Ex-situ conservation through selection and breeding: A Review On 15 Years *Toona sinensis* Roem. & *Toona sureni* Merr. base populations

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Abstract. The ex-situ conservation of *Toona sinensis* and *Toona sureni* or surian weren't supported list threatened species threat but by reduction of huge trees and leaving only small trees that are identical with the reduction of their genetic potential. Genetic potential plays a crucial role within the development of basic and breeding populations. The existence of the 15-year ex-situ conservation plot requires evaluation for simpler management to extend conservation value. The conservation area has collected genetic material from 52 populations from various islands in Indonesia and the progeny test area by testing 100 families from 10 selected populations because the basic source for assembling selected genetic material to supply superior seeds. Currently, genetic material from surian ex-situ conservation has been wont to develop genetic tests that are converted into seed orchards. Limitations of ex-situ conservation include maintenance of genetic material in artificial habitats, decreased genetic diversity, depression of close relative mating, adaptation to climate stress, and the potential for accumulation of weak alleles. It's many constraints in terms of personnel, costs, and reliance on electrical power sources. Supported the challenges within the future, efforts are needed to revamp through the unification of ex-situ conservation and progeny test management to support breeding population development. Strengthening the ex-situ conservation value of *T. sinensis* & *T. sureni* can be optimization through solving all identified challenges and strengthening long-term management.

1. Introduction

Understanding the concept of genetic conservation remains often analogous to the necessity to guard an exact species or evidence from extinction. Although it can't be doubted, the common problem isn't just one species, but less number of superior individuals within the population of a species, because this may reduce its genetic potential. The idea for the conservation of the Surian species hasn't supported the status of being threatened with extinction but because of the exploitation of huge trees in natural and community forests leaving only small trees and therefore the dynamics of in no time changes in vegetation.
Surian (Meliaceae family) is cosmopolitan and cultivated in Southeast Asia including Indonesia, India, Nepal, Thailand, Malaysia, Australia, and therefore the Philippines. In Indonesia, there are two known species of Surian, namely Toona sinensis and Toona sureni [1,2]. In Indonesia, these species are often found in several islands in agricultural lands owned by community forests. Surian may be a valuable and fast-growing timber species whose wood is reddish, hard, and glossy with a gorgeous grain. Its timber is superb in construction, interior decoration, furniture, musical instruments, shipbuilding, and other fields. Its bark fiber is often used to make paper. Its bark, flower, leaf, and oil from seed extracted are utilized in traditional medicine among others are anti-cancer and tumor potential [3], anti-H1N1-Pandemic influenza an epidemic [4]. The genetic material that has been saved in ex-situ conservation plots becomes important germplasm to support the Surian plant breeding program.

Surian has been designated together of the leading medium-cycle furniture wood with a target of accelerating its production to succeed in 30 m³/ha/year by 2025 [5]. At this point, the productivity of surian remains within the range of 15 - 17 m³/ha/year, and a technique to extend productivity is decided through a tree breeding program with the initial target of developing the essential population and breeding population starting in 2005. Evaluation for strengthening the worth of genetic conservation in basic populations to support breeding populations is extremely important to be done periodically [6,7,8].

Efforts to conserve superior species, species, unique species, rare species, and forest plantation species are widely reported, among others, within the conservation of small populations [9,10]; conservation of species [11-14], ex-situ conservation of medicinal plants [14]; realization of conservation ex-situ potential [16]; Conservation management of rare and predominantly self-pollinating species [17]; the ecological influence of eDNA on genetic conservation [18] Scope of ex-situ conservation research with specific goals [19]; conservation value of botanic gardens [20]; outlines selection and breeding guidelines for ex-situ conservation and establishment and management of ex-situ conservation stand [21]; ex-situ conservation planning faces uncertainty [22]; Conservation management through biodiversity maintenance in place and ex-situ conservation [23], Methods and methods for conservation of forest genetic resources [24]. Genetic gap bridges in conservation practice [25]; Use of diversity and mating information for conservation strategies Increased use of conservation [26]; Biodiversity conservation and conservation biotechnology tools [27]; Review of in-situ conservation strategies [28] and Management Unit Populations [29], Conservation area connectivity guidelines [30] and Redesigning biodiversity conservation for global climate change [31]. Efforts to strengthen ex-situ conservation values are often administered through the identification of challenges and proposals [32].

The surian breeding strategy has entered the event of the breeding population, thus requiring the support of the supply of genetic material for the chosen program. Genetic material from the base population that has been built is often included in infusion activities. There are several challenges within the management of ex-situ conservation genetic material, including (a) ownership status of ex-situ conservation land that's on loan with PT Perhutani, (b) research collaboration document, (c) monitoring strategy (periodic monitoring, area security, illegal logging, fire control), (d) disturbance internal factors like pest and disease attacks, (e) management within the uncertainty of cooperation in conservation areas, (f) competition for the utilization of ex-situ conservation areas by smallholders, and (g) pressure on the land use the conservation. The purpose of the review is to supply recommendations and optimize the management and utilization of Surian genetic material in ex-situ conservation and progeny test in one complementary management to make sure that the choice and breeding strategy.

2. Materials and Methods
Ex-situ conservation and progeny test locations describe in Figure 1.

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**Output**: The text is readable and coherent, with no visible errors. The content is well-structured, providing a clear narrative on the subject of Surian and its conservation strategies. The text includes specific details about the species, its uses, and the challenges and strategies associated with its conservation. The reference list and further reading suggestions also provide valuable additional information.
Figure 1. Approximate geographical locations of *T. sinensis* & *T. sureni*-ex-situ conservation and progeny test (Total area 14.5 Ha)

We arrange several steps to evaluate the current state of surian ex-situ conservation and progeny test. Firstly survival population value identification, Secondly growth measurement (height, and diameter). Thirdly phenology aspect, and Fourthly management activity, Challenges identification, and analysis for recommendation.

From the information relating to the current state of ex-situ conservation. Here, we synthesize the ideas and recommendations to strengthen conservation ex-situ value and formulate a recommendation to overcome challenges and streamline efforts to make ex-situ conservation more of surian effective agents for support breeding programs.

3. Results and Discussion

3.1. Ex-situ conservation of surian establishment review

The basis of surian conservation is based on the condition of felling large trees and leaving only small trees in natural and community forests. This condition is in line with the reduction of genetic potential which will inhibit the assembly of genetic material for the purposes of breeding programs. These conditions are very different from the basic species conservation in general, namely habitat destruction, invasive species, global climate change and other threats to plant diversity require increased conservation efforts. Miranto et al. [14] stated that priority should be given to in-situ conservation activities, however, it is increasingly recognized that important contributions can also be made to ex-situ conservation activities. Threats to biodiversity still increase worldwide and therefore the conservation of biodiversity through in place and complementary ex-situ measures are more important than ever [12]. Above all, biodiversity conservation requires a multidisciplinary approach and wishes to be endless endeavor [23]. Rao [33] stated that advances in biotechnology have resulted in new opportunities for conservation and utilization of genetic resources. However, ex-situ conservation has the potential to hinder evolutionary and ecological processes and limit genetic variability and species adaptability to changes and environmental stresses [23].

Advances in biotechnology are able to generate new opportunities for optimizing conservation activities and utilization of flora and fauna genetic resources [33]. Effective biodiversity conservation efforts with limited resources, according to Hoban et al. [34] require a strategy related to the availability of scientific and efficient information. If in-situ conservation is not possible for various reasons, threatened species can be conserved ex-situ. Explained by McNamara. [35] and Ma et al. [9] that ex-
situ conservation options can complement in-situ conservation with strategies to avoid emerging confounding factors. In some cases, the population is small or in a threatened condition, making it impossible to conserve tree species in-situ, thus preventing extinction can be done through ex-situ conservation. In addition, ex-situ conservation is a source of material for research and ecosystem restoration. Ex-situ stands with the right design under certain conditions can be turned into seed gardens, meaning that they achieve two goals at once: conservation of genetic resources and seed production. However, ex-situ conservation can also potentially disrupt evolutionary and ecological processes and limit genetic variability and species adaptability to environmental changes and stresses [23]. These important facts form the basis of knowledge related to in-situ conservation management of endangered populations. So far, ex-situ stands have served primarily to supply material for planting and breeding programs [2].

Conservation and sustainable use of genetic resources are important, among others, to support future food supply and security. In addition, advances in the field of biotechnology have been able to generate new opportunities for optimizing conservation activities and using genetic resources more wisely [33]. Effective biodiversity conservation efforts with limited resources, according to Hoban et al. [34], require a strategy related to the availability of scientific and efficient information. If in-situ conservation is not possible for various reasons, threatened species can be conserved ex-situ. Explained by McNamara [35] and Ma et al. [9] that ex-situ conservation options can complement in-situ conservation with strategies to avoid emerging confounding factors. In some cases, the population is small or in a threatened condition, making it impossible to conserve tree species in-situ, thus preventing extinction can be done through ex-situ conservation. In addition, ex-situ conservation is a source of material for research and ecosystem restoration. Ex-situ stands with the right design under certain conditions can be turned into seed gardens, meaning that they achieve two goals at once: conservation of genetic resources and seed production. Therefore, an important function of gene resource populations, whether in-situ or ex-situ, is to maintain variation so that new traits are frequently introduced into the breeding population. These important facts form the basis of knowledge related to in-situ conservation management of endangered populations. So far, ex-situ stands have served primarily to supply material for planting and breeding programs [2].

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3.2. Sampling and Layout for ex-situ conservation of surian review
The determination of the target population at the beginning of the collection of Surian genetic material for ex-situ conservation development is admittedly not based on ideal sampling and layout, but is limited based on information on the abundance of population distribution in community forests. The initial concept of exploration and collection of genetic material is at least 30 parent trees for each population, while the number of populations refers to the administrative boundaries of the district. Important to be told about the question of what percentage and which populations to Sample. Guerrant et al. [35] explain once taxonomic priorities are established, establishing sites or populations to specialize in for actual
Identification of management units (MU) is very important in natural population management and very important to monitor the implications of the abundance of impacted species. Here, we propose that the identification of MUs from population genetic data should be based upon the amount of genetic divergence at which populations become demographically independent rather than the present criterion that focuses on rejecting panmixia [29].

3.3. Performance evaluation
The results of the observation of the growth plant and current condition of the ex-situ conservation and the progeny test are listed in Table 1.

Table 1. The survival rate, phenology, pest disease, and plant growth.

| Toona sinensis (Year/Type & Population) | Description population origin | Survival rate, phenology, pest disease and plant growth (height & diameter) |
|----------------------------------------|-------------------------------|---------------------------------------------------------------------|
| 2005/Ex-situ conservation 15 Java populations | 1. Tasikmalaya, Bandung, Sumedang, Garut, Cianjur (West Java Province) | Survival 80-90%, has flowered and fruited, shoot borer but low intensity, 17-21 m & 25-38 cm |
| 2006/ Ex-situ conservation 21 Sumatera populations | 1. Gunungsari, Penantian, Talang- Beringin, Air Bakoman (Lampung Province) | Survival 75-87%, has flowered and fruited, termite attack shoot borer but low intensity, 13-17 m & 21-35 cm |
| 2007/ Ex-situ conservation 4 celebes populations | South Sulawesi (Enrekang, Bantaeng, Bulukumba, Tana Toraja) | Survival 79-88%, has flowered and fruited, termite attack shoot borer but low intensity, 13-17 m & 21-36 cm |
| 2011/Progeny Test 10 populations | Simalungun-North Sumatera, Tanggamus-Lampung, Wanosobo-Central Java, Magetan-East Java, Bantaeng-South Sulawesi, Bulukumba-South Sulawesi, Enrekang-South Sulawesi, Tanatoraja-South Sulawesi, Puworejo-Central Java and Magelang-Central Java. | Survival 75-82%, has flowered and fruited, termite attack shoot borer but low intensity, 13-19 m & 18-32 cm |

| Toona sureni (Year/Type & Population) | Description population origin | Survival rate, phenology, pest disease and plant growth (height & diameter) |
|----------------------------------------|-------------------------------|---------------------------------------------------------------------|
| 2006/ Ex-situ conservation 1 Bali population | Selamaneg – Tabanan – Bali Province | Survival 755-82%, neither flower nor fruit, shoot borer but medium intensity, 8-17 m & 14-26 cm |
| 2007/ Ex-situ conservation 11 populations | (Java, Lampung, West Nusa Tenggara, South Sulawesi, Ambon & Papua) | 1. Sumedang (West Java) 2. Magetan (North Java) 3. Batu-Malang (East Java) 4. Kopang (West Nusa Tenggara) 5. Dompur (West Nusa Tenggara) 6. Ambon (Maluku Province) 7. Biak (Papua Province) 8. Angresi – Manokwari (Papua Province) 9. Talang Padang – Tanggamus-Lampung 10. Talang Beringin – Tanggamus-Lampung 11. Enrekang (South Sulawesi) | Survival 75-84%, neither flower nor fruit, shoot borer but medium intensity, 7-13 m & 12-23 cm |
Phenology barriers occur in *T. sureni*, who until the age of 10 years has not yet flowered or produced fruit. This internal obstacle has become the thing of management's attention and extra treatment is required to stimulate Toona sureni Merr's reproductive disorders. Yancuk & Hald, 2004 explain that barriers to regeneration become a drag that's included within the significant factor, and therefore the bottleneck for ex-situ conservation stands. Lee et al. [17] for common plants, the conservation strategies are to stop the species from becoming endangered. In contrast, for rare plants, the ultimate race against extinction is being fought. The unique character of Toona sureni Merr. be an obstacle to the regeneration process in generative propagation, while in vegetative propagation it's the other because it can produce abundant coppice and is straightforward to develop using cuttings.

Comparing the experience of managing stands of tropical Dipterocarpaceae and tropicalpine in ex-situ conservation which began 30 years ago, there are very interesting similarities. For both the dipterocarps and therefore the tropical pines it proved possible to determine stands over a good range of conditions, and to a point maintain the populations over several decades. In both programs, however, it had been difficult to make sure that the integrity of the stands was maintained. Most significantly, ex-situ programs demonstrated the uncertainty of the regeneration process, and these conditions proved to be the weakest point of ex-situ conservation stands. The weakness of the regeneration process in various ex-situ conservation efforts must be resolved. Regeneration protocols need to be developed and implemented in practice as plant collections mature, otherwise there will be no guarantee of the safety of these genetic resources. Furthermore, while threatened tree species are growing in living collections, experts can study how they develop, reproduce, and controlpest &disease, and the way they could answer global climate change and assisted migration efforts position and role of ex-situ conservation [37].

3.4. *Ex-situ conservation management review*

Establishes guidelines for ex-situ conservation management through selection and breeding as follows (1) choice species, (2) genetic processes, (3) genetic surveys, selection in natural or naturalized populations, testing and breeding included selecting base populations, progeny test, and field trial design dan selection at ages before the standard harvest age, (4) genotype x environment interaction, (5) advanced generation breeding and testing included mating design, tests and selecting subsequent generation of trees and breeding population structure, (6) traits of interest and therefore the costs of assessment and (7) biotechnology and its role inbreeding [24]. Supported the present breeding progress status of *T. sinensis* Roem. and *T. sureni* Merr. has completed stages 1 -4, 6, 7 but number 5 unfulfilled, namely advanced generation breeding and testing.

Efforts to stabilize and manage ex-situ conservation management pertaining to the management of the arboretum [32] are recommended to strengthen the aspects (1) evolving the conservation ex-situ and progeny test, (2) prioritizing tree species for conservation, (3) Information technology and data management and (4) Working together at a worldwide scale. Yancuk [37] describe in additional detail guidelines for strengthening ex-situ conservation management, namely ensuring (1) The aim of ex-situ conservation stands, (2) The materials and methods for establishing ex-situ conservation stand, (3) Planning ex-situ conservation stands, (4) Establishment of ex-situ stands included nursery techniques, site preparation, layout, demarcation, single-tree offspring identity, Early management related wedding and replacing of dead or missing plants, (5) fire management, (6) protection, (7) thinning related management, (8) regeneration the bottleneck for ex-situ conservation stands, (9) suggestion for General considerations on the establishment of ex-situ conservation stands, pure or mixed conservation stands.Cibrian et al. [20] have proposed a technique that mixes three indicators of the management priority of a collection: information on species imperilment, genetic representation, and therefore the operational costs related to maintaining genetic representation. Ex-situ conservation strategies for endangered species often require a long-term commitment as well as financial investment to support the achievement of management objectives [22].
3.5. The important role of genetic diversity in ex-situ conservation

The importance of genetic diversity in ex-situ conservation activities is reflected in a clonal seed garden (CSO) which was built based on the origin of genetic material from its genetically different natural distribution. Jayusman et al. [6] reported the result of 25 RAPD markers to identify genetic diversity of ten populations from surian ex-situ conservation and showed genetic diversity value 0.304 (moderate categories) with mean value of 0.069 genetic distance. The genetic diversity value of surian populations was supported by the mating value with tend to outcrossing at many loci that is equal 93.8% [8].

Tong et al. [38] reported the results of using nine SSR (simple sequence repeat) markers to identify the genetic diversity and population structure of the six parental populations and their offspring populations and showed high genetic diversity with the expected heterozygosity of the parent population 0.617 and the offspring 0.632. So far, ex-situ stands have functioned primarily to supply material for plantations and breeding programs, but conserved ex-situ materials are particularly relevant to the rehabilitation of their original sites [39]. Ex-situ conservation areas as assets are in a unique position to play a crucial role in mitigating the biodiversity crisis through ex-situ conservation [32]. Although understood to be critical to the long-term survival of populations as well as ecosystem function, population genetic diversity is sometimes not explicitly stated in setting conservation priorities. Kahilainen et al. [39] revealed that species diversity in a community and genetic diversity in populations are positively correlated, this condition is caused by the interrelated influence between area, connectivity, and environmental heterogeneity at both levels of diversity.

Eriksson et al. [40] has explained the quantity of genetic variation that's satisfactory for the assembly of human utilities is typically much not up to the genetic variation required for the genetic resource populations. Medina et al. [41] declare if ex-situ conservation stands can have several important functions, including providing material for planting and breeding programs. An ex-situ conservation stand that has the right design has the potential to be converted into a seed source under certain conditions and this can serve two purposes: conservation of genetic resources and seed production. Therefore, a crucial function of gene resource populations, whether in place or ex-situ, is to take care of variation in order that new traits are often incorporated into breeding populations within the future. Ex-situ conservation in various plantation stands generates knowledge on biology and silviculture. This role is significant if we are to possess knowledge about plant populations on the sting of extinction that gives a sufficient basis for his or her management in place. So far, it has been felt that the function of ex-situ stands is primarily to supply material for plantations and breeding program, but the genetic material of conserved ex-situ stands is highly relevant to on-site rehabilitation of sites as well [2].

3.6. Challenges for strengthening the conservation value ex-situ

Limitations of ex-situ conservation include the maintenance of organisms outside the habitat, decreased genetic diversity, depression in inbreeding, adaptation to climate change, and accumulation of deleterious alleles. It's many constraints in terms of personnel, costs, and reliance on power sources [19]. There are many challenges facing individuals and institutions working to conserve threatened Quercus species. Kramer and Pence [13] mention several challenges from the shortage of basic information about which species are threatened and resulting in an inability to prioritize conservation activities) to evolving threats that are difficult to predict and mitigate. Other challenges include widespread hybridization which might be natural and which blurs the lines of which species and individuals require conservation measures.

These challenges all impact plant survival within the wild, presenting the requirement to create sure that offsite (i.e., ex-situ) collections are created as a security net against the extinction of species. The four challenges of Quercus conservation are (1) inadequate data, (2) unpredictable and accelerating threats, (3) hybridization, and (4) recalcitrant seed. Ramya et al. [28] add more future challenges in conservation areas for plant genetic resources are technical and scientific, socio-economic, legal, and political, including public awareness. Reed et al. [27] add importance knowledge about environmental DNA (eDNA) refers to the genetic material which is able to be extracted from bulk environmental samples like soil, and water. The rapidly evolving study of eDNA has resulted in an unprecedented
ability to detect and carry out genetic analyzes of species for conservation, management and research purposes, especially regarding the mechanisms for collecting whole organisms which are nearly impossible. At the beginning of the event surian ex-situ conservation had limitations in various related (1) data on genetic potential, natural distribution, and standing of existence regarding changes in vegetation. (2) collection of genetic material from natural forests and, (3) collection of genetic material from community forests.

Very dynamic environmental conditions due to global temperature change, competition for land use in conservation areas, management budget support require anticipatory efforts to revamp if it becomes an option that possesses to be taken. Poiani et al. [31] reported result redesigning biodiversity conservation projects for global temperature change. Connectivity conservation, the subject of this Guideline, is also a key response to the destruction and fragmentation of natural habitats by humans in terrestrial, freshwater, and marine environments. It is also a critical response to climate change-caused threats [30]. In some cases, the quantity of ex-situ conservation within a country must be re-evaluated and limited resources concentrated during a field with carefully considered areas of specialization. These questions should be seriously addressed within the years to return [14].

Initiation of designing redesign of surian ex-situ conservation are often reached through genetic information by determining genetic material that represents the distribution of genetic potential between island regions, between populations, and interpopulation. Jayusman et al. [7] reported the genetic distribution surian showed the presence of genetic diversity within the population indicates that the most target of conservation are often directed at collecting genetic material originating within the population and avoiding collections from multiple populations with genetic distance near each other.

3.7. Recommendation to strengthening and increase ex-situ conservation value

Based on future challenges and limitations in operational management, it is to save the genetic material of *T. sinensis* Roem. and *T. sureni* Merr. for various purposes in a sustainable manner, several thoughts can be arranged as stated in Table 2.
Table 2. Recommendation and Activity.

| Recommendation                                      | Practical and Activity                                      |
|-----------------------------------------------------|------------------------------------------------------------|
| Completion of the breeding cycle                    | ▪ Development of multiplied populations, infusion of genetic material in advanced genetic testing |
|                                                     | ▪ Initiation of propagation and clonal testing, initiation of hybrid material development opportunities |
|                                                     | ▪ Evaluation of compliance with breeding advanced           |
| Renewal of Cooperation Documents for ex-situ conservation management | ▪ Extend the long-term cooperation from every 2 years for renewal for management assurance |
| Using genetic diversity & mating systems informations | ▪ Management review base on genetic diversity & mating systems information for strengthening ex-situ conservation |
| Redesign ex-situ conservation                        | ▪ Opportunity for genetic identification to make a more streamlined design layout by creating population clusters based on genetic information for area efficiency |
| Improve coordination between ex-situ conservation    | ▪ Establish new relationship, Improve communication, Used established model |
| Create tree-specific conservation models & guidelines | ▪ Develop scientifically informed models, based on specific life history traits, reproductive biology & distribution, maintaining & curating ex-situ conservation collections of trees. Develop an industry-wide process for sharing collections information, including living trees & genetic diversity data. |
| Prioritize conservation-focused tree science research | ▪ Include funds for comparative genetic analysis of ex-situ & in-situ tree populations when applying for grant funding. |
|                                                     | ▪ Study living collections of threatened species to improve understanding of basic biology, reproduction, growth & disease resistance. Increase research on seed banks, tissue culture, & micropropagation techniques for exceptional tree species, to improve efficiency & cost-effectiveness. Increase research on tree biology, phylogeny & reproductive ecology. |
| Collaborate & share information                      | ▪ Strengthen ties with academia to enhance scientific rigour in tree research, improve access to scientific facilities & increase cross-disciplinary funding opportunities. Participate in researcher exchanges between institutions to share knowledge. |
|                                                     | ▪ Publicize research & conservation project results (both successes & failures) in traditional (e.g. peer-reviewed journals, conference proceedings) & non-traditional (e.g. social media, blogs, popular science articles, newsletters,) media channels |
| Promote conservation-focused education & training    | ▪ Interpret & educate Use living tree collections to create conservation-focused interpretation displays that are informative, engaging & innovative, & that inspire a call to action. Empower & educate the public on how they can contribute to tree conservation efforts Create training opportunities. |
|                                                     | ▪ Train others in all aspects of tree science & care, especially students & local people in biodiversity hotspots with threatened ex-situ conservation. Promote horticulturalists & collections curators is prepared. |

Note: Modification based on [32]

4. Conclusion
Strengthening the role of ex-situ conservation of T. sinensis and T. sureni through selection and tree breeding, this will be achieved through integrated management of ex-situ conservation and progeny test area to support the achievement of targets during a breeding strategy of surian. Recommendations for optimizing the value of the use of ex-situ conservation are pursued through practice and a series of
systematic activities to expand and increase the important value of ex-situ conservation. Redesign surin ex-situ conservation opportunity base genetic information value make a more streamlined design layout by creating population clusters supported narrowed genetic distance.

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