Trojan Y-Chromosome Approach to Dealing with Invasive Species

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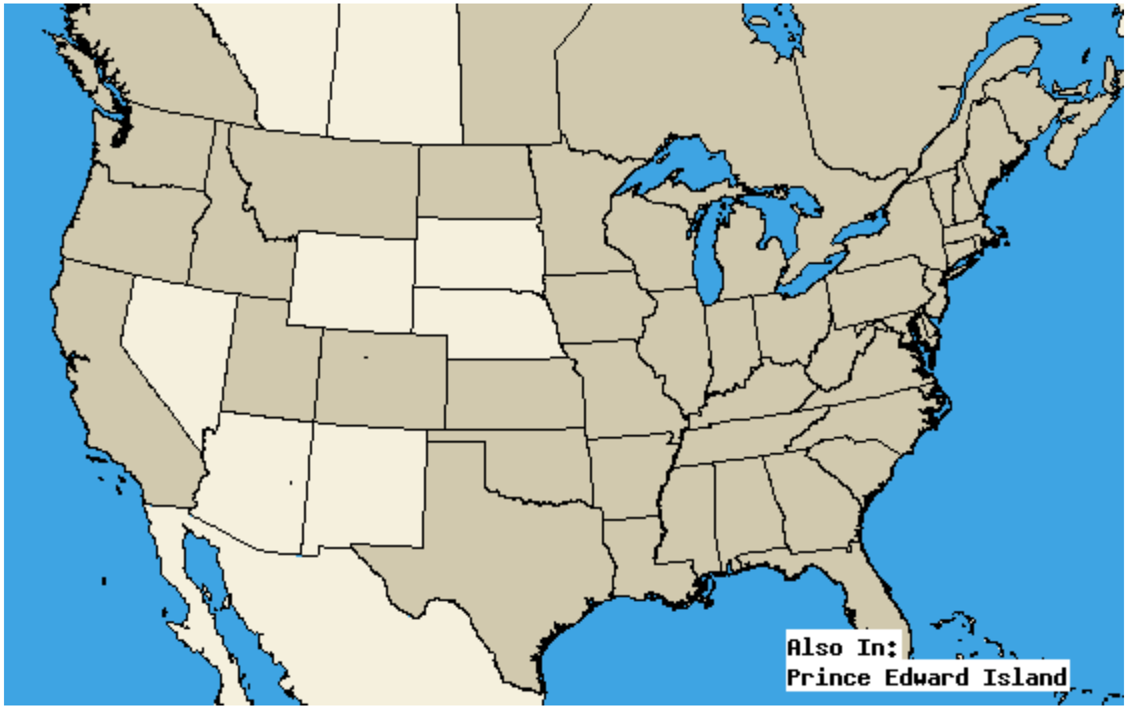
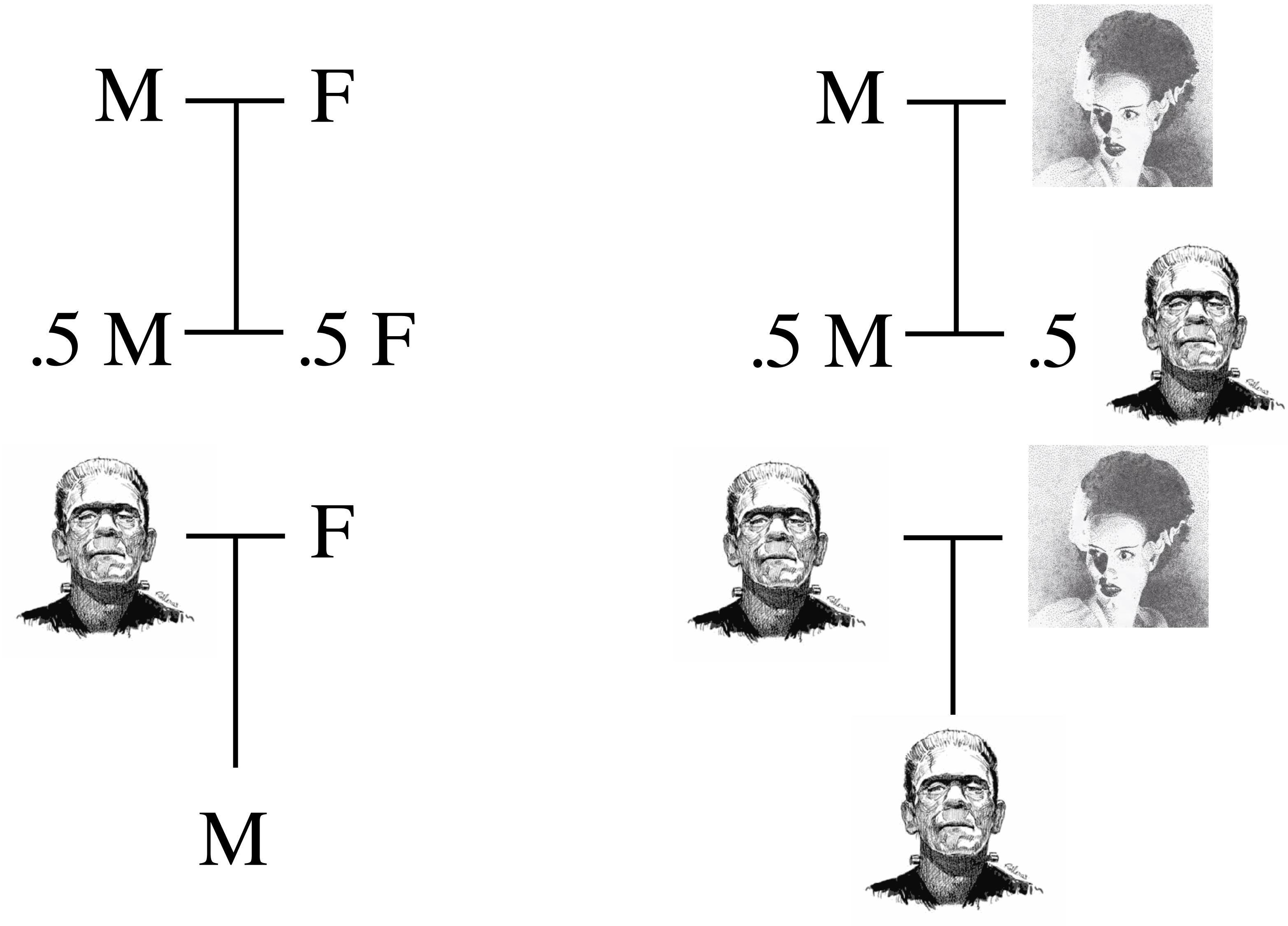
The Problem



Solutions

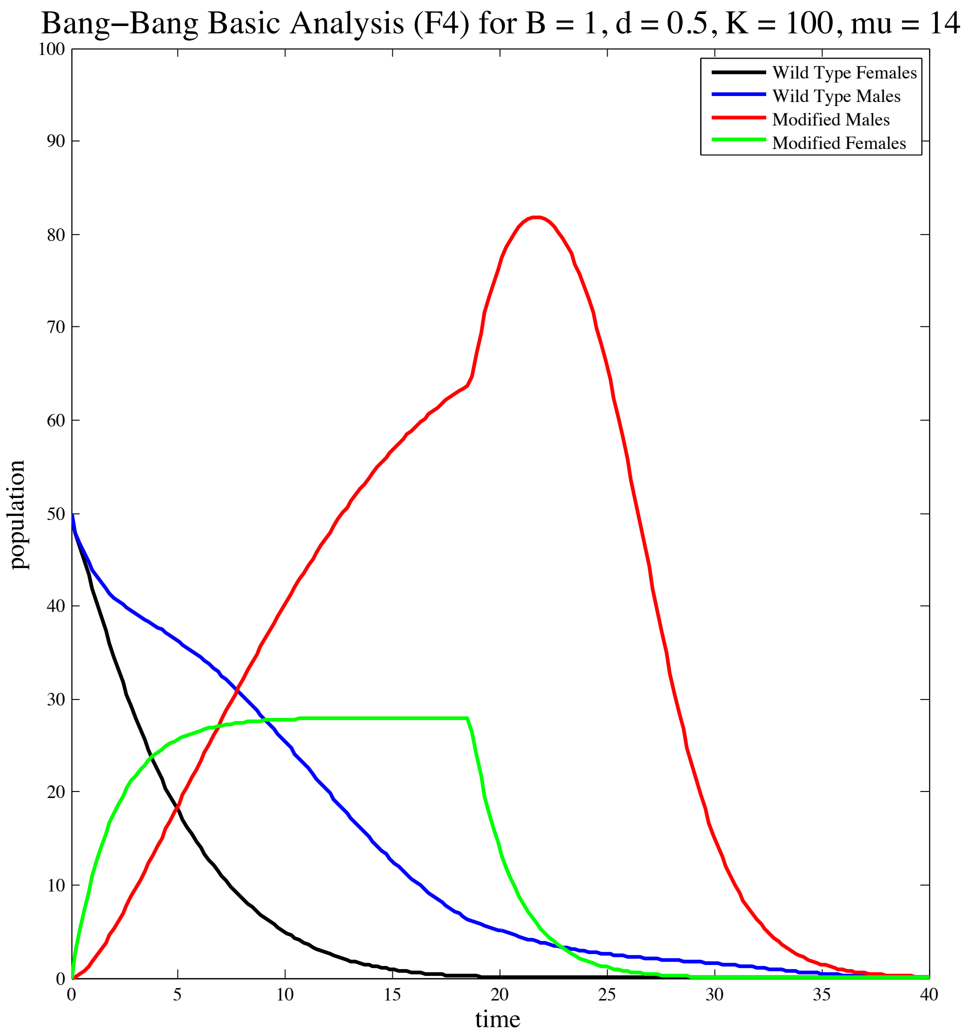
- Poison
- Introduction of Foreign Species

Trojan Breeding



Basic Model

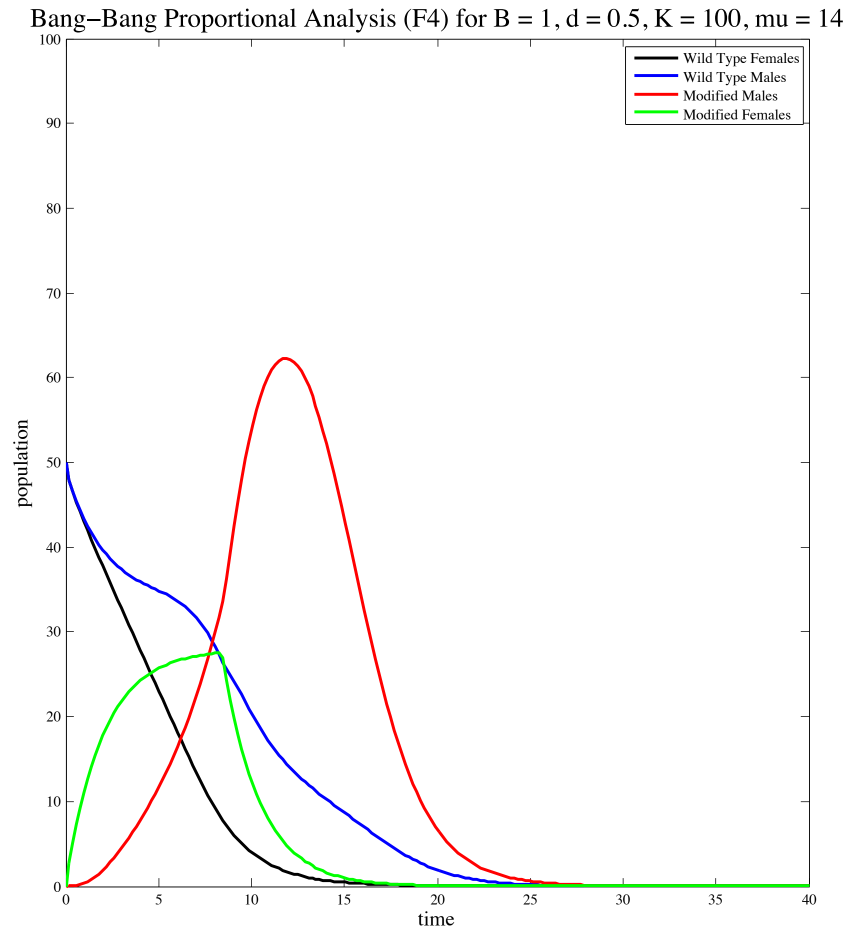
$$\frac{df}{dt} = \frac{1}{2}\beta f m L - \delta f$$
$$\frac{dm}{dt} = (\frac{1}{2} f m + \frac{1}{2} r m + f s)\beta L - \delta m$$
$$\frac{ds}{dt} = (\frac{1}{2} r m + r s)\beta L - \delta s$$
$$\frac{dr}{dt} = \mu - \delta r$$
$$L = 1 - \frac{f+m+s+r}{K}$$



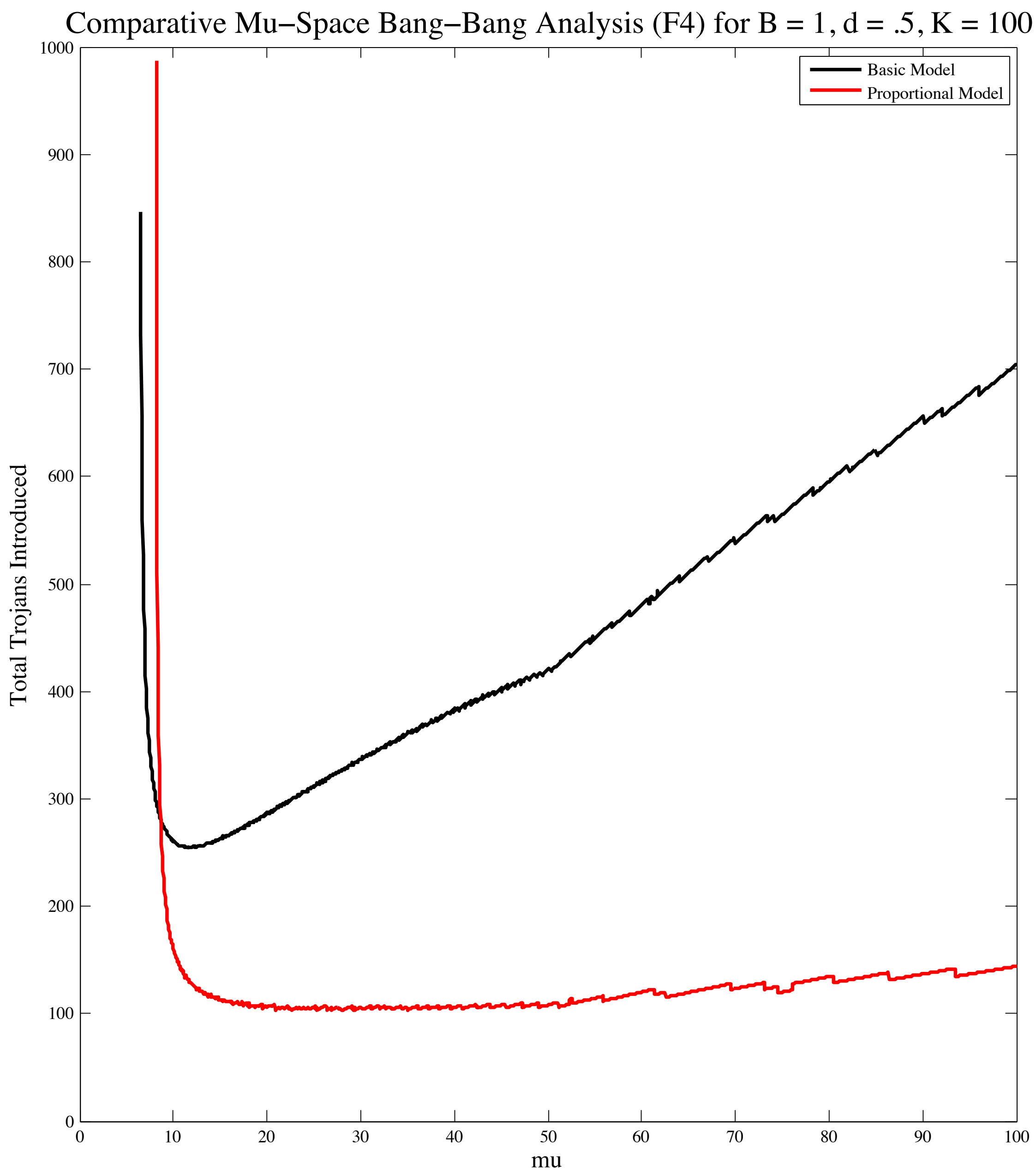
Proportional Model

$$\frac{df}{dt} = \frac{1}{2}\beta f m P_{fm} L - \delta f$$
$$\frac{dm}{dt} = (\frac{1}{2} f m P_{fm} + \frac{1}{2} r m P_{rm} + f s P_{fs})\beta L - \delta m$$
$$\frac{ds}{dt} = (\frac{1}{2} r m P_{rm} + r s P_{rs})\beta L - \delta s$$
$$\frac{dr}{dt} = \mu - \delta r$$
$$L = 1 - \frac{f+m+s+r}{K}$$

$$P_{fm} = \frac{fm}{(m+s)(f+r)}$$
$$P_{fs} = \frac{fs}{(m+s)(f+r)}$$
$$P_{rm} = \frac{rm}{(m+s)(f+r)}$$
$$P_{rs} = \frac{rs}{(m+s)(f+r)}$$



μ Minimization



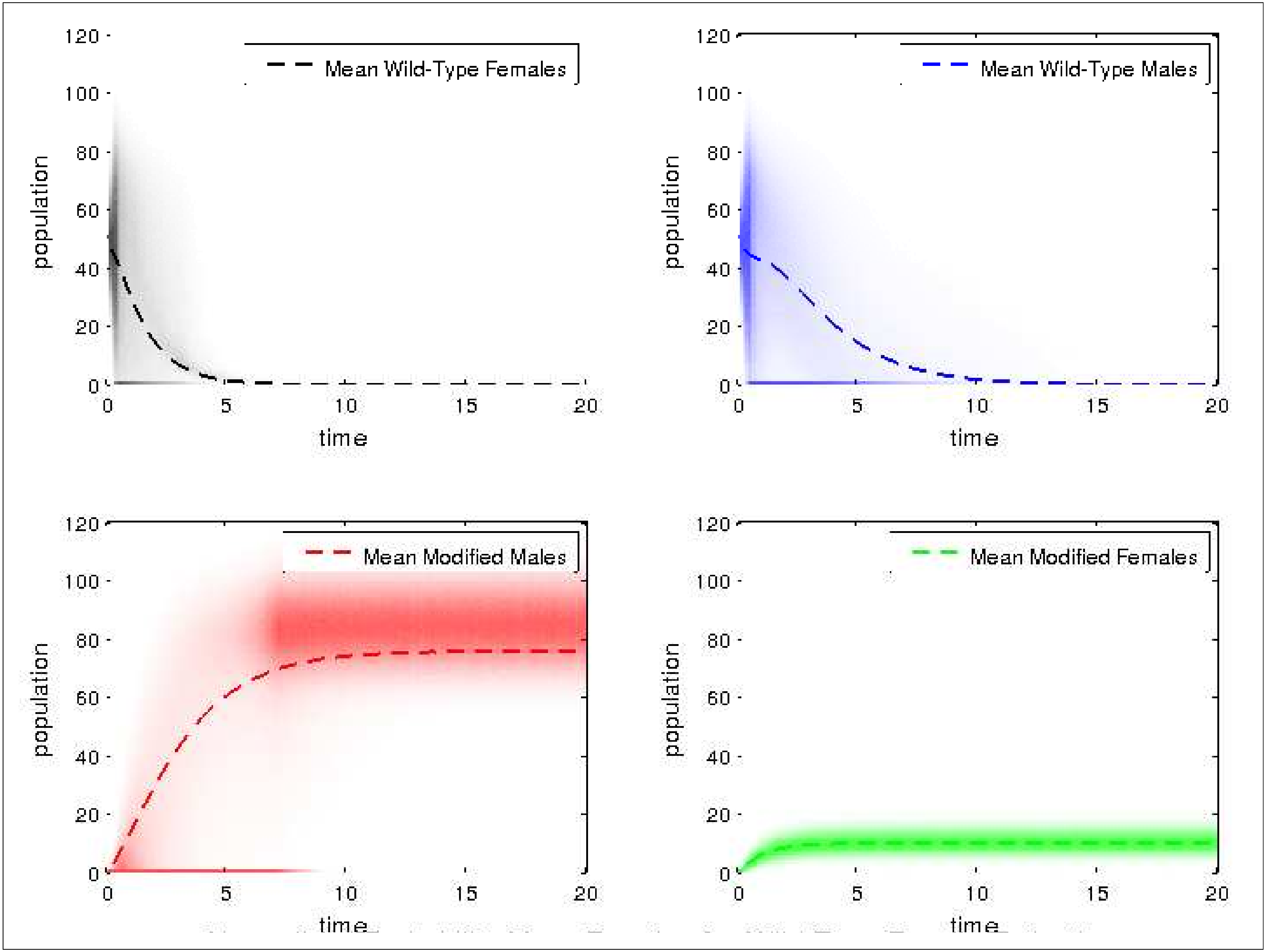
Stochasticity

- Low Population Systems
- Random Events

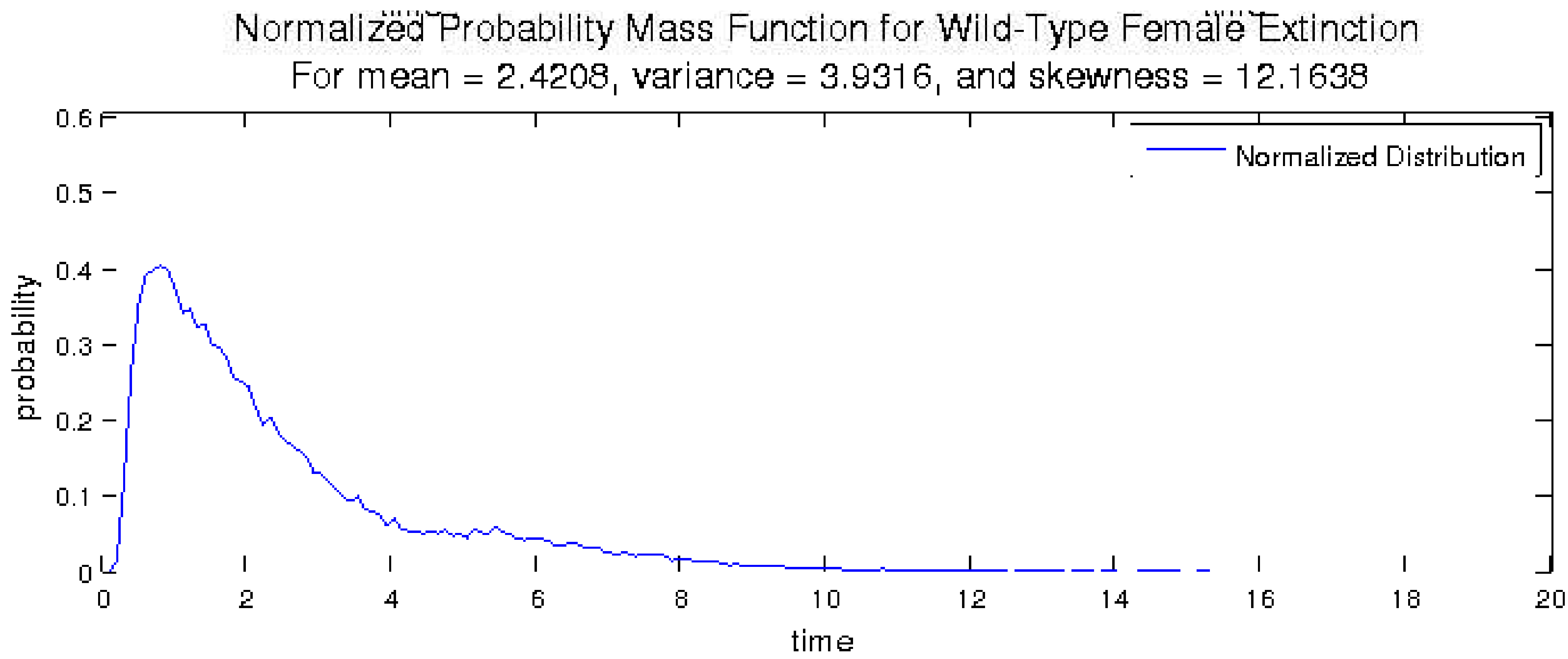
0-Dimensional System

$F\ Birth = \frac{1}{2}\beta f m$
$M\ Birth = \beta(\frac{1}{2} f m + \frac{1}{2} r m + f s)$
$S\ Birth = \beta(\frac{1}{2} r m + r s)$
$R\ Birth = \mu$
$L' = \frac{f+m+s+r}{K}$

$F\ Death = \frac{1}{2}\beta f m L' + f$
$M\ Death = \beta L'(\frac{1}{2} f m + \frac{1}{2} r m + f s) + m$
$S\ Death = \beta L'(\frac{1}{2} r m + r s) + s$
$R\ Death = r$



Mean Wild-Type Females
Mean Wild-Type Males
Mean Modified Males
Mean Modified Females
population
time
0
5
10
15
20
40
60
80
100
120


Normalized Probability Mass Function for Wild-Type Female Extinction
For mean = 2.4208, variance = 3.9316, and skewness = 12.1638
Normalized Distribution
probability
time
0
0.1
0.2
0.3
0.4
0.5
0.6
0
2
4
6
8
10
12
14
16
18
20

2-dimensional System

$F\ Birth = \frac{1}{2}\beta fm$

$M\ Birth = \beta(\frac{1}{2}fm + \frac{1}{2}rm + fs)$

$S\ Birth = \beta(\frac{1}{2}rm + rs)$

$R\ Birth = \mu$

$L' = \frac{f+m+s+r}{K}$

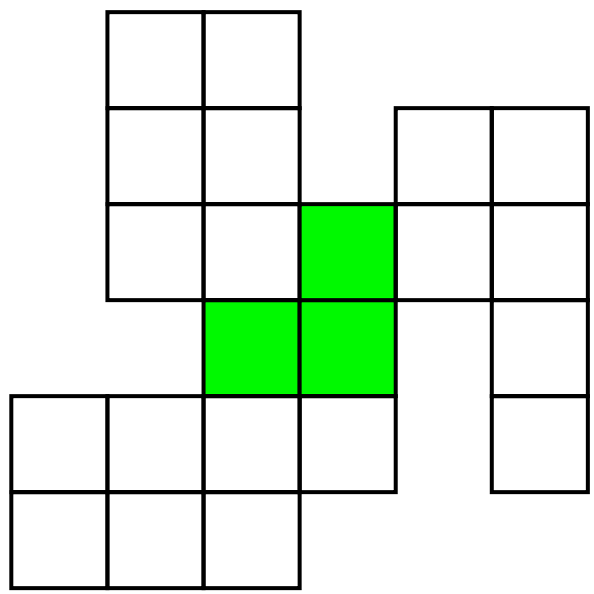
$F\ Death = \frac{1}{2}\beta fmL' + f$

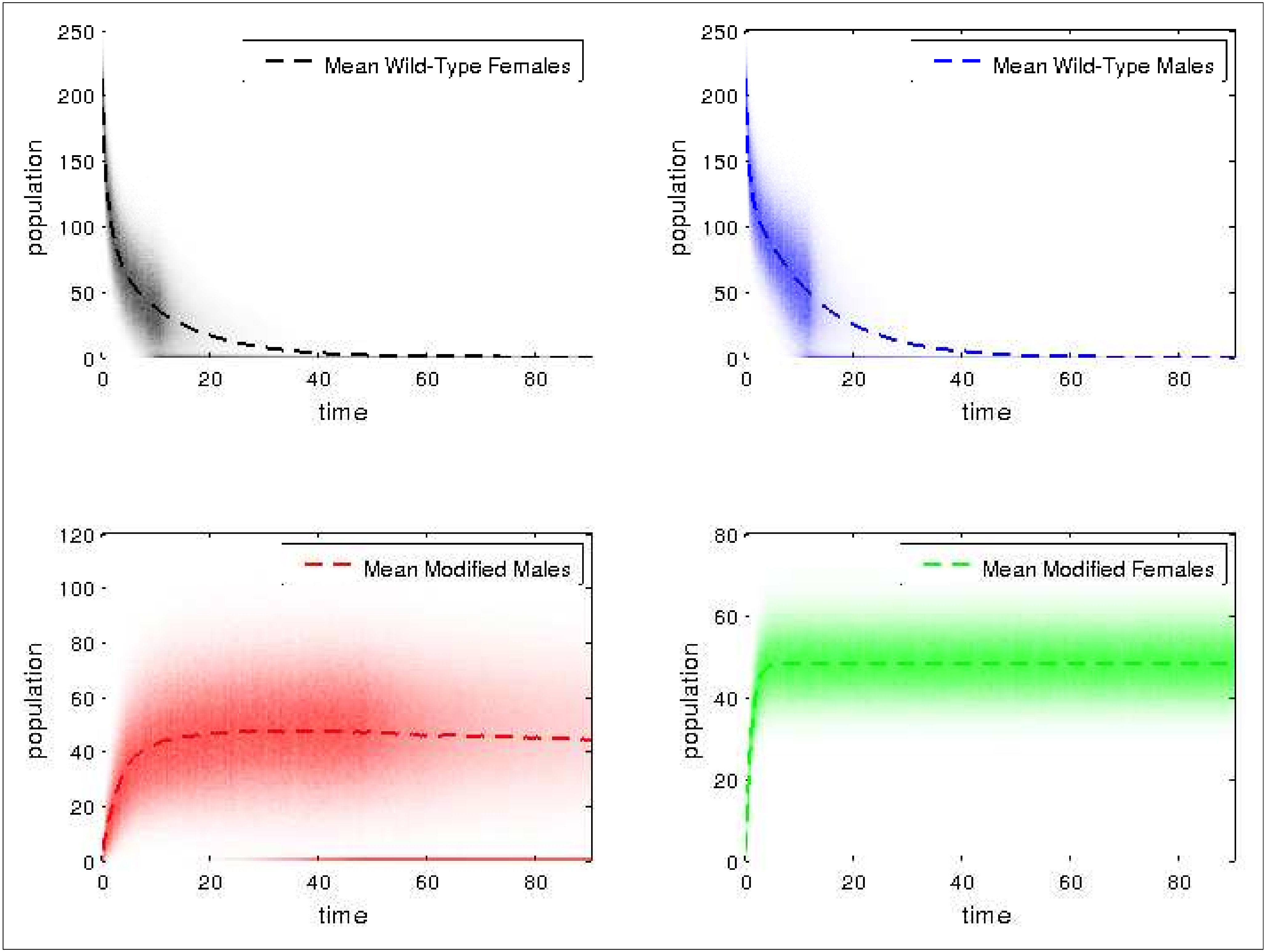
$M\ Death = \beta L'(\frac{1}{2}fm + \frac{1}{2}rm + fs) + m$

$S\ Death = \beta L'(\frac{1}{2}rm + rs) + s$

$R\ Death = r$

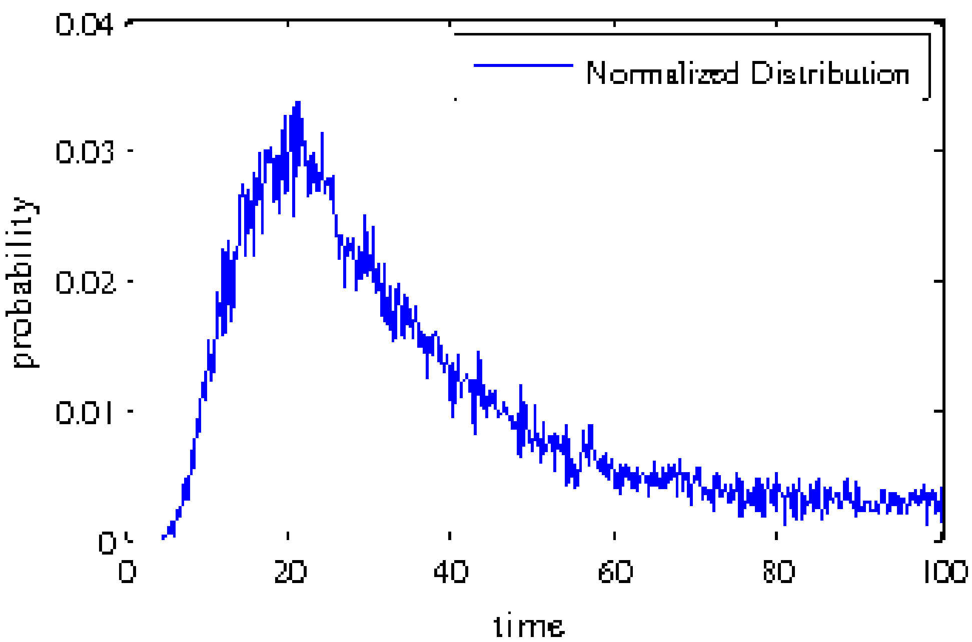
$$Migrate = \frac{population * migration\_speed}{cell\_length}$$

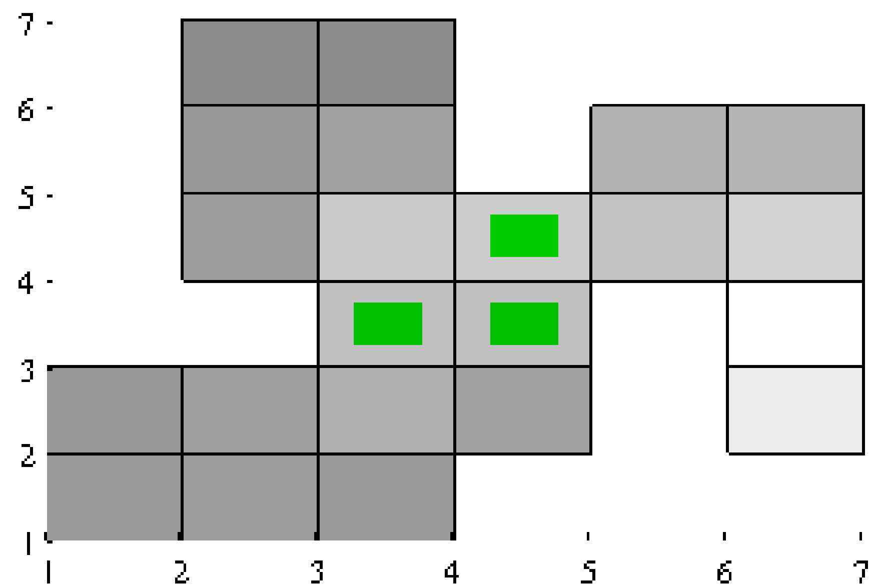



Mean Wild-Type Females
Mean Wild-Type Males
Mean Modified Males
Mean Modified Females
population
time
0
20
40
60
80
50
100
150
200
250
120

- mean = 35.3 (tδ)
- variance = 465
- skewness = 11,500

Max time = 27.7





- mean = 28.8 (tδ)
- variance = 295
- skewness = 6690

Max time = 26.7