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Sex, death and silence in Hawaiian crickets

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Study Area

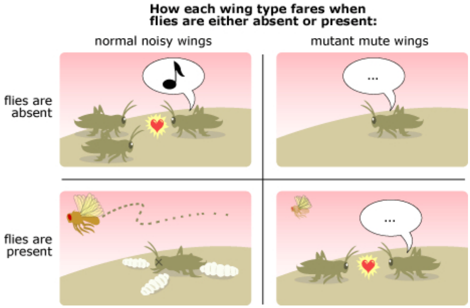
Figure: Kauai

Prey and Predator

Figure: *Teleogryllus oceanicus*

Figure: *Ormia ochracea*

Mating System



- A mutation in a sex-linked gene lead created a new silent morphotype.
- Sex determination system: XO(male), XX(female).

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- Under what conditions will the three populations coexist?
- What is the effect of the predator on the dynamics of the two morphotypes?

Model

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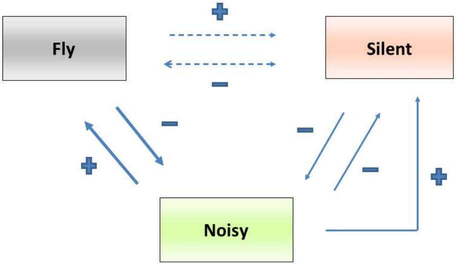

Figure: Ecological relationships of the system.

Assumptions of our Model

- The flies don't infect the silent crickets.
- The flies are specialists.
- The flies are superpredators.
- No limitation by the number of females.

Model

$$\frac{dN_f}{dt} = \alpha N_f N_n - \beta N_f$$

Model

$$\frac{dN_f}{dt} = \alpha N_f N_n - \beta N_f$$

$$\frac{dN_n}{dt} = \gamma N_n \Pi + \gamma N_s \Pi \rho - \delta N_f N_n - \mu N_n \left(1 + \frac{N_n + N_s}{K}\right)$$

Model

$$\frac{dN_f}{dt} = \alpha N_f N_n - \beta N_f$$

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$$\frac{dN_s}{dt} = \gamma N_n (1 - \Pi) + \gamma N_s (1 - \Pi) \rho - \mu N_s \left(1 + \frac{N_n + N_s}{K}\right)$$

Model

$$\frac{dN_f}{dt} = \alpha N_f N_n - \beta N_f$$

$$\frac{dN_n}{dt} = \gamma N_n \Pi + \gamma N_s \Pi \rho - \delta N_f N_n - \mu N_n \left(1 + \frac{N_n + N_s}{K}\right)$$

$$\frac{dN_s}{dt} = \gamma N_n (1 - \Pi) + \gamma N_s (1 - \Pi) \rho - \mu N_s \left(1 + \frac{N_n + N_s}{K}\right)$$

$$\Pi = \frac{N_n}{N_n + \rho N_s} \qquad \rho = \frac{N_n}{N_n + Q}$$

Rescaling

$$\tau = \mu t \quad f = N_f \delta/\mu \quad n = N_n \alpha/\beta \quad s = N_s \alpha/\beta$$
$$a = \beta/\mu \quad b = \gamma/\mu \quad h = Q/c \quad g = K/c$$

Rescaling

$$\tau = \mu t \quad f = N_f \delta / \mu \quad n = N_n \alpha / \beta \quad s = N_s \alpha / \beta$$

$$a = \beta / \mu \quad b = \gamma / \mu \quad h = Q / c \quad g = K / c$$

$$\frac{df}{d\tau} = af(n-1)$$

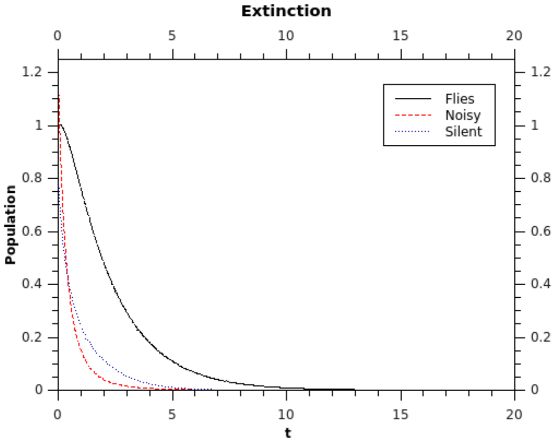
$$\frac{dn}{d\tau} = n\left(b - \frac{n+s}{g} - f - 1\right)$$

$$\frac{ds}{d\tau} = s\left(b\frac{n}{n+h} - \frac{n+s}{g} - 1\right)$$

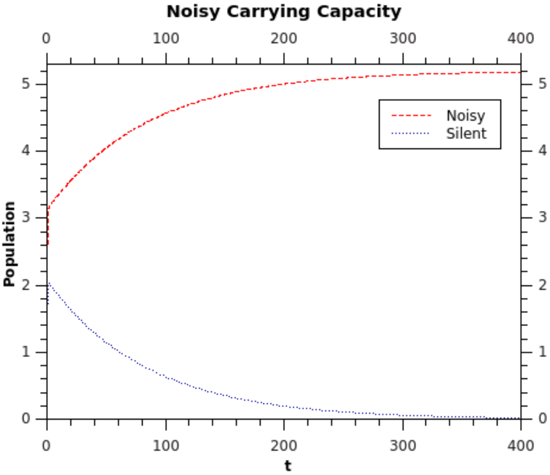
Fixed Point Analysis

f^*	n^*	s^*	
0	0	0	Extinction
0	$g(b-1)$	0	Noisy Logistic Growth
$b-1-1/g$	1	0	Predator Prey
$b\frac{h}{1+h}$	1	$g\left(\frac{b}{1+h}-1\right)-1$	Coexistence

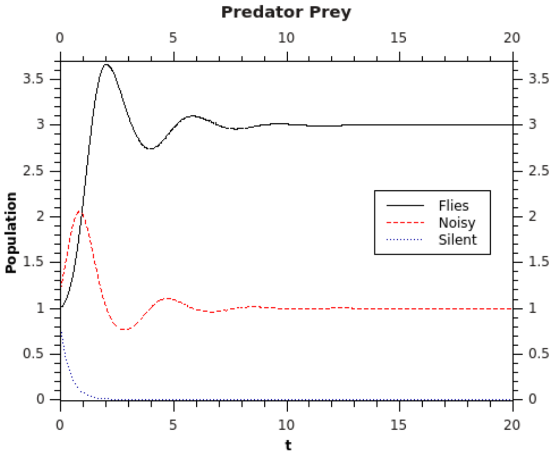
Extinction


Extinction
0
5
10
15
20
1.2
1
0.8
0.6
0.4
0.2
0
Population
t
Flies
Noisy
Silent

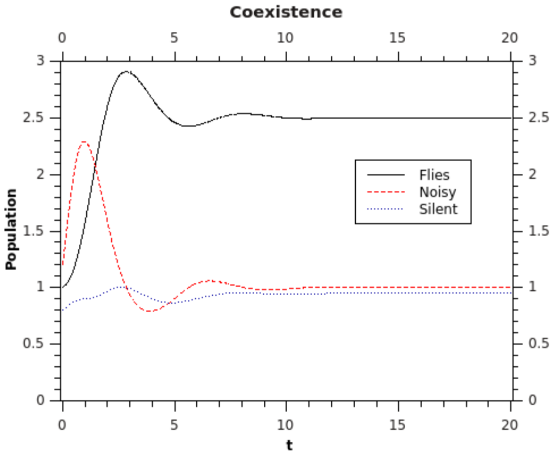
Noisy Logistic Growth



Predator Prey



Coexistence



Estimation of Parameters

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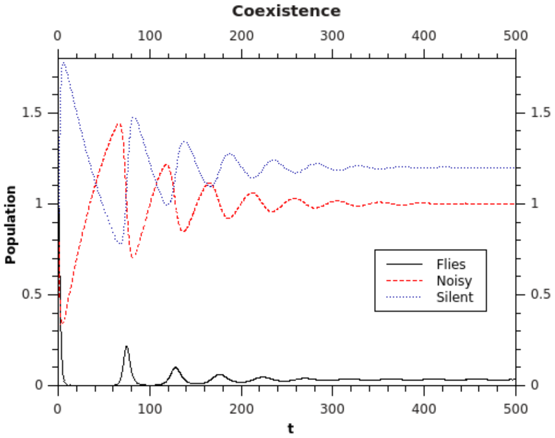
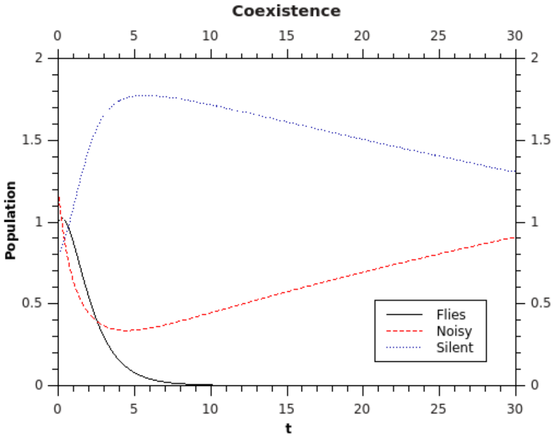
- $\alpha \approx 1 \times 10^{-5}$ *cricket*$^{-1}$ *day*$^{-1}$
- $\beta \approx 0.03$ *day*$^{-1}$
- $\gamma \approx 0.09$ *day*$^{-1}$
- $\delta \approx 1.5 \times 10^{-5}$ *fly*$^{-1}$ *day*$^{-1}$
- $\mu \approx 0.03$ *day*$^{-1}$
- $Q \approx 32$ *cricket*
- $K \approx 5000$ *cricket*

Coexistence



Coexistence



Conclusions

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Conclusions

- The coexistence is possible only when the noisy crickets are under pressure from the flies.
- Without flies the maladaptive trait goes extinct.

References

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Thank you all for listening.