Emerald Ash Borers :Biological controls & Agent based model

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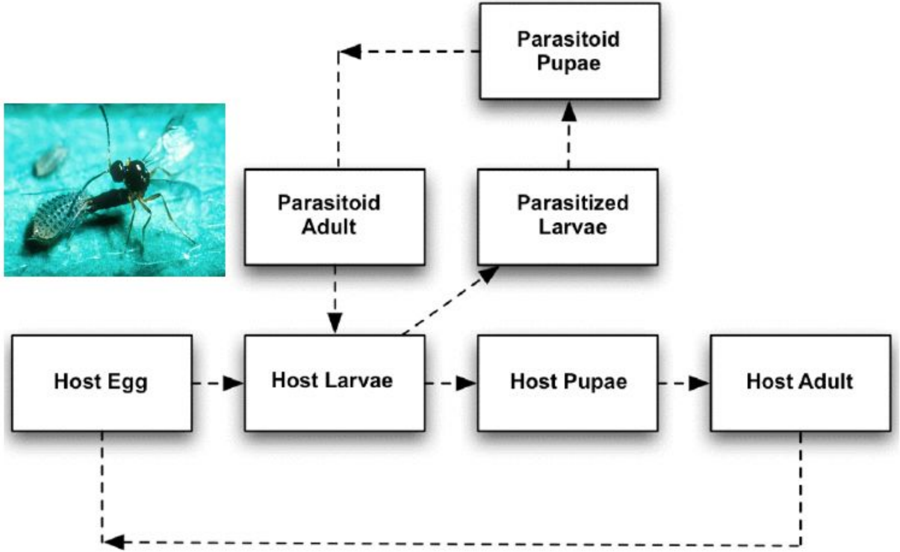
Contexts

- Biocontrols
- Agent Based Model for EAB Population
- What’s next

Parasitism as Biocontrol method

Parasitoid: T. planipennisi



Basic Nicholson & Bailey model

H_{t+1}=R H_t exp(-c P_t)

P_{t+1}=K R H_t [1-exp(-c P_t)]

H_t:Adult EAB density **P_t : Adult parasitoid density**

R: EAB growth rate in ash

K: Progeny of parasitoid per larval in ash

exp(-c P_t): "Escape probability" of EAB in ash

C: Attack rate of the wasps

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Stability

Model:

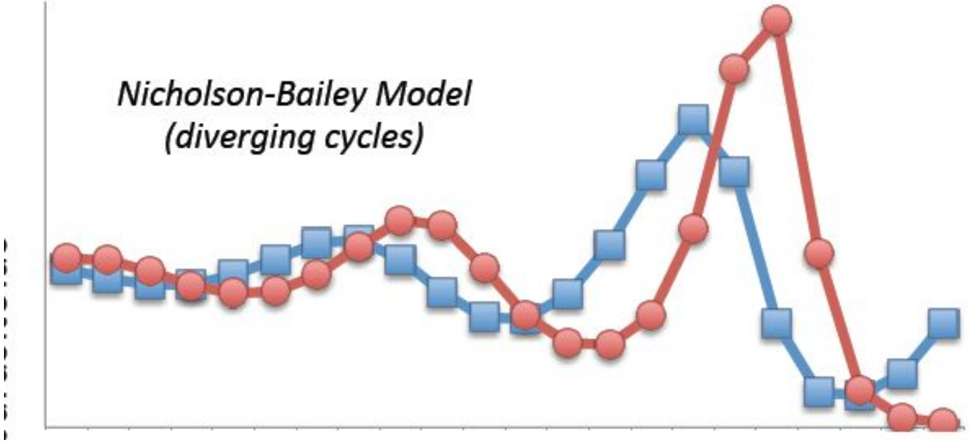
$$H_{t+1} = R\,H_t \exp(-c\,P_t)$$

$$P_{t+1} = K\,R\,H_t\,[1-\exp(-c\,P_t)]$$

Equilibrium:

Set $H_{t+1}=H_t=H^*$ $P_{t+1}=P_t=P^*$

$$H^* = \frac{\ln(R)}{(R-1)\,K\,c} \quad P^* = \frac{\ln(R)}{c}$$



Large and unstable oscillations lead to the extinction of parasitoid while EAB population is still active, dH^*/dR <0 when it's unstable.

Stability occurs if and only if $\boxed{\frac{dH^*}{dR} > 0.}$

Refuge Model

Model:

$$H_{t+1} = \mu \lambda R H_t + (1-\mu) R H_t \exp(-c P_t)$$

$$P_{t+1} = (1-\mu) (1-\exp(-c P_t)) * k R H_t$$

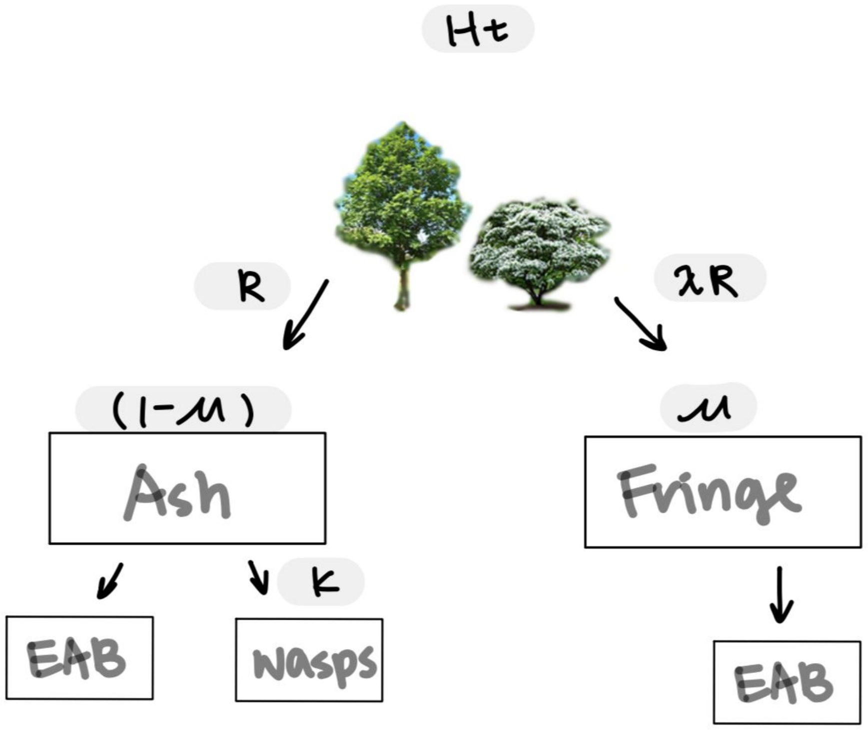
Equilibrium:

$$H^* = \frac{1}{k c} * \frac{\left(\log\left(\frac{(1-\mu) R}{1-\mu \lambda R}\right)\right)}{(R-1) - (1-\lambda) \mu R}$$

$$P^* = (1-\mu) k R H^* (1-\exp(-c P^*))$$

Stability condition: $\frac{d}{dR} H^* > 0$

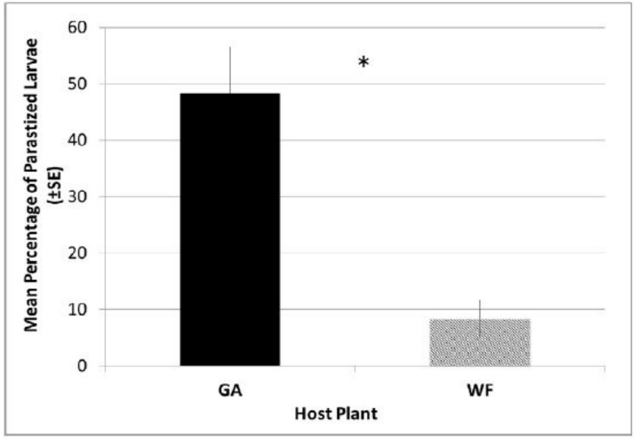
Implies stable positive equilibrium

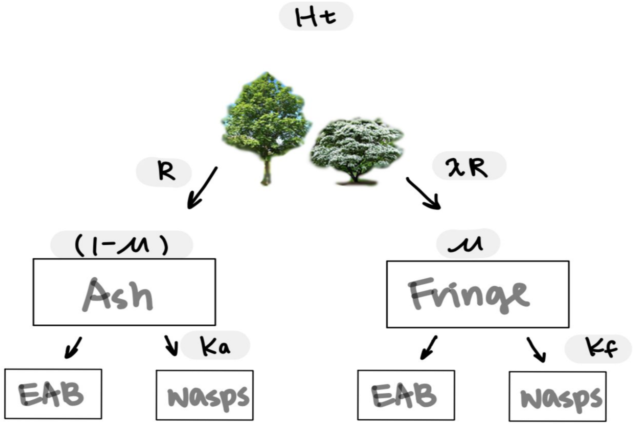


Partial Refuge model

$$H_{t+1} = \lambda \mu R H_t \exp(-c P_t \nu) + (1-\mu) R H_t \exp(-c P_t (1-\nu))$$

$$P_{t+1} = \lambda \mu (1 - \exp(-c P_t \nu)) \, kf \, R H_t + (1-\mu)(1 - \exp(-c T P_t (1-\nu))) \, ka \, R H_t$$

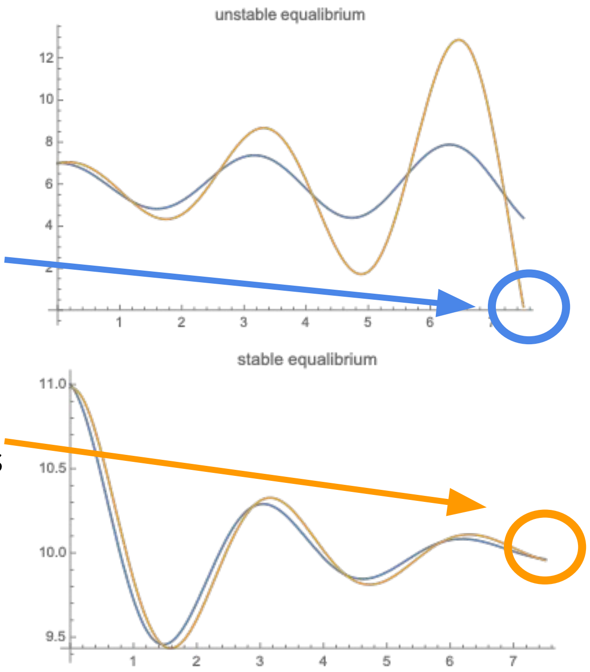


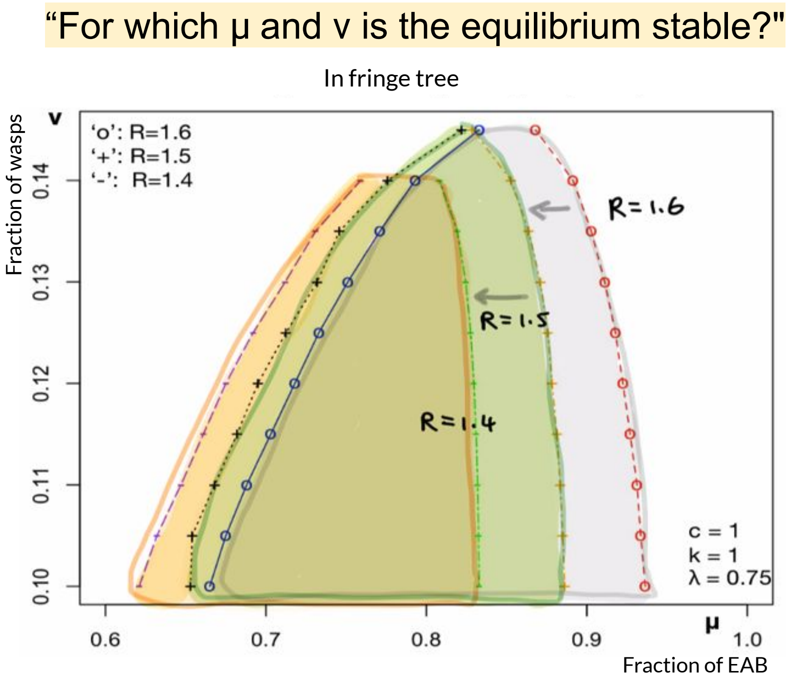


Parameter space for μ & ν

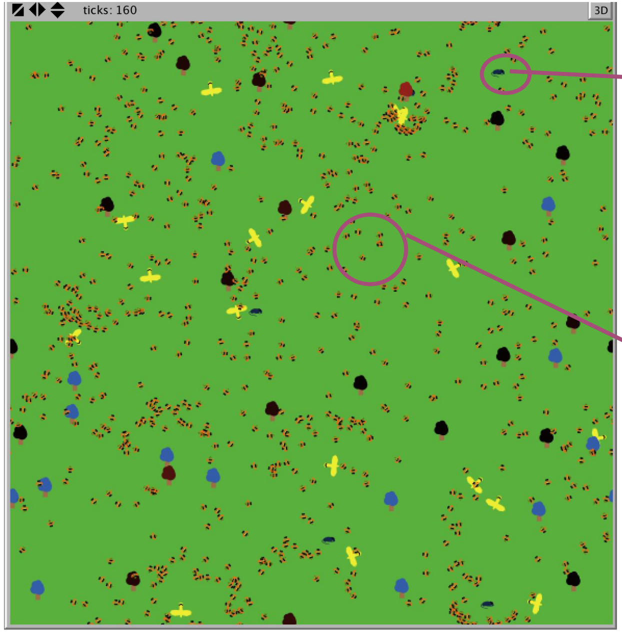
Extinction

Stable populations





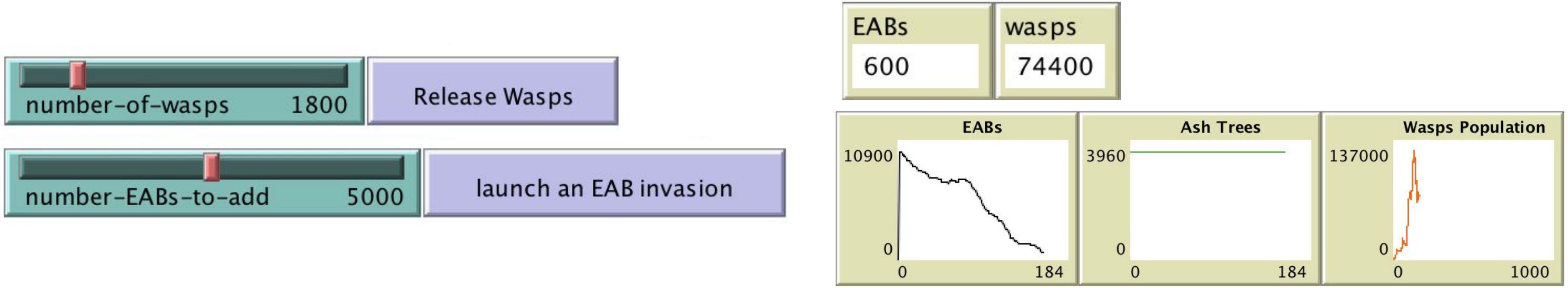
Agents



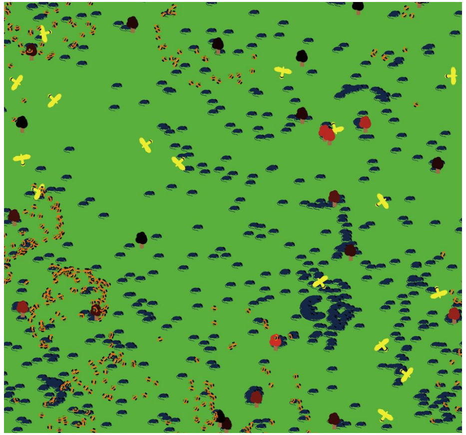
Emerald Ash Borers

Parasitic Wasps

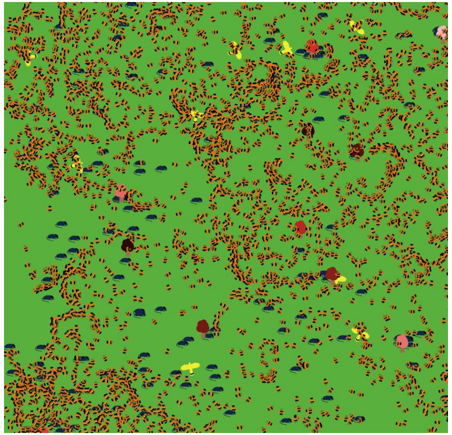
Basic Settings & Data Monitor



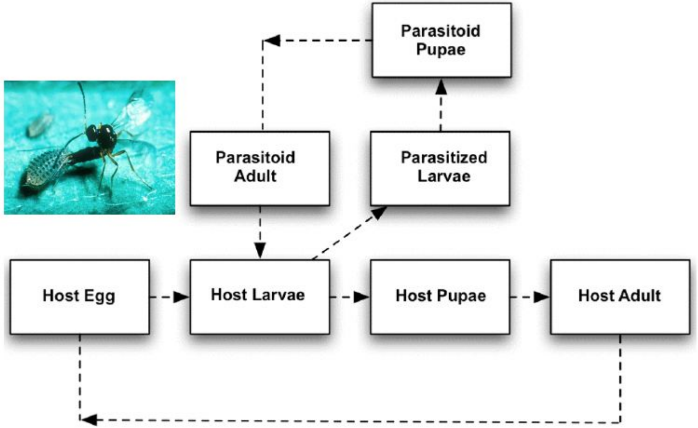
Life Cycles are not synchronized



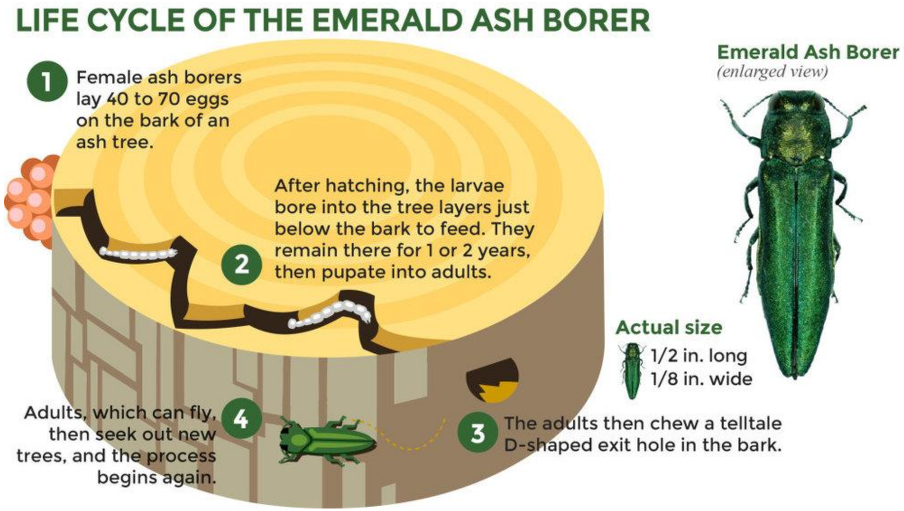
EAB



Wasps



Next step



- Break the model into a more detailed version based on the life stages of Emerald Ash Borer.
- Examine the effects of biological controls through agent.
- Merge published life-cycle data with the Nicholson-Bailey model

Thank You !