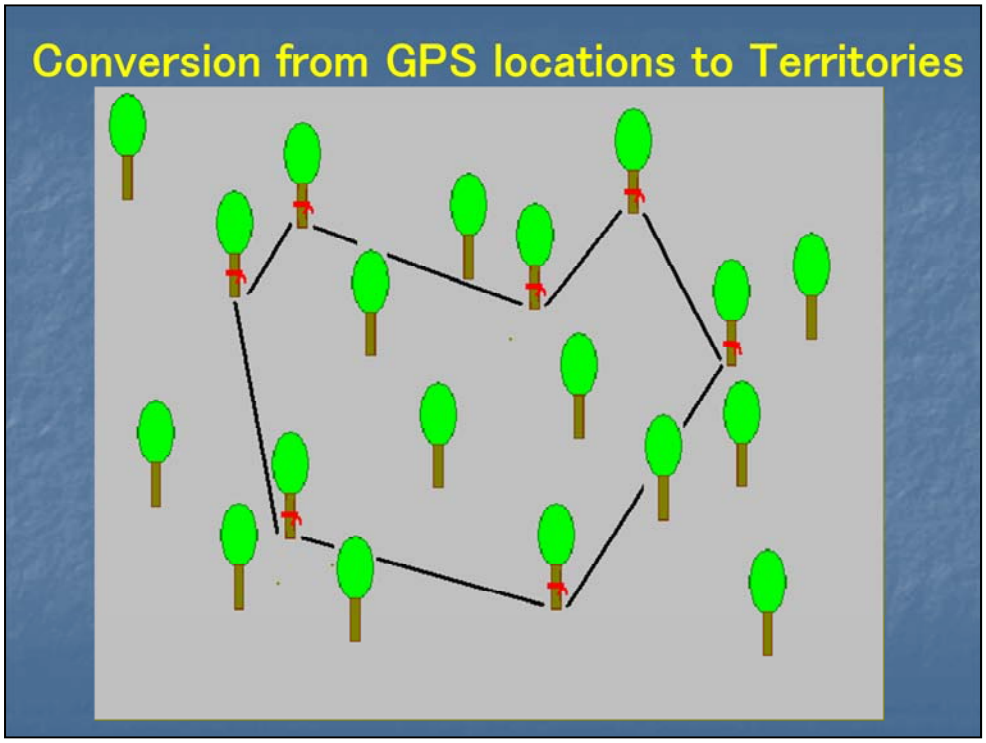
Methodology – Territory Demarcation

➢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 males 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 males' boundary.






Conversion from GPS locations to Territories

Point Count Results: Pre-treatment Data

Unit #	Detections 2007	Males/km² 2007	Detections 2008	Males/km² 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
6	8	4.08	4	2.04	P=0.110
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

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

Territory Size Results: Pre-treatment Data

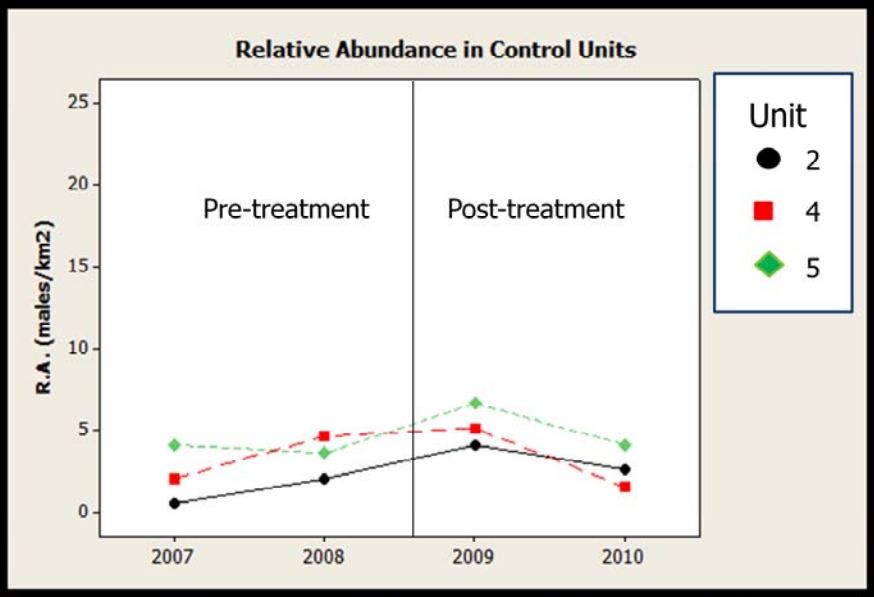
✓In **2007 and 2008**, a **total** of **120** Cerulean Warbler **territories** were **demarcated**. The number of territories demarcated at each study site ranged from 0 to 24.

✓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

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

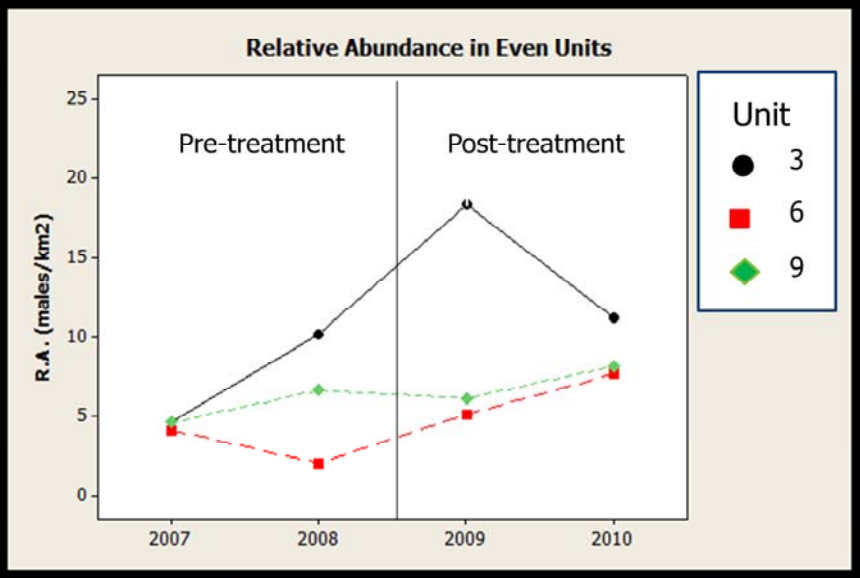


	2007 (n)	R.A.	2008 (n)	R.A.	2009 (n)	R.A.	2010 (n)	R.A.
Total:	**13**	**2.21**	**20**	**3.4**	**31**	**5.27**	**16**	**2.72**

Relative Abundance – Control Sites

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

✓The **table** in the bottom shows the **number of detections** for each year **and** the calculated **relative abundance** (males/km^2).

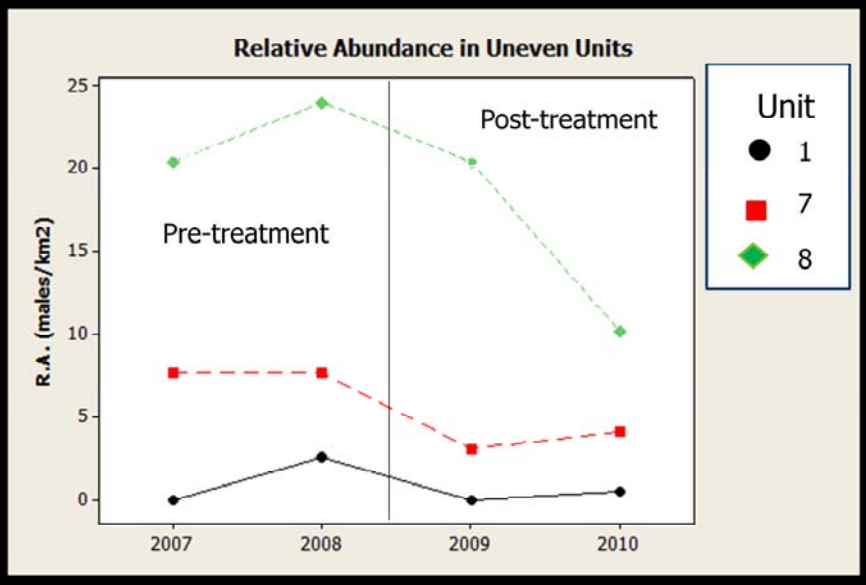


	2007 (n)	R.A.	2008 (n)	R.A.	2009 (n)	R.A.	2010 (n)	R.A.
Total	**26**	**4.42**	**37**	**6.29**	**58**	**9.86**	**53**	**9.01**

<u>Relative Abundance – Even-aged Units</u>

✓Many **more birds in Unit 3 after** the **harvest** (10-18 males/km2), **but** then **fell** again in **2010**. Does this have to do with a **<u>lag effect?</u>**

✓The **table** in the bottom shows the **number of detections** for each year **and** the calculated **relative abundance** (males/km^2).

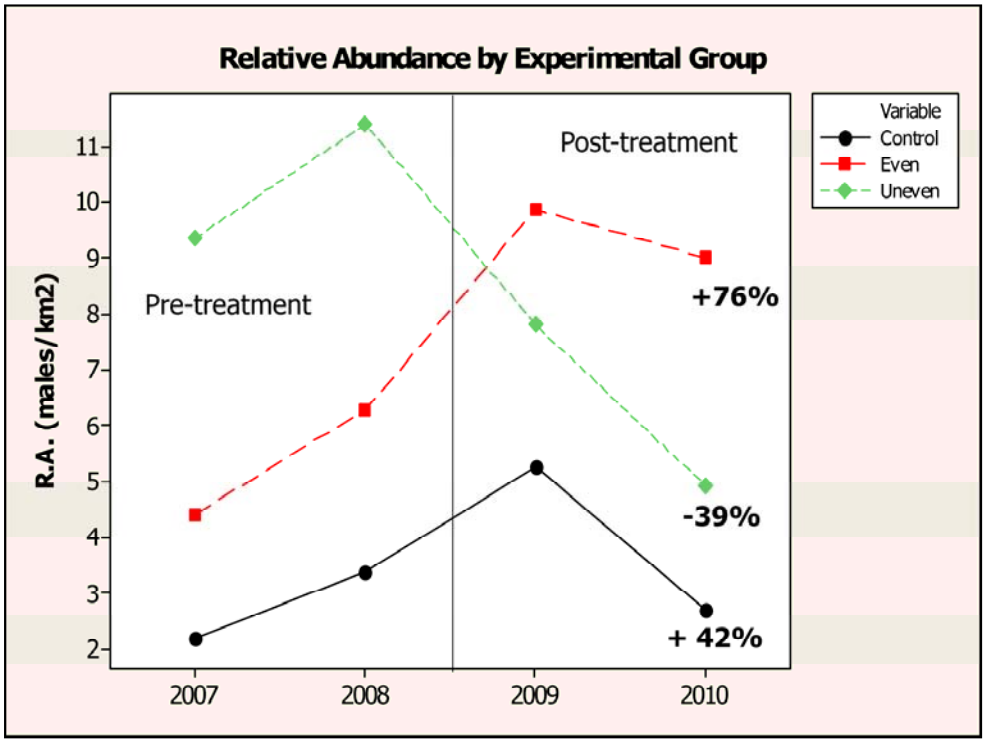


	2007 (n)	R.A.	2008 (n)	R.A.	2009 (n)	R.A.	2010 (n)	R.A.
Total	**55**	**9.35**	**67**	**11.39**	**46**	**7.82**	**29**	**4.93**

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%.

✓The **table** in the bottom shows the **number of detections** for each year **and** the calculated **relative abundance** (males/km^2).



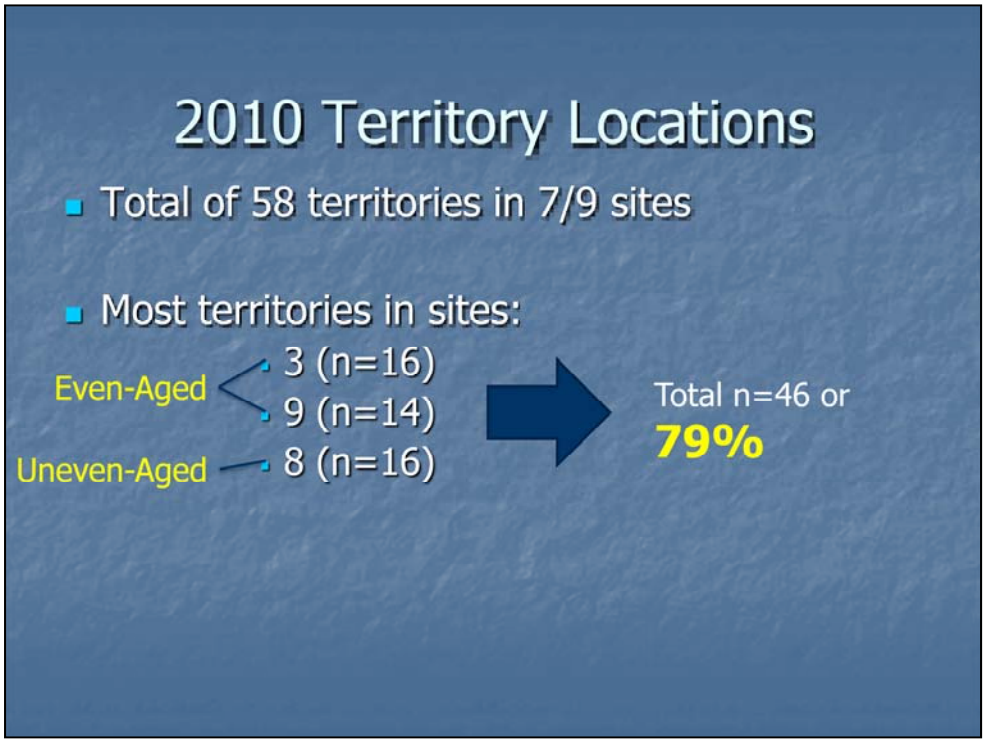
Relative Abundance Estimates – Pre-treatment vs. Post-treatment

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

1) **+41.75%** increase in the **control** sites,

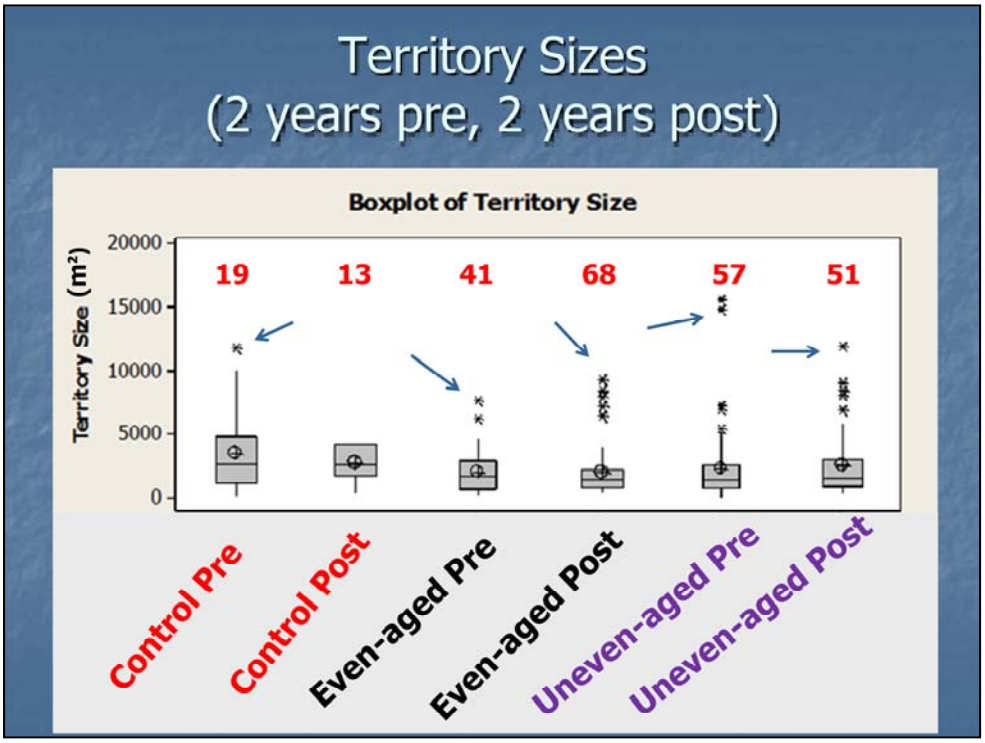
2) **+76.19%** increase in the **even-aged** sites, and a

3) **-38.52%** decrease in the **uneven-aged** sites.



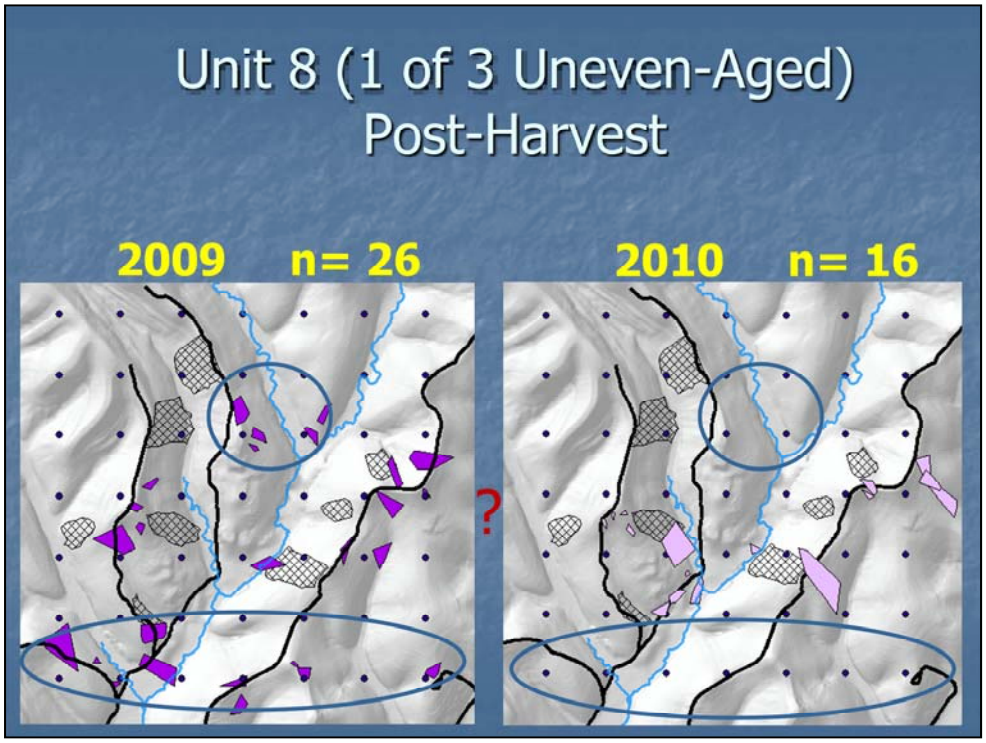
2010 Territory Locations

During 2010, 58 territories were demarcated in 7 of 9 sites. However, 79% of all territories were located in even-aged and uneven-aged sites.



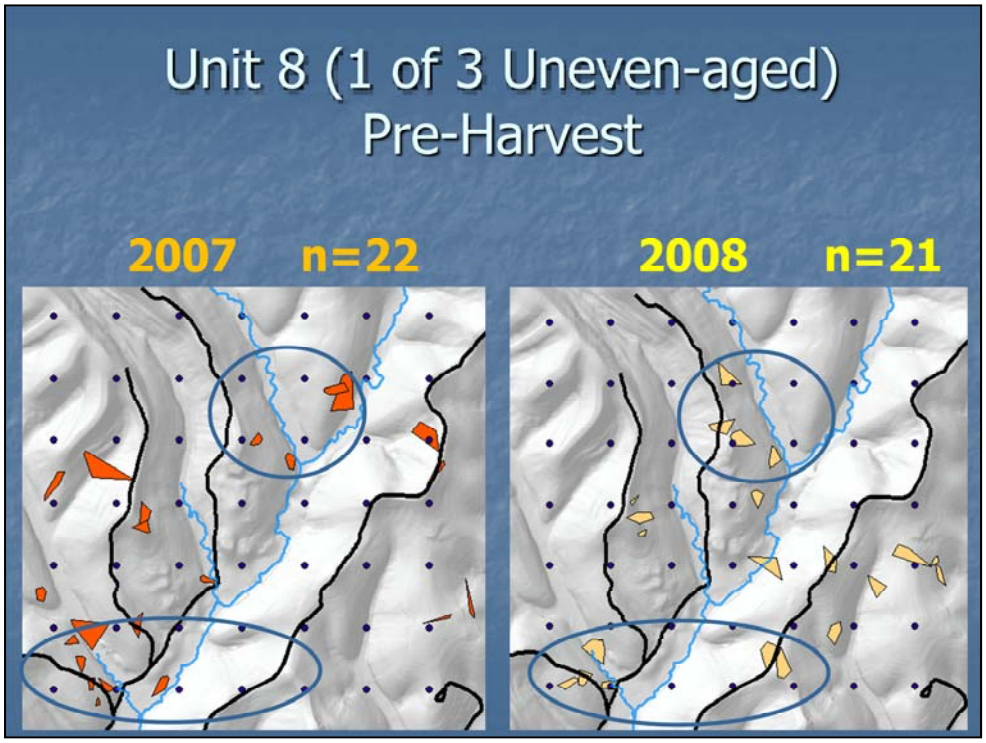
Territory Sizes (2 years pre, 2 years post)

The number of territories between pre- and post-treatment sites dropped slightly in the control and uneven-aged stands but increased dramatically in even-aged sites. There was a slight decrease in territory sizes between pre- and post-treatment. However, there was a lot o variability in the sizes of the territories at each site.



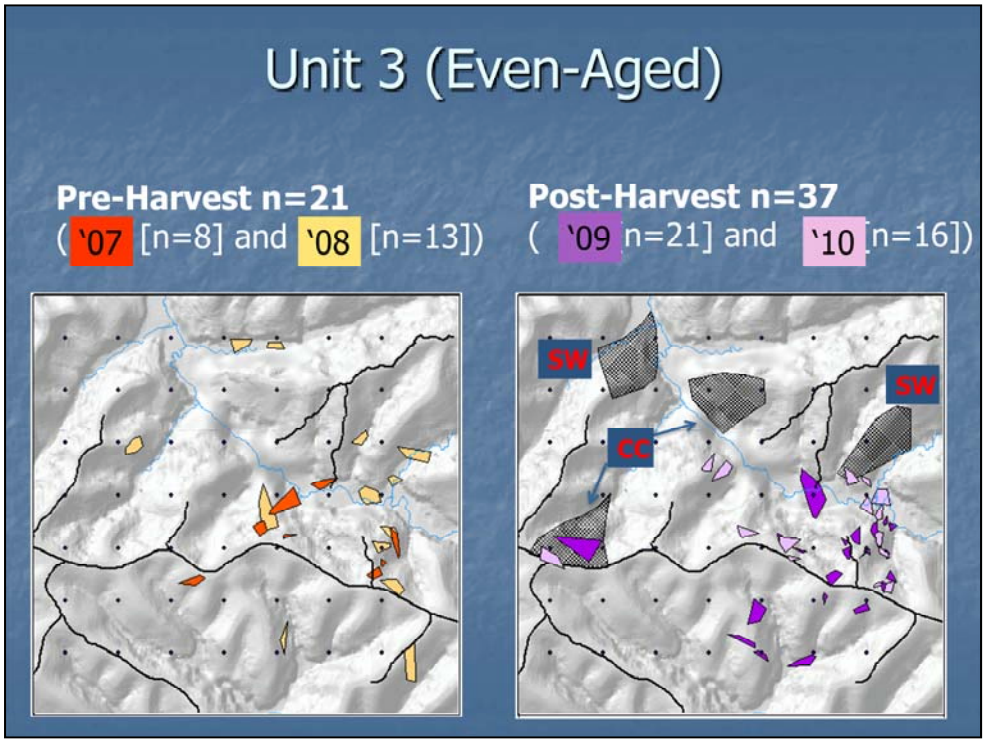
Spatial Arrangements of Territories – Unit 8 (1 of 3 Uneven-Aged) Post-Harvest

Unit 8, which was one of 3 uneven-aged stands, had the greatest number of territories for the post-harvest years. However, the location of territories between 2009 and 2010 changed. Areas where we had Ceruleans in 2009 did not have them in 2010. This suggest a “lag-time” effect between when the birds left in 2008 and the harvest took place and when they returned the following spring.



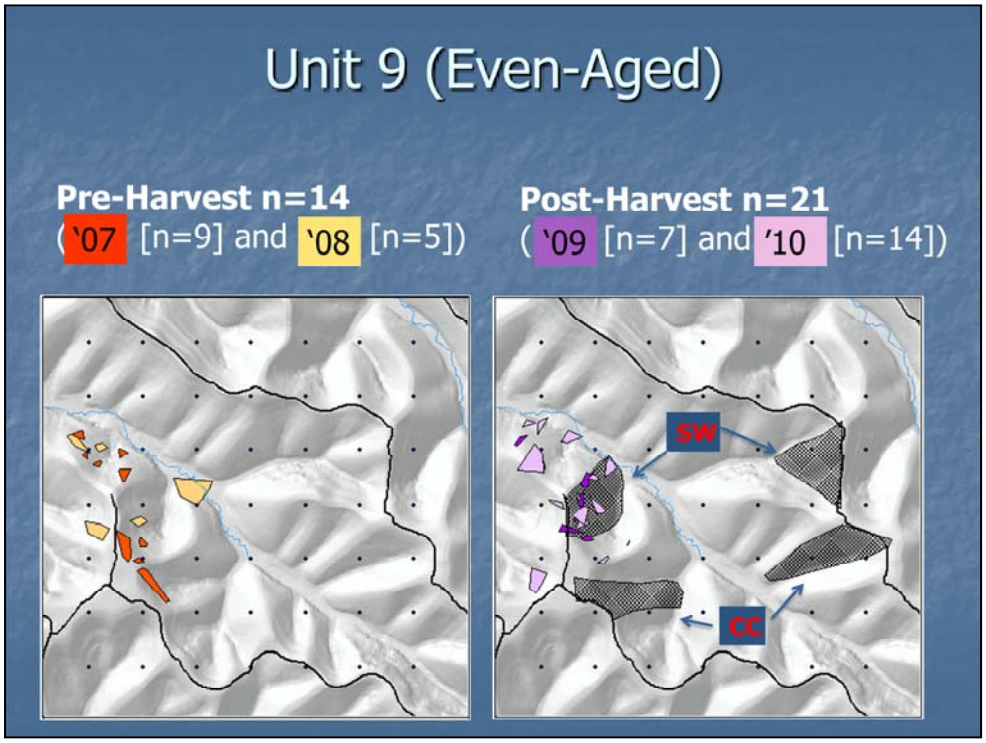
Unit 8 (1 of 3 Uneven-Aged) Post-Harvest

Furthermore, if we look at the locations of these territories in the two pre-treatment years of 2007 and 2008, these locations were also selected to set up territories.



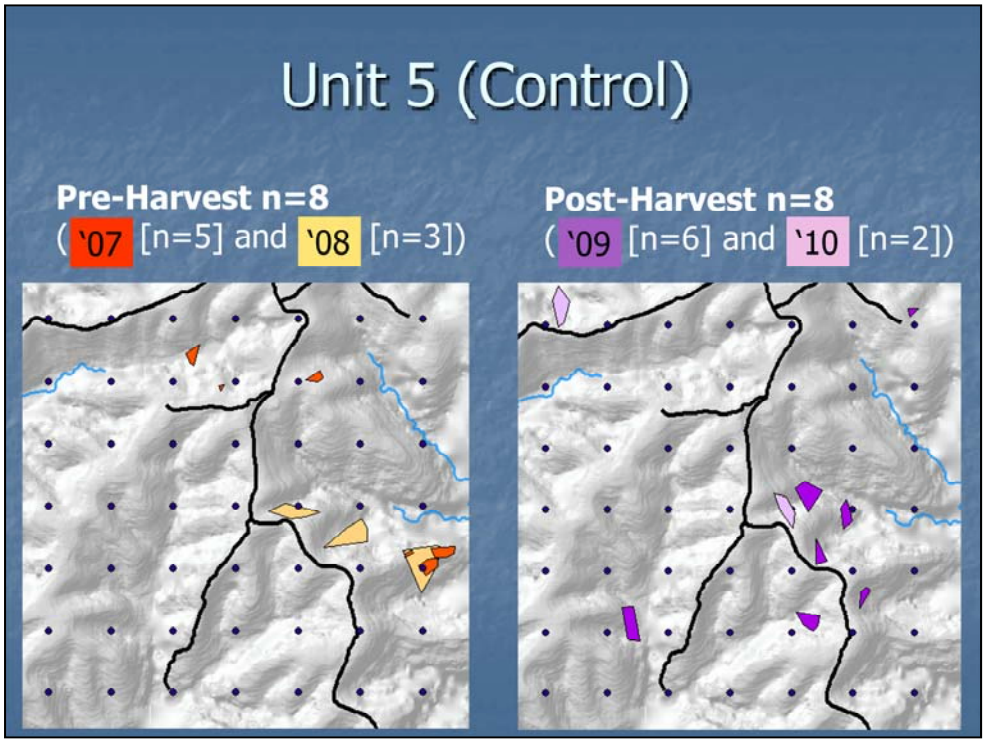
Spatial Arrangements of Territories – Unit 3 (Even-Aged) Pre- and Post-Harvest

In even-aged stands, territories did not change that much in spatial distribution between pre-and post –treatment. In fact, we had one male that used the clearcut as part of his territory. And there were males that established territories within the shelterwood sites.



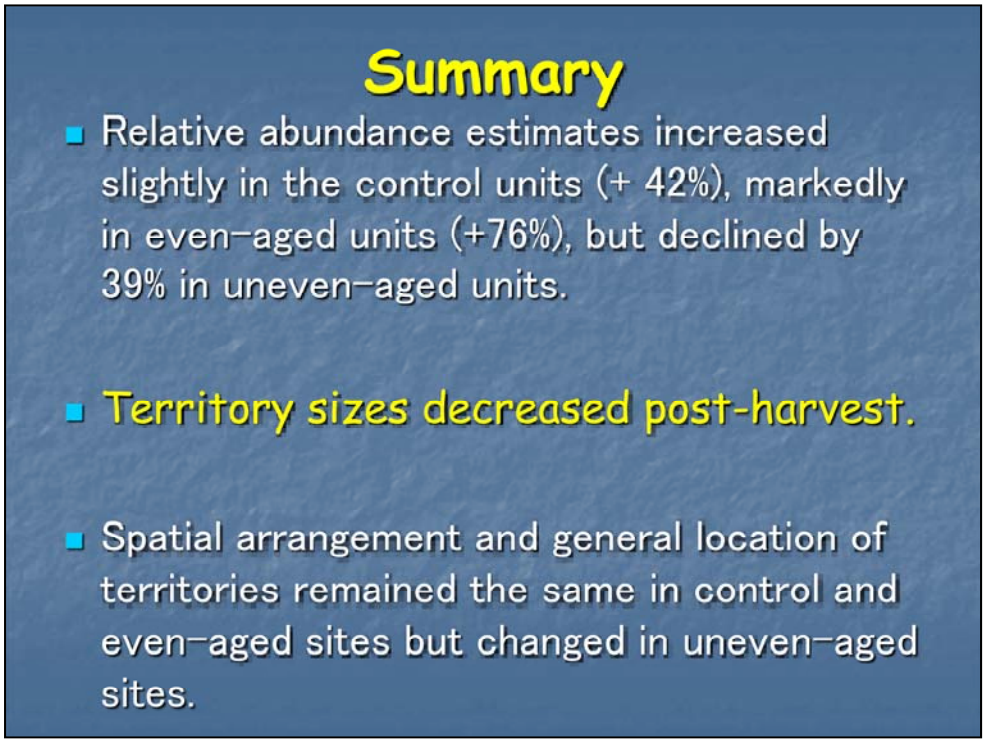
Spatial Arrangements of Territories – Unit 9 (Even-Aged) Pre- and Post-Harvest

In fact, in another even-aged unit, unit 9, several territories were established in a shelterwood site during both of the post-harvest years.



Spatial Arrangements of Territories – Control Unit Pre- and Post-Harvest

Even though we had smaller numbers in the control units, there was not much change in the location of these territories between pre-and post-harvest years.

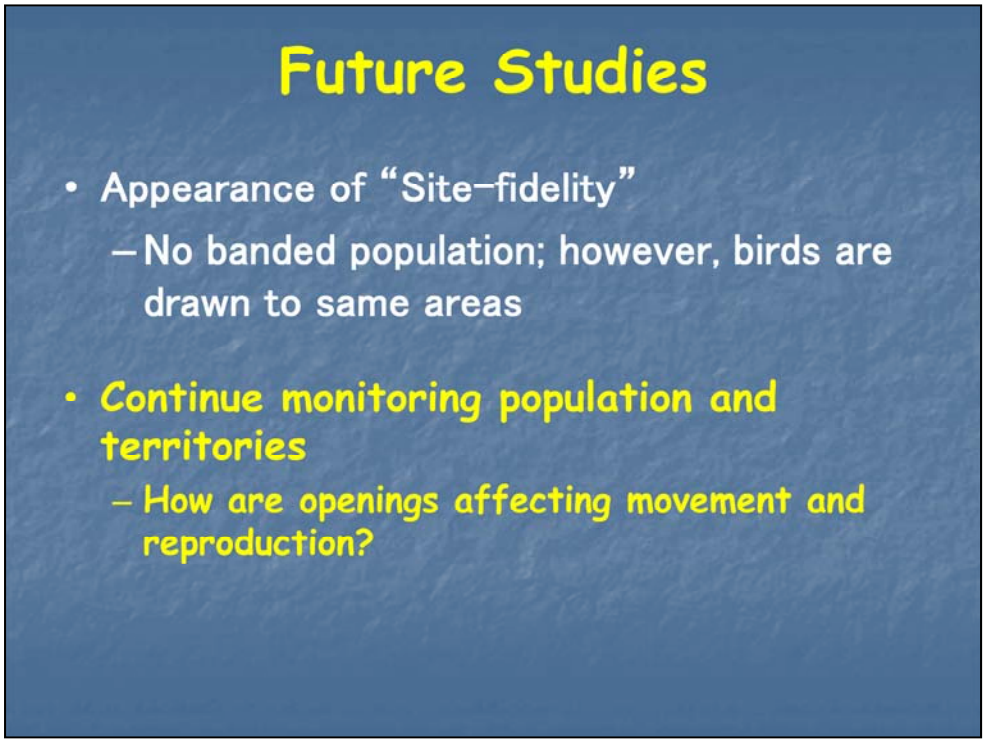


Summary

✓Relative abundance estimates increased slightly in the control units (+ 42%), markedly in even-aged units (+76%), but declined by 39% in uneven-aged units.

✓Territory sizes decreased post-harvest.

✓ Spatial arrangement and general location of territories remained the same in control and even-aged sites but changed in uneven-aged sites.



Future Studies

- Appearance of "Site-fidelity"
  - No banded population; however, birds are drawn to same areas
- Continue monitoring population and territories
  - How are openings affecting movement and reproduction?

Future Studies

1) Abundance estimates do not equate to reproductive fitness

Unable to determine if silviculture is affecting reproductive success

2) Intensive Nest Monitoring

Are some territories better habitat?

Successful vs. Unsuccessful breeding areas

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?