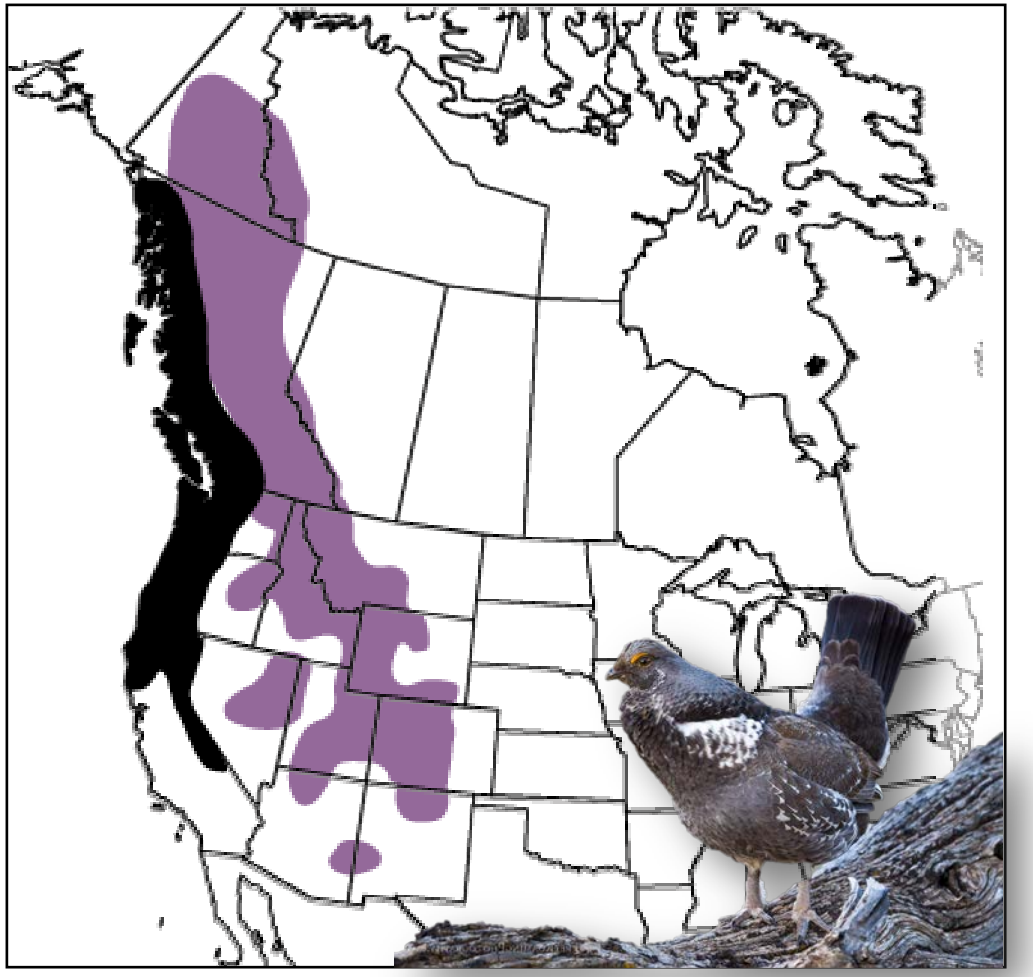
The role of forest disturbance in habitat relationships and population ecology of Spruce Grouse.

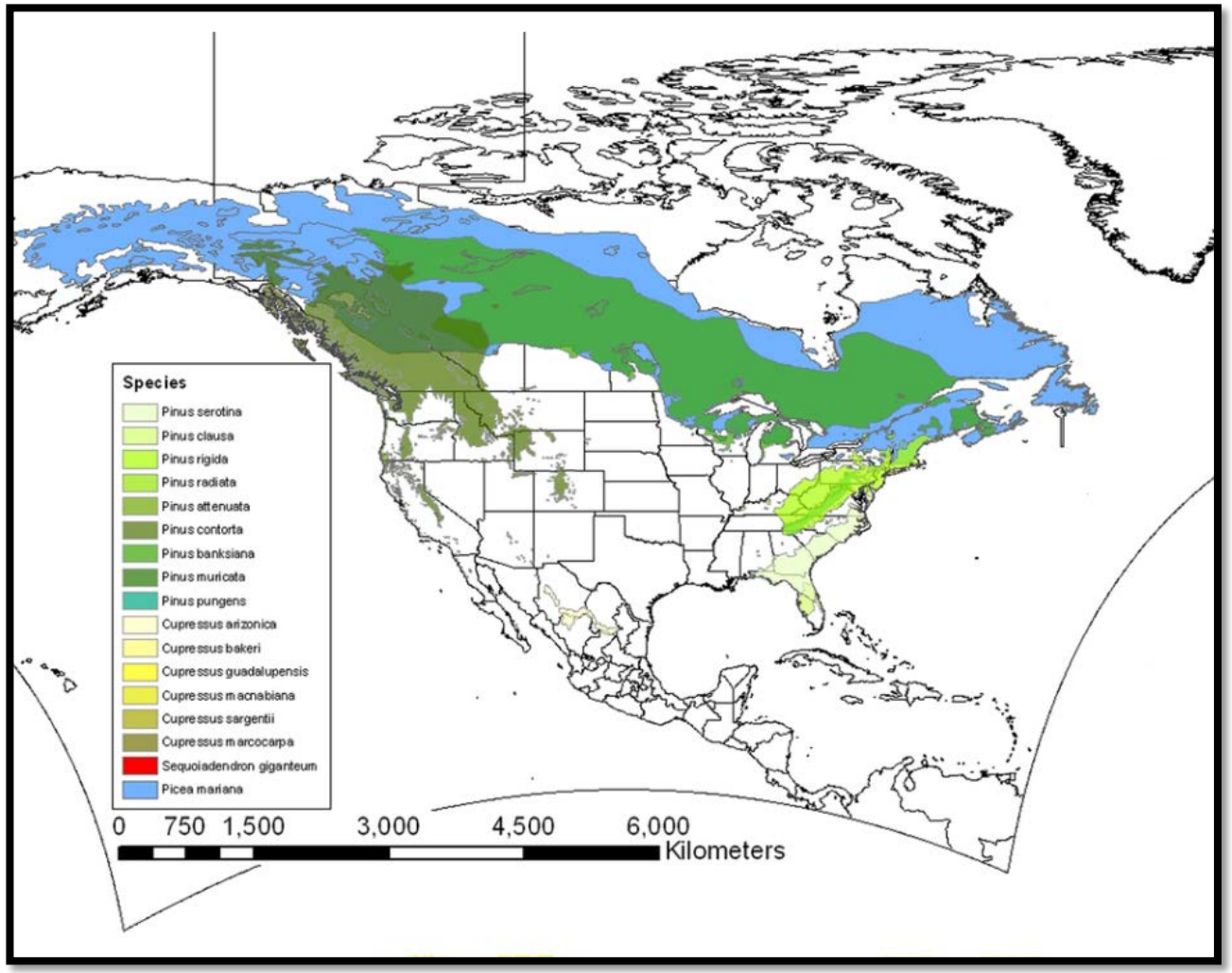
Erik Blomberg, Joel Tebbenkamp, Stephen Dunham, and Daniel Harrison

No sooner had I entered the State of Maine, than I considered the Canada Grouse as one of the principal objects of my inquiry … and although I ultimately succeeded in this, the task was perhaps as severe as any which I ever undertook. John James Audubon

Spruce grouse are a resident obligate of northern forests dominated by short-needled conifers.



Often the conifer systems Spruce Grouse inhabit are fire-dependent (e.g. jack pine).



Buma et al. 2013 BioScience 63:866-876.

Most of Maine generally presumed to have long (>200 year) pre-colonial fire return intervals.

THE PRESETTLEMENT FOREST AND NATURAL DISTURBANCE CYCLE OF NORTHEASTERN MAINE[1]

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School of Forestry and Environmental Studies, Duke University, Durham, North Carolina 27706 USA

Abstract. Land survey records of 1793–1827 containing forest data for 1.65 × 10^6 ha of northern Maine were analyzed for species composition, successional status, and frequency of large-scale disturbance. Quantitative data consists of 1,448 sample trees spaced 1.6 km apart along a 9.7- × 9.7-km grid. Species which each comprised > 10% of the total were *Picea* spp., *Fagus grandifolia*, *Abies balsamea*, *Thuja occidentalis*, and *Betula lutea*. These forests appeared to be largely in a climax state as indicated by the dominance of shade-tolerant

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Forest Ecology and Management 155 (2002) 357–367

Forest Ecology and Management

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Natural disturbance regimes in northeastern North America—evaluating silvicultural systems using natural scales and frequencies

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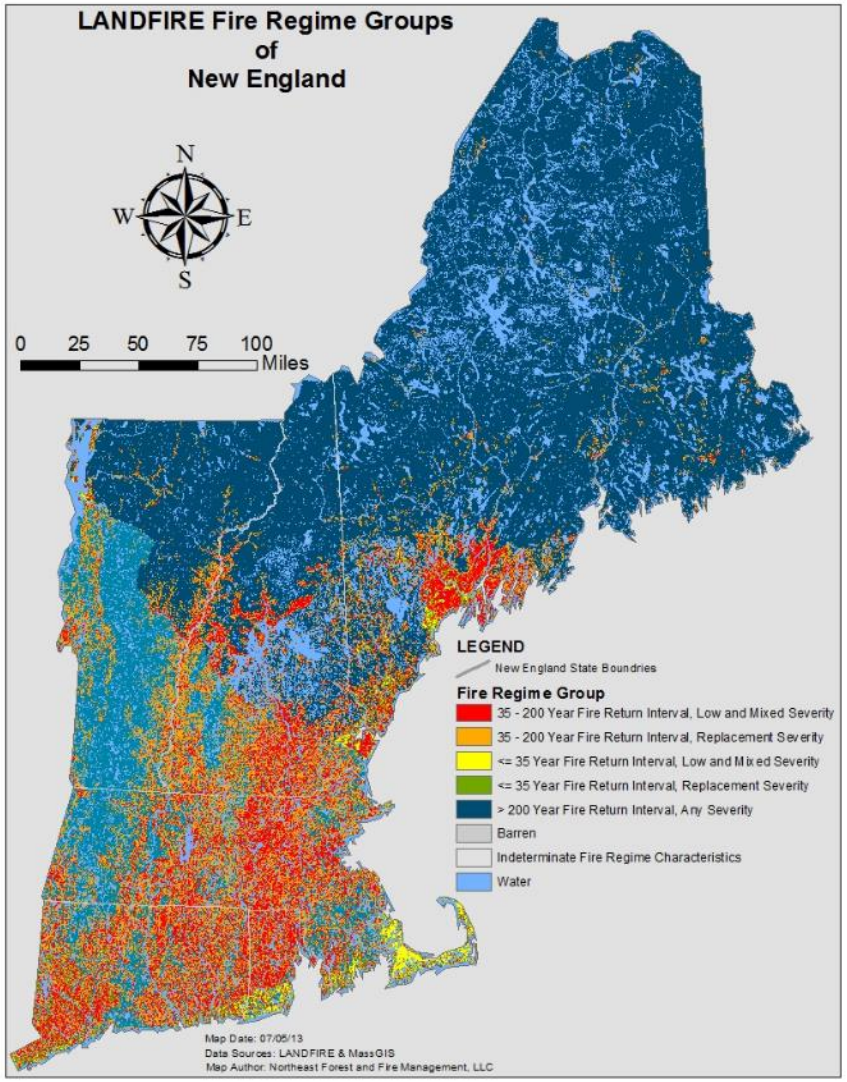
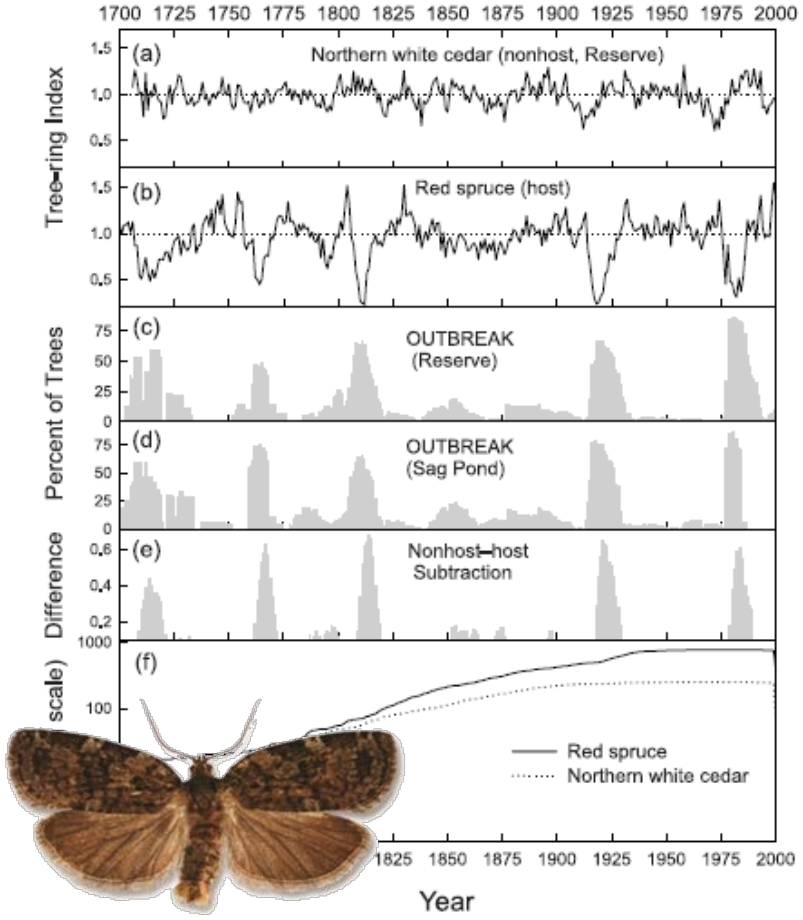


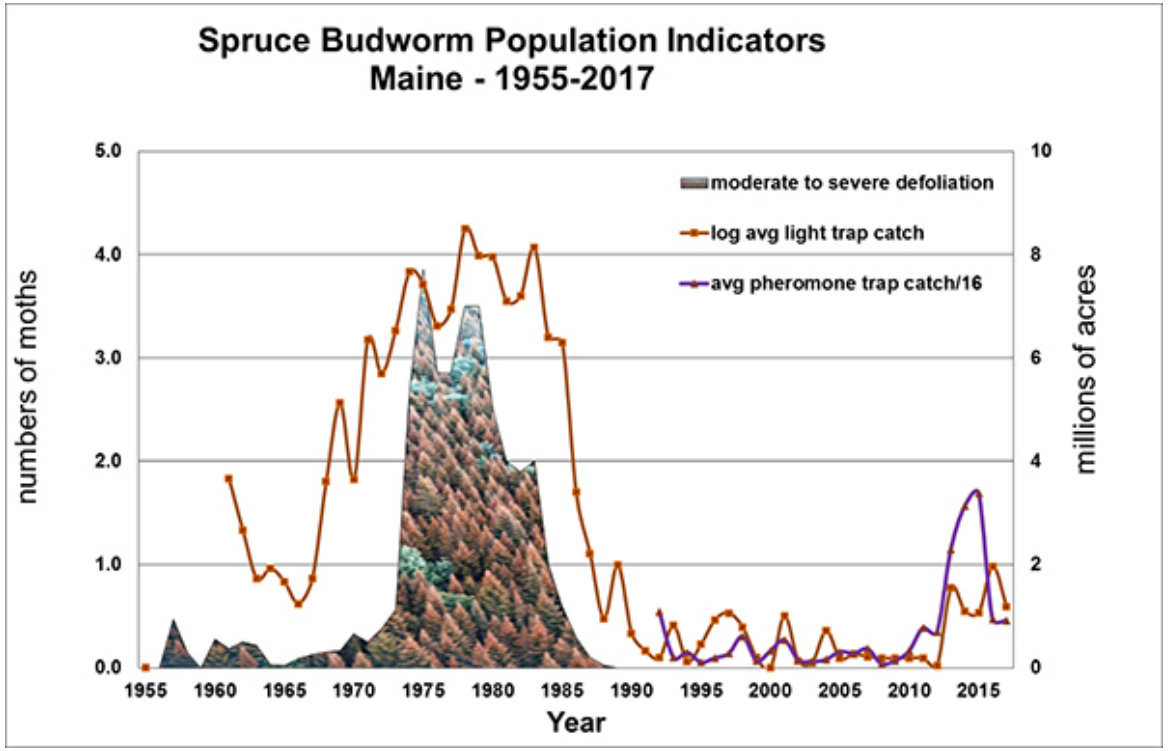
Fig. 2. (*a*) Standardized chronology for northern white cedar (nonhost) derived from the Big Reed Forest Reserve; (*b*) standardized chronology for red spruce (host) from the Reserve, suggesting five spruce budworm outbreaks as dramatic growth reductions beginning 1709, 1762, 1808, 1914, 1976; (*c*) results of the OUTBREAK (host–nohost) analysis, using the nonhost chronology from the Reserve, showing the percent of trees in each year meeting predefined criteria for budworm outbreak detection, with peaks indicating budworm outbreaks; (*d*) results of the OUTBREAK analysis using the nonhost chronology from Sag Pond; (*e*) subtraction of the host standardized chronology from the nonhost chronology, after smoothing with a 6 year running mean; (*f*) sample depth (number of tree-ring series) used in the chronologies and analyses, based on material from the Reserve.



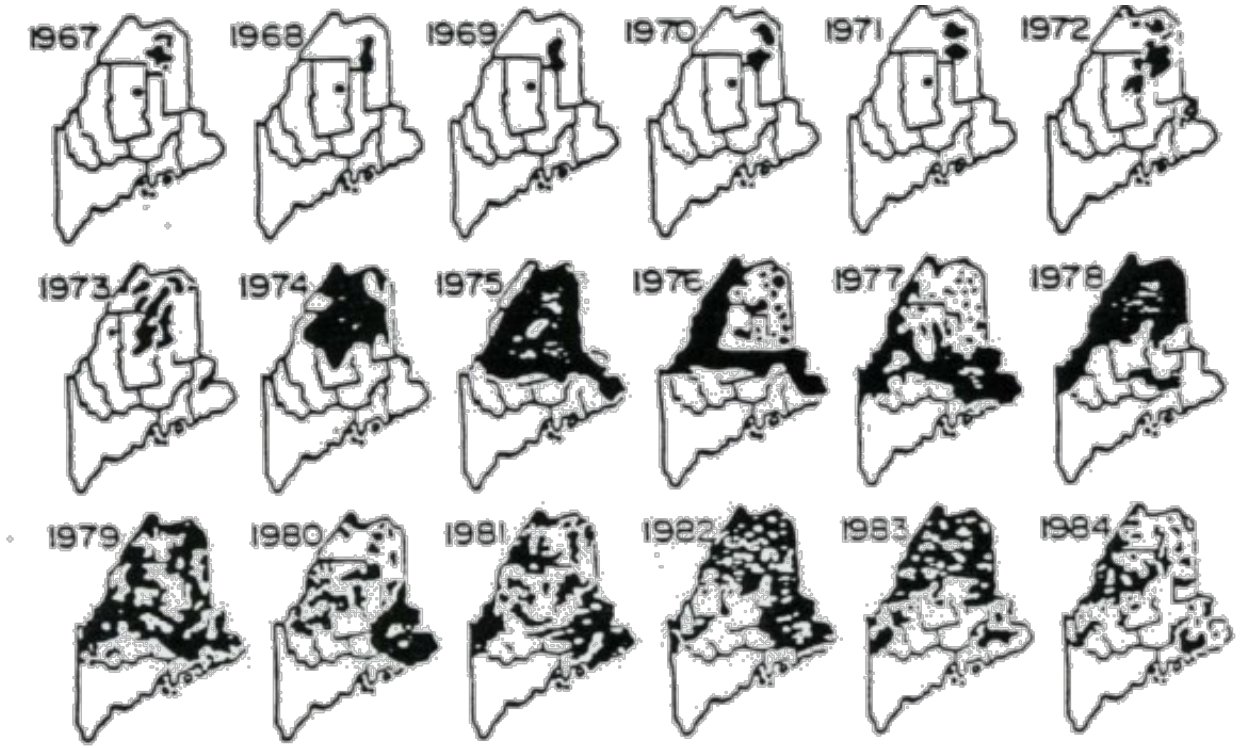
Periodic insect outbreak and defoliation as a major historic disturbance agent.

Fraver et al. 2007. Can. J. For. Res. 37:523-529

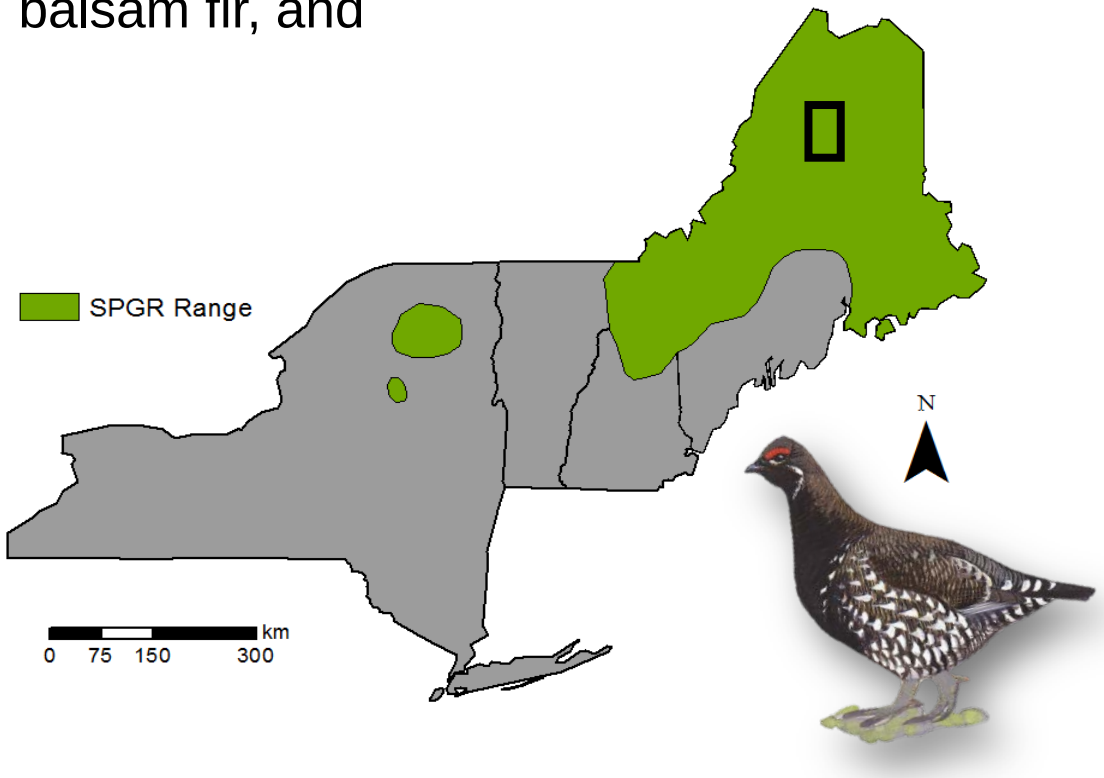
- A large-scale outbreak of spruce budworm in the 1970s and 80s prompted massive response by the forest products industry (salvage logging, insecticide use).
- Widespread clearcutting and negative public reactions prompted passage of regulations that restrict clearcutting practices.
- Much of the present-day composition of the landscape in Northern Maine is a result of this disturbance legacy.



Maine Forest Service



- Study Area located in the ‘Telos’ region of the North Maine Woods.
- Primarily privately-owned commercial forests with a small proportion (~20%) in the Baxter State Park Scientific Forest Management Area.
- Conifer forests dominated by red and black spruce, balsam fir, and tamarack



We conducted Spruce Grouse research in this system from 2012-2018 in conjunction with 2 graduate student projects

Work centered on use of VHF radio telemetry to monitor Spruce Grouse habitat use and demographics.

- 150 Spruce Grouse radio-marked over 6 years.
- Annual survival information from 116 adult birds.
- First fall/winter survival for 43 juvenile birds.
- Observed 60 females with broods.
- Located and monitored 26 nests.
- Collected >2000 locations to establish habitat use.

REGENERATING CLEARCUT

- >90% overstory removal, low residual basal area.
- No entry or treatment following the original harvest.
- ‘Natural’ regeneration of a spruce-fir dominant stand without post-harvest treatment (i.e. certain site characteristics present).

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- Pre-commercial hand thinning to reduce standing density and improve growth and yield.

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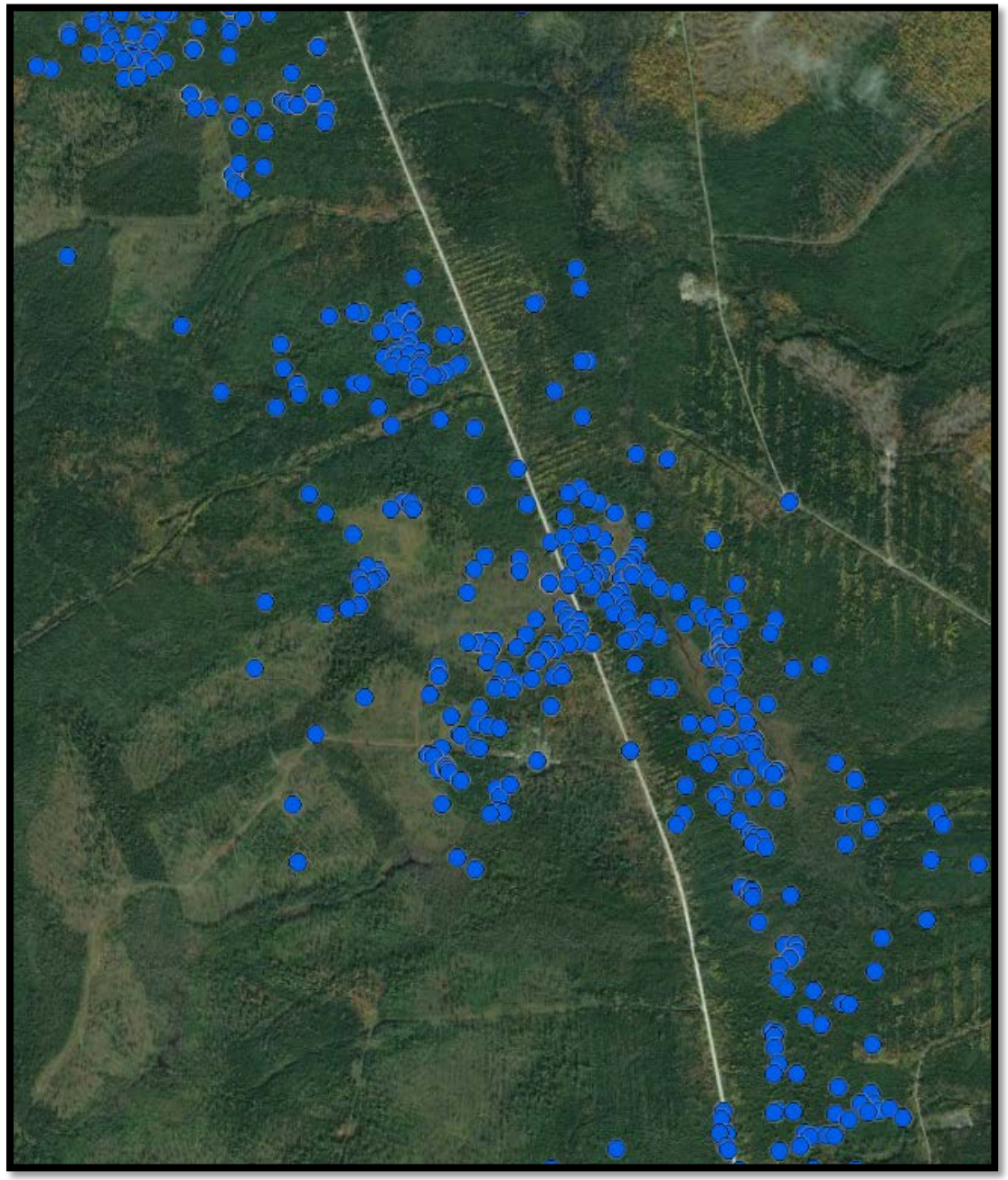
RESIDUAL

- No history of stand entry since at least 1981
- In practice the majority of these stands have not been harvested since before the 1970s spruce budworm outbreak.
- All second-growth, not necessarily synonymous with ‘mature forest’ and certainly not old growth.

There are other forest types in the system such as deciduous-dominant, and those that experienced partial harvests (e.g. selection or partial overstory removal), but Spruce Grouse did not use these enough for us to consider them.

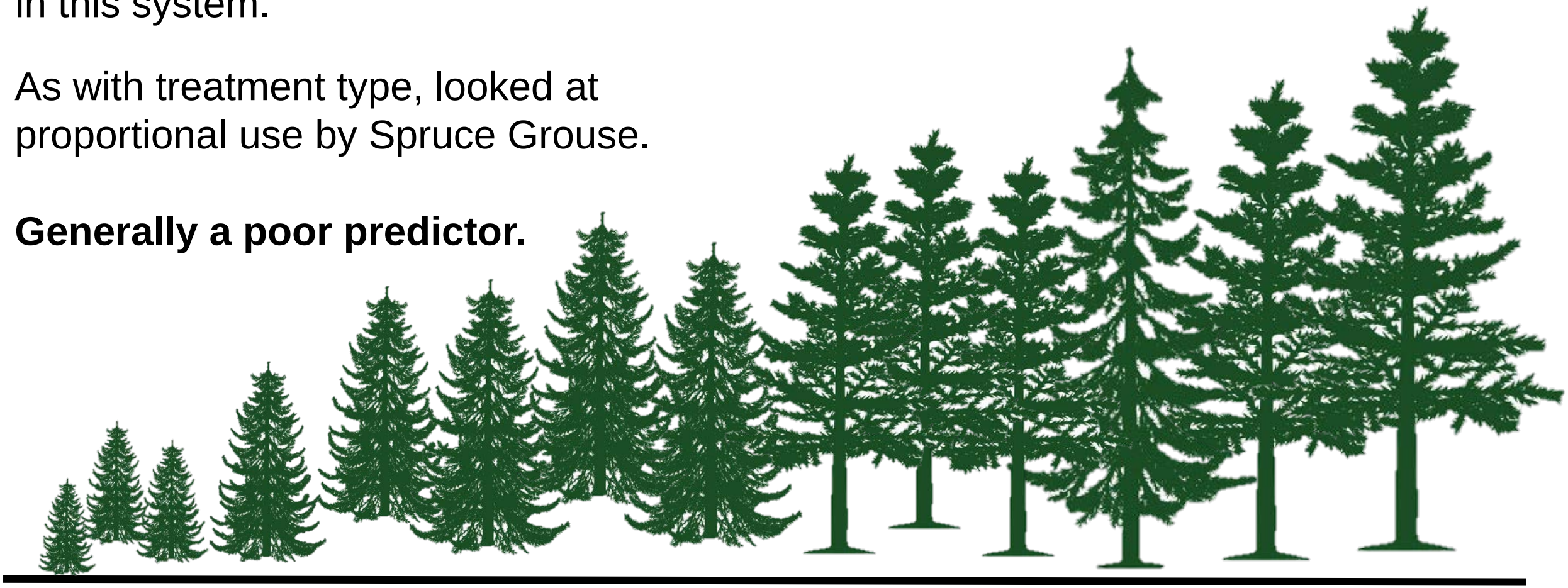

Treated Clearcut
Clearcut (not treated)
Residual Stands
Other Stand Types
Spruce Grouse Loc.



We also categorized stand age (years since last harvest), which loosely corresponds with sapling, pole, and mature size classes in this system.

As with treatment type, looked at proportional use by Spruce Grouse.

Generally a poor predictor.



0 to 20 Years	21 to 30 Years	>31Years

Nest Survival

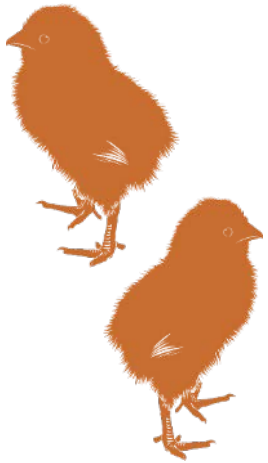
- Daily survival rate

- Prob. of survival to 32 days (lay + incubation).

Adult (AHY) Survival

- Monthly survival prob.

- 12-month annual survival May-April



Brood Success

- Weekly brood survival

- Prob. of ≥ 1 chick alive 10 weeks post-hatch

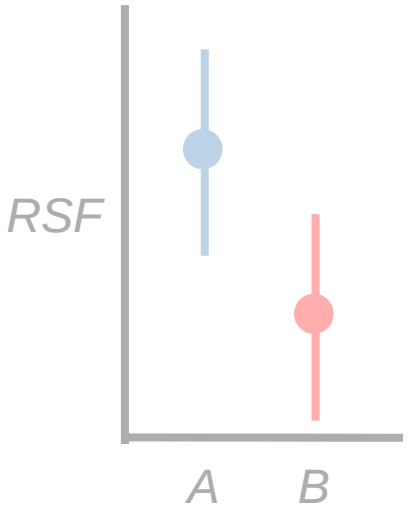
Juvenile (HY) Survival

- Monthly survival prob.

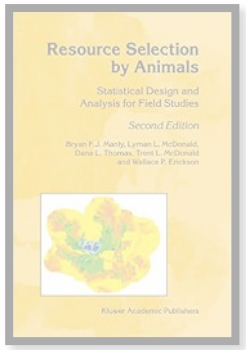
- 8-month survival from September-May

Analysis Overview

Habitat Selection

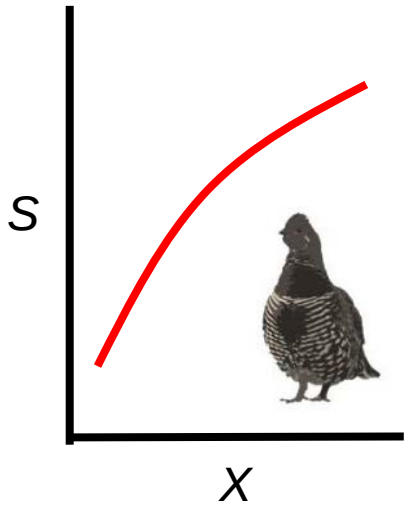


$$RSF = e^{\beta_0 + \beta_1 A}$$



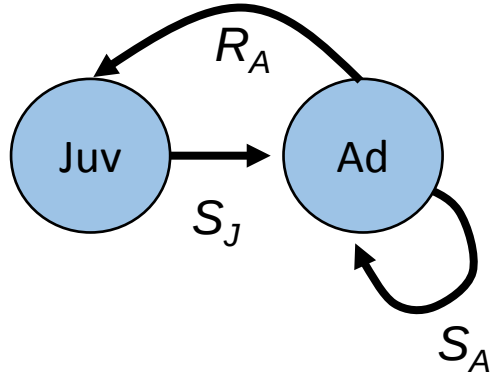
Spruce Grouse Stand Use

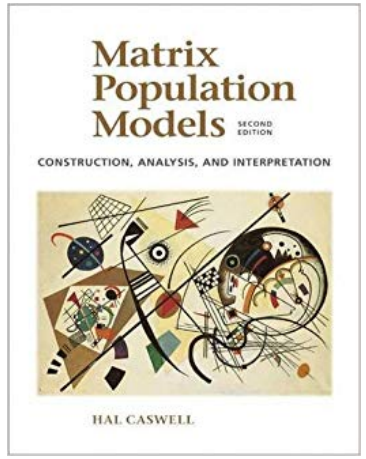
Demographic Response



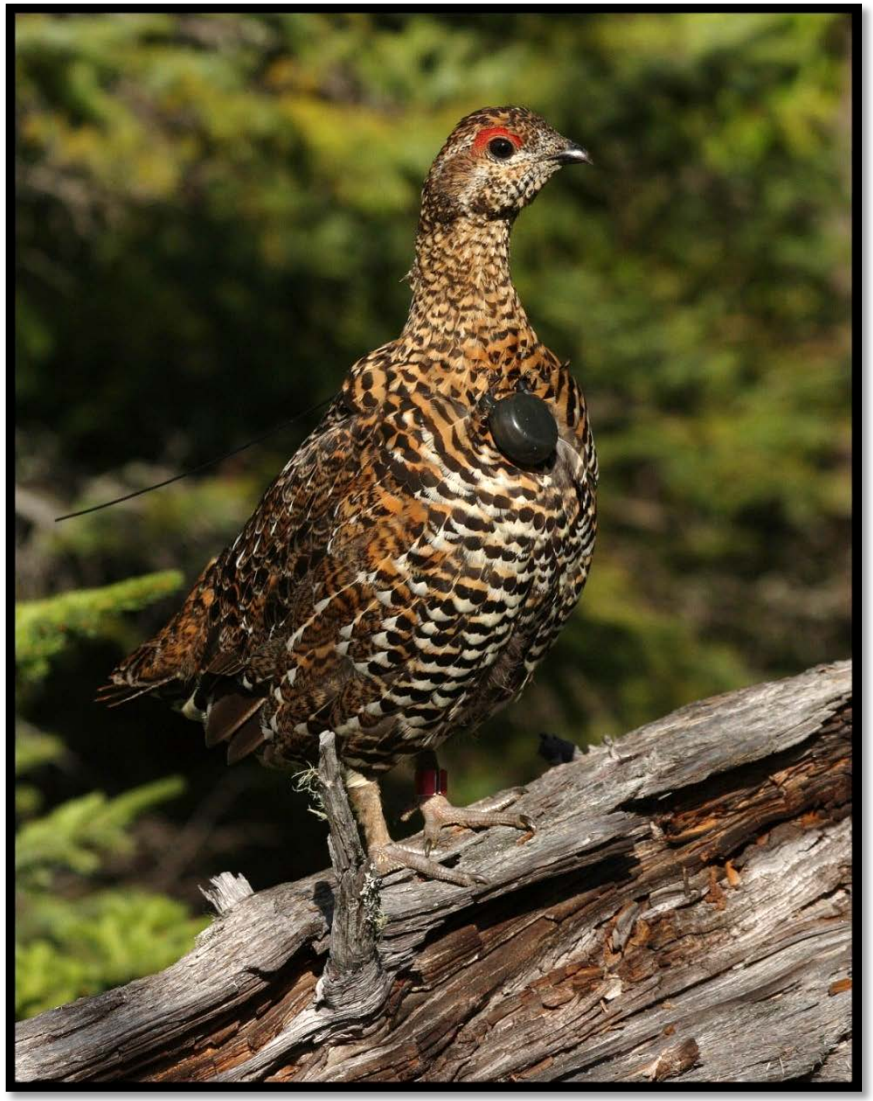
$$logit(S_i) = \beta_0 + \beta_1 X_1$$

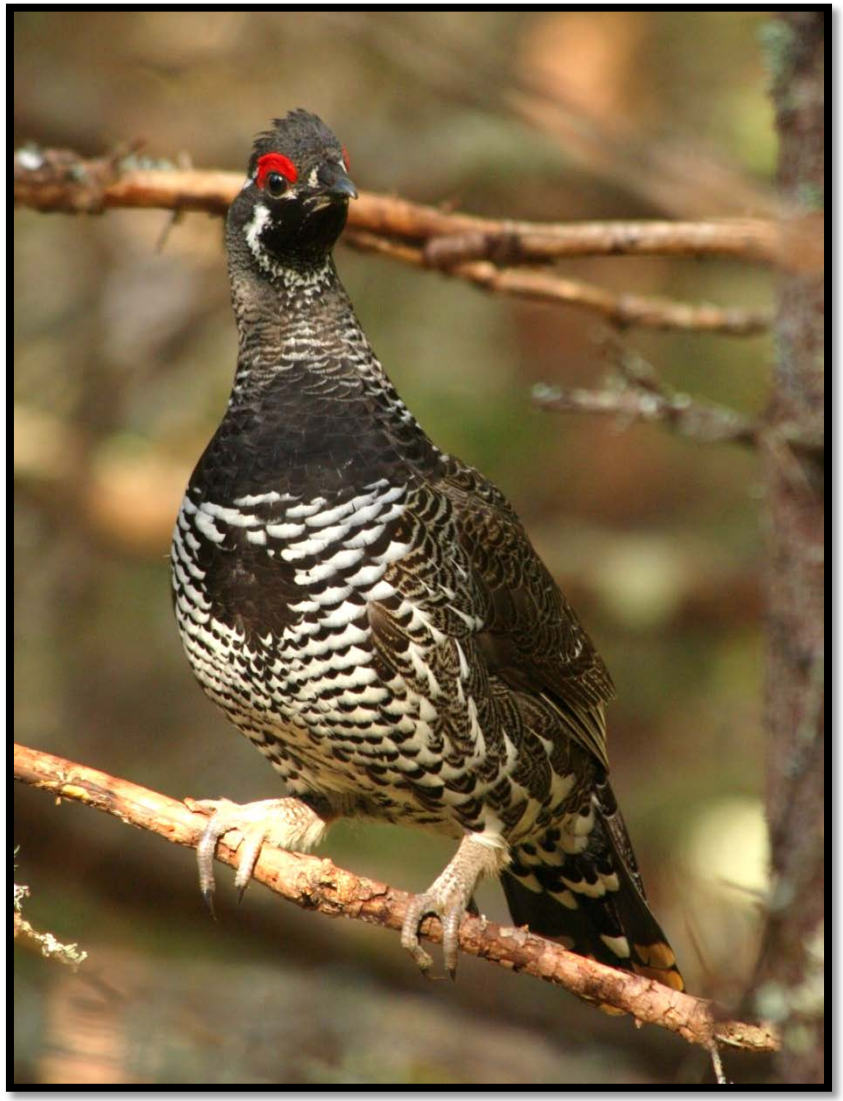
Population Response





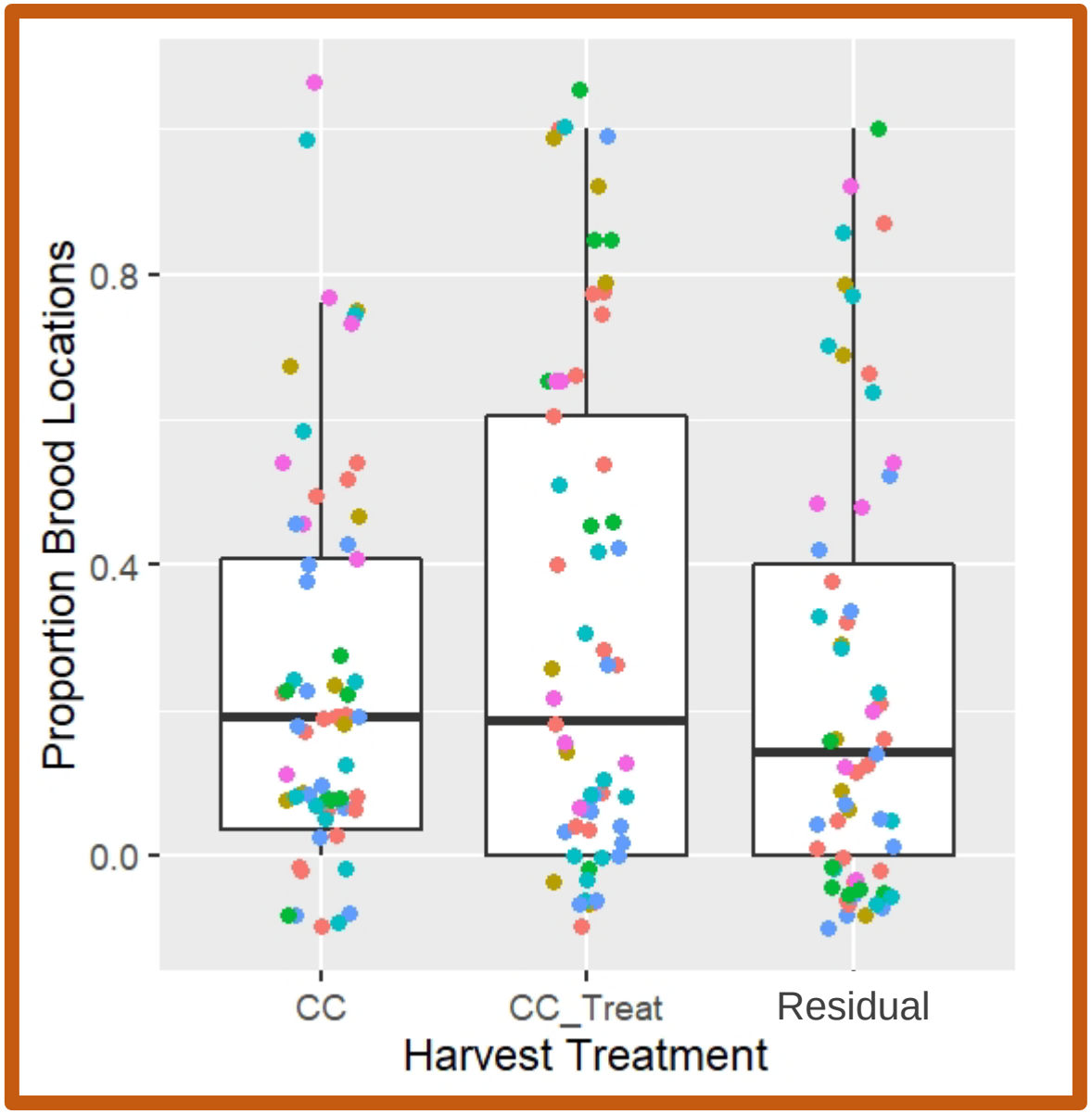
Caveat: We can only evaluate spruce grouse demographics where they actually exist – So stand-level effects are conditioned on use.

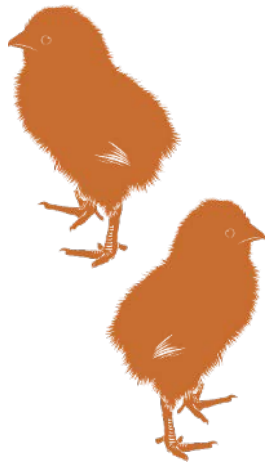




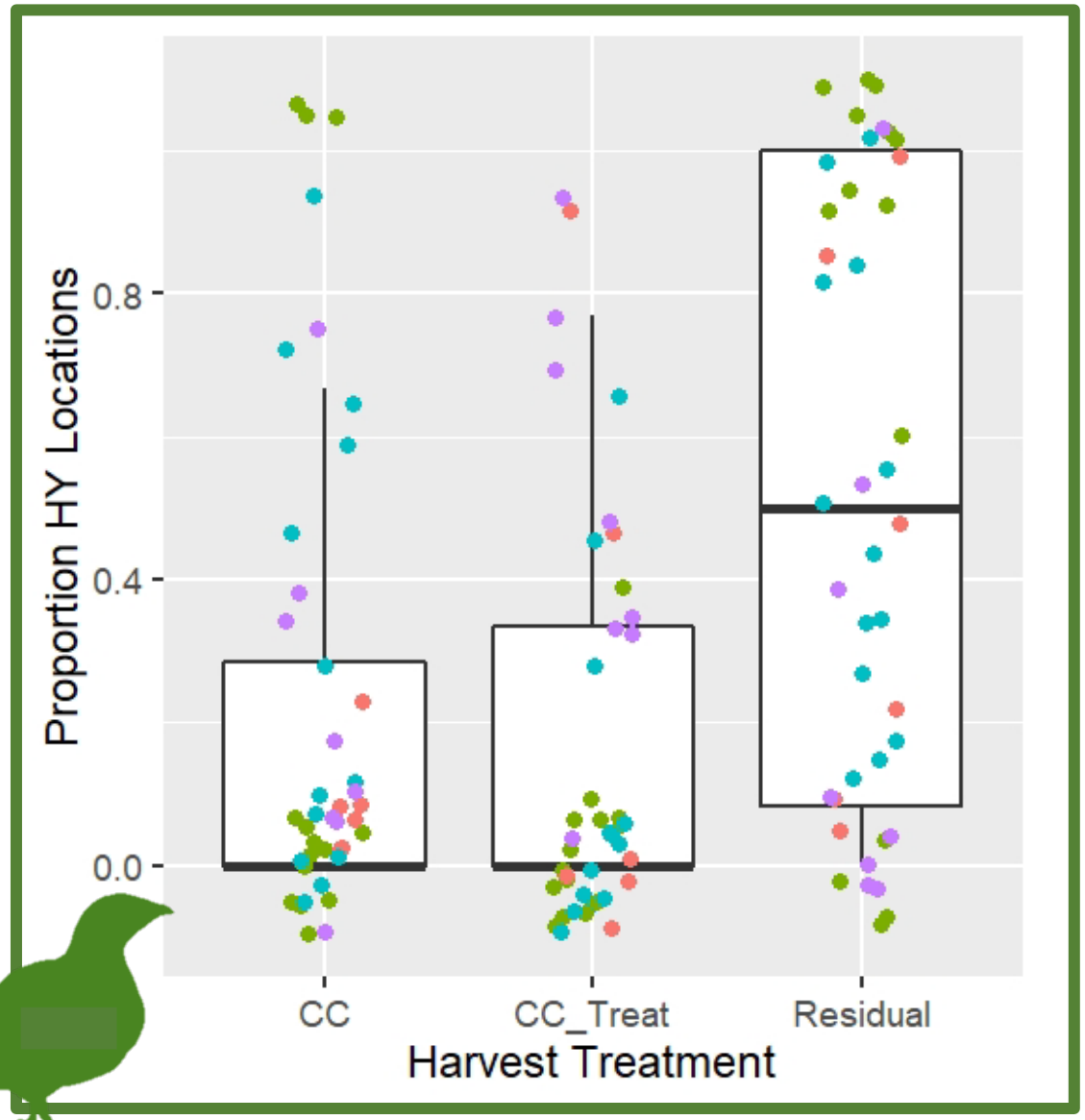
Mixed use of stand types for both nesting and brood-rearing.

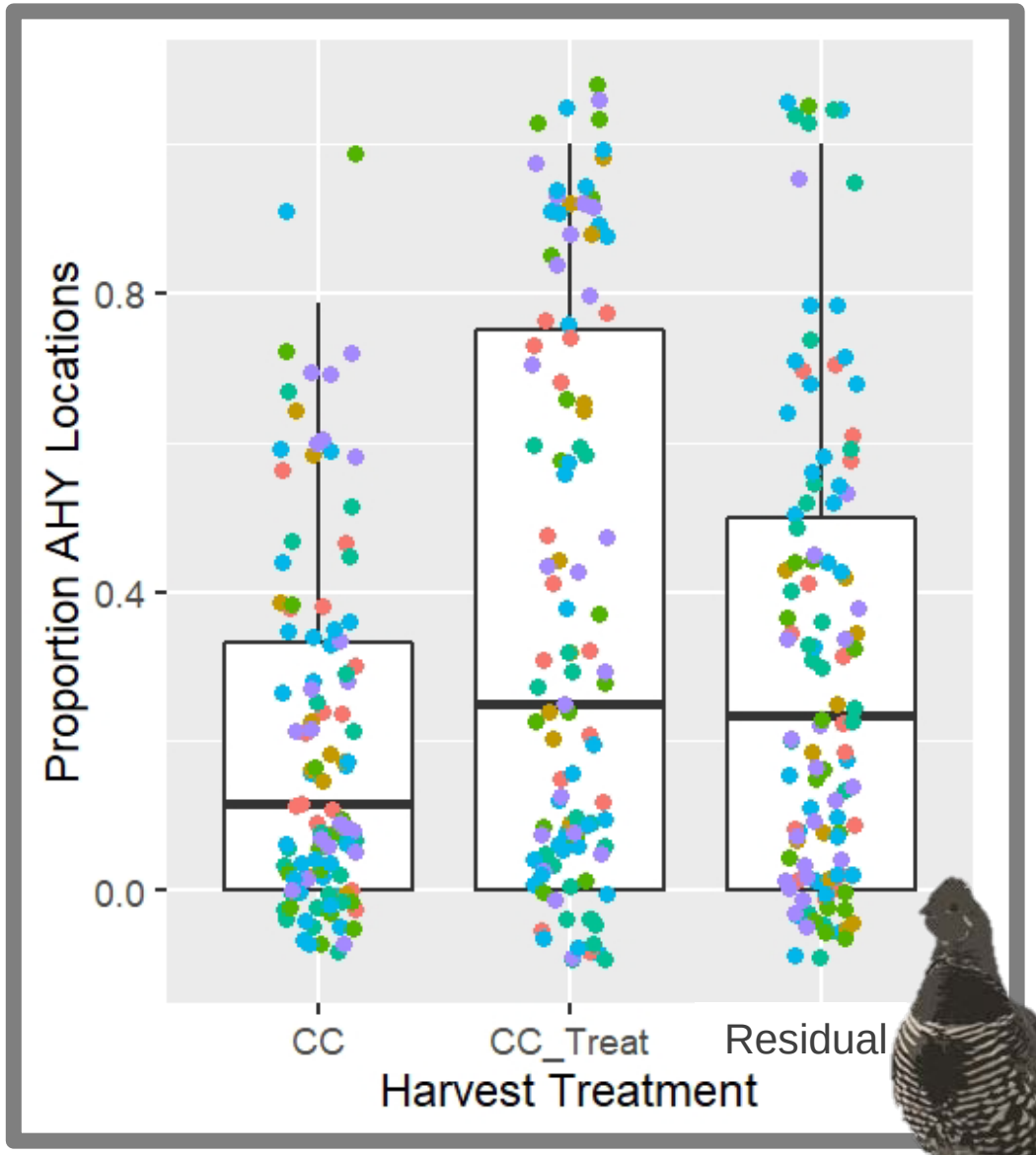
- 31% of nests in clearcuts (untreated)
- 27% of nests in treated clearcuts
- 23% in residual stands
- Remainder in other stand types (e.g. mixed-deciduous).

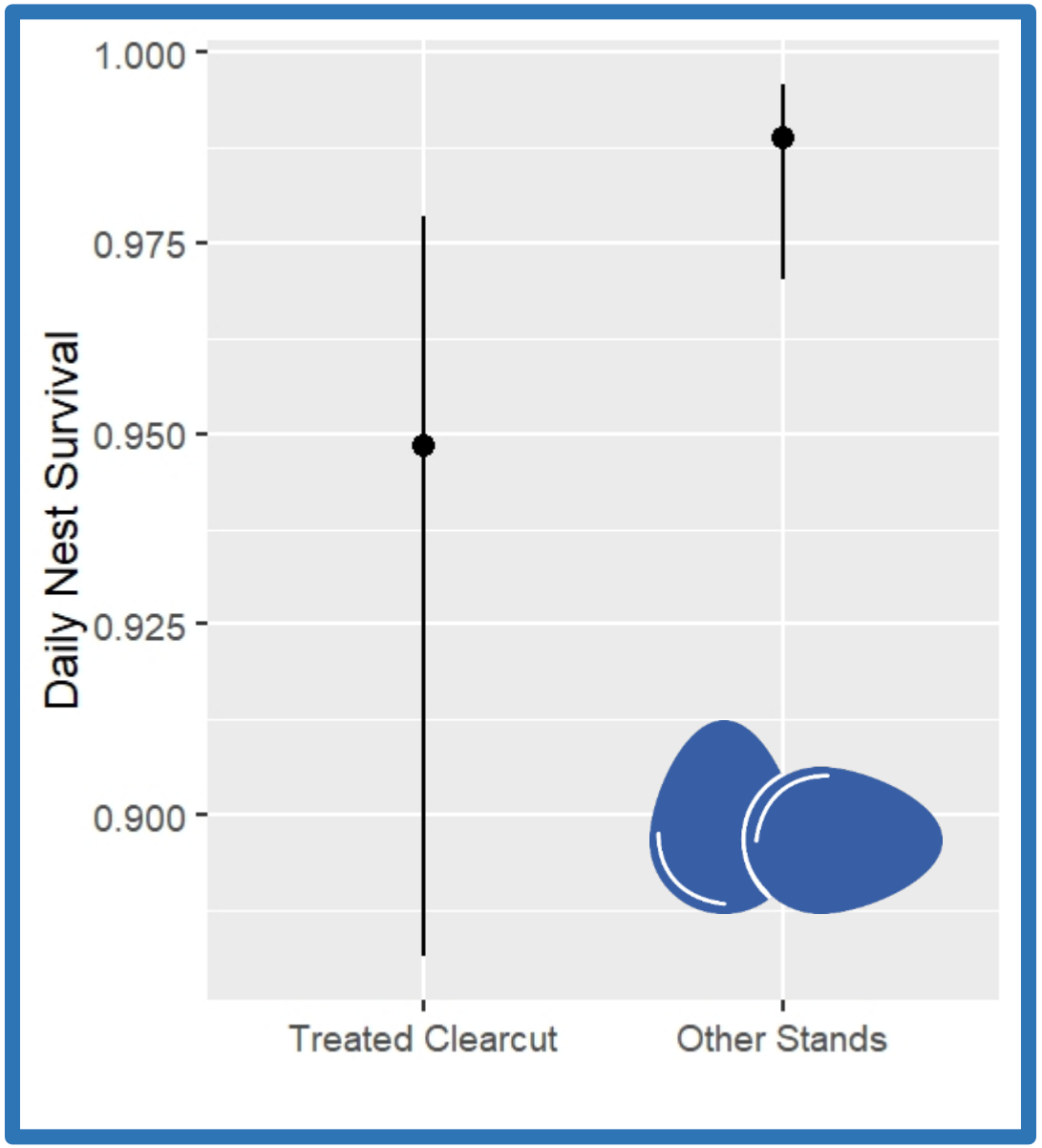




Juvenile spruce grouse greatest use of residual stands, adults mixed use among stand types.

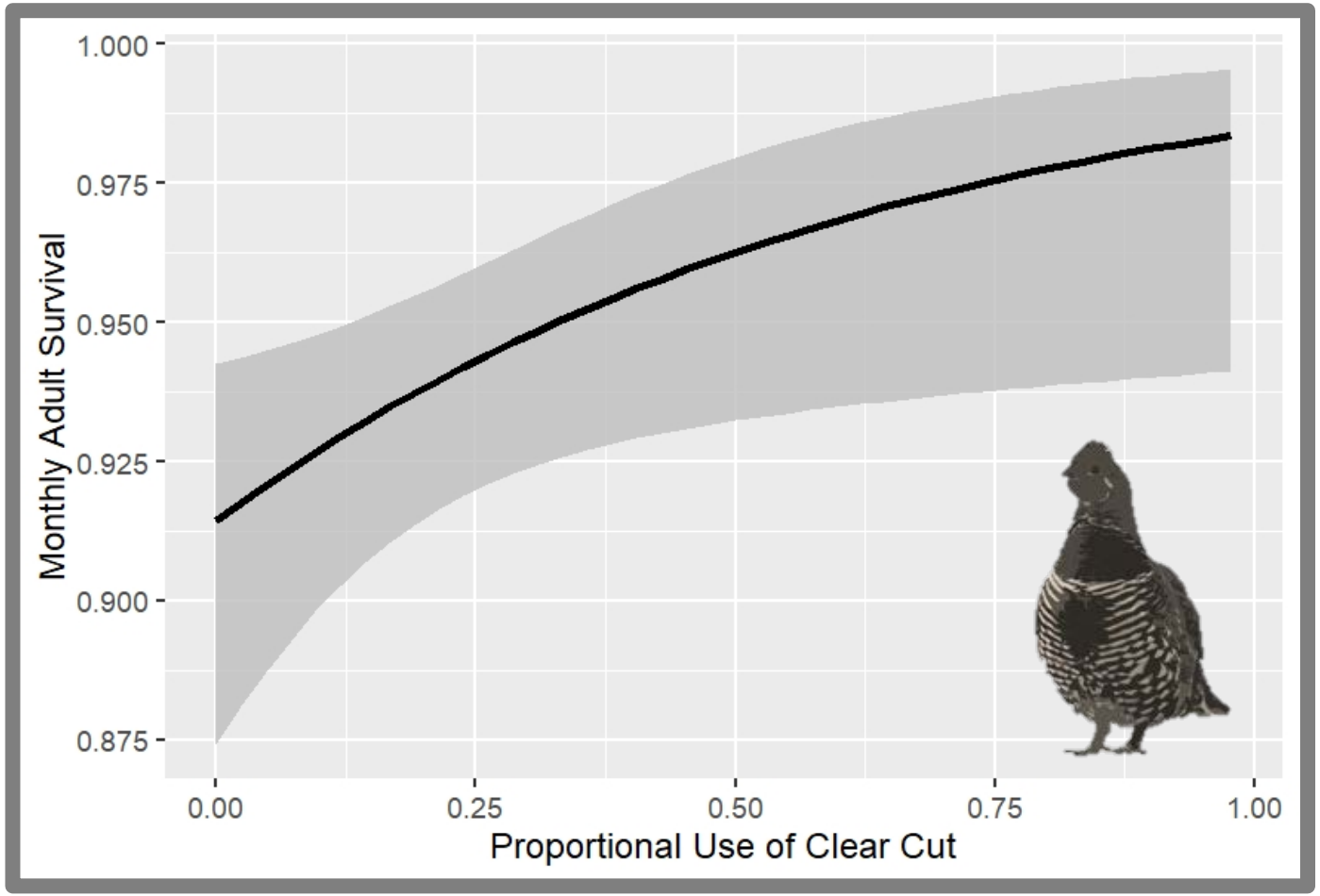




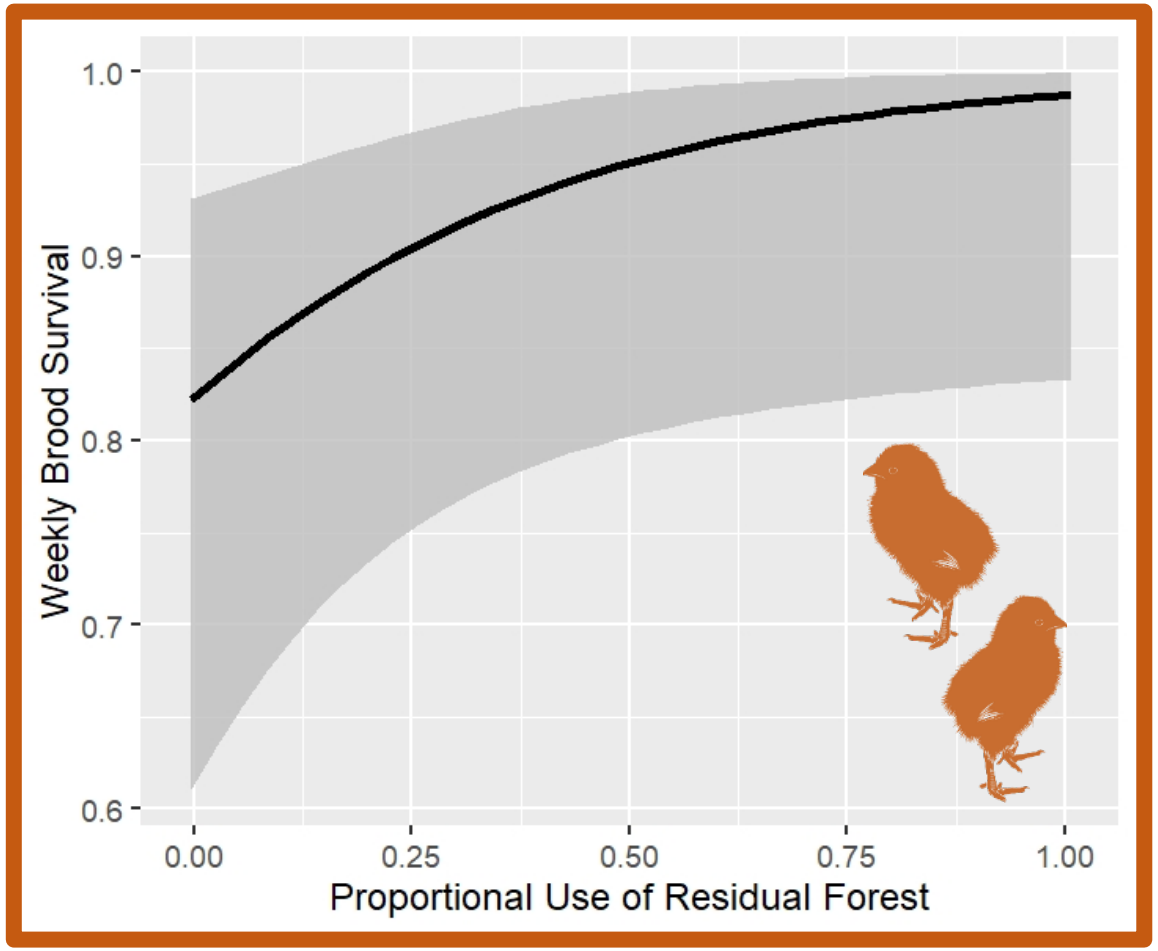


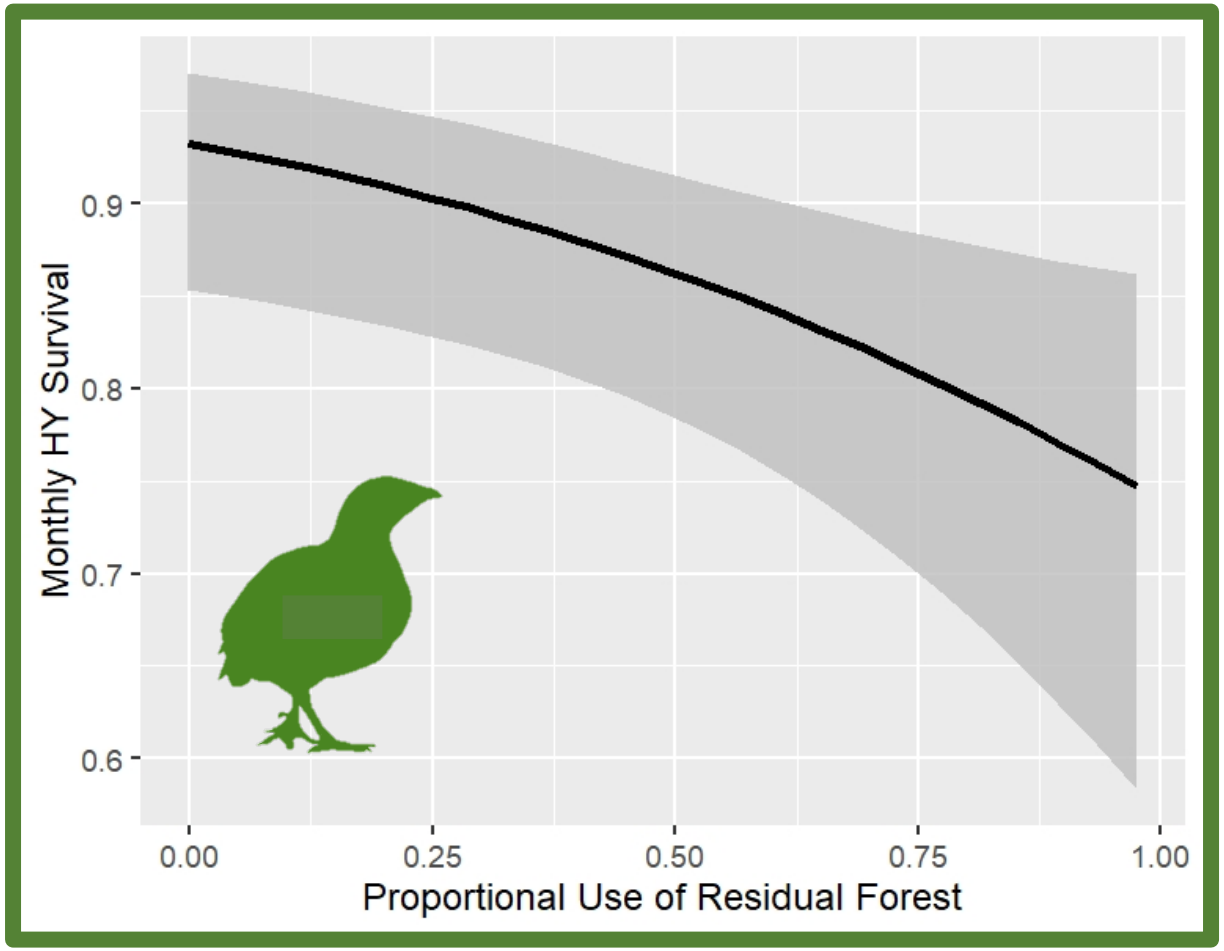
Nests had lower survival when located in clearcuts with post-harvest treatment

Adult spruce grouse had greater survival when they made greater use of un-treated clearcuts.



Opposing effects of residual forest stand use on hatch-year survival. Brood success was greater in residual stands while juvenile birds had lower survival when they made greater use of the same stand type.





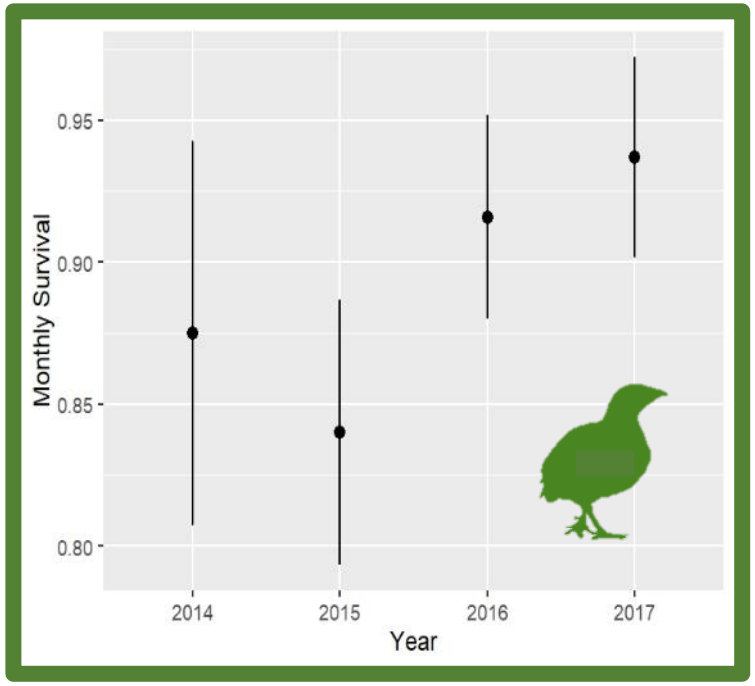
- **Large annual variation in vital rates.**

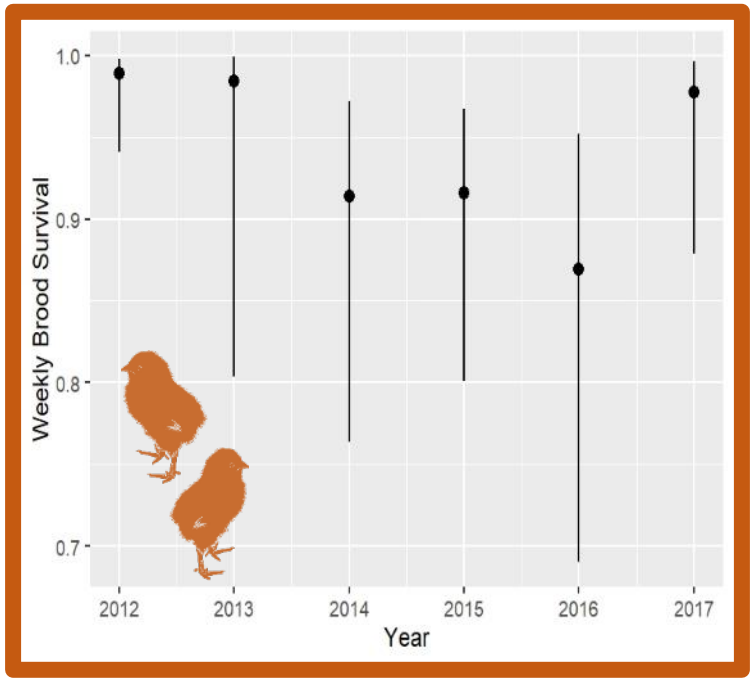
- **Population growth (λ>1.0) in only 1 of 6 years.**

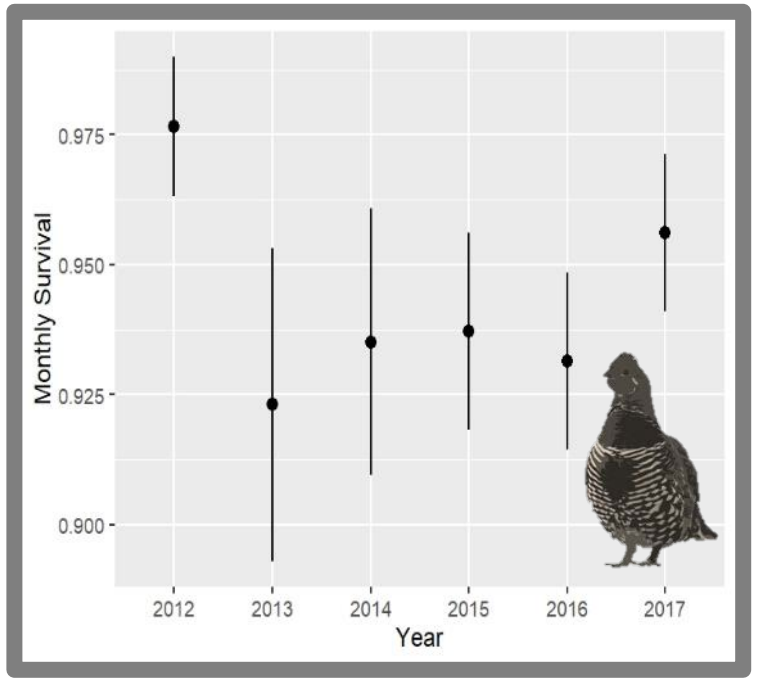
- **Predicted mean population decline.**

$$\lambda = 0.730; 95\%\ CI = 0.626\ to\ 0.851$$

Year	Brood Success	Juv. Survival	Adult Survival	Pop. Growth (λ)
2012	0.894	-	0.642	0.980*
2013	0.854	-	0.488	0.808*
2014	0.406	0.396	0.393	0.524
2015	0.415	0.293	0.388	0.486
2016	0.246	0.543	0.308	0.416
2017	0.797	0.636	0.608	1.034

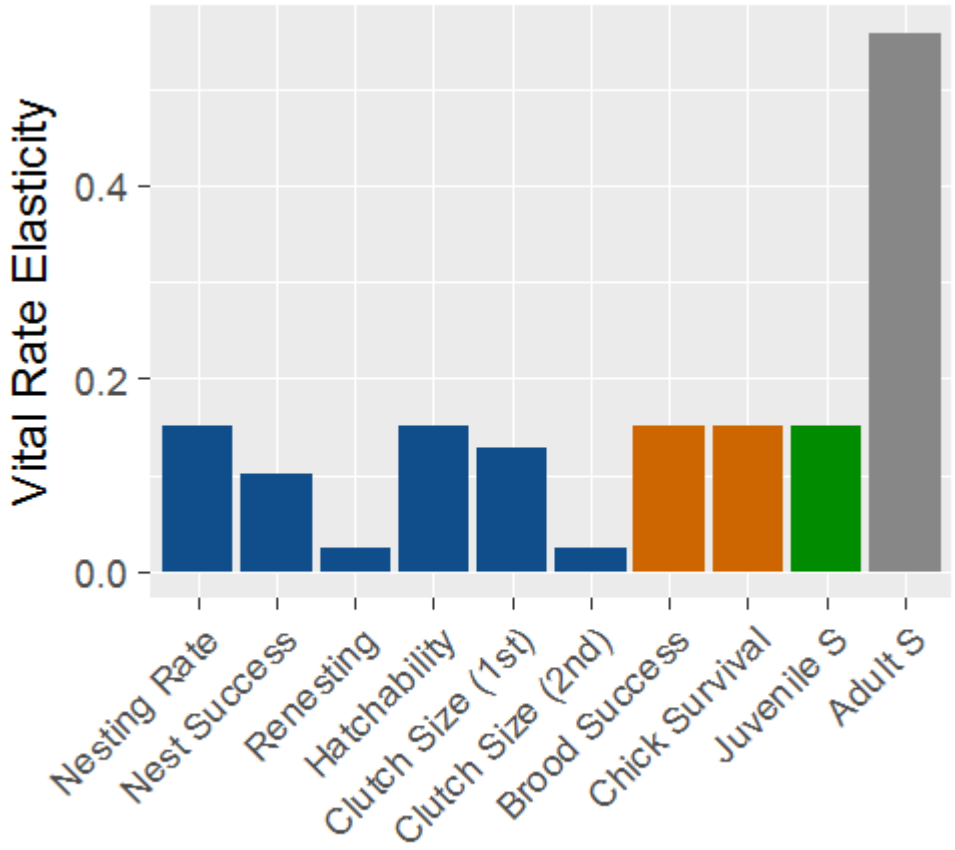


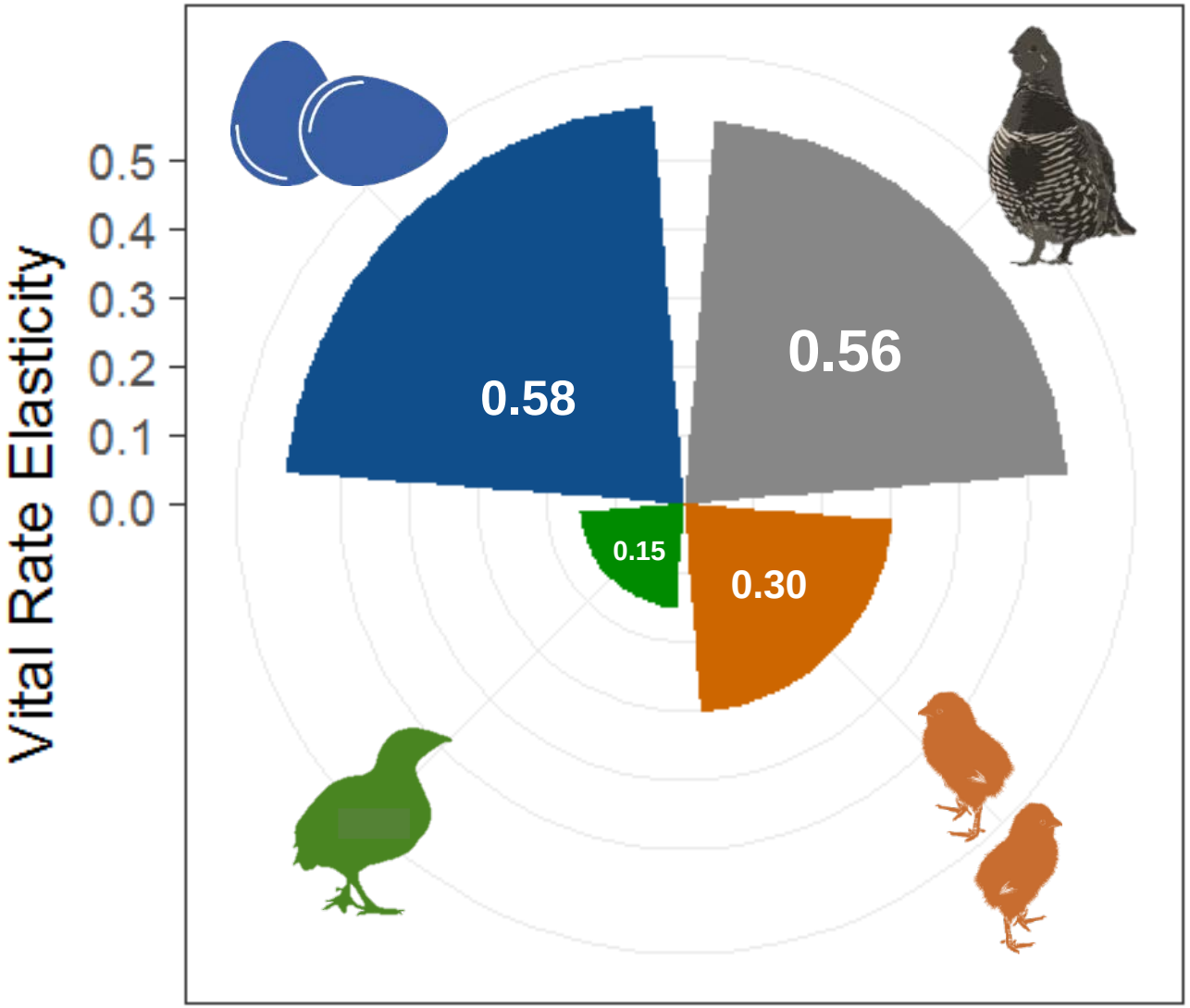


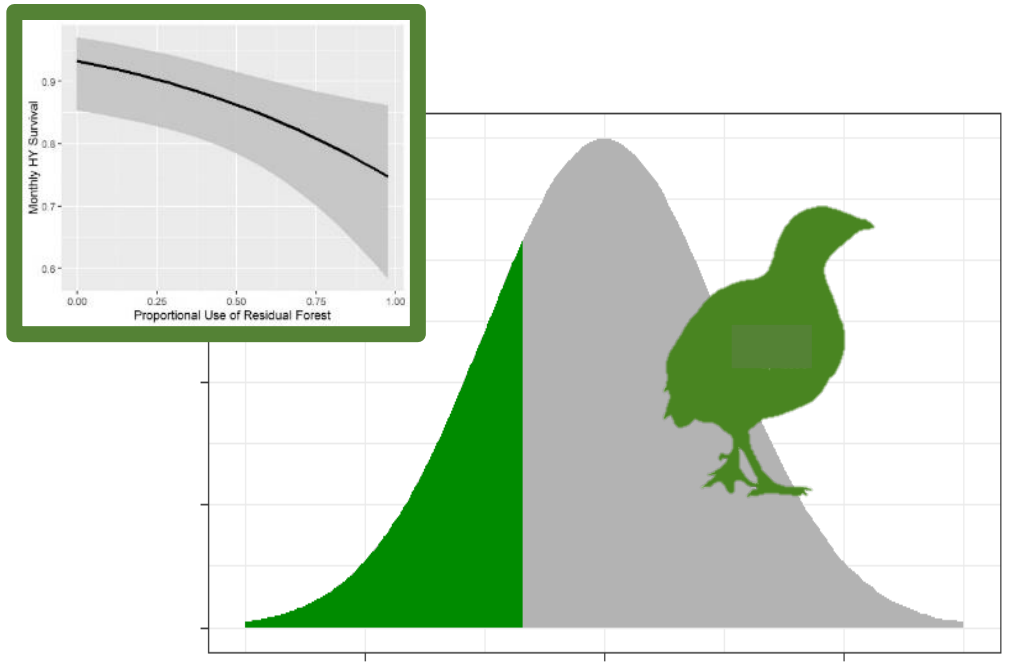


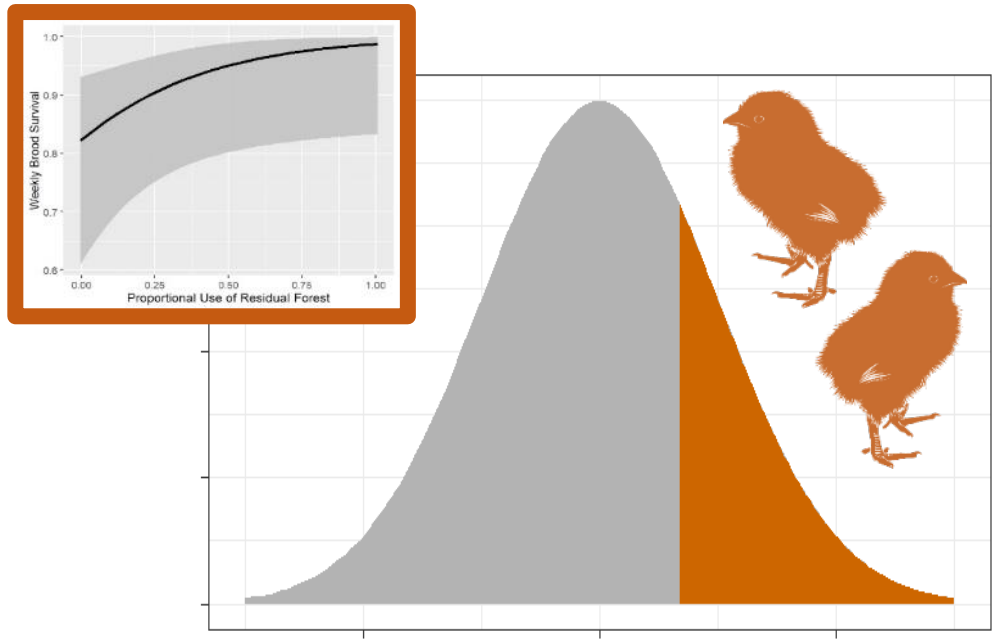
Population growth most sensitive and elastic to adult annual survival.

Combined elasticity of nesting components also relatively high

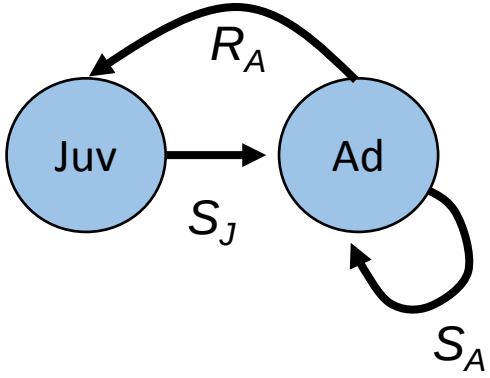


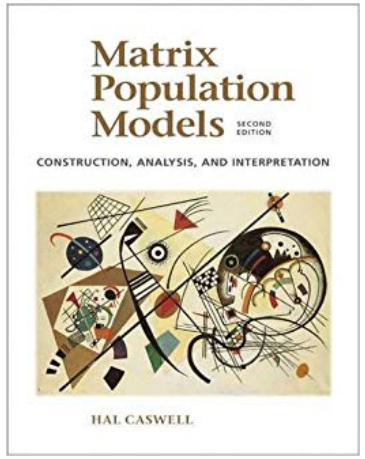




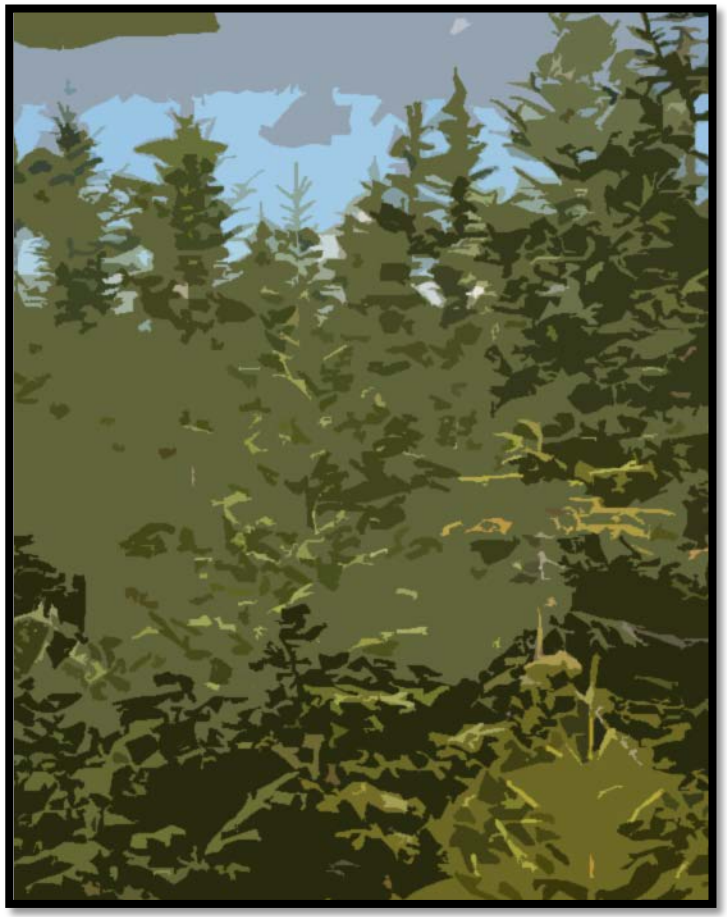


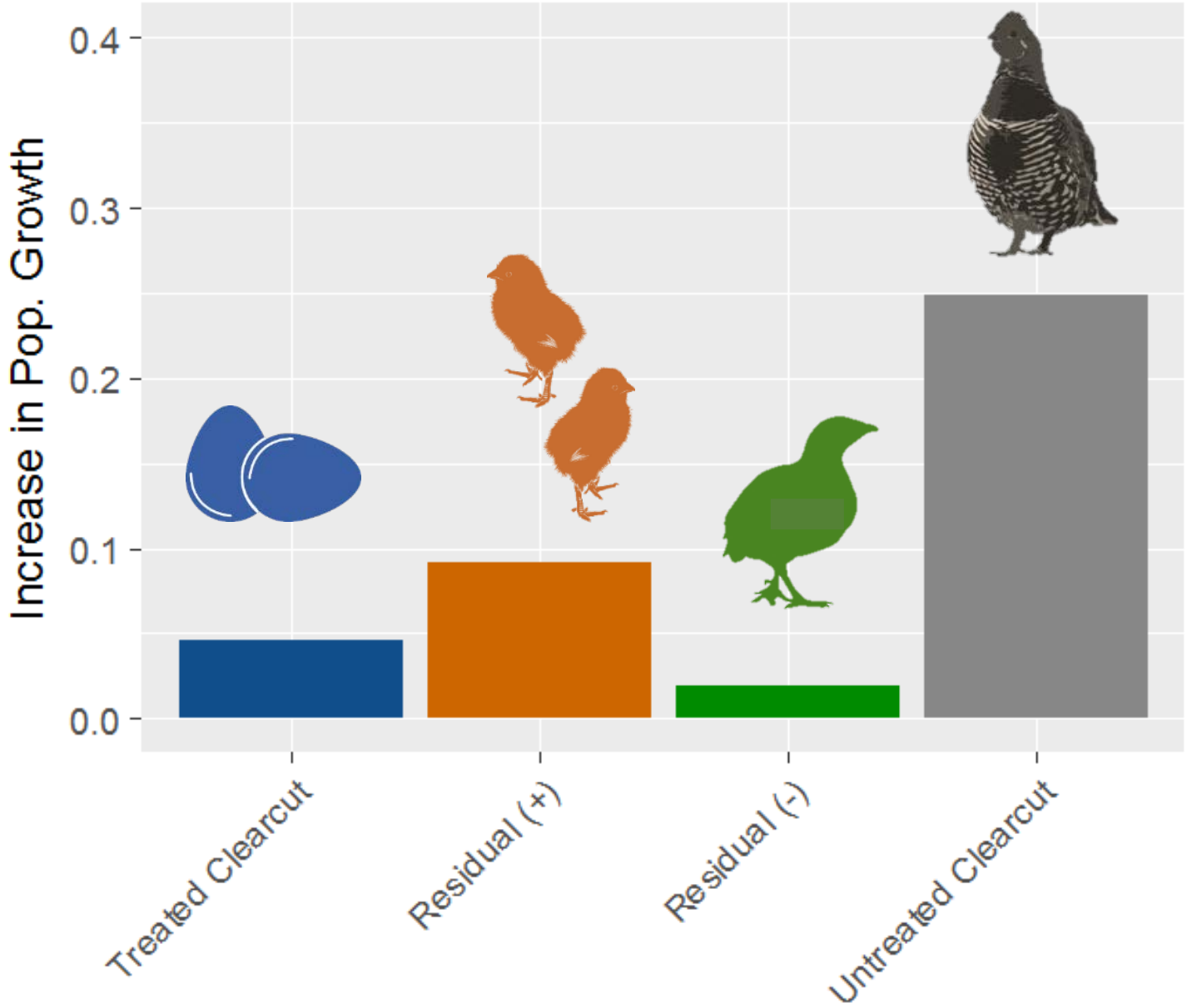
Population Response

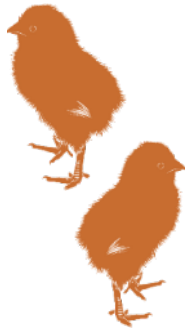




Increased use of regenerating clearcuts without post-harvest treatment by adults has the greatest potential to increase population growth.







- **The relationship between stand harvest/disturbance history and Spruce Grouse vital rates is varied.**

- **Habitat heterogeneny is likely key to meet Spruce Grouse resource needs at all life stages.**

- **Future population decline seem most likely for this population, perhaps Spruce Grouse in Maine generally.**

- **Matches all other recent assessments from the southern extent of the species range:**

  1) Wisconsin: Population growth rate <1.0 (Anich et al. 2013)

  2) New York: 71% loss of occupied area over 40 years (Ross et al. 2016).

  3) Southern Maine: 50% decline in occupancy and large decrease in apparent abundance over 25 years (Gilbert and Blomberg *in press*).

We see regional shifts in forest composition due to regulatory change and harvest strategy.

Likely to trend away from conifer-dominated to a more mixed deciduous/conifer composition.

- 2.3-5% of mature conifer stands ‘partially harvested’ annually. (Simons-Legaard et al. 2016).

- Promotes greater deciduous regeneration.

- Essentially non-use of these stand types by Spruce Grouse.

- Implications for future pop. persistence unclear.

Predictions in fire-dependent systems.

Spruce Grouse depend on forest heterogeneity for meeting all life history requirements, so local fire heterogeneity probably of critical importance.

Prediction: Higher intensity, stand-replacing fires that result in early- to mid-successional conifer stands greatest benefit to adult survival.

Prediction: Retention of residual, more mature forest near higher intensity burns important for brood production.

Example: Jack Pine 'stringers' in the upper Midwest.

Occurrence depends on large-scale (>80 ha) high-intensity fires.

Stringers more frequent with larger patches as fire size increases.

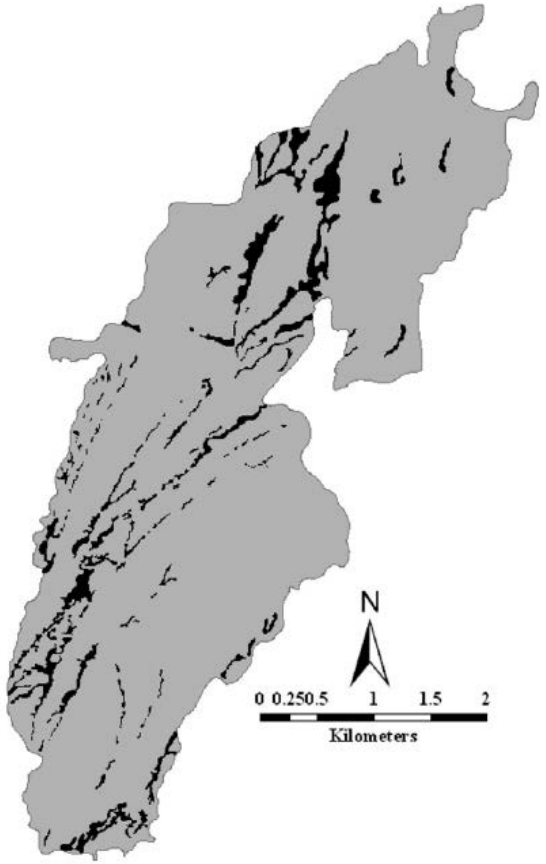


Fig. 4. Stringers (shown in black) within the fire perimeter of the 2000 No Pablo Fire in Oscoda County, Michigan (mapped from 2005 imagery). Stringers are dominated by many small patches.

Kashian et al. 2012 Forest Ecology and Manage. 263:148-158

Predictions in fire-dependent systems.

The stands where we saw limited nest success (clearcuts with post-harvest treatments) reflect fairly artificial conditions.

Prediction: Nesting and nest success unlikely to be a limiting factor in a fire-dependent system.

We expect the same offsetting effect of residual forest stands, but more work needed to understand role of landscape connectivity.

Prediction: First year survival of juveniles not likely limiting, but more work needed in this area.

Major caveat: *factors other than forest structure, such as predator communities and variation in landscape composition will also drive system-specific dynamics.*

Summary:

1) Grouse in general are tightly linked with ecosystem function, which inextricably connects them to successional processes - Spruce Grouse are no exception.

2) Fire is a significant player in Spruce Grouse – Habitat – Population relationships throughout much of the species' range.

3) In a fire-free system, we find a fairly nuanced relationship between forest disturbance history and spruce grouse demographics – and we expect the same to be true in fire-dependent systems.

4) Detailed studies of Spruce Grouse response to fire are either relatively dated, short-term and focused on direct effects, or tied up in larger avian community studies. Much potential to learn more.

Acknowledgments

Land access and logistics from Katahdin Forest Management, Baxter State Park Authority, Prentice and Carlisle LLC, and Gerald Pelletier Inc.

Many field technicians and volunteers.

Major funding from Maine Outdoor Heritage Fund, Maine Department of Inland Fisheries and Wildlife, University of Maine and the Maine Cooperative Forestry Research Unit.

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2018 - 2019 Webinar Series
March 27, 2019

LSFSC intern projects from 2018:

1. Seasonal burning to improve management for brushland-dependent species.

2. Effects of fire restoration in pine woodlands on the culturally important species: lowbush and velvetleaf blueberry (Vaccinium angustifolium and V. myrtilloides).