Lecture 12

Reproductive value, sensitivity, and elasticity

WILD3810 (Spring 2020)

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Readings

> Mills 103-109

Management questions

What is the short-term growth of this population given the current age/stage structure?

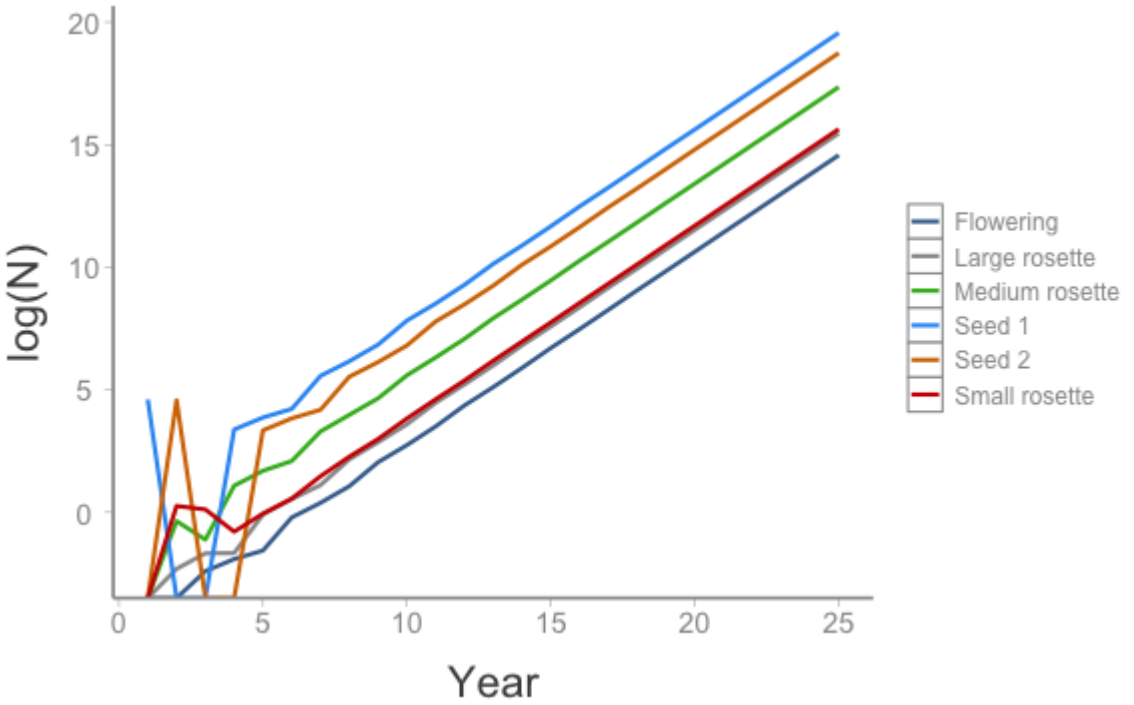
What is the long-term growth of this population given the current vital rates?

Which age/stage contributes most to future population growth?

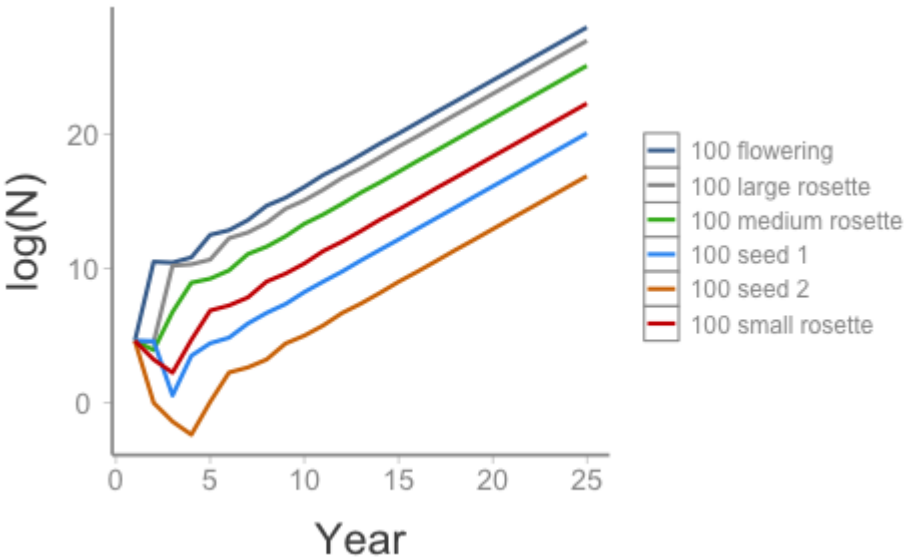
Which vital rates have the biggest effect on future growth?

How would future population dynamics change if different vital rates were changed?

Common teasel example



How does initial stage-distribution effect growth?



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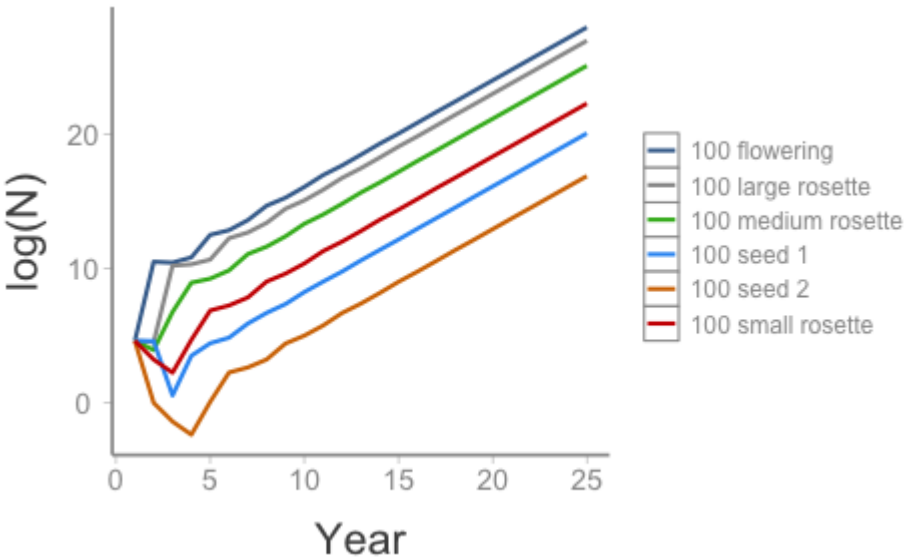

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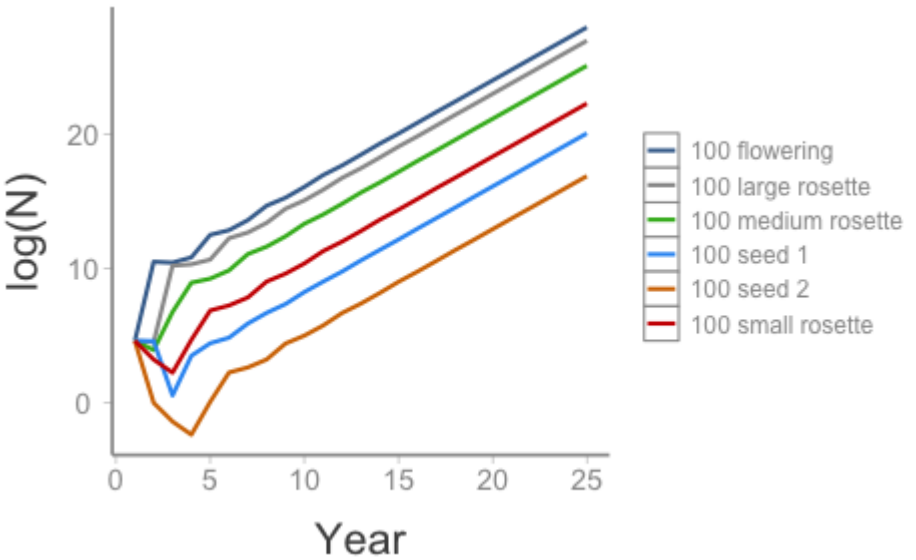

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- Expected future reproductive output

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Factors that influence reproductive value:

- Expected future reproductive output
- Survival probability

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Factors that influence reproductive value:

- Expected future reproductive output
- Survival probability
- Age at maturity

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Intuitive, but complex to compute

Factors that influence reproductive value:

- Expected future reproductive output
- Survival probability
- Age at maturity

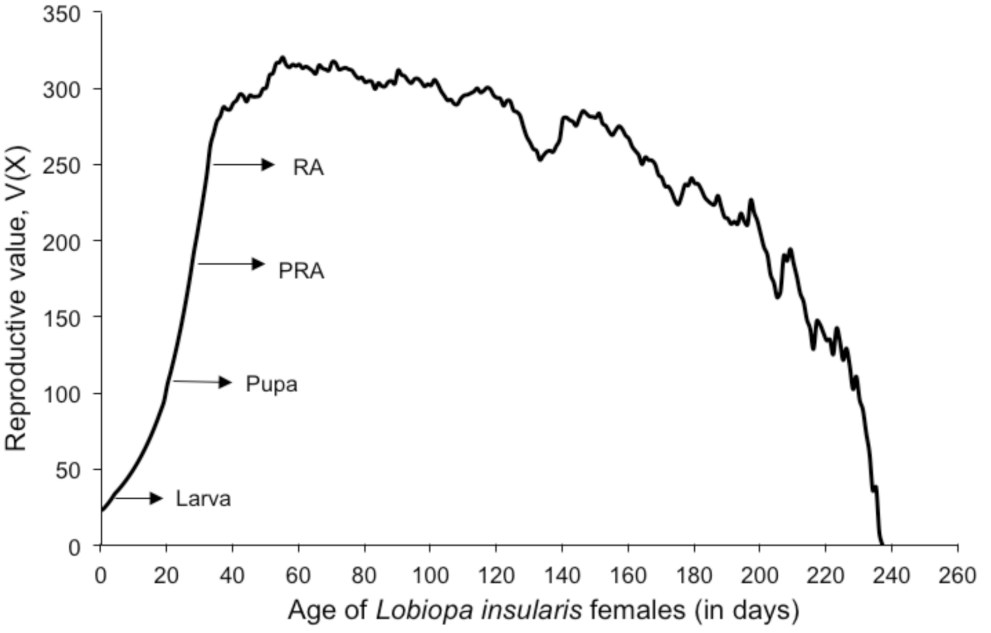
- Population growth rate
    - if a population is growing, future offspring will be smaller contribution to

Reproductive value

Teasel example

- Dormant seeds, year 1:
- Dormant seeds, year 2:
- Small rosette:
- Medium rosette:
- Large rosette:
- Flowering plant:

Reproductive value



Reproductive value

Population inertia

Population inertia

> difference between the long-term population size of a population that experiences transient dynamics and the long-term population size of a population that grows at the SSD

Population inertia

Grey wolf population matrix

Population inertia

Grey wolf population matrix

Population inertia

Grey wolf population matrix

Reproductive values:

Population inertia

What is the projected growth if reintroduced population starts at SAD?

SAD:

Population inertia

What is the projected growth if reintroduced population starts with all 9 year olds?

Population inertia

What is the projected growth if reintroduced population starts with all 3 year olds?

Population inertia and reproductive value in practice

What age/stage distribution will lead to largest for introduced population?

What age/stage should be the target for reducing invasive species?

What age/stage distribution can be harvested to maintain stable population of game species?

Sensitivity and elasticity

Sensitivity

Remember that is determined by the birth and death rates of a population

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As managers, we might want to increase or decrease of certain species by manipulating age-specific and rates

But does not respond equally to all vital rates

- in some cases, a small change in adult survival may result in a large change in
- in other cases, a small change in fecundity or juvenile survival may result in a large change in

Sensitivity

Sensitivity

> the change in caused by a small change in a vital rate

$$\frac{\quad}{\quad}$$

where and are the reproductive value and stable stage distribution of stage

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where and are the reproductive value and stable stage distribution of stage

- large reproductive values or large stable stable distribution lead to large sensitivity

Sensitivity

Common frog (*Rana temporaria*)

3 stages:

- pre-juvenile (egg - tadpole)
- juvenile (tadpole - 2 years)
- adult (> 2 years)

Estimating sensitivity

By hand

Estimating sensitivity

By hand

Estimating sensitivity

By hand

Analytically

```
popbio::sensitivity(A)[2,1] = 26.05
```

Estimating sensitivity

By hand

Estimating sensitivity

By hand

Estimating sensitivity

By hand

Analytically

```
popbio::sensitivity(A)[1,2] = 0.006
```

Elasticity

Does it make sense to compare a change of 0.01 in a survival value to a change of 0.01 in fecundity?

- 0.01 is about 52% of 0.019
- 0.01 is about 0.02% of 52

Elasticity

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- 0.01 is about 0.02% of 52

Elasticity

> the change in caused by a small *proportional* change in a vital rate

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Elasticity

Common frog example

By hand

Elasticity

Common frog example

By hand

Analytically

```
popbio::elasticity(A)[2,1] = 0.3699
```

```
popbio::elasticity(A)[1,2] = 0.251
```

Life history variation

Organisms have limited resources to investment between growth, reproduction, and survivorship

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Evolution selects for different combinations of *life history traits*

> Demographic traits that influence fitness (i.e.,)

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- growth pattern
- age at maturity
- fecundity schedule
- mortality schedule
- length of life

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