Fixation Time Properties of Drift

$p =$ frequency of A_1
$q =$ frequency of A_2

Time to fixation of either A_1 or A_2, no selection

$$\bar{t}(p) = -4N_e(p \log_e p + q \log_e q)$$

with $p = 1/2N$

$$\bar{t}(1/2N) \approx 2\left(\frac{N_e}{N}\right)\log_e(2N) + 2\left(\frac{N_e}{N}\right)$$

with $p = 1/2$

$$\bar{t}(1/2) \approx 2.8N_e$$

Time to fixation of A_1, no selection

$$\bar{t}_1(p) = -4N_e\left(\frac{q}{p}\right)\log_e q\}$$

with $p = 1/2N$

$$\bar{t}_1(1/2N) \approx 4N_e$$

with $p = 1/2$

$$\bar{t}_1(1/2) \approx 2.8N_e$$

Time to loss of A_1, no selection

$$\bar{t}_0(p) = -4N_e\left(\frac{p}{q}\right)\log_e p$$

with $p = 1/2N$

$$\bar{t}_0(1/2N) \approx 2\left(\frac{N_e}{N}\right)\log_e(2N)$$

with $p = 1/2$

$$\bar{t}_0(1/2) \approx 2.8N_e$$

Probabilities of Fixation under Drift with Selection

Consider directional selection of the following form:

Genotype	A_1A_1	A_1A_2	A_2A_2
Fitness	$1+s$	$1+(\frac{1}{2})s$	1

Then $P_1(p)$, the probability that A_1 is eventually fixed is given by

$$P_1(p) = \frac{1-e^{-2N_e sp}}{1-e^{-2N_e s}}.$$

Consider the case of a newly arisen favorable mutant, $p = 1/2N$. Then

$$\begin{aligned} P_1(1/2N) &= \frac{1-e^{-2N_e s(1/2N)}}{1-e^{-2N_e s}} \\ &= 1-e^{-s(\frac{N_e}{N})} \\ &= s(\frac{N_e}{N}). \end{aligned}$$

Most newly arisen favored alleles are lost.

Consider the case of a newly arisen unfavorable mutant, i.e., $s < 0$. Then

$$P_1(1/2N) = \frac{-s(\frac{N_e}{N})}{1-e^{-2N_e s}}.$$

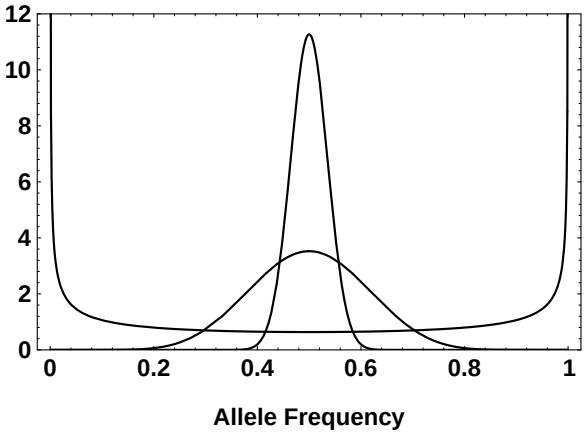
For example, suppose $N = 100$, then the probability of fixation if the allele were neutral is $\frac{1}{2N} = 0.005$.

	N_e	
s	4	100
0.001	0.005	0.005
0.01	0.005	0.002
0.1	0.003	0.0000000002

In populations with a small effective population size mildly deleterious alleles are nearly as likely to be fixed as neutral alleles. If $Ns \ll 1$, drift dominates the dynamics. If $Ns \gg 1$, selection dominates the dynamics.

Drift and Mutation

$$\mu = 10^{-6}, N_e = 125000$$
$$N_e = 2500000$$
$$N_e = 25000000$$



Drift, Selection, and Mutation

$$\mu = 10^{-6}, N_e = 1000, h = 0.5, s = 10^{-3}$$
$$= 10^{-2}$$