Guidelines for establishing and managing an oak metacollection site

US Region

Version 2023-1

Global Conservation Consortium

Oak

LED BY The Morton Arboretum

Oak collection at The Morton Arboretum. Photo by Emily Beckman

BOTANIC GARDENS CONSERVATION INTERNATIONAL

FOREST SERVICE US DEPARTMENT OF AGRICULTURE

UNITED STATES BOTANIC GARDEN

INSTITUTE of Museum and Library SERVICES

Background on the GCCO

The Global Conservation Consortium for Oak (GCCO) brings together the world's oak experts, conservationists, and the botanic garden community to ensure that no wild species of oak becomes extinct. Because oak acorns cannot be seed banked for long-term conservation, one of the core objectives of the GCCO is to conserve genetic diversity of priority oak species via coordinated living *ex situ* collections - metacollections - of high conservation value. In the US, the GCCO will focus on coordinating metacollections for the species of conservation concern identified in the Conservation Gap Analysis of Native US Oaks (Beckman et al., 2019, and listed below). The Consortium plans to work with numerous stakeholders from different sectors, as oaks are large and long-lived, so space and capacity are two factors to address to effectively grow and conserve the oak species of conservation concern in the US. Working with gardens, universities, municipalities, government managed land, tribal lands, land conservancies, provenance trial sites, living gene banks/repositories, seed orchards, and other similar sites will be key to successfully meeting this objective.

Background on Metacollections

Published by BGCI in 2019, *Toward the Metacollection: Coordinating conservation collections to safeguard plant diversity* (Griffith et al., 2019), defines a metacollection as: "The combined holdings of a group of collections. For gardens, metacollections are envisioned as common resources held by separate institutions but stewarded collaboratively for research and conservation purposes. Networking multiple collections into a single metacollection increases potential coverage within a group, allows broader access to greater diversity, dilutes risk of loss, and can reduce maintenance costs. The American Public Gardens Association's Multisite Collections, BGCI's Global Conservation Consortia (GCC) and the CPC National Collection are established examples of metacollections. Like any collection, a metacollection can be of any scope or taxonomic level."

GCC Members' Role(s) within Metacollections

The metacollection concept is aligned with the Global Conservation Consortia (GCC) objective to: "Establish and manage coordinated *ex situ* collections of high conservation value". Specifically, the GCC has designated Species Stewards which are institutions, represented by named individuals, that commit to long-term management of priority species at:

(1) *ex situ* sites such as at a botanic garden or other collection;
(2) near situ (or similar) conservation sites, such as plantations or reintroduction sites within the natural range of a species; and/or
(3) sites where priority threatened species grow *in situ* as part of the native ecosystem (e.g., forest plots or reserves).

Species Stewards may manage priority species at any combination of conservation sites, which constitute a portion of the metacollection for a priority species.

Species Stewards for particular species may identify Species Coordinators who may compile, coordinate, and report activities among Species Stewards and Consortium Affiliates (Affiliates may support,

collaborate, or advise on any Consortium activities in coordination with the Consortium Steering Committee and/or Species Stewards) for the priority species.

Purpose of document

This document is meant to serve as a guide for those establishing, managing, and/or supporting the development of a metacollection site(s) for one or more priority oak species. This is a dynamic document, as updates will be made on a quarterly basis and/or as new information becomes available that is relevant to include. This document provides information for developing metacollections for oaks native to the United States, but we hope this approach will be applicable in other regions. Also, we are planning to adapt this document into other versions which would incorporate information and guidelines for the other priority oaks around the world.

Contact

As you read through this document, if you have any questions, feedback or comments, please reach out to the designated contact: Amy Byrne, GCCO Coordinator.

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Characteristics of an ideal oak metacollection site

- Available acreage to plant 10s-100s of oak trees
- Ability to care for trees, especially in the first few years of establishment, including watering, pest control, mowing, etc.

- Ability to assess site(s) characteristics (hydrology, soils/geology, exposure/aspect, etc.) to see how they might or do affect the growth habit of the priority oak species (silvics)
- Ability to monitor and gather data on tree health (e.g. trunk, limb and leaf health), growth, reproductive capacity, and pests/pathogens
- Site longevity, such that the trees will be maintained for 20+ years
- Site accessibility and security (so the right people can access the site at the right times)
- Ability to maintain provenance data (origin of the material) and identification labels on trees
- Ability and willingness to exchange plant material and data with key stakeholders (e.g., other GCCO members, researchers, land managers)

Where/how to obtain plant material?

- Please check with Consortium partners for material. You can contact the various sub-regions through Google Group communications
    - gcco-western-us@mortonarb.org
    - gcco-eastern-us@mortonarb.org
    - gcco-texas-southwest@mortonarb.org
- Also, this spreadsheet, is another resource to look at for material
- Please check with the GCCO Coordinator for other potential sources of material
- If you are interested in receiving material from a certain species, please fill out this germplasm exchange spreadsheet, in which the GCCO Coordinator and other members can view to know who is interested in receiving additional material
    - If you have additional material, please share this with the GCCO Coordinator directly, or upload the information to BGCI's PlantShare
- Contact your local arboretum/botanic garden's curator
- Collect seeds from wild populations (see collecting considerations below)
- If seed collection is not successful, you can collect woody material for grafting to produce stock plants
    - This would be particularly effective for species that do not produce a lot of seed and have small populations such as *Q. robusta* as it would be possible to propagate every plant, even without acorns.
- Check out the GCCO Oak Collection and Storage Guidance Brief

What to consider when collecting/obtaining metacollection material to grow

- Evaluate which populations are represented in existing ex situ collections to prioritize collecting from populations that are underrepresented, identify ex situ individuals that could be backed up at your site, and strategically shape your site for the greatest compatibility to the broader metacollection (i.e. how is your site contributing to the overall species metacollection? For

example, is it hosting rare individuals, is it hosting individuals from a population that is only backed up at one other site, etc.?)
    - Connect with the GCCO Coordinator for collections information for one or more of the 29 species of conservation concern
- Consider genetic diversity; ideal to collect from multiple wild populations, and multiple maternal lines within each population to capture sufficient diversity in your collection
    - Refer to the Hoban et al., 2020 paper for more information
    - Refer to Rosenberger et al., 2021 paper for more information
- Consider related species already at or near your site, if they might pose a challenge to future breeding efforts (i.e., hybridizes easily with target species)
- Consider climate compatibility (now and in the future) of your site with target species
    - SelecTree, a tree selection guide; The California Polytechnic State University
- Consider the potential pest/pathogens associated with the species and/or in its native habitat; check out the Sentinel Plant Network for up to date information
- Consider the life history of the species and its growth habit (e.g. how large does it get at maturity)
- Sustainably/responsibly collect from a wild population(s) following the legal obligations in place in the region of collection
- Document the collection appropriately, ensuring that these priority fields from the accessions level data template are filled out
- Wild provenance material is high priority for genetic conservation, and so tracking provenance information is important but not to discount non-wild origin (or undocumented wild origin) provenance material, especially if that is the only material remaining for the species

Steps/timeline for establishing a metacollection site

- Consider the best planting strategy for the species and location. You can:
    - Directly plant the seeds with protective measures in place as acorns are prone to herbivory
    - Grow the seeds out into seedlings for then planting out
- If planting seedlings, grow the collected seeds for 3-5 years or until they are at a durable size (see more information on how to best propagate seeds of the specific species you are looking to grow in the table below, if included; this information is a work in progress)
    - If the seedlings are kept in pots, you need to ensure the roots are not restricted and you can move them to larger pots as needed
    - Gradually give more light to the seedlings as they grow in the nursery; more light helps to ripen the wood
- Full site preparation for planting, things to consider:
    - Site history
    - Conducting soil tests, determining the soil texture
    - Determining hydrology and slope

    - Access to water
    - Vehicle access to site
    - Site security
    - Pest/pathogen management
    - Local seasonal impacts, susceptibility of site to disturbance/disasters (i.e., is the site prone to flooding, fire, etc.)
    - Assess and manage vegetation already on the site as appropriate, including identification and removal of invasive plants, undesirable plants (ex: poison ivy), weeds, etc.
    - Encourage soil health, and avoid using herbicides when possible
    - Mark where the seedlings will be planted considering the appropriate amount of space between them so that long term growth and development is possible
- Planting: Best planting practices are specific to the climate at the planting location and the target species
    - Want to ensure there is a large enough window of time for roots to establish before the weather changes to prevent the plants enduring a lot of stress (e.g. very dry/hot weather, or freezing temperatures)
    - Dig holes two times the width of the root ball and at the depth where root flare is visible
    - If the existing soil from the planting hole has a high clay content, you can add 10-15 percent organic matter (leave mold or compost) before backfilling the hole
    - Fertilization at time of planting is not recommended
    - Apply even layer of mulch (3-4 inches deep); not needed, but increases tree growth
    - If herbivory is anticipated, install cages or tubes as needed to protect plants from rodents, rabbits, or deer
- Management/care after planting
    - Water seedlings once a week or every 10 days or depending on the season and climate, water as frequently or as little as needed
        - Watering may not be necessary depending on the climate of the garden, however, it is important to check the plants to see if they need water in their first year before the roots have had time to establish
    - When stability is an issue, trunks of trees should be staked for 1-3 years
    - Cut out underbrush, remove weeds/invasive when needed
    - Monitor for health, environmental, etc. issues monthly

Data gathering/documentation

- Accessions level data template; The template is for you to reference when collecting and tracking data for the priority oak species; these are the priority data fields we are gathering data on currently to be used for future analyses, annual reporting and updating of maps to identify gaps in collections. Listed below are some other areas you might want to consider tracking internally, that we will be incorporating into the BGCI PlantSearch Pedigree Module in the future:
    - Parentage (maternal/paternal plant sources)

    - Reproductive Life History
        - Reproductive status (fertile/infertile, pre/post-reproductive)
        - Gamete type (male, female, both, n/a)

Ideas for projects/research to conduct on site

- Phenology studies
    - Tracking growth, fruiting and seed production data and comparing across individuals, populations, and sites to assess patterns
    - Gathering weather data and noting if it is affecting the growth of the plants
    - Having students/volunteers collect data
- Monitoring for pests and diseases, track, and compare across metacollection sites.
- Monitoring for potential hybridization and adaptation, especially if the site is incorporating multiple populations

Climate change/environmental factors to consider

- Climate Mapper tool: allows you to see what the average temperature, among other variables, throughout the different seasons of the year could be in your region under future conditions of higher CO2 emissions or lower emissions--which will help you identify which species you could potentially grow in your region that will thrive given the future climate conditions.
- Climate Change Pressures in the 21st Century (USDA Forest Service): these maps show three metrics that affect plant growth and survival: growing degree days, plant hardiness zones, and heat zones. It maps projections of change over time for the US. Each map compares recent conditions (1980-2009) to conditions under a scenario of high greenhouse gas emissions at the end of the century (2070–2099).
- Seedlot selection tool: provides comparisons between planting sites and where acorns can be collected from places with climates that match that site.

Ideas for what GCCO participants can do to support (on- and off-site) oak metacollection sites

- Collection and/or sharing of material (e.g., seed, grafted material)
    - If you have additional material, please share this with the GCCO Coordinator directly, or upload the information to BGCI's PlantShare
    - Check out the GCCO Oak Collection and Storage Guidance Brief
    - Oak acorn collection video
- Propagation of material to a suitable planting size
    - Check out these short videos on how to propagate and oak species in the nursery from horticulturists at Royal Botanical Garden of Kew and Sir Harold Hillier Gardens
    - Tips on propagating oak species

- Propagation protocol development and distribution to metacollection site partners and where appropriate
- Assist with labeling, plant records
- Long-term metacollection care and management
    - California Oak restoration webinar; Dave Muffly
- Data collection
- Monitoring
- Controlled crossing or breeding for conservation
- Genetic analysis
- Cryopreservation protocol development
- Living Among the Oaks: A Management Guide for Woodland Owners and Managers (specific to oaks in California)
- Guidelines for Planting Native Oaks (specific to oaks in California, but useful, general information about acorn planting and planting seedlings)
- Planting Native Oaks in the Pacific Northwest
- Pest and disease monitoring
    - Check out The Oak Conservation Alliance for more information on pests/diseases to be aware of for oaks
- If you have not already filled out the metacollection needs assessment form, we highly encourage you to do so. The information you provide in the needs assessment will allow Amy and the GCCO Metacollection Design working group to better understand your specific needs and how we can best support your efforts. Thank you!

Additional Resources

- For information on where to obtain germplasm of one of the 29 US species of conservation concern, please contact the GCCO coordinator.
- For guidance on acquiring and maintaining the material for a conservation collection, check out the Center for Plant Conservation (CPC) Best Practices document, chapter "Alternatives to Conventional Seed Banking".
- Check out The Morton Arboretum Plant Clinic for information on planting and growing trees
- Labeling resources
    - Check out the ArbNet website resources section: "Tree Collections" under "Labeling & Walking Maps" for ideas on labeling
    - Lark Labels
    - Plants Map
    - Online mapping and labeling: Google Earth, ArcGIS, R
- Propagation manual(s)
    - Oak Propagation Manual (in Spanish)
    - Check out the RNGR webpage for numerous oak propagation manuals and general propagation techniques

- Citizen science project ideas/resources
    - Having students/volunteers collect data on Budburst (Budburst is a project of the Chicago Botanic Garden)
    - National Phenology Network
- Pest and disease monitoring
    - Check out the International Plant Sentinel Network and/or The Oak Conservation Alliance for more information on pests/diseases to be aware of for oaks
- Guidelines for Securing and Planting Upland Oak Seedlings in the Southern Region

Species of conservation concern of Native US Oaks, Species Specific Resources and Guidelines

Species	Propagation Protocol	Other management guidelines
Quercus acerifolia		
Quercus ajoensis		
Quercus arkansana	https://npn.rngr.net/renderNPNProtocolDetails?selectedProtocolIds=fagaceae-quercus-2014	
Quercus austrina		
Quercus boyntonii		
Quercus carmenensis		
Quercus cedrosensis		
Quercus chapmanii		
Quercus cornelius-mulleri		
Quercus dumosa	https://npn.rngr.net/renderNPNProtocolDetails?selectedProtocolIds=fagaceae-quercus-1674	
Quercus engelmannii		
Quercus georgiana		
Quercus graciliformis		
Quercus havardii		
Quercus hinckleyi		
Quercus inopina		
Quercus laceyi		

Quercus lobata		
Quercus oglethorpensis		
Quercus pacifica	https://npn.rngr.net/renderNPNProtocolDetails?selectedProtocolIds=fagaceae-quercus-3195	
Quercus palmeri		
Quercus parvula	https://npn.rngr.net/renderNPNProtocolDetails?selectedProtocolIds=fagaceae-quercus-667	
Quercus pumila		
Quercus robusta		
Quercus sadleriana		
Quercus similis		
Quercus tardifolia		
Quercus tomentella	https://npn.rngr.net/renderNPNProtocolDetails?selectedProtocolIds=fagaceae-quercus-3194	
Quercus toumeyi		

Frequently Asked Questions

1. What are you considering a 'large' collection for Species Stewards?
    a. A large collection would be in the range of 100s of individual trees planted out, however, if you don't have the space to grow that many trees, up to as many as 10 or more individual trees would be relevant.
    b. If you have extra plant material, but not the space to grow it long-term, the GCCO coordinator can help you identify other Consortium partner institutions to plant material at.
    c. Also, there is an opportunity to be a part of the Oak metacollection Partnership Program. See here for more information. If interested, please fill out this needs assessment.

2. What is the data that would be reported annually to the Species Coordinator? (size, health, numbers?)
    a. Data will be reported to the designated Species Coordinator and/or the GCCO Coordinator (if a Species Coordinator is not assigned) on an annual basis.

b. The data you gather for your designated metacollection accessions will be compiled, and tracked in the Metacollections data template, and later the PlantSearch Pedigree Module. Please ensure you are uploading your collections data to PlantSearch annually; See here for instructions.

3. Are we expected to share germplasm from our collection(s) on a regular basis with other gardens?
    a. No, there is no expectation to share germplasm on a regular basis. The transfer of material will need to be marked in the data template, so we can ensure each individual is tracked. It is best practice to back up unique lineages at more than one site however.
    b. If you are interested in sharing germplasm, and need assistance in identifying institutions to send it to, please contact the GCCO coordinator.

4. What are the ecological and environmental conditions we need to take into consideration when setting up a grove?
    a. Check out the "Climate change/environmental factors to consider" section above.
    b. For more specific information, please contact the GCCO coordinator to set up a meeting with the Metacollection Design Working Group.

5. What other considerations need to be addressed, such as spacing/distribution throughout a landscape or the potential for hybridization with existing oaks in the area?
    a. For specific questions like these, please contact the GCCO coordinator to set up a meeting with the Metacollection Design Working Group.

References

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