Figure Legend

Four views of the joint result of simulation on genetic gain and final genetic standard deviation. Each view presents the same scatterplot, with each point representing one simulation setting. Points are colored black for the current practice and red for the improved practice, with each figure showing a different obstacle to overcome. Lines connect simulation settings that are identical except for the improved practice.

Figure interpretation:

1. The lack of interaction between simulation setting factors is shown by the generally parallel orientation and similar length of the lines: changing one factor in the settings has basically the same effect regardless of the levels of the other factors.
2. The orientation of the lines points toward higher genetic gain and lower final genetic standard deviation for all changes in practice, ***except*** for increasing the number of plots evaluated. In that case, lines are close to vertical indicating that the principal effect of this change would be to cause greater variance to be retained, without increasing the gain from selection substantially.

The domestication process of sugar kelp in the Northeast U.S. was initiated via selective breeding two years ago. In this study, we will demonstrate how obstacles for accelerated genetic gain can be assessed using simulation approaches that inform resource allocation decisions in a breeding program. Thus far, we used 140 wild sporophytes (SPs) that were sampled from the northern Gulf of Maine (GOM) to southern New England (SNE). Gametophytes (GPs) and over 600 unique crosses were made using SPs collected from different locations while respecting a natural geographic barrier separating GOM and SNE. The biphasic life cycle of kelp gives a great advantage in selective breeding as we can potentially select both on the SPs and GPs. However, several challenges exist, such as the amount of time it takes to complete a breeding cycle, the number of GPs that can be maintained in the lab, and whether or not positive selection can be conducted on farm tested SPs. Using the GOM population characteristics for heritability and effective population size, we simulated a founder population of 1000 individuals and evaluated the effects of overcoming these challenges in terms of accelerated gain. Our results showed that key factors to improve current genetic gain rely mainly on our ability to induce reproduction of the best farm-tested SPs, and to accelerate the clonal vegetative growth of released GPs so that enough GP biomass is ready for making crosses in the next growing season. If we are to overcome these challenges, we could improve genetic gain more than two-fold over 5 years. Future research should focus on conditions favorable for inducing spring and early summer reproduction, and increasing the amount of GP tissue available in time to make fall crosses.