Altering traits and fates of wild populations with Mendelian DNA sequence modifying Allele Sails

Supplementary Figures

Extended Data

Supplementary Figure 1. Behavior of Allele Sail edits in response to different types of fitness costs: dominant, additive or recessive. Fitness costs and benefits are associated with the edit. For the dominant and recessive types, fitness costs/benefits are 10% (either positive or negative), and in the additive case are '5%', such that a heterozygous individual has a cost/benefit of 5%, and a homozygous individual has a cost/benefit of 10%. **A)** The average frequency of the edit, both with and without an editor, when transgenic (bearing the edit, or or the edit and editor) individuals are introduced at 10% of carrying capacity and the edit has a 10% (dominant/recessive) fitness benefit. **B)** The same as A, but for a 10% fitness cost. **C)** A heatmap showing the relationship

between introduction frequency and fitness costs, when the cost/benefits are dominant and apply to the edit. The percent carriers being plotted here is taken from Generation 50. **D)** The same as C, but for recessive cost/benefits.
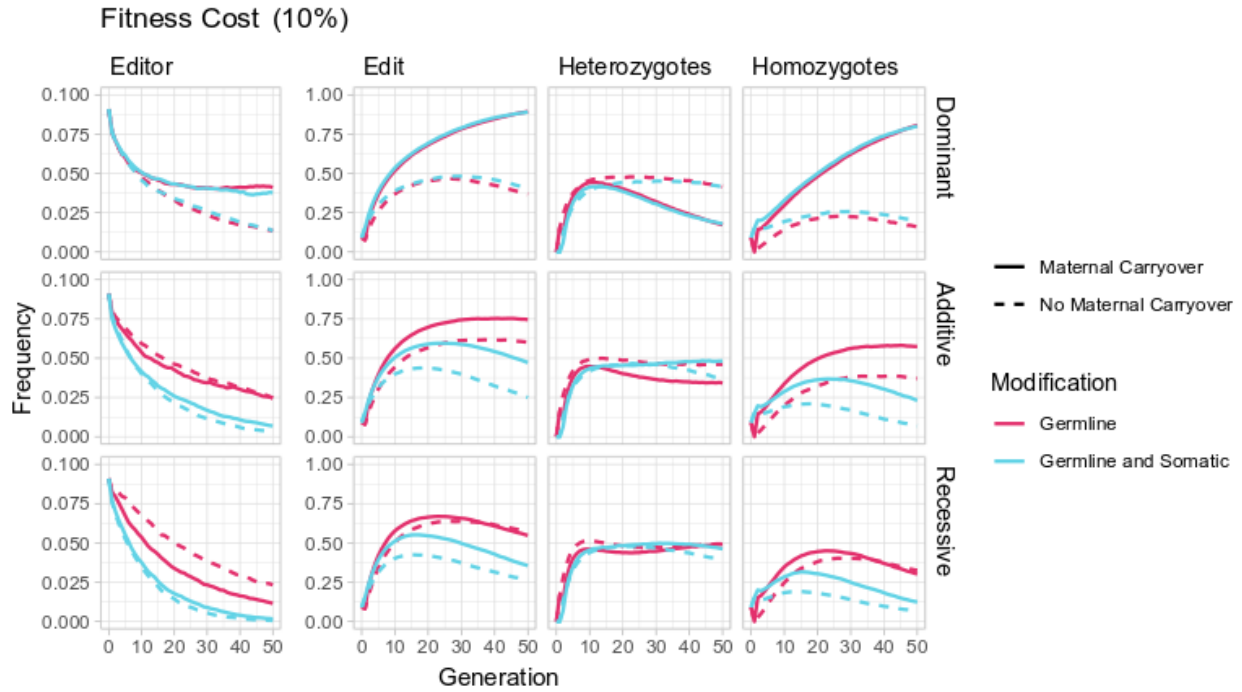
Supplementary Figure 2. Behavior of Allele Sail edits in response to different types of fitness costs and different modification times. The allele frequency of edits and the editor averaged over 20 runs, along with the frequency of heterozygotes and homozygotes for the edit. This is for different fitness types (Dominant, Additive, and Recessive) as well as for different modifications, either Germline or Germline with Somatic, and also with and without Maternal Carryover. Maternal Carryover refers to Maternal Carryover of the editor, which leads to somatic editing in all offspring of an editor-bearing female. This includes offspring that do not carry the editor themselves.
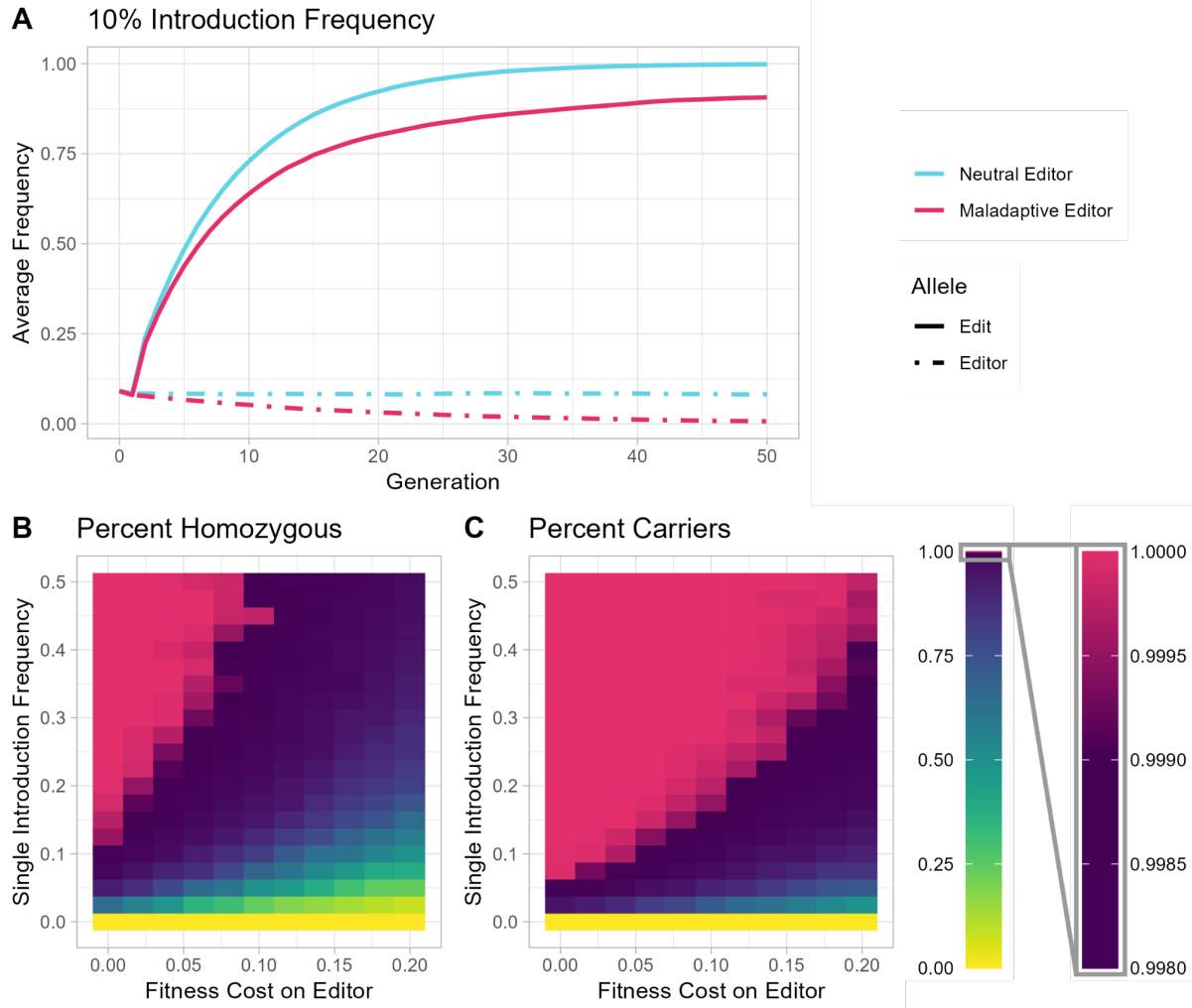
Supplementary Figure 3. Behavior of a Non-neutral editor & a Neutral edit. A) The average allele frequency of edits after being introduced at 10% frequency. Introduced individuals are homozygous for both edit and editor. The non-neutral editor includes an additive 5% fitness cost. **B)** Average percent of the population that is homozygous for our edit after 50 generations, for various editor introduction frequencies and fitness costs associated with the editor. **C)** Average percent of the population that carries at least one copy of the edit, for various editor introduction frequencies and fitness costs.
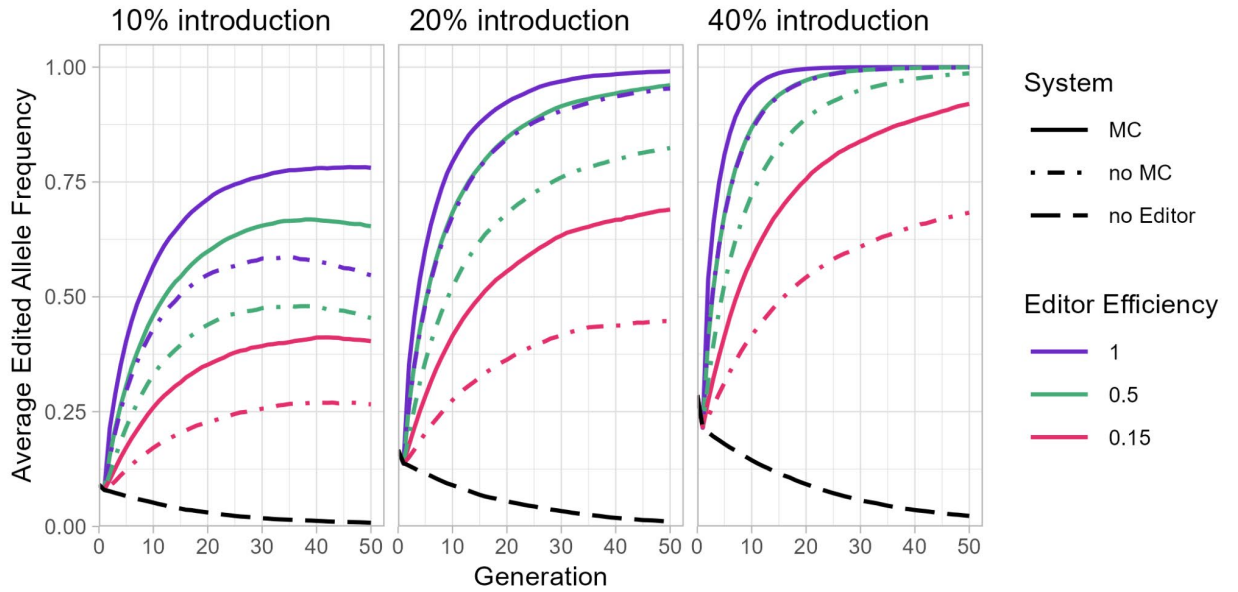
Supplementary Figure 4. Increasing Introduction Frequency can Overcome Fitness Costs when Editor Efficiency is low. The average edited allele frequency over time when each copy of the edited allele confers a 5% fitness cost. Releases consist of all males homozygous for both the editor and the edit (or only the edit, in the case of the no Editor system). The systems with editor introduced either have maternal carryover (MC) or do not have maternal carryover occurring (no MC).
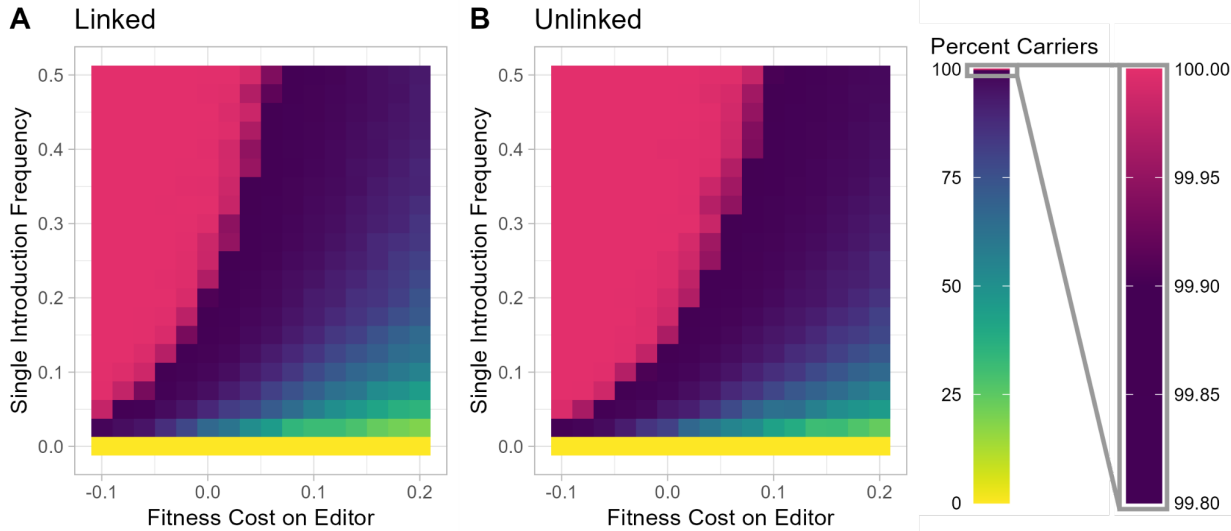
Supplementary Figure 5. Effects of Linkage on Population Modification, with Cost on the Editor. Rates of germline editing are 50% and there is no maternal carryover editing. No costs are associated with the edit. **A, B)** The percentage of the population that has at least one edited allele / sail present in their genome, averaged over 20 simulations. For moderate costs, linkage between editor and edits results in lower rates of editing **(A)** than does independent assortment. **(B)**.
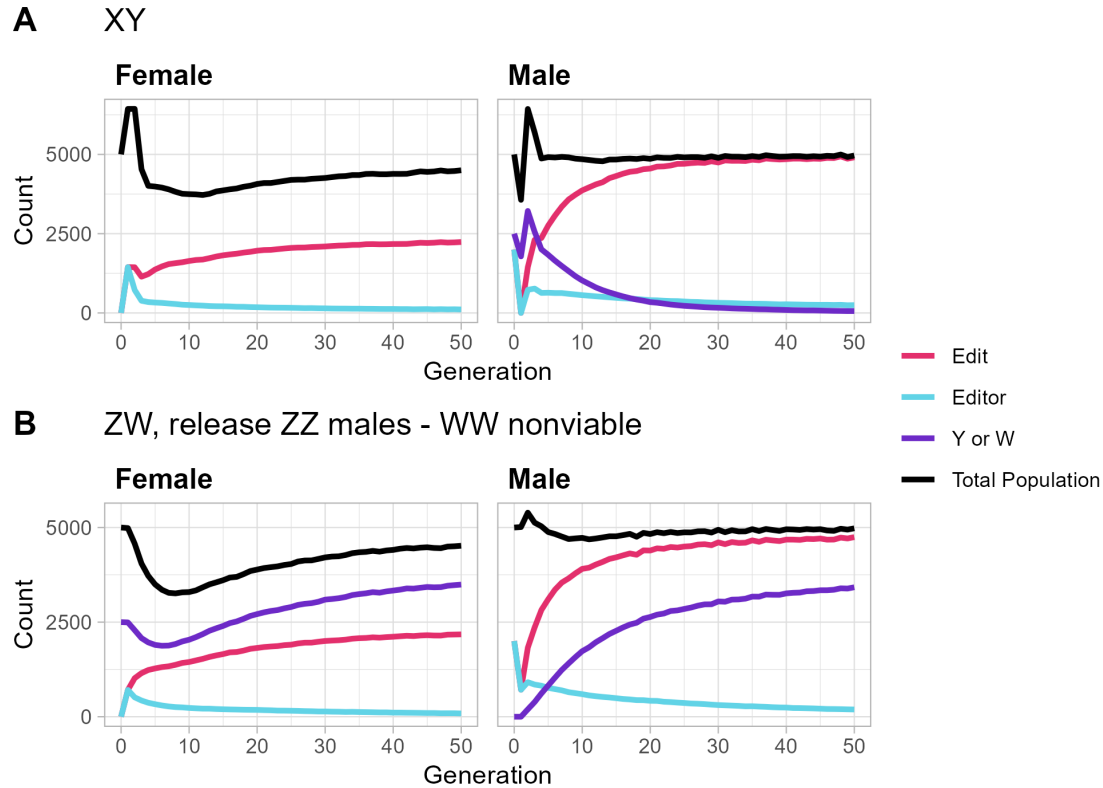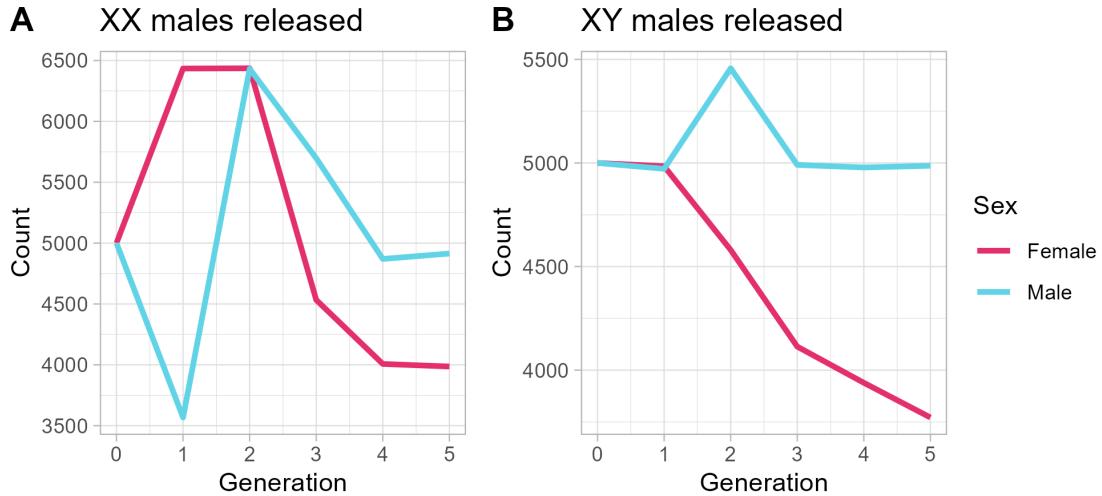
Supplementary Figure 6. Amounts of Edit and Editor by Sex. A) Average total population graphed with the average number of edit-bearing, editor-bearing, and Y-bearing individuals. The editor is introduced in males, is present in only females for the first generation, and then drops quickly in females. The low level of editor in females is because editor offspring are skewed male. The higher frequency of the editor in males over females results in the editor being lost over time, because the editor is removed due to dilution: as sex distortion increases, the editor is segregated into males and fewer of these–as compared with non-editor males– are chosen to participate in mating with the Non-editor females. **B)** The same as **A**, for a ZW system where WW is nonviable. As with the XY system in **A**, the editor has a higher frequency in males than females and decreases over time.
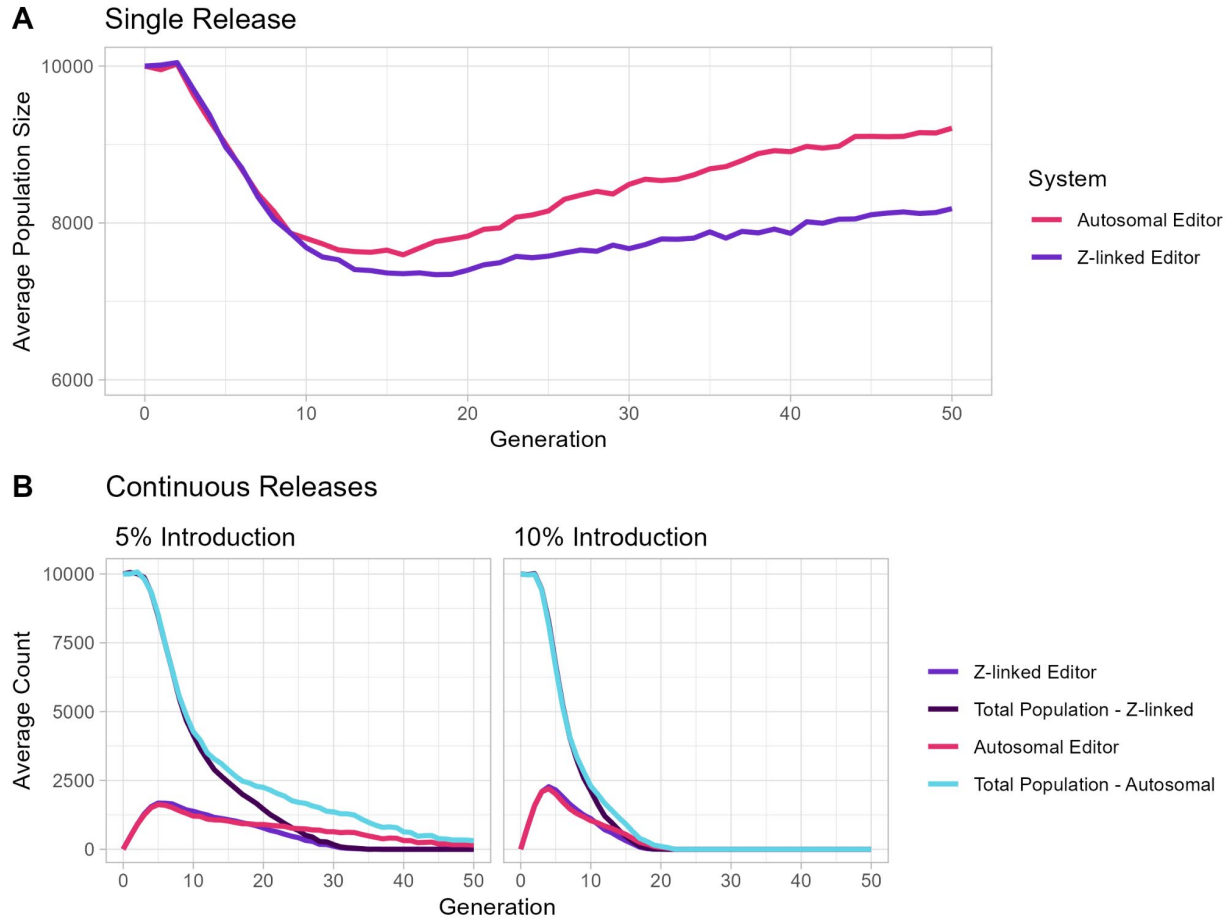
Supplementary Figure 7: Suppression Behavior of a Z-linked Aromatase Editor. A) The average population size over time, following a single release of editor-bearing individuals at 10% of the carrying capacity. Since the released individuals are males, and population numbers are determined by the number of fertile females, these additional males are not counted at generation 1. **B)** The average population size and the number of editor alleles over time. Individuals are released every generation at either 5% or 10% of the carrying capacity. Those released individuals do not count towards the number of alleles in the population, but all of their offspring do.

Supplementary Figure 8. Amount of Males and Females under Population Suppression. A) XX males carrying both editor and edit are released into the population at a frequency of 20%, at Generation 0. Notice that after this release, the number of females initially spikes due to increased X frequency. In the second generation, the number of males and females are equal, and higher than carrying capacity due to an increased number of females. After this, the frequency of the edit increases in the population and the sex ratio becomes skewed towards male. **B)** Under the same conditions as A, XY males are released. Notice that there is almost immediate sex skew and no spike in population, because there is no change in the frequency of X and Y chromosomes.

Average generation of collapse, for each type and introduction frequency
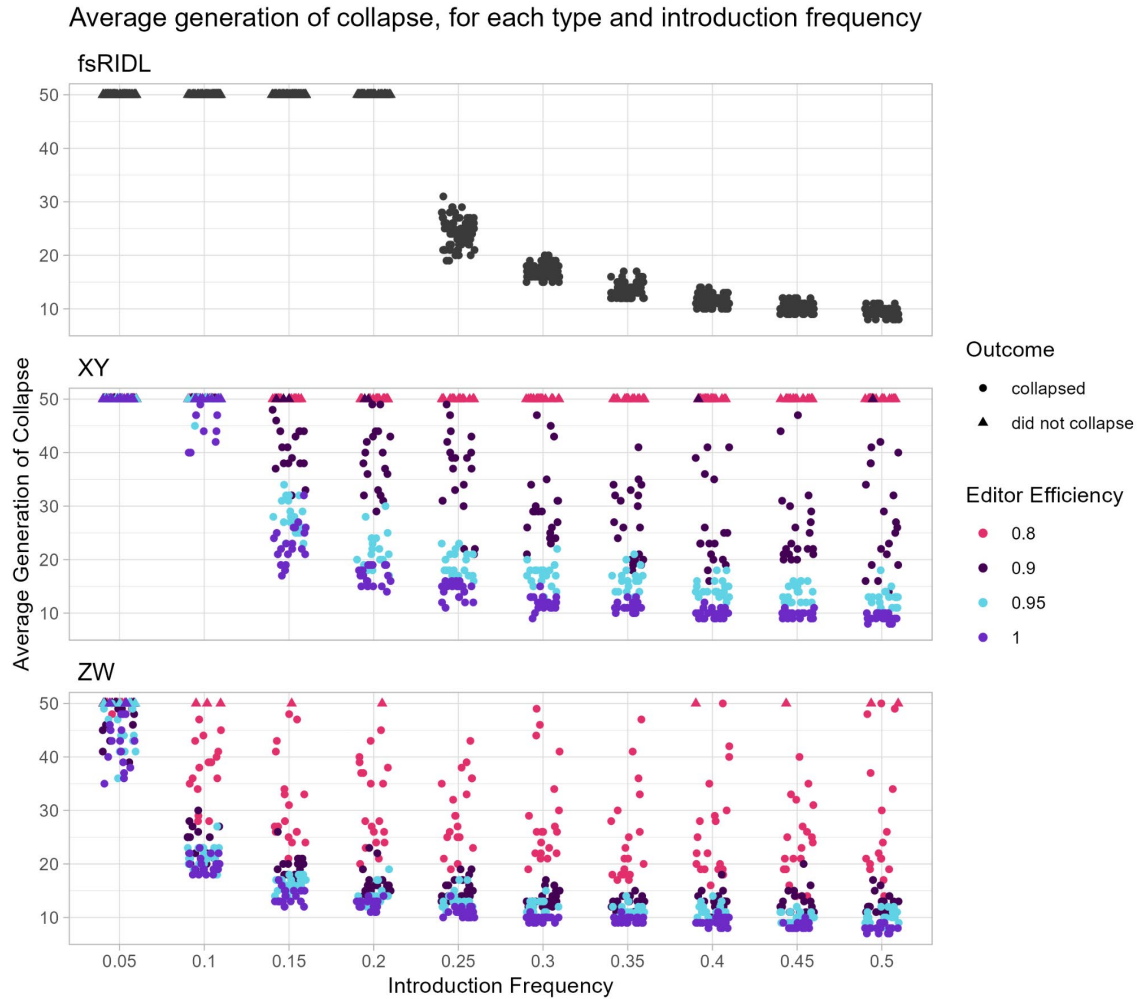
Supplementary Figure 9: Average time to Population Collapse, for various editor efficiencies. Each dot represents the last non-zero generation of a simulation using the given editor efficiency. As such, simulations that ran to generation 50 but did not collapse are also shown here, but are represented by triangles instead of circles. Twenty simulations were run for each scenario, i.e., for each editor efficiency and system. In the fsRIDL case, changing the editor efficiency did not affect the simulation, as there is no editor present. Even so, there are 80 points for each introduction frequency.

Average generation of collapse, for each type and introduction frequency
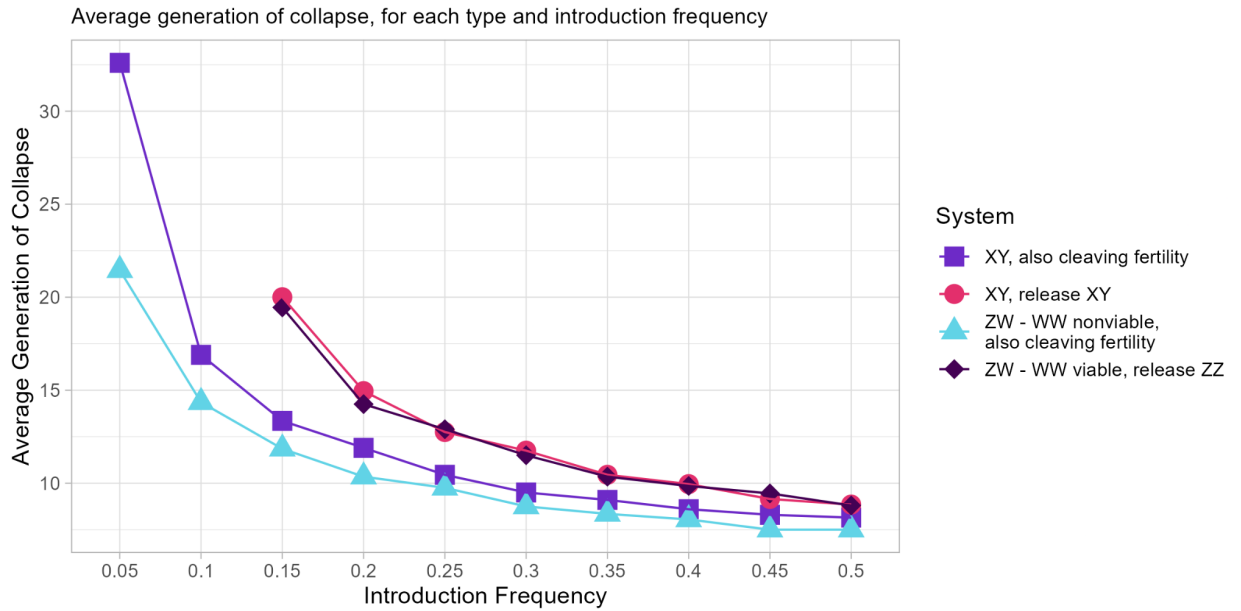
Supplementary Figure 10. Average time to Population Collapse, including addition of an edit that sterilizes females when homozygous. The same as Figure 6B from the main text, but for different sex determination systems and varying modifications. Points plotted here are the average of 20 simulations, where all 20 simulations went to collapse within 50 generations. If all 20 simulations did not go to fixation within 50 generations, the corresponding point is not plotted here. Transgenic individuals were introduced at the corresponding introduction frequency, once every generation, until collapse. Purple squares (XY system) and light blue triangles (ZW system) show that germine cleavage of a haplosufficient gene required in somatic cells for female fertility, as well as a gene required for femalness, significantly increases the efficiency of an Allele Sail as a suppressive mechanism.