Demographic consequences of management options for wild ginseng in central Appalachia: What we know and what we need to know

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What is demography?

- The study of controls over population growth rate

How is it done?

- Locate a population
- Mark and map every individual
- Measure each individual's size - May, yr 1
- Measure each individual's seed # - Aug, yr 1
- Return to the population - May, yr 2
  - Re-measure size
  - Add new seedlings to database
  - Note deaths and perform autopsy

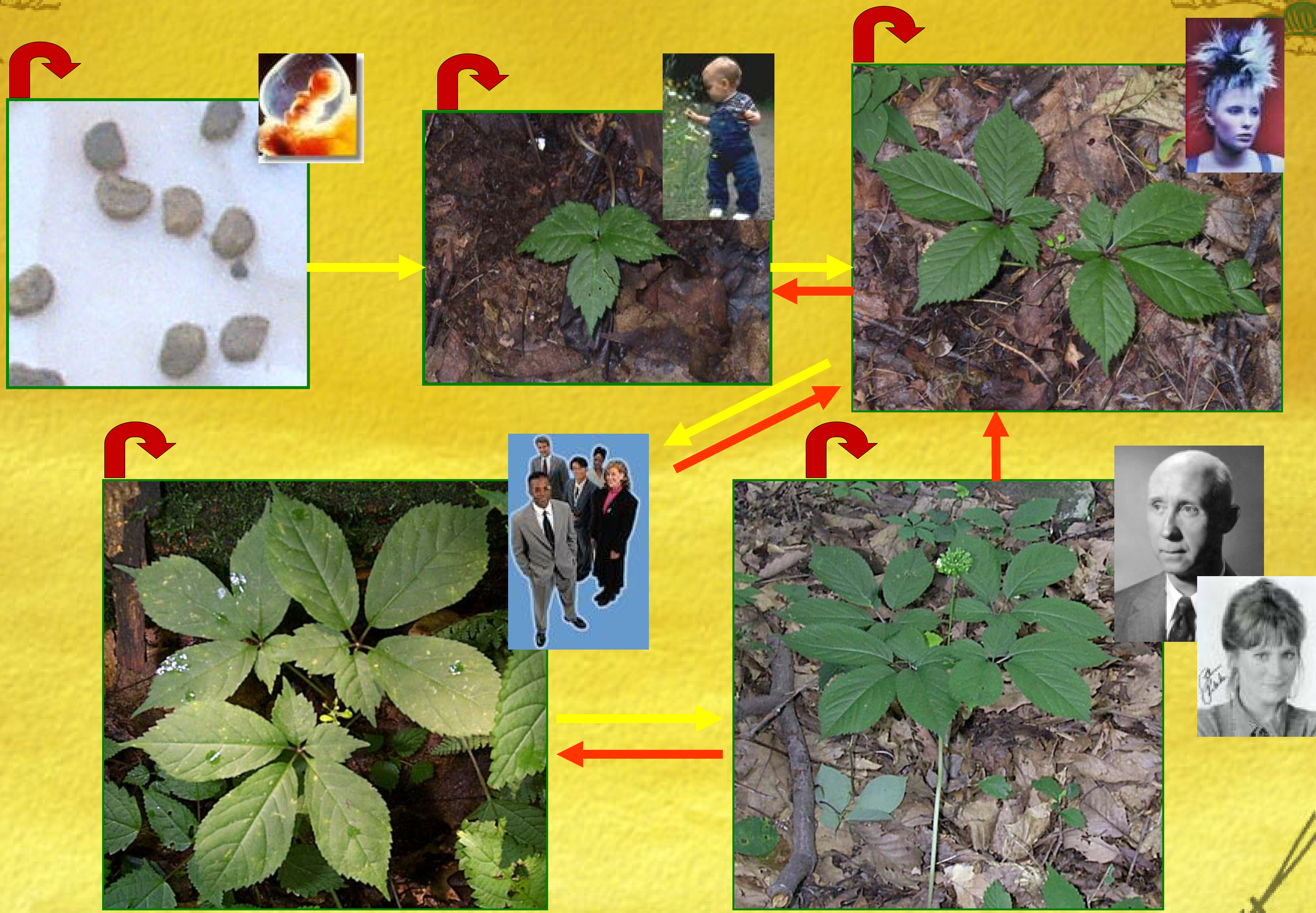
What can you learn?

- Immediate changes in numbers
- Projected population growth rate (λ)
- What individuals and parameters are controlling λ
- Why two or more populations differ in λ
- Test ‘what if’ scenarios with demographic models

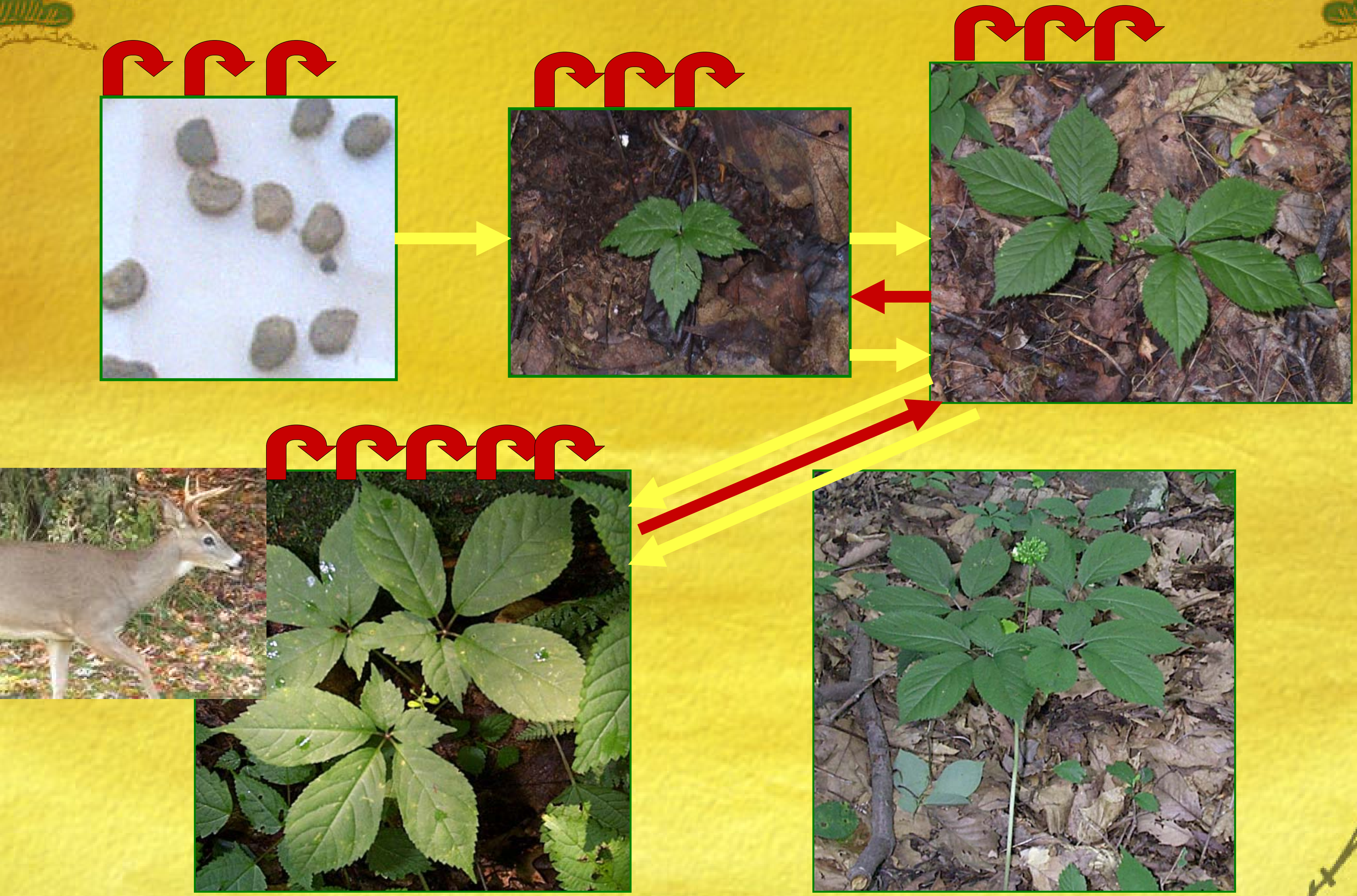
What else?

- With many years of data, you can project population viability
- Given that the years you measured are ‘representative’, population viability is <u>the chance that a population will still be around in 100 years</u>

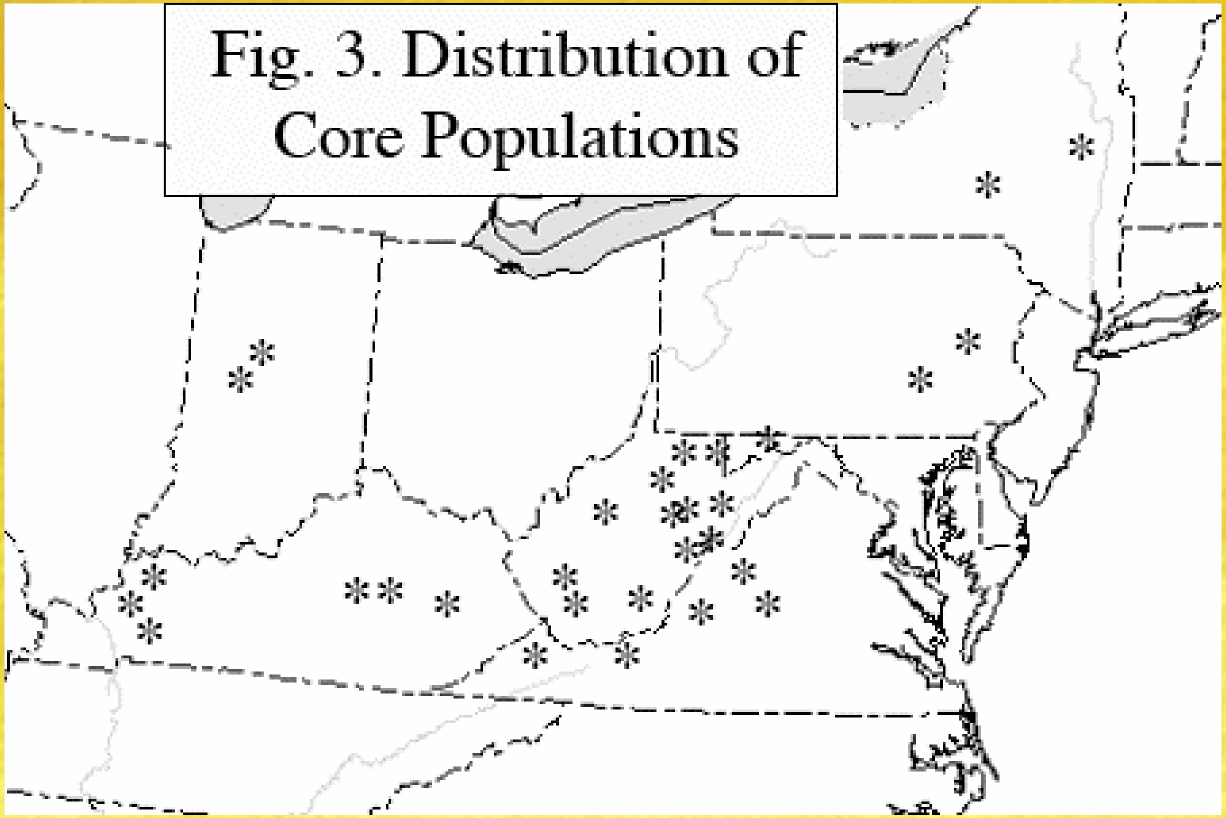
Ginseng Life Cycle



Ginseng Life Cycle



Our work



30+ populations

7 states

>4000 plants

3 - 9 years

10,000 miles

Several weeks for data collection alone!

What have we learned?

- 1. Which individuals contribute most to population growth? Yellow Taxi Analysis
  - A. Two-leaved plants that grow to small adult size have a large positive effect

What have we learned?

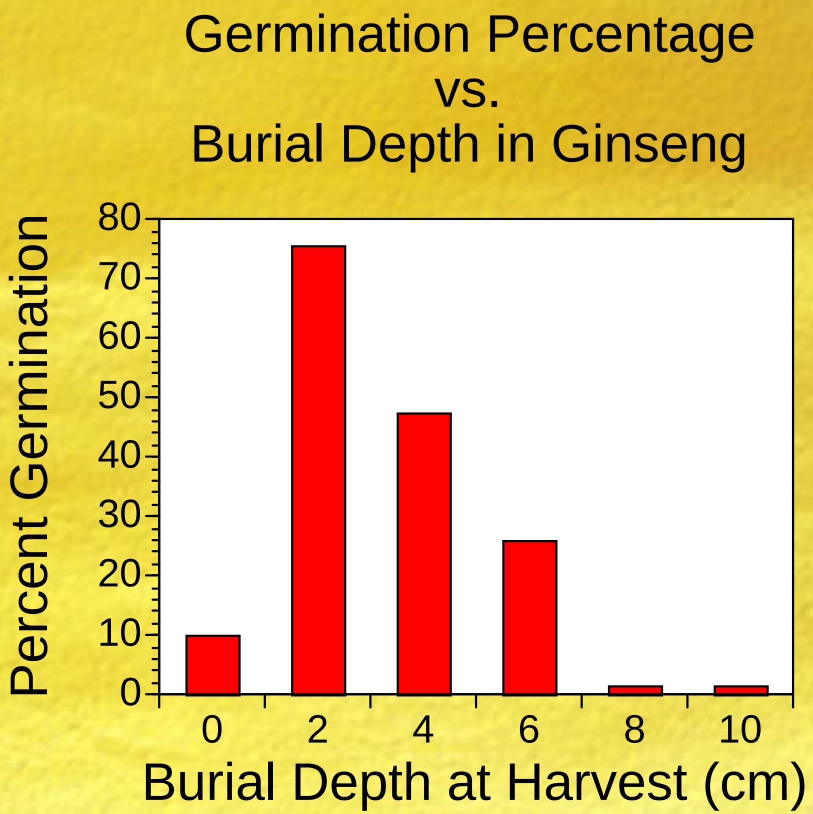
- B. Large nonreproductive adults that die have a strong negative effect.

What have we learned?

- C. Large adults that survive and produce 20 or more seeds have large positive effects.

Harvesting huge reproductive plants is not <u>necessarily</u> bad for the population

- Why?
- Harvesters can plant the seeds!
- Caveat: Is this planting effect observed everywhere?



(Note: 2 1/2 cm = 1 inch)

What have we learned?

- Which demographic parameters contribute the most?
  - Sensitivity analysis pinpoints <u>the rate at which 2-leaved plants grow to small adults</u>

$$s_{ij} = \begin{pmatrix} - & - & .088 & .019 & .017 \\ .052 & .193 & .086 & .018 & - \\ - & .570 & .255 & .054 & .050 \\ - & - & .903 & .191 & .177 \\ - & - & - & .332 & .308 \end{pmatrix}$$

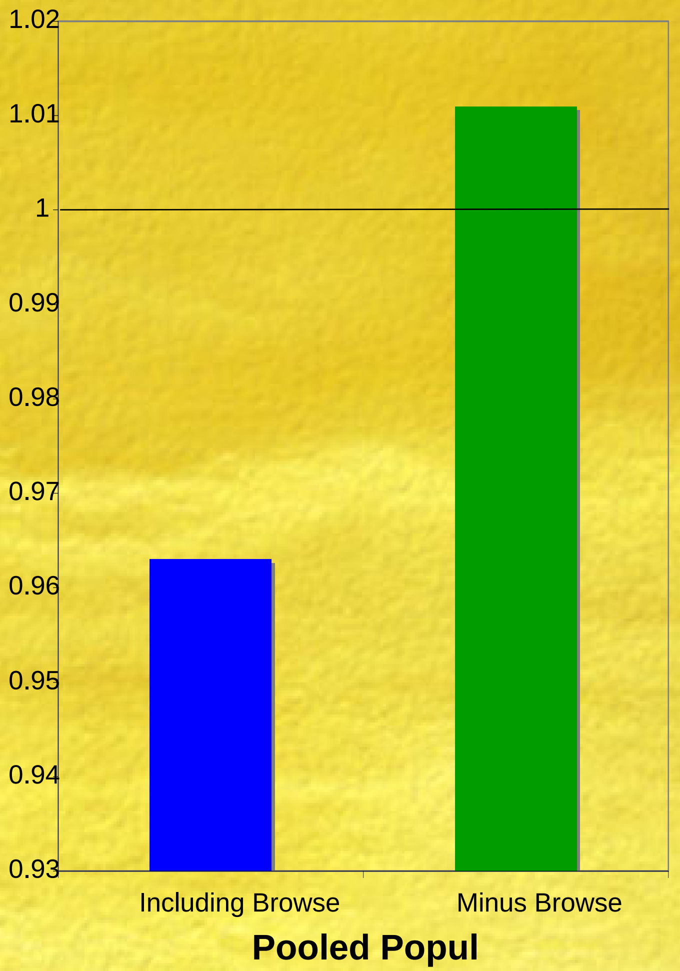
What have we learned?

- Which demographic parameters contribute the most?
  - Elasticity analysis pinpoints <u>the rate at which large adults stay large adults</u>

$$e_{ij} = \begin{pmatrix} - & - & .001 & .007 & .045 \\ .053 & .126 & .014 & .0005 & - \\ - & .068 & .169 & .017 & .002 \\ - & - & .071 & .077 & .044 \\ - & - & - & .090 & .218 \end{pmatrix}$$

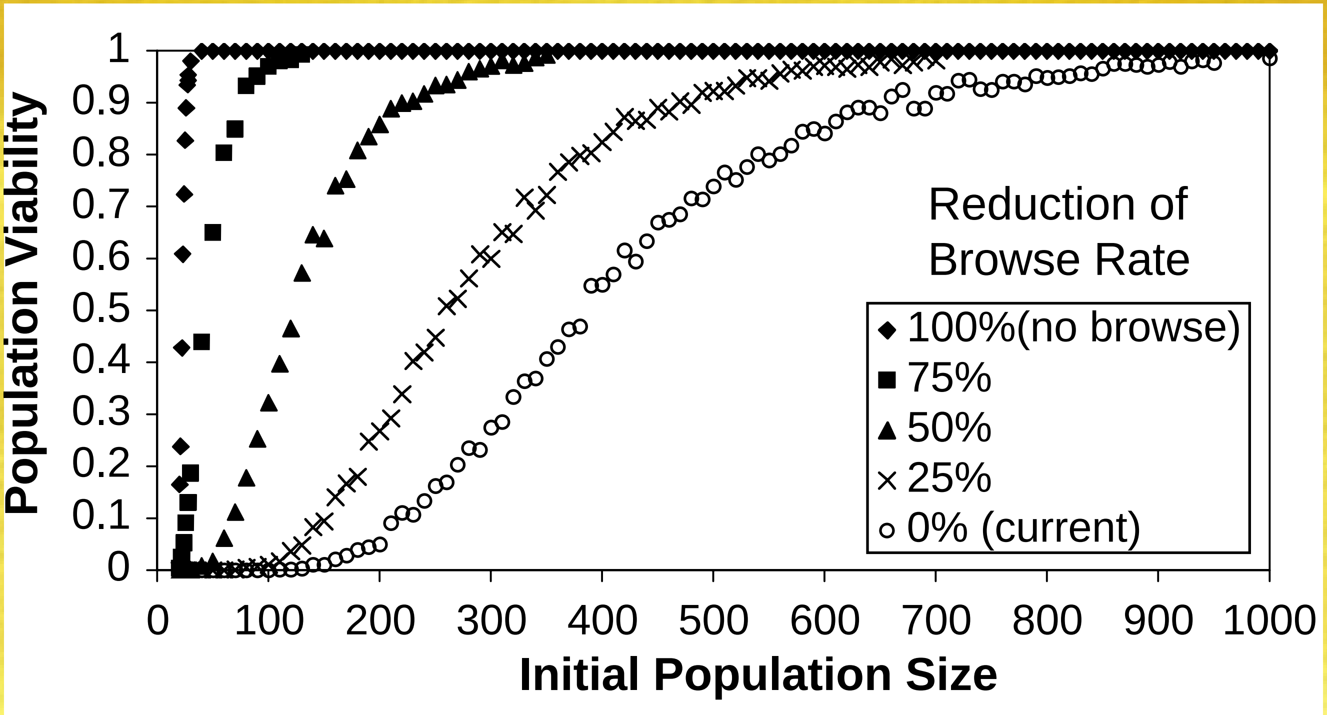
What have we learned?

- Furedi's deer-ginseng studies



What have we learned?

- Population viability analysis (PVA): 7 WV populations



What have we learned?

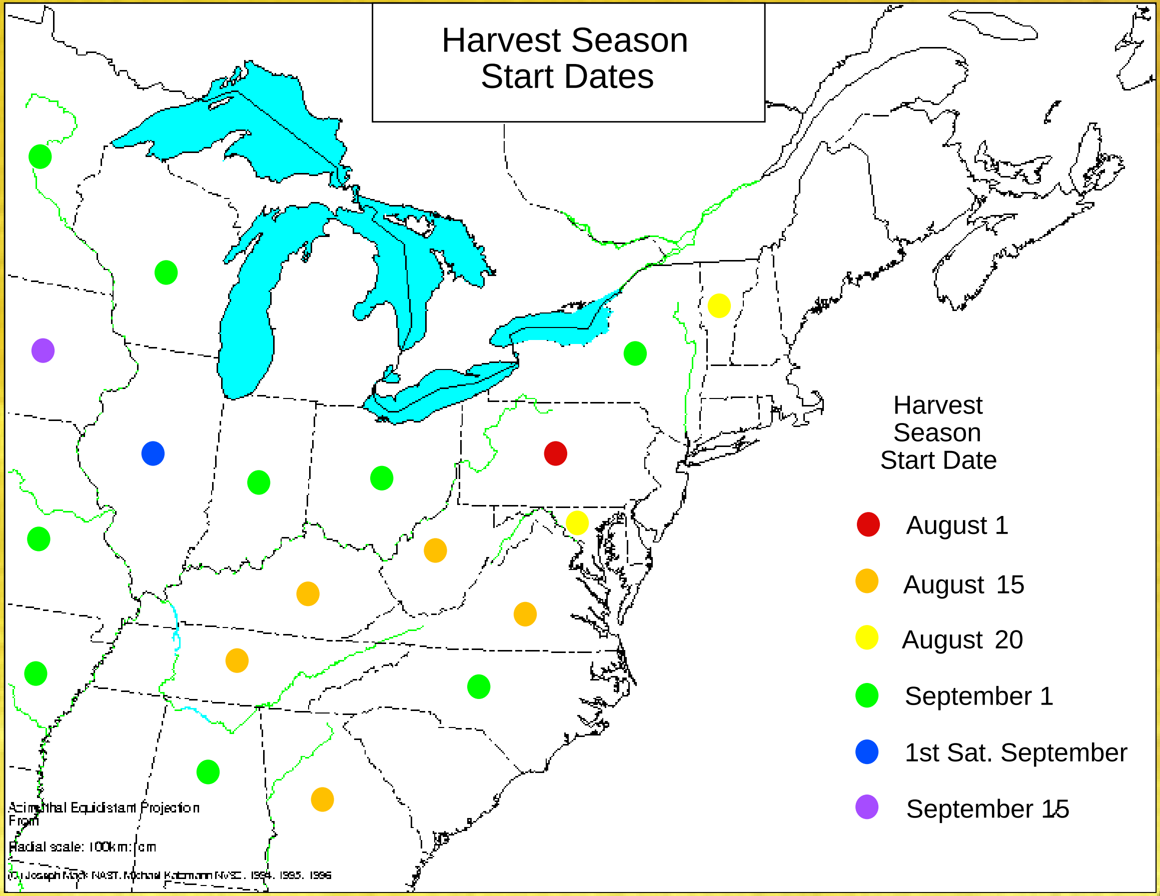
- PVA shows:
  - Many, if not most, populations may go extinct due to overbrowsing <u>if deer populations remain high</u> (note: this is not saying the <u>species</u> will go extinct)
  - In the absence of hard data, <u>we cannot assume harvesters are the cause of population decline</u>

What have we learned?

- Opportunities for management
  - Seasons
  - Age limits
  - Size limits
  - Licensing
  - Enforcement tactics
  - Harvester/dealer training/education
  - Leasing harvest rights

What have we learned?

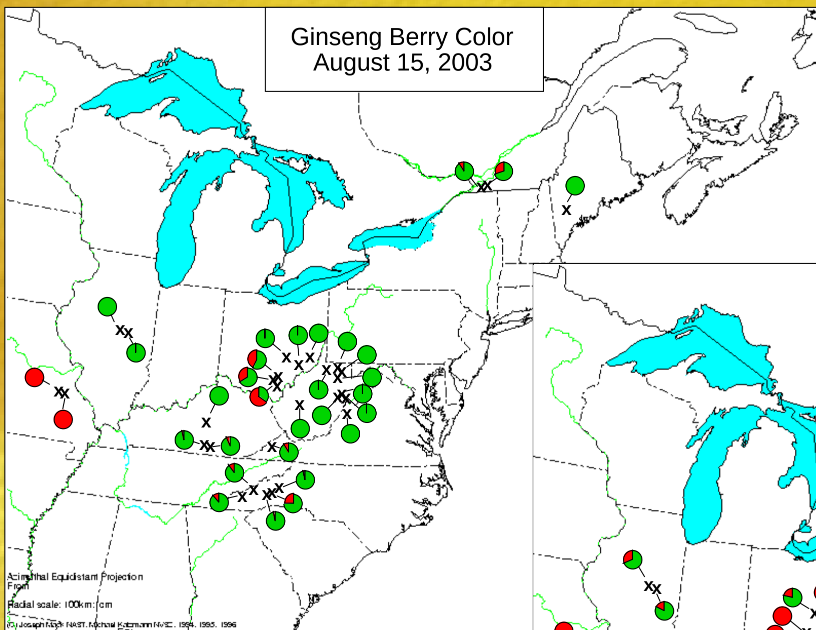
- Premise: Harvest seasons should be related to the plant's reproductive cycle



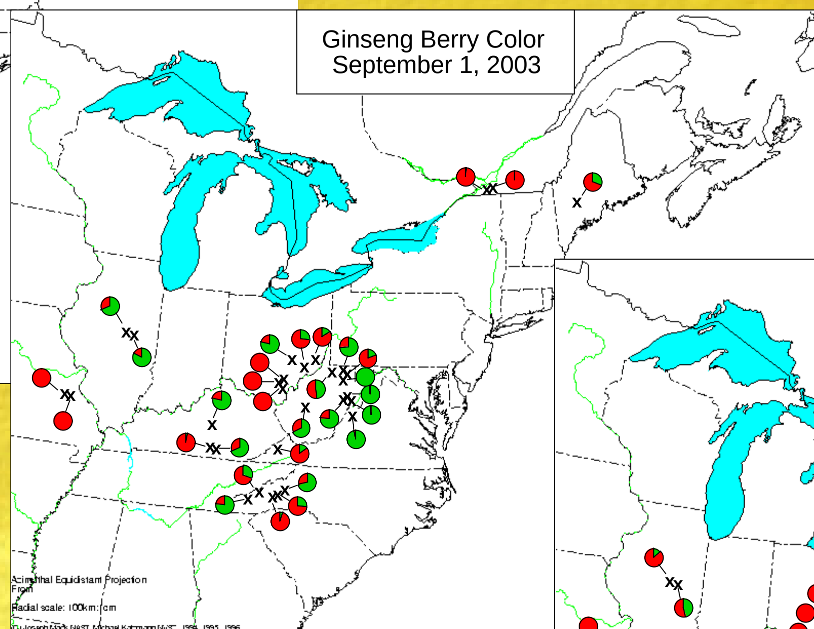
What have we learned?

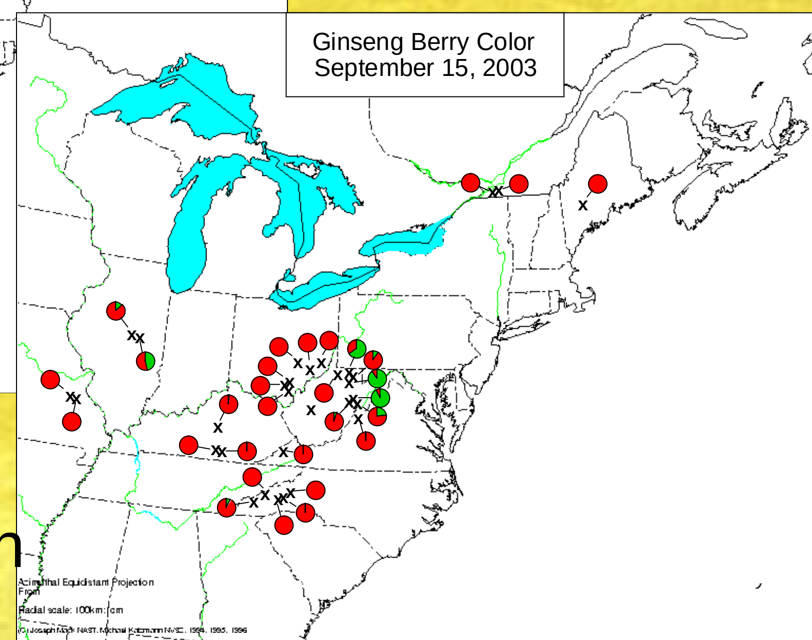
- Network of 16 ginseng aficionados; Aug.,Sept. 2003
- Monitored >5 reproductive individuals per population
- 9 states/provinces
- 31 populations
- 402 plants
- 2035 berries

What have we learned?



August 15: 80% unripe seeds
Sept. 1: 44% unripe seeds
Sept. 15: 13% unripe seeds





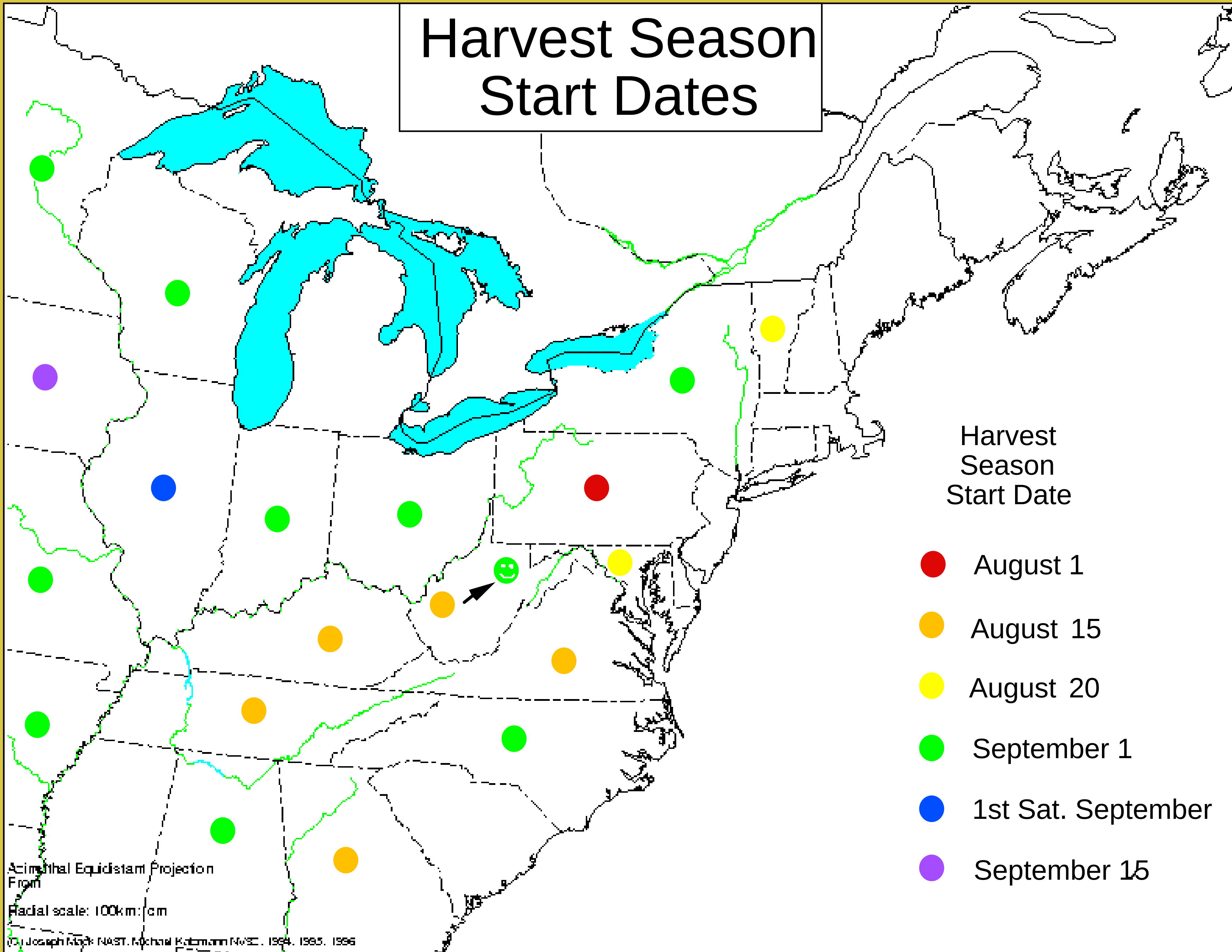
State-to-state variation low
Population-to-population variation high

What have we learned?

- Geographic variation in berry ripening is unrelated to current harvest season onset dates
- There is no biological justification for differences in harvest season onset dates

What have we learned?

Date:	Advantages	Disadvantages
Aug. 15	•3 of top 4 harvest states (TN, KY,VA) would not be affected by a change (WV has already changed)	•80% fruits unripe: *In situ* seed planting by harvesters will be ineffective: only mechanism to enhance populations (barring seed supplementation)
Sept. 1	•Fewest regulatory changes needed (10 of 19 states already use it) •Most fruits still on plant; allows planting by harvester (ca. 8-fold advantage if done right!)	•44% fruits unripe (but ca. 50% will germinate)
Sept. 15	•Most seeds ripe •Adult plants more cryptic - more escape harvest	•Only 13% unripe, BUT many seeds already dispersed (precludes planting) •Regulation changes needed in 18 of 19 states •Greater temptation to violate harvest season regs


Harvest Season Start Dates
Harvest Season Start Date
August 1
August 15
August 20
September 1
1st Sat. September
September 15

What do we need to know?

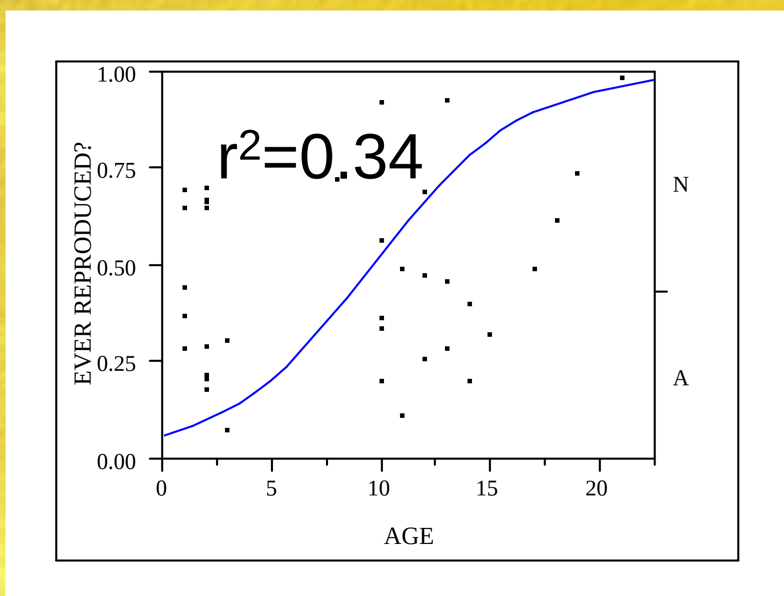
- Demographic consequences of different harvest seasons:
  - Given a certain harvest season, what proportion of ginseng is harvested on what dates?
  - What proportion of populations are harvested annually?
  - How intense is the harvest?
  - How much out-of-season, illegal harvest would occur?
- Are simulations necessary, given what we already know about (a) berry ripening, (b) effects of seed planting on different dates?

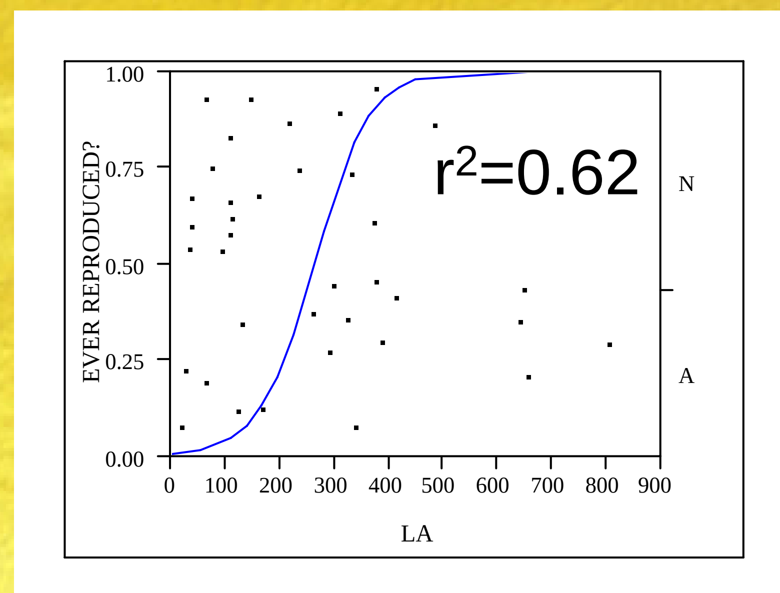
What do we need to know?

- Age limits
  - What are the demographic consequences of a 5 year age limit vs. 10 year age limit?
  - Is age the appropriate criterion for determining harvestability? Premise: Age is linked to reproductive output.

What do we know?

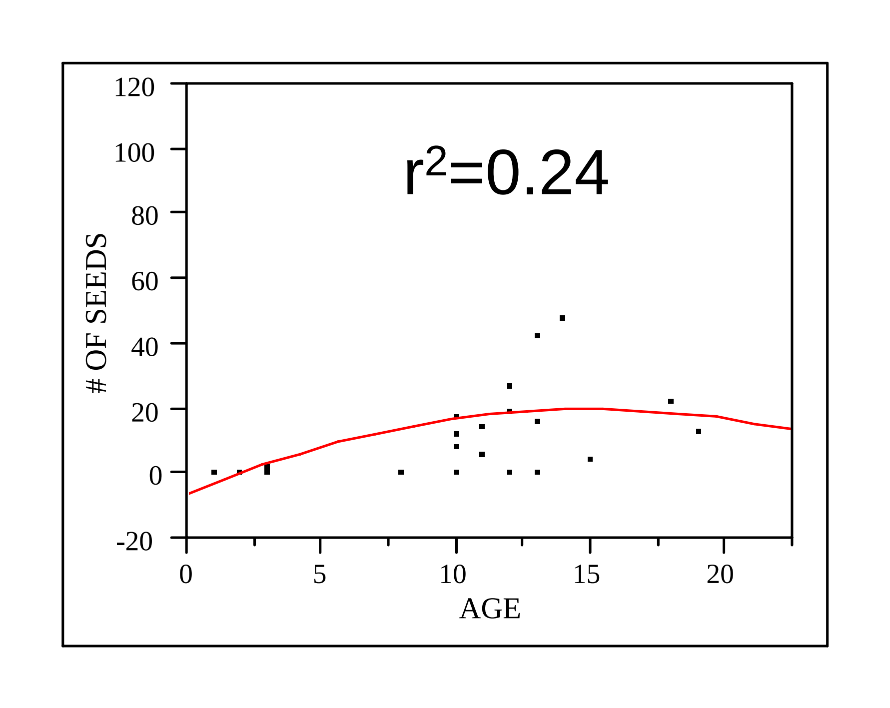
- Age is a relatively <u>poor predictor</u> of the probability that a plant has produced ANY seeds in the past 5 years, and

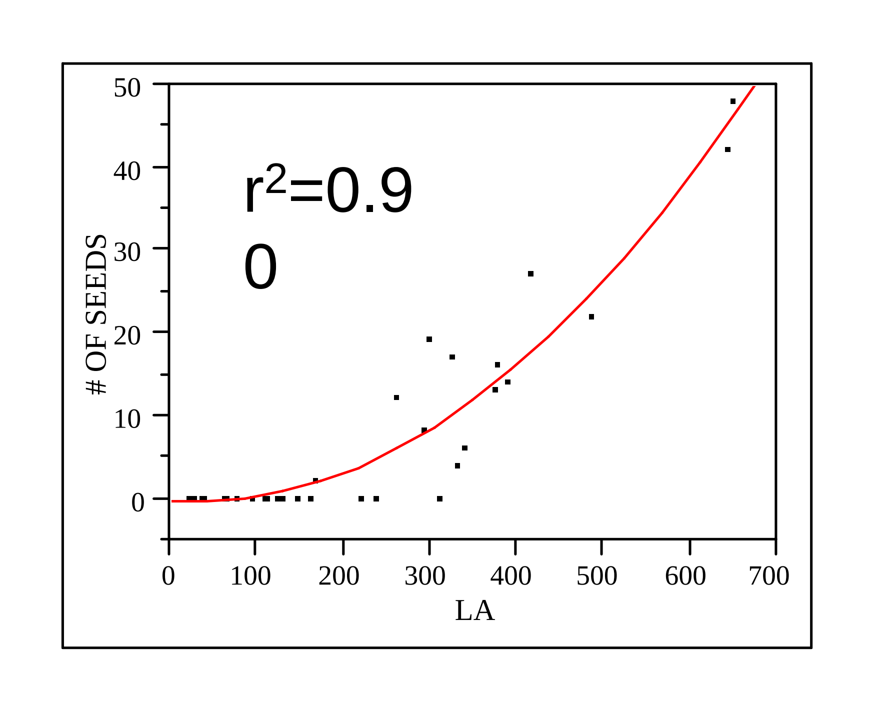




What have we learned?

- Age is a relatively poor predictor of number of seeds produced in the past 5 years





What do we need to know?

- At what plant size is past + present seed production sufficient to ensure nondetrimental effects of harvest?
  - Need answer for many populations in many environments across the range
- If this size is selected as the threshold, harvesting should have neutral or perhaps even positive effects on numbers!

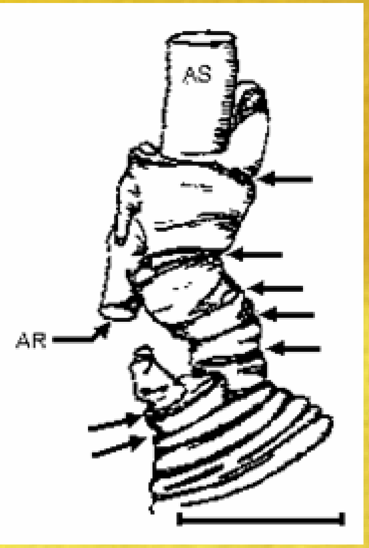
What do we need to know?

- What is a practical, verifiable size measure?

Plant Measure	Practical for harvester?	Verifiable after harvest?	Predicts seed production? (multi-year)	Overall 'score'
Leaf area			9	
Leaf #			3-4	
Sympodium (stem) height			8	
Seed number			6-8	
Rhizome length			3-5	
Root diameter			7-9	
Root weight			7-9	

What have we learned?

- Rhizomes are capable of sprouting and producing new roots
- A size threshold should be chosen that allows harvesters to plant rhizomes *in situ*, a practice that was once common
- Planting rhizomes should be encouraged, but not required, because some very old roots take on special value - great age is proven by the rhizome bud scars.



Summary

- New understandings derived from experiments, observations and demographic analyses of natural ginseng populations show:
- Current harvest seasons are not optimized
- Age-based harvest criteria are suboptimal from a biological standpoint; they also prevent harvesters from planting rhizomes
- Size-based harvest criteria would be preferable
- A minimum size threshold must be:
  - Practical for the harvester
  - Verifiable for the dealer/export controllers

Summary

- We need to know:
  - What is a practical verifiable size measure?
  - How is harvest at or above that size going to affect population growth rate in populations across a wide geographic area?
- Go slow in making changes!

Acknowledgments

- Funding: National Science Foundation, The Nature Conservancy, USGS-DOI, USFWS
- Many thanks to Mary Ann Furedi, Emily Mooney, Erin Hackney, Suzanne Sanders, Martha Van der Voort, Brent Bailey, Anne Lubbers, Mindi Spencer, Jessica Jeffries, Pam Tegelman, Chris Packert, Bill Slagle, April (Slagle) Stark, Harmony Burwell, Rebecca Kenyon, Sarah Lightner, Mary Olive, Rick May, Britni Schoonover, Nathaniel Lee and a host of ginseng berry monitors.
- Thanks to all the ginseng dealers, harvesters, and growers who have helped us understand their end of the ginseng trade, and who share the goal of stewardship of wild ginseng populations
- Thanks to Pat Ford, Roddy Gabel, and Ken Stansell for hosting this conference and ensuring that good science continues to be one of the important inputs on policymaking.