Fresh start:
# Demographic Stochasticity at the Population Level

particular case
Binomial survival process
Poisson birth process
Discrete time
"global propert" births and deaths are independent between individuals

notation

$\alpha$ death probability

$\beta$ Poisson birth rate (mean and variance)

$N$ population size

$N_\alpha$ number of deaths of one time step

$N_\beta$ number of births in one time step

$$N_{t+1} = N_t + N_\beta - N_\alpha$$

Mean outcome

$$\bar{N}_\alpha = N\alpha$$

$$\bar{N}_\beta = N\beta$$

Population level process:

$$N_\alpha \sim B(N, \alpha)$$

$$\mathrm{Var}(N_\alpha) = N\alpha(1-\alpha)$$

$$N_\beta \sim P(N\beta)$$

$$\mathrm{Var}(N_\beta) = N\beta$$

define $\lambda_t = \dfrac{N_{t+1}}{N_t}$

$$= \frac{N_t + N_\beta - N_\alpha}{N_t}$$

$$= 1 + \frac{N_\beta}{N} - \frac{N_\alpha}{N}.$$

$$\bar{\lambda} = 1 + \beta - \alpha$$

$$\mathrm{Var}\left(1+\frac{N_\beta}{N}-\frac{N_\alpha}{N}\right)$$

$$=0+\frac{\mathrm{Var}(N_\beta)}{N^2}+\frac{\mathrm{Var}(N_\alpha)}{N^2}$$

$$=\frac{1}{N^2}\Big(N\beta+N\big(\alpha(1-\alpha)\big)\Big)$$

$$=\frac{1}{N}\big(\beta+\alpha(1-\alpha)\big)$$

$$\sigma_\lambda = \sqrt{\frac{\beta + \alpha(1-\alpha)}{N}}$$

$$\pm 1.96\,\sigma_\lambda = \pm 1.96 \sqrt{\frac{\beta + \alpha(1-\alpha)}{N}}$$

$$\bar{\lambda} - 1.96\,\sigma_\lambda = 1 + \beta - \alpha - 1.96\sqrt{\quad}$$

For 97.5% prob of growth in one time step

$$1+\beta-\alpha-1.96\sqrt{\frac{\beta+\alpha(1-\alpha)}{N}} > 1$$

$$\beta-\alpha-1.96\sqrt{\frac{\beta+\alpha(1-\alpha)}{N}} > 0$$

for $\beta = .55$ and $\alpha = .5$

$$.05-1.96\sqrt{\frac{1.05-\alpha^2}{N}} > 0$$

# Conditional probabilities in the PVAX series programs

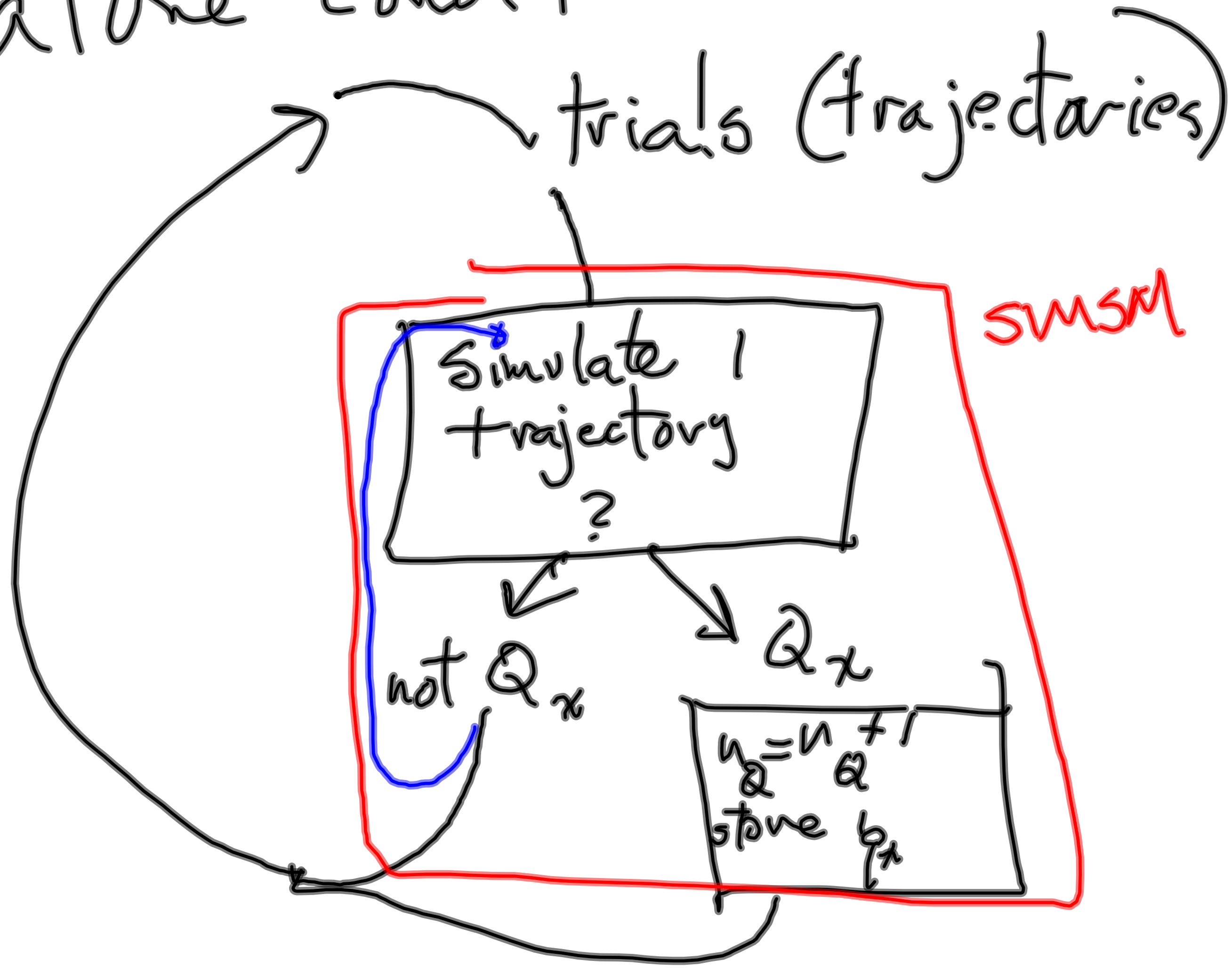
Reporting parameters:

1) probability of quasi-extinction by time horizon

code as 1 if trajectory is quasi-extinct, code as 0 if not; read fraction directly off marginal summary table

2) time to quasi-extinction conditional on quasi-extinction by the time horizon

Flow chart for stand alone conditional

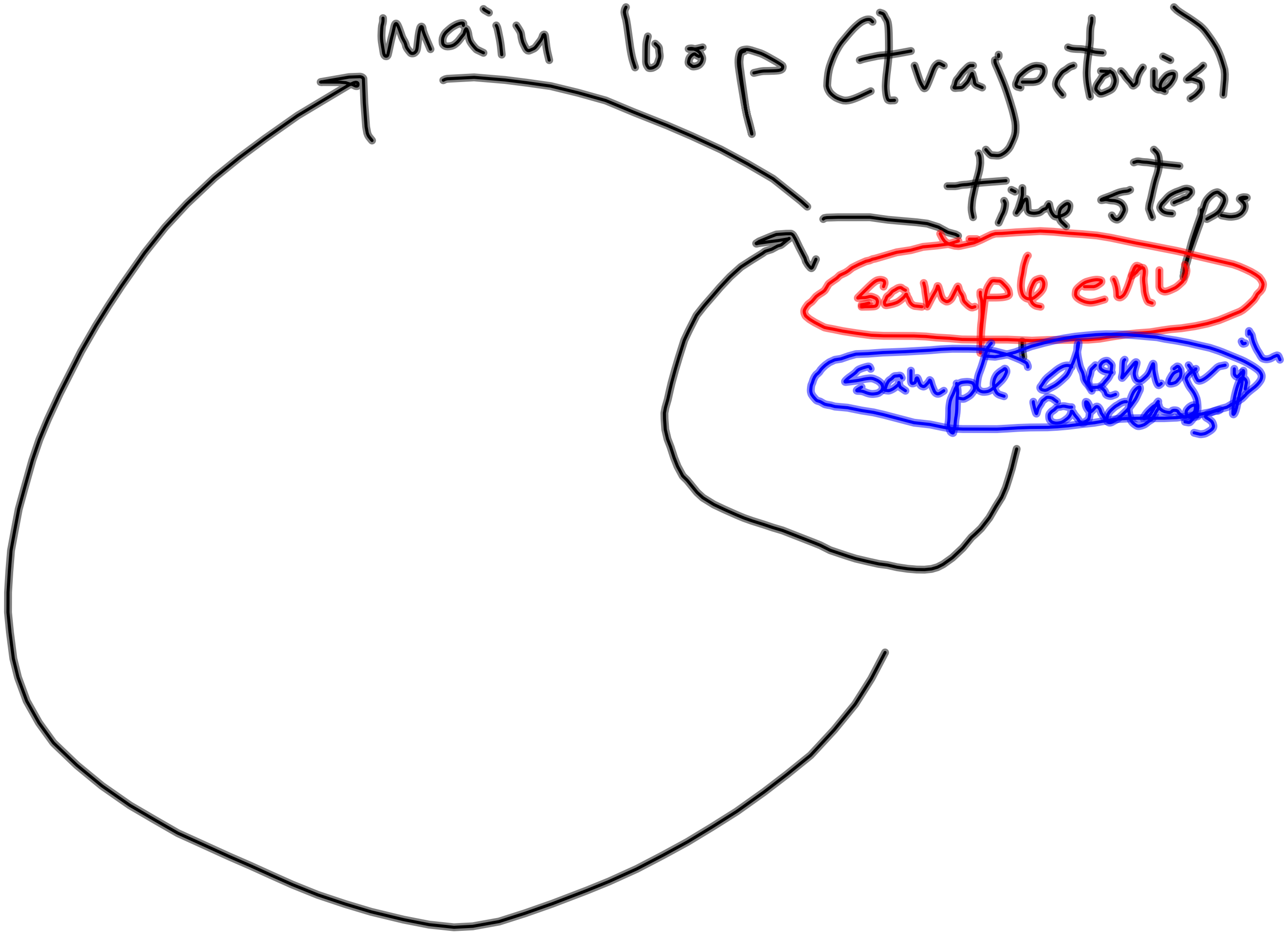


3) Population size at time horizon <u>conditional</u> on <u>not</u> having gone quasi-extinct

(same trick)

# ENVIRONMENTAL VARIATION

* SAMPLED EACH YEAR
* AFFECTS ALL INDIVIDUALS THE SAME WAY


main loop (trajectories)
time steps
sample env
sample memory
randomly