A food pulse drives conflicting fecundity and nest-site constraints for a cavity-nesting bird

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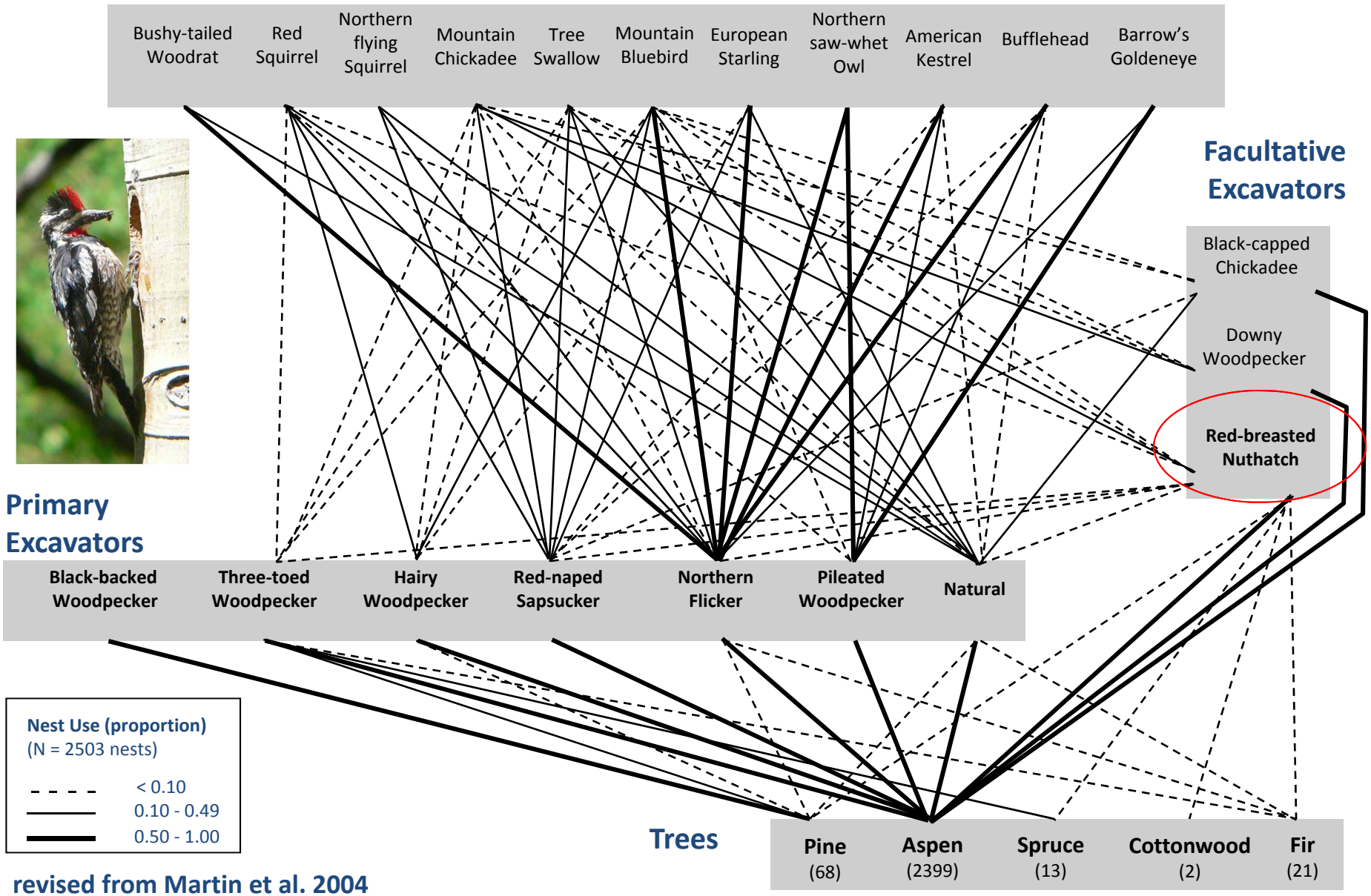
Nestweb

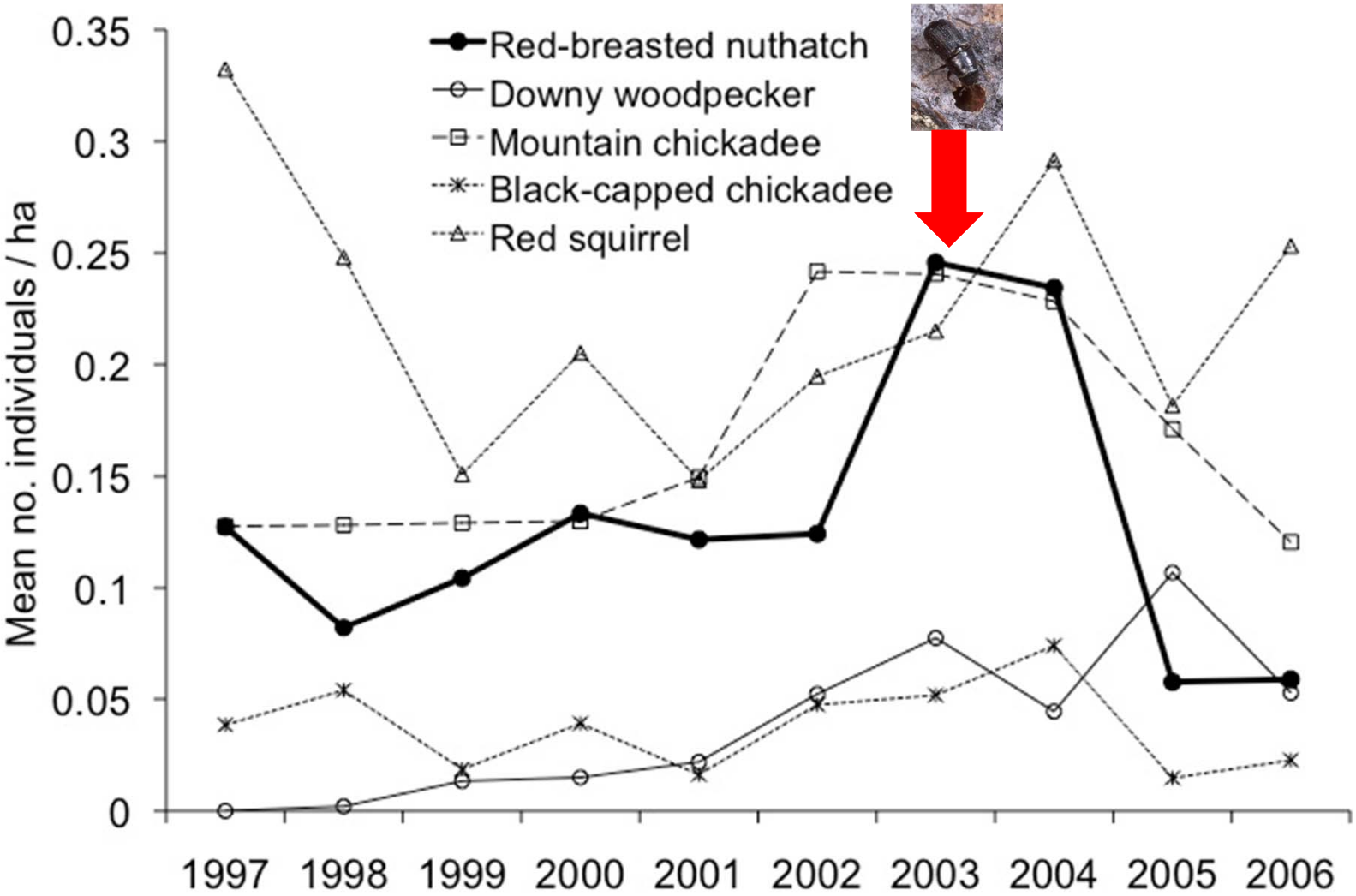


revised from Martin et al. 2004
1995-2010

Mountain pine beetle (*Dendroctonus ponderosae*): a food pulse in the nestweb

- Year-round food supply for cavity producers, competitors and predators
- Red-breasted nuthatch (*Sitta canadensis*)
  - irruptive, resident, bark insectivore, facultative excavator

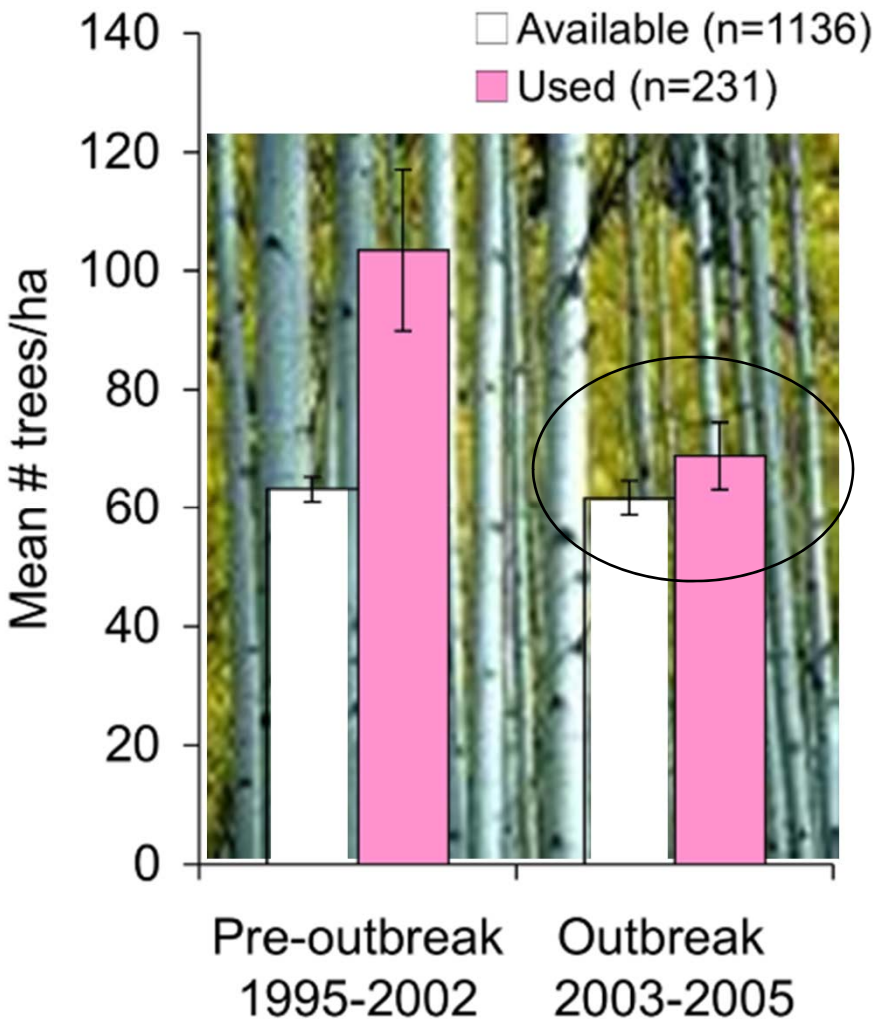
Cavity-nester densities ⇧ with beetle



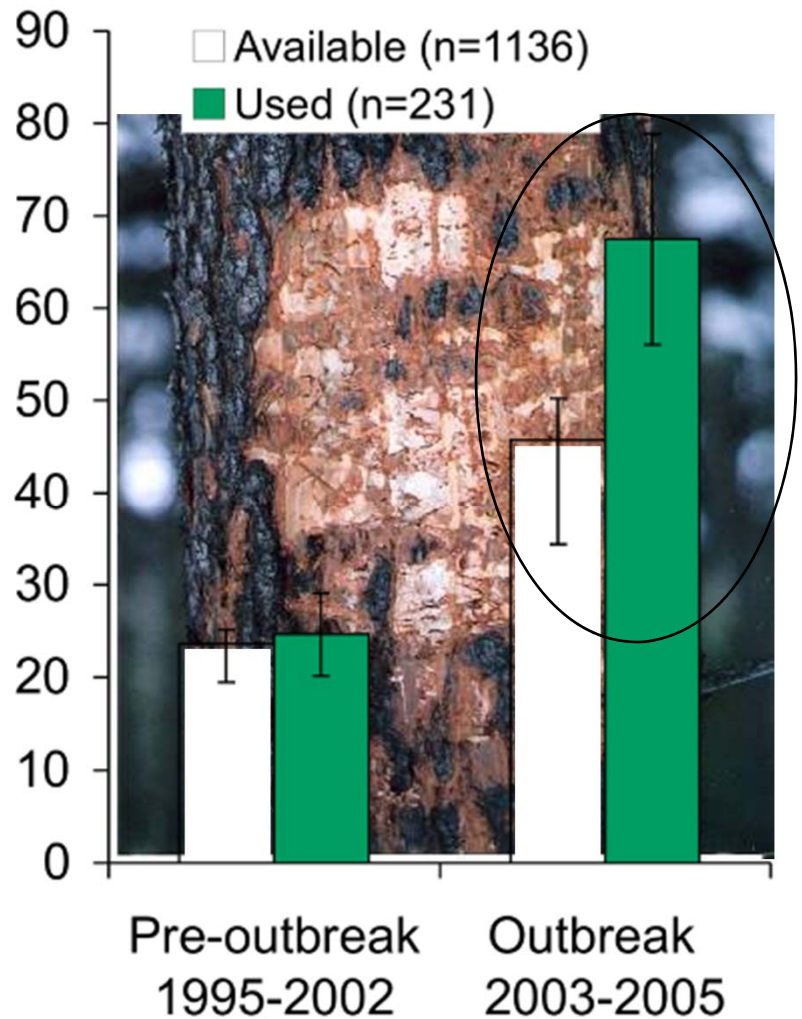
Norris & Martin Oikos 2010

Nuthatches followed the food

Decayed aspen trees



Beetle-infected pine



Norris & Martin. 2008 J. Wildl. Mgmt.

Questions

- Excavate more cavities?
- Fecundity increase?
- Nest survival decline due to inc comp & pred?

Methods

- 418 nuthatch nests
- 30 sites, 1995-2009
- fecundity (# eggs, hatched, fledged...)
- Population densities: point count surveys
- Veg surveys: cavity, tree & habitat characteristics

Mixed model approach:

1. Excavation?
2. Fecundity?
3. Nest survival?

$$y \sim \beta_o + \beta_a a + \beta_b b + \beta_c c + \beta_d d + (1 \mid Z)$$

Excavation

eggs laid
Julian hatch date
hatched
fledged

Nest survived

Beetle abundance
Cavity "freshness"
Clutch size
Julian hatch date
Nuthatch pop density
Squirrel pop density
No. visits
2° interactions

Tree ID
Site

(Poisson, Quasipoisson, Normal, Binomial distributions)

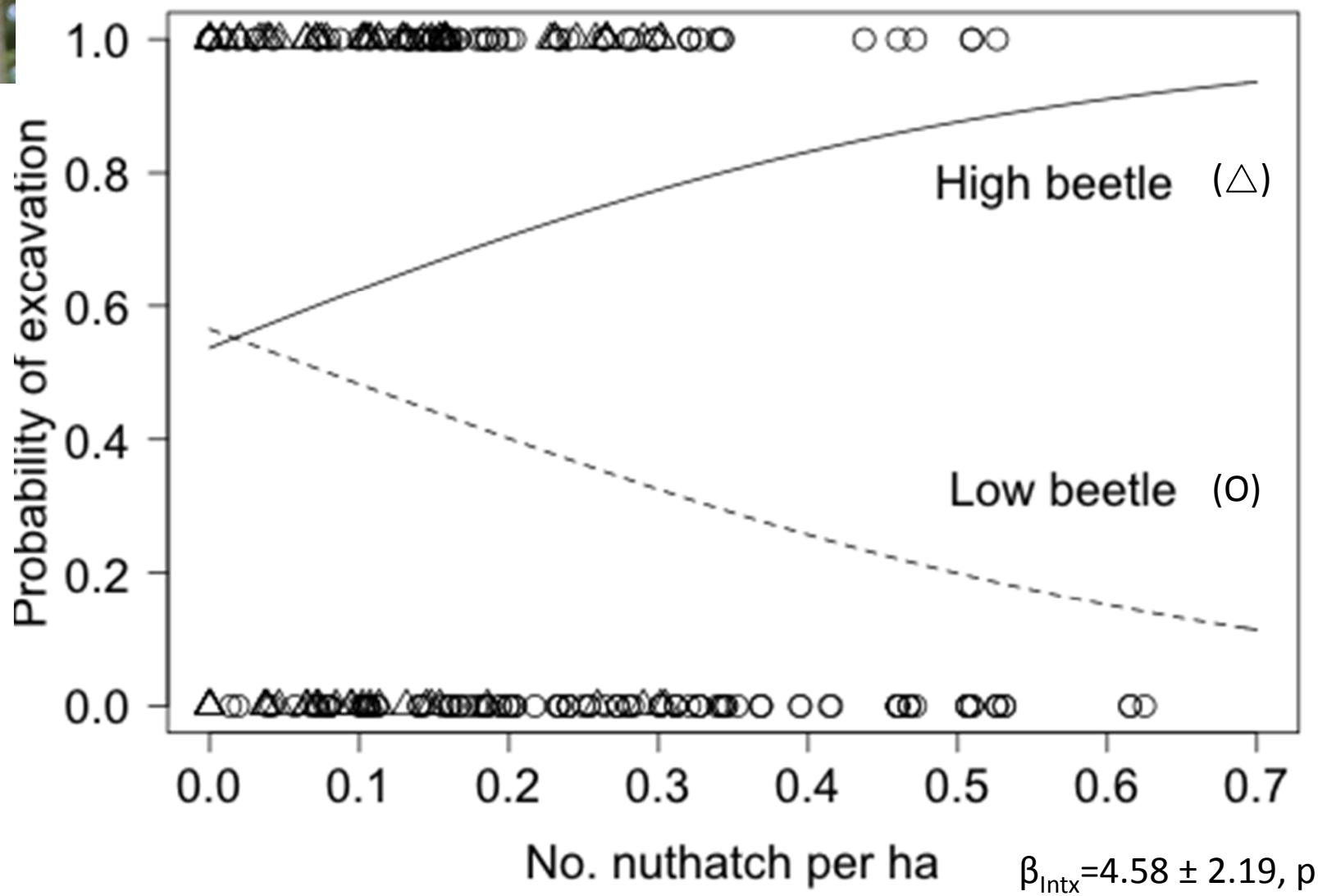
Six best fit models for each response variable

$$y \sim \beta_o + \beta_a a + \beta_b b + \beta_c c + \beta_d d + (1|Z)$$

E.g., No Fledged ~ Beetle + Nuthatch density + Squirrel density| Site/TreeID

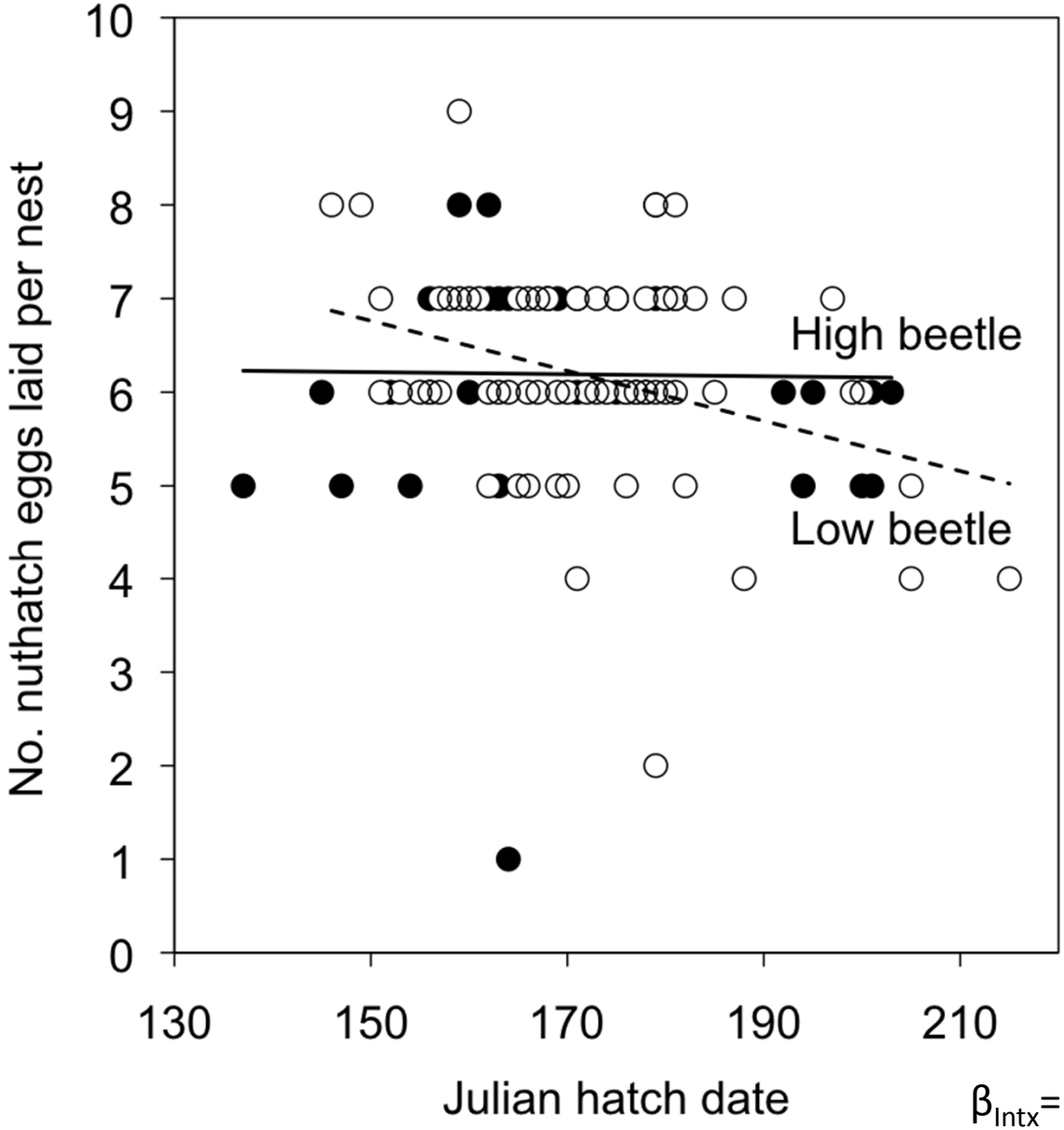
Fixed effect	Parameter estimate	Standard error	DF	t-value	p-value
(Intercept)	1.56	0.05	115	33.99	**0.000**
$Beetle_{t-1}$	0.05	0.02	29	2.45	**0.021**
Nuthatch density	0.36	0.17	29	2.11	**0.044**
Squirrel density	-0.26	0.14	29	-1.94	0.063

More new excavations at sites and in years with high beetle abundance



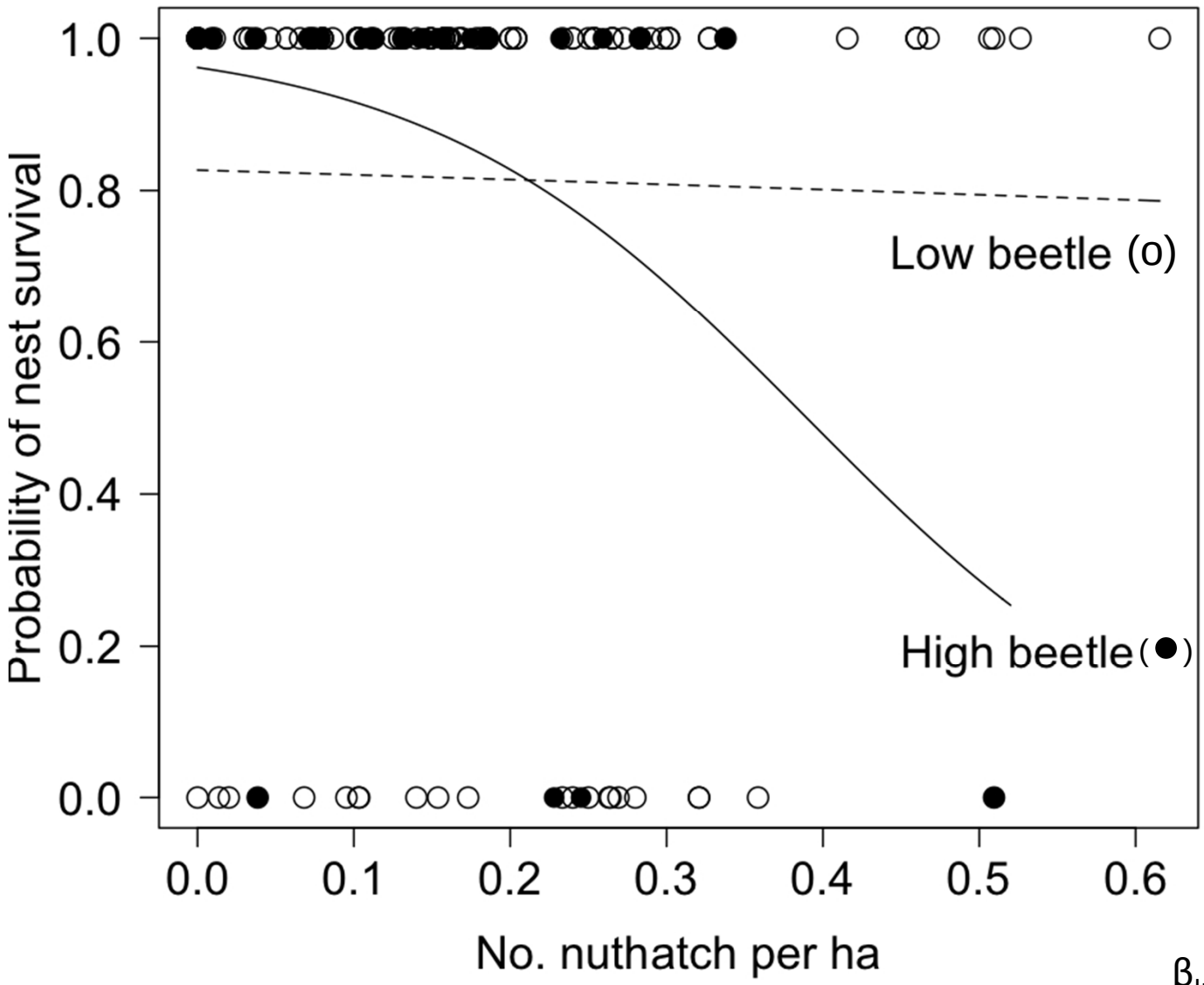
β_{Intx}=4.58 ± 2.19, p=0.04

Earlier nests & no *cost* of later nests



β_{Intx}=1.88 ± 0.78, p=0.02

Nest survival declined as pops & beetle inc.



β_{Intx}=-12.7 ± 4.7, p=0.009

Summary

- Beetle outbreak increased fecundity for nuthatches
- As pops inc., high comp for cavs & pred in beetle patches → excavation
- Smaller clutches associated w later breeding in new cavs ameliorated with beetle
- Higher pred where beetle high, as densities increased: density dependent nest predation
- Nuthatches traded off low nest predation risk & low cavity availability for food availability

Conservation Implications

- Insect outbreaks influence complex interactions between resource constraints & species interactions
- Other species, such as non-excavators may not be as resilient (e.g., Aitken & Martin 2008)
- Retention of current and future cavity-bearing trees may be essential for long-term maintenance of cavity-nesting communities

TAKE-HOME MESSAGE:

- ✓ More new excavations
- ✓ Higher reproductive output
- ✓ Increased predation

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NSERC CRSNG

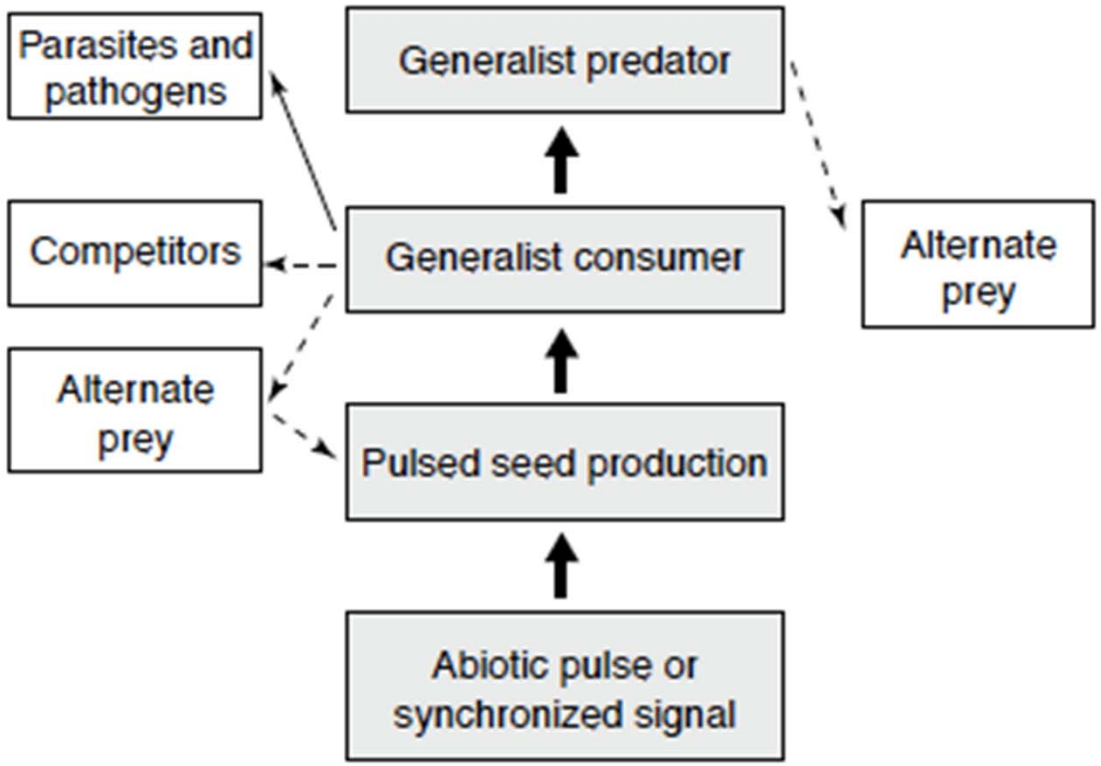
Environment Canada

FIA Forest Investment Account Forest Science Program

Future research

- Climate change may increase the intensity, frequency & synchrony of resource pulses → cascading effects on communities (Yang & Rudolf 2010 Ecol Lett)
- Irruptive populations resilient to change, but this is dependent on heterogeneous disturbance across landscapes
- What are the long-term, broad-scale implications of synchronous resource pulses on communities?

Resource pulses

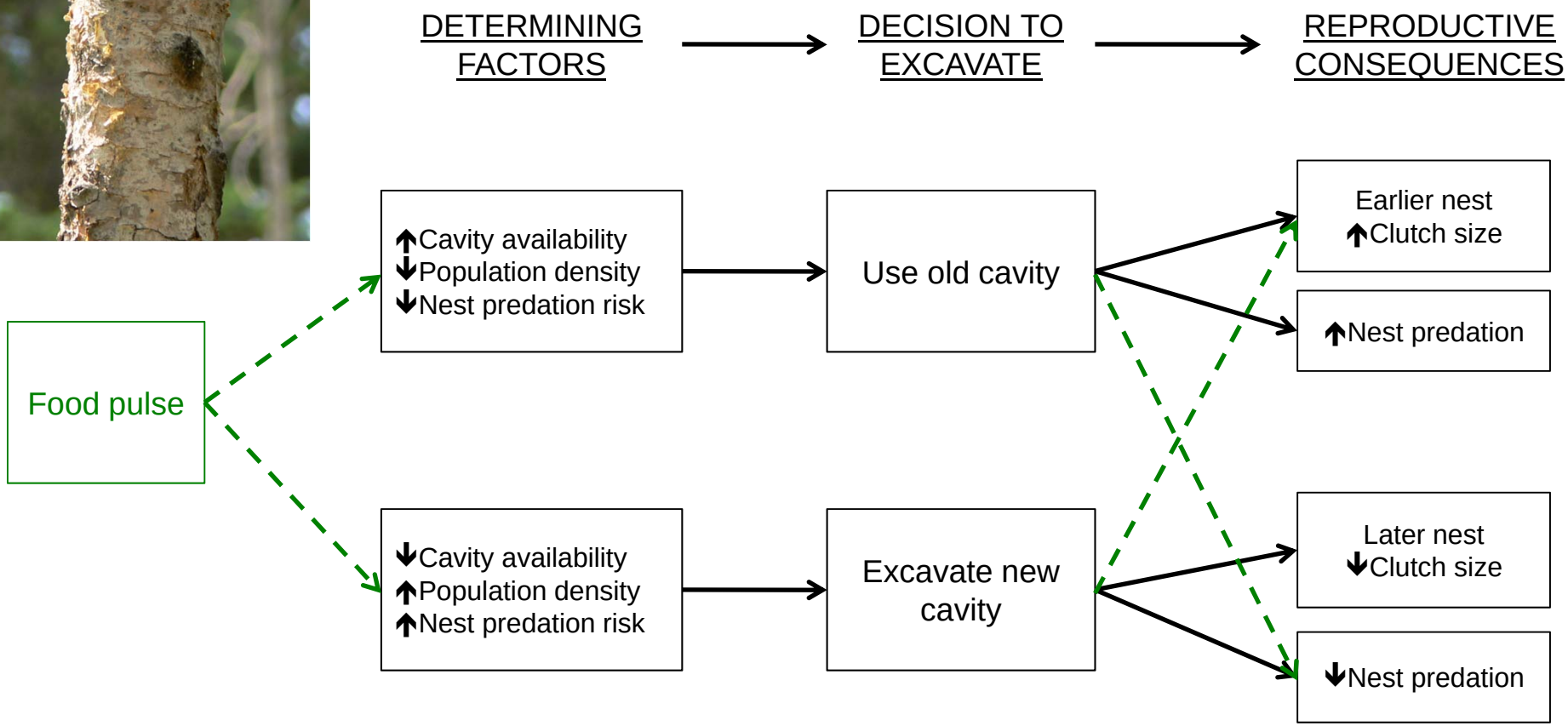


Trends in Ecology & Evolution

Fig. 1. Conceptual model of the effects of pulsed resources permeating through a food web. The direction of arrows represents the direction of causal change in abundance or biomass. Solid lines indicate a positive effect and broken lines indicate a negative effect of one trophic group on another.

Ostfeld & Keesing (2000)

- Direct, bottom-up effects
- Indirect, top-down effects


DETERMINING FACTORS
DECISION TO EXCAVATE
REPRODUCTIVE CONSEQUENCES
Food pulse
↑Cavity availability
↓Population density
↓Nest predation risk
↓Cavity availability
↑Population density
↑Nest predation risk
Use old cavity
Excavate new cavity
Earlier nest
↑Clutch size
↑Nest predation
Later nest
↓Clutch size
↓Nest predation

Nest survival low in forest interior