

Conservation Gap Analysis of Native U.S. Yews

August 2021

Emily Beckman[1], Abby Meyer[2], David Pivorunas[3], Sean Hoban[1] and Murphy Westwood[1,4]

[1]The Morton Arboretum [2]Botanic Gardens Conservation International, U.S.
[3]USDA Forest Service [4]Botanic Gardens Conservation International

---

Taxus brevifolia Nutt. (Pacific yew)
Taxus canadensis Marshall (Canada yew)
Taxus floridana Nutt. ex Chapm. (Florida yew)

The Morton Arboretum®

BOTANIC GARDENS CONSERVATION INTERNATIONAL

INSTITUTE of Museum and Library SERVICES

FOREST SERVICE U.S. DEPARTMENT OF AGRICULTURE

THE MORTON ARBORETUM is an internationally recognized outdoor tree museum and tree research center located in Lisle, Illinois. As the champion of trees, the Arboretum is committed to scientifically informed action, both locally and globally, and encouraging the planting and conservation of trees for a greener, healthier, more beautiful world. The Morton Arboretum welcomes more than 1.3 million visitors annually to explore its 1,700 acres with 222,000 plant specimens representing 4,650 different kinds of plants. The Arboretum's Global Tree Conservation Program works to prevent tree extinctions around the world by generating resources, fostering cross-sector collaborations, and engaging local partners in conservation projects. The Center for Tree Science seeks to create the scientific knowledge and technical expertise necessary to sustain trees, in all their diversity, in built environments, natural landscapes, and living collections. The Arboretum also hosts and coordinates ArbNet, the interactive, collaborative, international community of arboreta and tree-focused professionals.

BOTANIC GARDENS CONSERVATION INTERNATIONAL (BGCI) is the world's largest plant conservation network, comprising more than 600 botanic gardens in over 100 countries, and provides the secretariat to the IUCN/SSC Global Tree Specialist Group. BGCI was established in 1987 and is a registered charity with offices in the UK, US, China, Singapore and Kenya.

THE INSTITUTE OF MUSEUM AND LIBRARY SERVICES is the primary source of federal support for the nation's libraries and museums. The IMLS advances, supports, and empowers America's museums, libraries, and related organizations through grantmaking, research, and policy development. Their vision is a nation where museums and libraries work together to transform the lives of individuals and communities. To learn more, visit www.imls.gov. The views, findings, conclusions or recommendations expressed in this publication do not necessarily represent those of the Institute of Museum and Library Services.

THE U.S. DEPARTMENT OF AGRICULTURE (USDA), FOREST SERVICE stewards over 193 million acres of forest and grasslands on behalf of the American people with the mission to sustain the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations. Besides the management of National Forest System lands, the USDA Forest Service provides technical and financial assistance to States, universities, and other organizations to support this mission. Additionally, the Agency conducts world renowned research helping to provide answers on pressing issues facing forest managers. This institution is an equal opportunity provider and employer.

ACKNOWLEDGEMENTS

First and foremost, many thanks to the hundreds of institutions who shared their *ex situ* accessions data and/or reported conservation activities. The original analyses presented in this report are made possible through their support and participation, and we hope this synthesis is a valuable resource for advancing tree conservation goals. A special thanks to the Biota of North America Program (BONAP) and USDA PLANTS for providing valuable *in situ* occurrence data, Shannon Still for aiding in the development of methods for spatial analyses, and Christina Carrero for coordinating IUCN Red List assessments for priority species. We also thank Botanic Gardens Conservation International U.S. as well as the Science & Conservation Department and leadership team of The Morton Arboretum for their organizational support, and the Institute of Museum and Library Services (award #MA-30-18-0273-18) for aiding in the funding of spatial analysis methodologies presented here. Finally, this publication was made possible by a grant to The Morton Arboretum under a cooperative agreement with the USDA Forest Service (Cooperative Agreement 16-CA-11132546-045).

The Morton Arboretum, 4100 Illinois Route 53, Lisle, IL 60532, USA.

Recommended citation: Beckman, E., Meyer, A., Pivorunas, D., Hoban, S., & Westwood, M. (2021). *Conservation Gap Analysis of Native U.S. Yews*. Lisle, IL: The Morton Arboretum.

INTRODUCTION

Trees are facing increasing threats globally, including habitat loss, natural systems modification, land use change, climate change, and pests and diseases. With more than 800 native tree species in the continental United States and more than 60,000 tree species globally, prioritizing species and conservation activities is vital for effectively utilizing limited resources. To facilitate this conservation planning, we developed a gap analysis methodology that examines both the accomplishments and most urgent needs for *in situ* (on-site) and *ex situ* (off-site) conservation of priority, at-risk tree groups in the U.S. This methodology was first implemented in our flagship report, *Conservation Gap Analysis of Native U.S. Oaks* (Beckman et al., 2019).

This report is one of seven that present the results of a second phase of gap analyses, which focuses on native U.S. trees within a group of priority genera that were selected due to particular economic importance, potential challenges with conventional *ex situ* conservation, and/or threats from emerging pests and diseases: *Carya, Fagus, Gymnocladus, Juglans, Pinus, Taxus,* and selected Lauraceae (*Lindera, Persea, Sassafras*). In each report, we provide a summary of ecology, distribution, and threats, and present results based on new data from a global survey of *ex situ* collections and a conservation action questionnaire that was distributed in 2019 to a wide range of conservation practitioners in the U.S. and botanical gardens globally. The aim of this report is to help prioritize conservation actions and coordinate activities between stakeholders to efficiently and effectively conserve these keystone trees in the U.S.

ECOLOGY & DISTRIBUTION

There are three species of yew (*Taxus*) native to the United States. They are notoriously difficult to differentiate visually, but their native distributions do not overlap and therefore they are easily distinguished geographically (Flora of North America, 1993; Figure 1). Native U.S. yews are evergreen trees or shrubs with thin, red or purple-brown, smooth bark, which grows scaly with age. With the exception of *T. brevifolia*, *Taxus* species are toxic due to the presence of taxine, which is found in the foliage, bark, and seeds. *Taxus* species have important uses in both past and present culture, including spiritual significance to native peoples and use as a source for the compound paclitaxel used in modern treatment for some types of cancer. Yews also have strong resistance to air pollution and great ornamental value, resulting in hundreds of yew cultivars (Earle, 2020). All three native U.S. yews have decreasing population trends due to a variety of human impacts (IUCN, 2020).

Taxus brevifolia (Pacific yew or Western yew) is distributed in the northwestern U.S., including California, Oregon, Washington, Idaho, Montana, and Alaska, and southwestern Canada. It is an evergreen shrub or small tree reaching 15 to 25 meters in height, and is found between sea level and 2,200 meters elevation. *Taxus brevifolia* can grow in "open to dense forests, along streams, moist flats, slopes, deep ravines, and coves" (Flora of North America, 1993). In most of its range, *T. brevifolia* "grows as a tree beneath a closed forest canopy in late-successional forests dominated by large conifers such as *Pseudotsuga menziesii* and *Tsuga heterophylla*, but in drier open forests such as in the Siskiyous and the eastern Cascade Range it adopts a shrub habit…forming broad mats" (Earle, 2020). Due to its durable yet easily-worked wood, *T. brevifolia* is often used locally for novelty items and has been selectively harvested extensively in some areas (Flora of North America, 1993). On the IUCN Red List of Threatened Species, *T. brevifolia* is assessed as Near Threatened due to a nearly 30% decline in the last century (Thomas, 2013). This decline is attributed to fire and logging, as well as past exploitation for its cancer-treating compounds that are now produced using alternate means. An updated assessment should be carried out in the near future, to confirm the species' status.

Taxus brevifolia (Susan McDougall)

Taxus canadensis (Canada yew, American yew, or Ground-hemlock) has a broad distribution in the northeastern U.S., upper Midwest, and eastern Canada, though its southern extent has decreased in the last century (Thomas, 2013). It is usually an evergreen shrub, no more than two meters tall, that is low and spreading and is found in "rich forests (deciduous, mixed, or coniferous), bogs, swamps, gorges, ravine slopes, and rocky banks" from zero to 1,500 meters above sea level (Flora of North America, 1993). Long-distance dispersal of *T. canadensis* is usually facilitated by birds, though clonal reproduction is more common and leads to layered populations (Earle, 2020). A variety of impacts have caused declines in *T. canadensis*, including "browsing by native ungulates, fire, intensive forest management, and clearing of land for agriculture and other development." Impacts from deer browsing have been recorded as particularly intense in some populations, causing a significant decline in seed production and therefore regeneration (Allison, 1990). The population size of *T. canadensis* is still large enough to place it within the Least Concern category on the IUCN Red List, but reassessment should be prioritized (Thomas, 2013).


Taxus canadensis (Ed Hedborn, The Morton Arboretum)

Taxus floridana (Florida yew) is a rare yew, endemic to the Florida panhandle. It is a shrub or small tree, six to ten meters in height, with stout, spreading branches. *Taxus floridana* habitat is "moist, shaded ravines in hardwood forests," at elevations between 15 and 30 meters (Flora of North America, 1993). It is ranked as Critically Endangered on the IUCN Red List, due to its very small range: "a 24 km section of ravines and bluffs along the Apalachicola River in Liberty and Gladsden counties." In addition to its limited distribution, *T. floridana* faces threats from low regeneration and increased deer grazing, causing the population to continue to decline. The root cause of insufficient regeneration is not yet understood. *Taxus floridana* is protected in several natural areas, including the Nature Conservancy's Apalachicola Bluffs and Ravines Preserve and the Torreya State Park (Spector et al., 2011).


Taxus floridana (Tom Cox)


Taxus canadensis (Ed Hedborn, The Morton Arboretum)

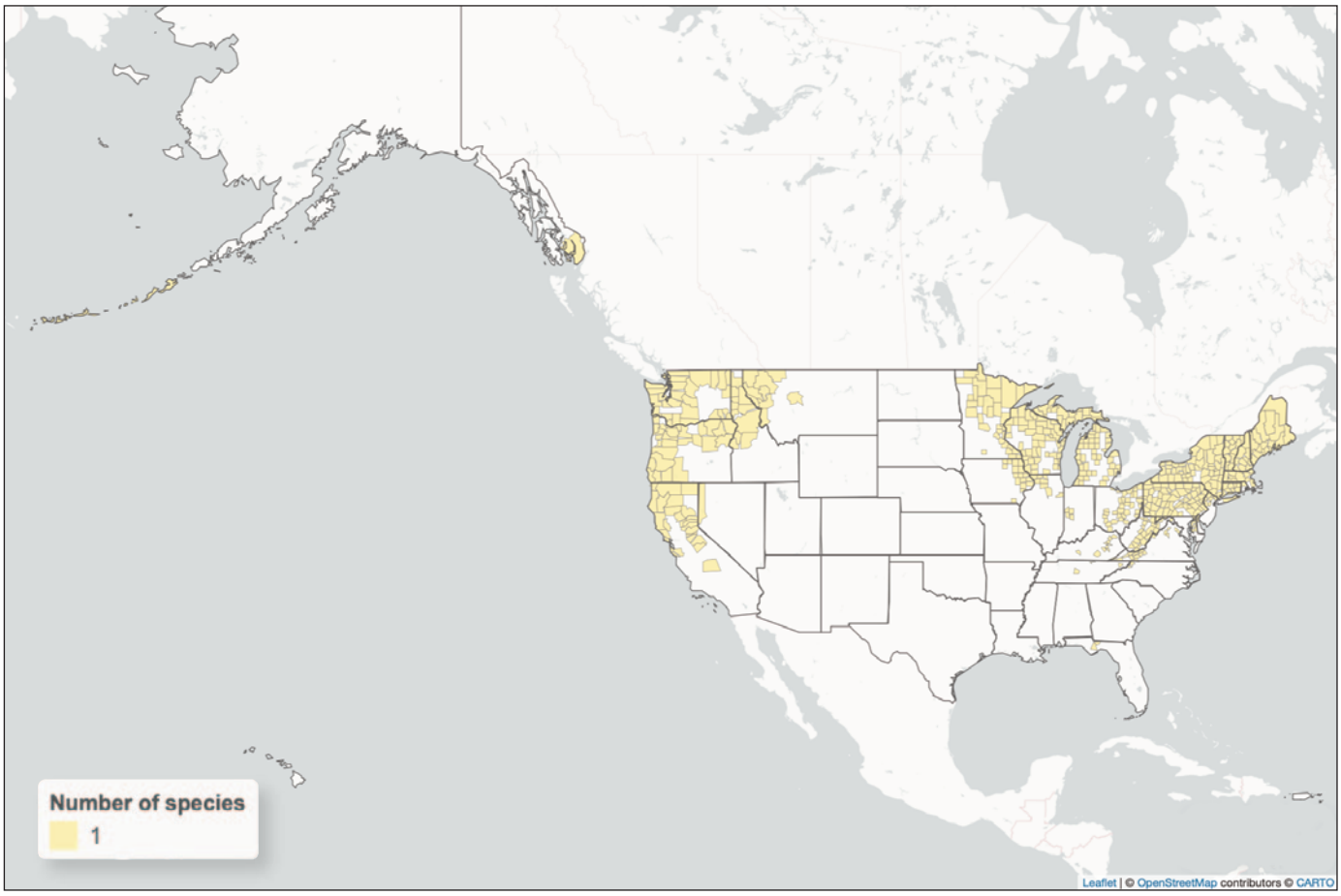


Figure 1. Species richness of native U.S. *Taxus* species by U.S. county, including *T. brevifolia, T. canadensis*, and *T. floridana*. County level distribution data from USDA PLANTS and Biota of North America Program (BONAP) have been combined to estimate species presence (Kartesz, 2018; USDA NRCS, 2018).


Taxus brevifolia (Jason Hollinger)


Taxus brevifolia (Susan McDougall)

PESTS & DISEASES

Native U.S. *Taxus* species face few pests and diseases, and all are minor. Results from the USDA Forest Service study *Important Insect and Disease Threats to United States Tree Species and Geographic Patterns of Their Potential Impacts* (Potter et al., 2019a) are provided in Table 1, to give an overview of the major pests and diseases affecting native U.S. *Taxus* species. That study performed a thorough literature review, including more than 200 sources, and consulted dozens of expert entomologists and pathologists to identify up to five of the most serious insect, disease, and parasitic plant threats facing each of 419 native U.S. tree species; priority was given to pests and diseases causing mortality of mature trees, rather than agents primarily affecting reproductive structures or seedlings. A second USDA Forest Service study, *Prioritizing the conservation needs of United States tree species: Evaluating vulnerability to forest insect and disease threats* (Potter et al., 2019b), combined results from Potter et al. (2019a) with species trait and vulnerability data to further categorize overall pest and disease vulnerability of the 419 target native U.S. tree species. Results from this study are provided in Table 2.


Taxus brevifolia (Wsiegmund)

Table 1. The most serious insect, disease, and parasitic plant agents affecting native U.S. *Taxus* species, from the results of Potter et al. (2019a), which analyzed 419 native U.S. tree species. *Taxus canadensis* was not included in the study. Numbers represent the severity of the agent's impact on the host species. * = nonnative invasive agent. Table adapted, with permission, from Potter et al. (2019a).

Host species	Insect, Disease, or Parasitic Plant Agent		
	Black vine weevil (*Otiorhynchus sulcatus*)*	Heterobasidion root disease (*Heterobasidion* spp.)	Port-Orford-cedar root disease (*Phytophthora lateralis*)*
Taxus brevifolia	**1**	**1**	**1**
Taxus floridana		**1**	

Severity of agent's impact

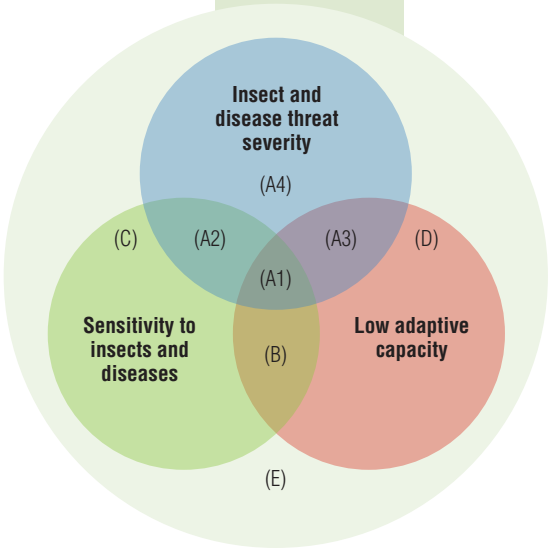
10 = near complete mortality of all mature host trees (>95%)
8 = significant mortality of mature host trees (25% to 95%)
5 = moderate mortality of mature host trees (10% to 25%)
3 = moderate mortality in association with other threats, such as drought stress (1% to 10%)
1 = minor mortality, generally to host trees that are already stressed (<1%)


Taxus canadensis (Ed Hedborn, The Morton Arboretum)


Taxus floridana (R. Cantrell)

Table 2. Pest and disease vulnerability of native U.S. *Taxus* species, from the results of a USDA Forest Service study that analyzed 419 native U.S. tree species. *Taxus canadensis* was not included in the study. Species are ordered by overall rank, from most vulnerable to least vulnerable. Figure is adapted, with permission, from Potter et al. (2019b).

Species	Vulnerability Class	Overall Rank (of 419)
Taxus floridana	B	31
Taxus brevifolia	E	390



Vulnerability Classes

A) High current severity
   1) High vulnerability
   2) Potential adaptation
   3) Potential persistence
   4) Potential persistence and adaptation

B) Potential high vulnerability to future threats

C) Potential high sensitivity to future threats

D) Potential low adaptation to future threats

E) Low current and potential vulnerability

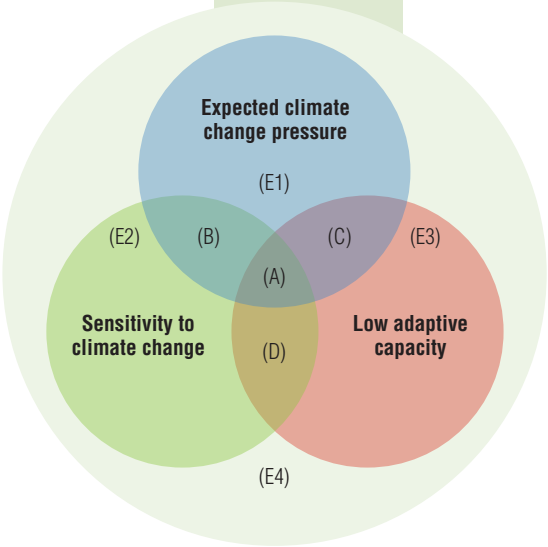

Taxus canadensis (Krzysztof Ziarnek)

CLIMATE CHANGE VULNERABILITY

Native U.S. *Taxus* species face varying impacts from climate change, though data is lacking for *T. floridana*. It is possible that *T. canadensis* will face declines if reduced snow cover leads to increased browsing pressure (Thomas, 2013). Using a similar methodology to Potter et al. (2019b), which focuses on species-specific traits in addition to vulnerability data, Potter et al. (2017) analyzed species vulnerability to climate change in the study, *A United States national prioritization framework for tree species vulnerability to climate change*. A selection of 339 native U.S. tree species were assessed through comprehensive literature review, in addition to input from 25 USDA Forest Service resource managers and scientists from across the country and varying departments within the agency. Results from that study are provided in Table 3.

Table 3. Climate change vulnerability of native U.S. *Taxus* species, from the results of a USDA Forest Service study that analyzed 339 native U.S. tree species. *Taxus canadensis* and *T. floridana* were not included in the study. Species are ordered by overall rank, from most vulnerable to least vulnerable. Figure is adapted, with permission, from Potter et al. (2017).

Species	Vulnerability Class	Overall Rank (of 339)
Taxus brevifolia	E2	319



Vulnerability Classes

A) High vulnerability, little adaptation or persistence potential

B) High vulnerability, potential adaptation

C) High vulnerability, potential persistence

D) Potential high future vulnerability

E) Low current vulnerability

EX SITU SURVEY RESULTS

Taxus species are considered orthodox, meaning their seeds can be dried to levels necessary for storage in a conventional seed bank, without losing significant viability. Once frozen, the seeds can be stored for years with little deterioration (Forest Research, 2020), though more research may be necessary to determine maximum storage length. Stored *Taxus* seeds can also take years to break dormancy (Thomas & Polwart, 2003), so living collections may provide opportunities for more accessible germplasm for activities such as research, restoration, or reintroduction.

In 2018, we conducted a global accessions-level *ex situ* survey of priority native U.S. tree species within nine target genera: *Carya, Fagus, Gymnocladus, Juglans, Lindera, Persea, Pinus, Sassafras*, and *Taxus*. The request for data was emailed directly to target *ex situ* collections, including arboreta, botanical gardens, private collections, and USDA Forest Service seed orchards. We started with institutions that had reported collections of these genera to BGCI's PlantSearch database, and whose contact information was available in BGCI's GardenSearch database. The data request was also distributed via newsletters and social media through ArbNet, the American Public Gardens Association, Botanic Gardens Conservation International, the Center for Plant Conservation, the Plant Conservation Alliance, The Morton Arboretum, and the USDA Forest Service. A total of 143 collections from 25 countries provided accessions data for our target genera, including 54 collections from 13 countries reporting native U.S. *Taxus* species (Figure 2). See Appendix A for a list of participating institutions. When providing *ex situ* collections data, institutions were asked to include the number of individuals in each accession. When such data were unavailable, we assumed the accession consisted of one individual; therefore our results represent a conservative estimate. Also, because *Taxus* species are orthodox and can be seed banked, the *ex situ* survey results presented here include both seed bank and living collections.


Taxus brevifolia (brewbooks)

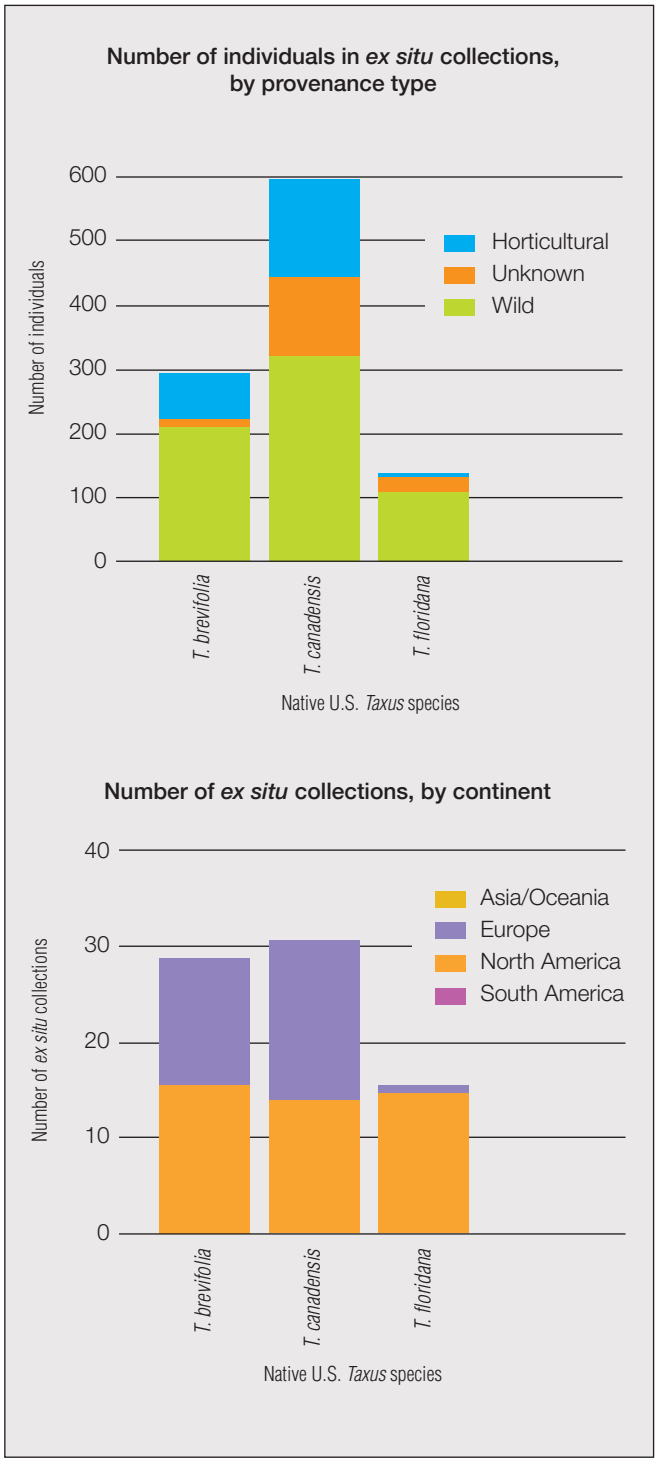


Figure 2. Results from a 2018 global accessions-level *ex situ* survey for native U.S. *Taxus* species.

SPATIAL ANALYSIS OF *EX SITU* COLLECTIONS

Ex situ collections conserve the most genetic diversity when they represent a large percent of the target species' geographic and ecological range. Therefore, identifying under-represented populations and ecoregions is vital to improving the conservation value of *ex situ* collections. To prioritize regions and species for future *ex situ* collecting, we mapped and analyzed the estimated native distribution of each target species versus the wild provenance localities of germplasm in *ex situ* collections.

We used two proxies for estimating *ex situ* genetic diversity representation: geographic and ecological coverage. These proxies are based on the assumption that sampling across a species' full native distribution and all ecological zones it inhabits is the best way to ensure that the full spectrum of its genetic diversity is captured in *ex situ* collections (CPC, 2018; Hanson et al., 2017; Khoury et al., 2015). Using methods introduced by Khoury et al. (2019) and Beckman et al. (2019), we calculated geographic and ecological coverage by comparing two sets of geographic points: 1) known *in situ* occurrences, and 2) *ex situ* collection source localities (e.g., wild occurrences where seed was collected for *ex situ* preservation). To approximate potential suitable habitat, nearby populations, and/or gene flow, we placed a circular buffer around each *in situ* occurrence point and each *ex situ* collection source locality. When buffers around *ex situ* collection source localities overlap with buffers around *in situ* occurrence points, that area is considered 'conserved' by *ex situ* collections (Figures 3-6; Table 4). Because our calculations of geographic and ecological coverage are based on a rough estimation of the distribution of a species and only address the portion of a species distribution within the contiguous U.S., the values reported here should be viewed as estimates that can be used to compare among species for prioritization rather than values reflecting the actual capture of genetic diversity (e.g., alleles or DNA sequence differences) in *ex situ* collections.

Taxus canadensis (Ed Hedborn, The Morton Arboretum)

Taxus floridana (Chris M)

In situ occurrence points for each target species were downloaded from a variety of publicly available data sources, including Biodiversity Information Serving Our Nation (BISON; USGS, 2019), Botanical Information and Ecology Network (BIEN; bien.nceas.ucsb.edu, 2020; Maitner, 2020), Forest Inventory and Analysis (FIA) Program of the USDA Forest Service (Forest Inventory and Analysis Database, 2019), Global Biodiversity Information Facility (GBIF.org, 2020; Chamberlain & Boettiger, 2017), Integrated Digitized Biocollections (iDigBio; idigbio.org, 2020; Michonneau & Collins, 2017), and U.S. herbarium consortia (e.g., SERNEC; Data Portal, 2020). To increase their reliability, these raw data points were automatically vetted using a set of common filters for biodiversity data (Zizka et al., 2019). Points were removed if they fell within 500 meters of a state centroid or 100 meters of a biodiversity institution, or if they were not within a county of native occurrence for the target species based on county-level data from Biota of North America (BONAP; Kartesz, 2018). Points were also removed if they were recorded before 1950, were missing a record year, were recorded as a living or fossil specimen, or were recorded as introduced, managed, or invasive. For species of conservation concern (assessed as Near Threatened, Vulnerable, Endangered, or Critically Endangered on the IUCN Red List) the *in situ* distribution points were also vetted manually based on literature review.

Ex situ data were gathered during the 2018 survey described in the previous section, and records for target species with a wild source locality description were manually geolocated when latitude and longitude were missing. For target native U.S. *Taxus* species, about 27% of records with wild or unknown provenance were manually geolocated, while 11% had latitude and longitude provided by the institution and 62% contained too little locality information to geolocate to county-level or finer. To map wild provenance localities of *ex situ* individuals, accessions collected from wild localities near each other were grouped together based on latitude and longitude rounded to one digit after the decimal. All data processing and mapping were performed in R (R Core Team, 2020; Graul, 2016).

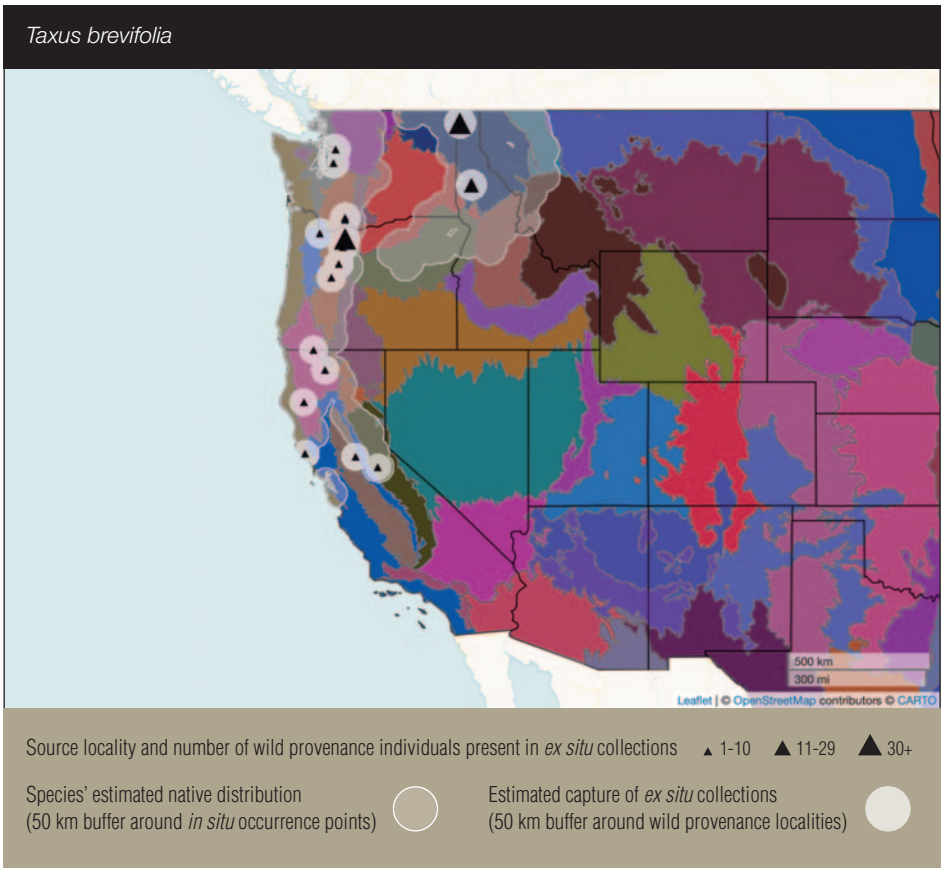


Figure 3. Native distribution and wild provenance localities of *ex situ* individuals for *Taxus brevifolia* in the contiguous U.S., based on 50 km buffers around *in situ* occurrence points and *ex situ* source localities. Background colors show EPA Level III Ecoregions (U.S. EPA Office of Research & Development, 2013a). In addition to standard *in situ* occurrence point filters applied to all target species, *T. brevifolia* occurrence points were further refined by removing records more than 100 km outside native counties provided in the USDA PLANTS database (USDA NRCS, 2018).

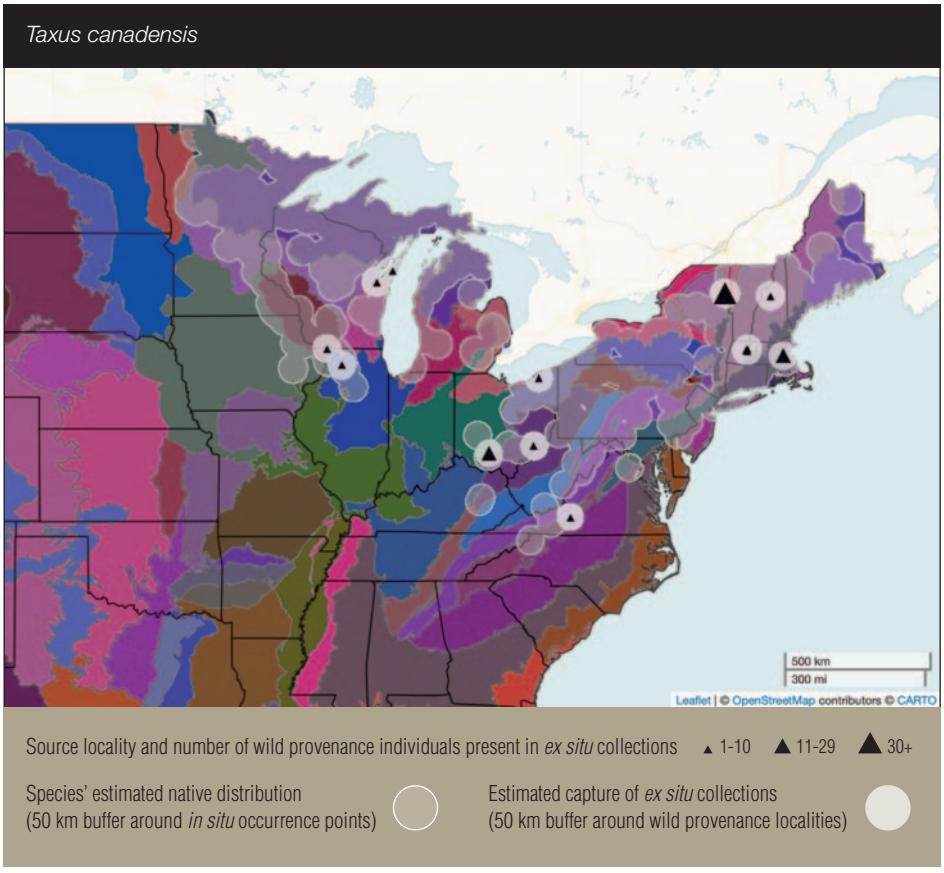


Figure 4. Native distribution and wild provenance localities of *ex situ* individuals for *Taxus canadensis* in the U.S., based on 50 km buffers around *in situ* occurrence points and *ex situ* source localities. Background colors show EPA Level III Ecoregions (U.S. EPA Office of Research & Development, 2013a).

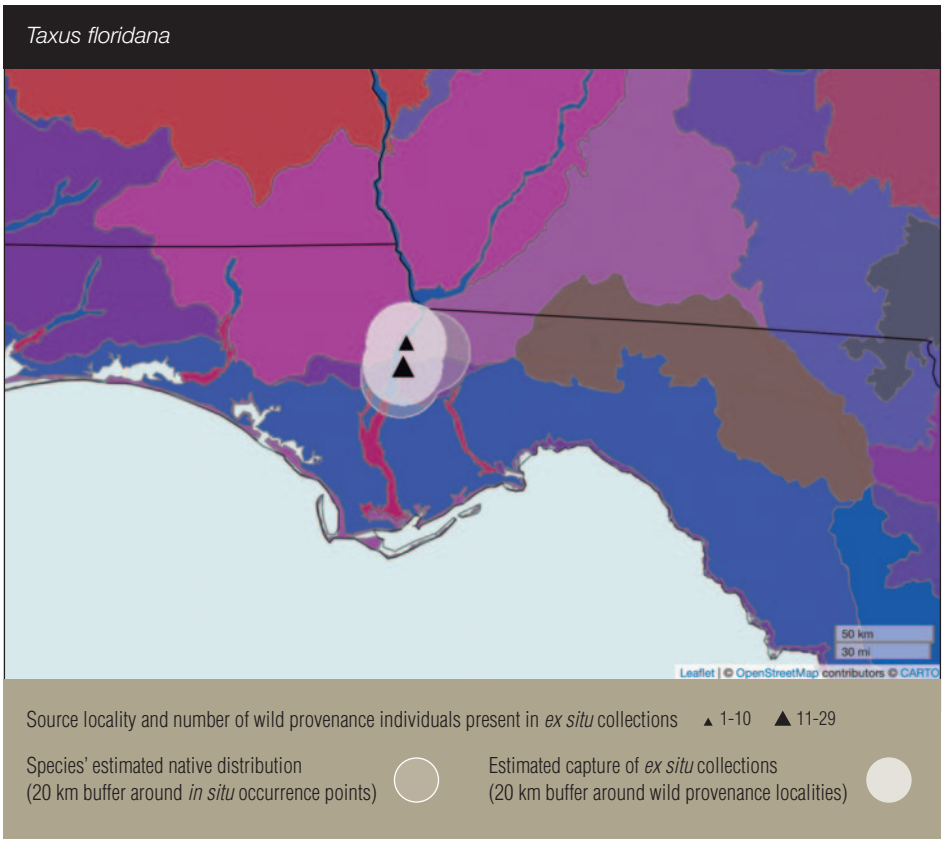


Figure 5. Native distribution and wild provenance localities of *ex situ* individuals for *Taxus floridana*, based on 20 km buffers around *in situ* occurrence points and *ex situ* source localities. Due to the species' extreme rarity, in addition to the availability of detailed data regarding its distribution (Spector et al., 2011), 20 km buffers have been used here instead of 50 km buffers. The smaller buffer size provides a more accurate estimate of the distribution and representation of *T. floridana* in *ex situ* collections. Background colors show EPA Level IV Ecoregions (U.S. EPA Office of Research & Development, 2013b).

Taxus floridana (Richard Carter, Valdosta State University, Bugwood.org)

Table 4. Estimated geographic and ecological coverage of *ex situ* collections of native U.S. *Taxus* species. Geographic coverage = area covered by buffers around *ex situ* wild provenance localities / area covered by buffers around *in situ* occurrence points (values are given in km^2). Ecological coverage = number of ecoregions under buffers around *ex situ* wild provenance localities / number of ecoregions under buffers around *in situ* occurrence points. U.S. EPA Level IV Ecoregions (2013b) were used for calculating ecological coverage. Buffer area falling outside the contiguous U.S. was removed for all calculations. Three different-sized buffers (radius of 20 km, 50 km, and 100 km) were used to show the variation in estimated *ex situ* genetic representation depending on assumptions regarding population size and gene flow. *Taxus floridana* is the exception: due to its extreme rarity and the availability of detailed distribution data, the larger buffer sizes do not provide meaningful estimates of distribution or representation in *ex situ* collections. Therefore, only the 20 km buffers have been used to calculate coverage for *T. floridana*.

Species	20 km buffers		50 km buffers		100 km buffers		Average of all three buffer sizes	
	Geographic coverage	Ecological coverage	Geographic coverage	Ecological coverage	Geographic coverage	Ecological coverage	Geographic coverage	Ecological coverage
Taxus brevifolia	19,793 / 304,644 **(6%)**	53 / 161 **(33%)**	102,646 / 502,180 **(20%)**	92 / 205 **(45%)**	302,334 / 698,375 **(43%)**	159 / 246 **(65%)**	**23%**	**47%**
Taxus canadensis	14,494 / 368,449 **(4%)**	39 / 184 **(21%)**	82,824 / 922,275 **(9%)**	68 / 210 **(32%)**	285,287 / 1,304,466 **(22%)**	98 / 229 **(43%)**	**12%**	**32%**
Taxus floridana	1,701 / 2,311 **(86%)**	6 / 6 **(100%)**					**86%**	**100%**

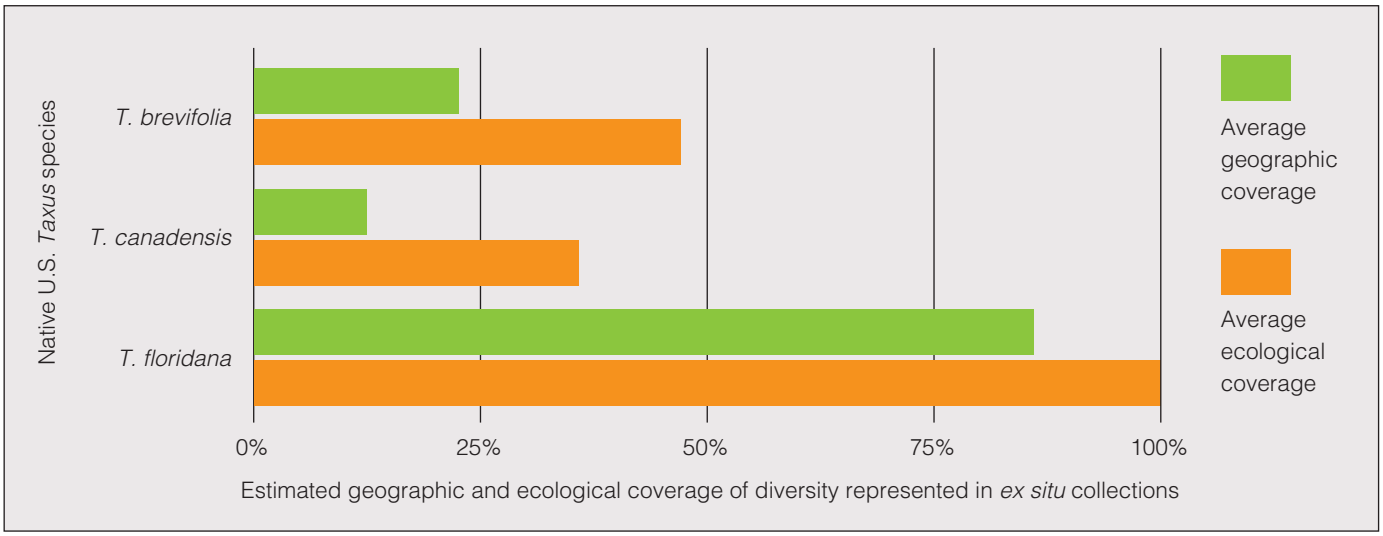


Figure 6. Average geographic and ecological coverage of *ex situ* collections for native U.S. *Taxus* species (See Table 4 for details).


Taxus canadensis (Ed Hedborn, The Morton Arboretum)


Taxus brevifolia (brewbooks)

TREE CONSERVATION QUESTIONNAIRE RESULTS

In 2019, we conducted a Tree Conservation Action Questionnaire for priority native U.S. tree species within nine target genera: *Carya, Fagus, Gymnocladus, Juglans, Lindera, Persea, Pinus, Sassafras*, and *Taxus*. The questionnaire was designed primarily to gather information regarding current or future planned conservation activities, but also to provide a platform to ask experts their opinion regarding most urgent conservation actions and most significant threats for each target species (Figure 7). A subset of target species were chosen to be included in the questionnaire based on threat rankings (IUCN Red List Category and NatureServe Global Status), climate change vulnerability, impact from pests and diseases, and representation in *ex situ* collections.

The questionnaire was emailed directly to targeted *ex situ* collections, content experts, attendees of the 2016 "Gene Conservation of Forest Trees: Banking on the Future" workshop, native plant societies and The Nature Conservancy contacts (from states with 20 or more target species), NatureServe and Natural Heritage Program contacts (from states with ten or more target species), BLM field offices, the USDA Forest Service RNGR National Nursery and Seed Directory, and USFS geneticists, botanists, and pest/disease specialists. The questionnaire was also distributed via newsletters and social media through ArbNet, the American Public Gardens Association, Botanic Gardens Conservation International, the Center for Plant Conservation, the Plant Conservation Alliance, The Morton Arboretum, and the USDA Forest Service.

More than 200 institutions completed the questionnaire, including 15 institutions that provided input on conservation activities for priority native U.S. *Taxus* species. Institutions reporting that they could "provide information regarding current conservation activities, most urgent conservation needs, and/or primary threats to wild populations" included 17 for *T. brevifolia* and 12 for *T. floridana*. Respondents were given the opportunity to fill in other native U.S. *Taxus* species that they considered of conservation concern; *T. canadensis* was listed by five respondents. See Appendix A for a list of participants and Appendix B for a full summary of questionnaire responses, which can be used to identify potential collaborators, coordinate conservation efforts, and recognize possible gaps in current activities.

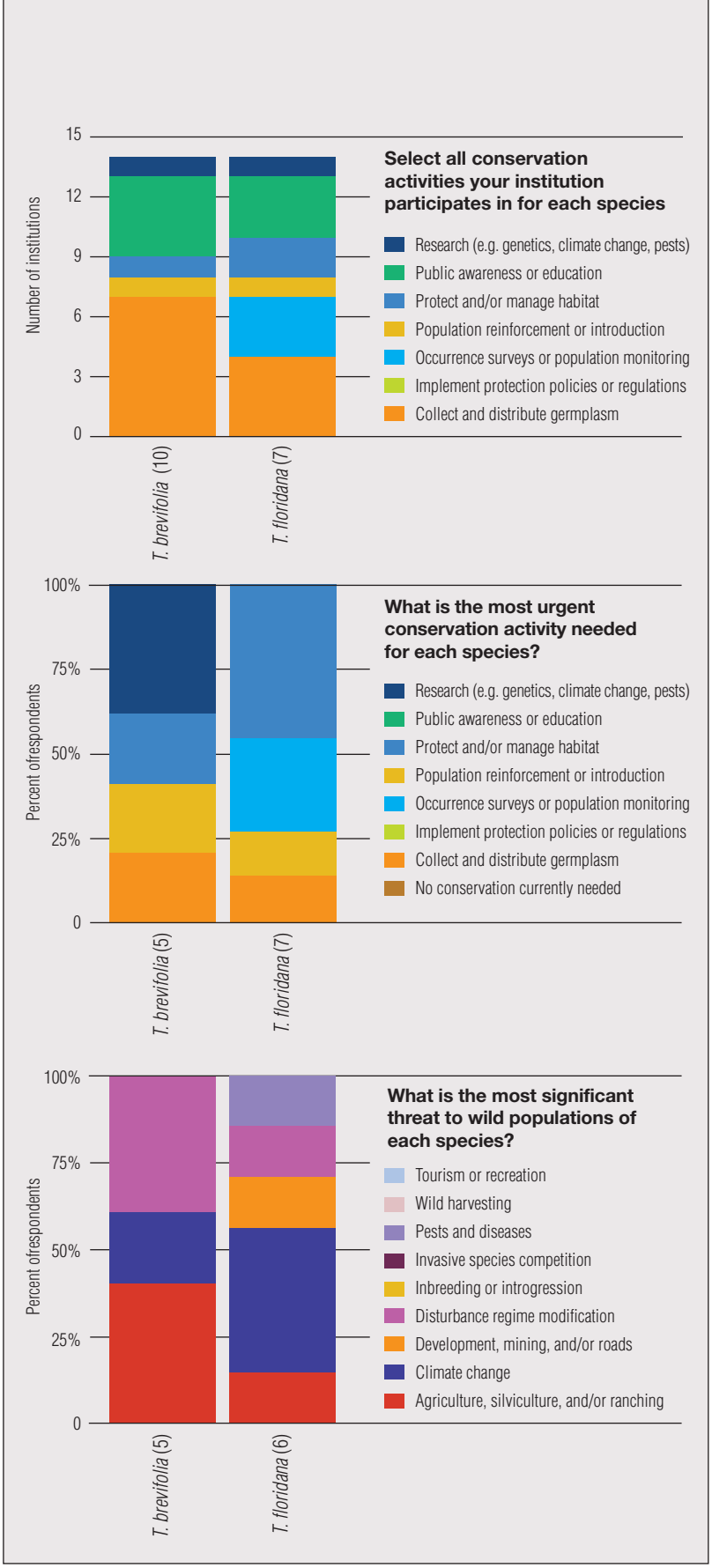


Figure 7. Results from the Tree Conservation Action Questionnaire for priority native U.S. *Taxus* species. The number of institutions or respondents participating in each question is listed in parentheses after the species' name. See Appendix B for details regarding which institutions reported each conservation activity.

CONCLUSIONS & RECOMMENDATIONS

Species' distributions and threats: There are three *Taxus* species native to the United States (Figure 1). *Taxus brevifolia* is distributed in the Northwest, *T. canadensis* ranges from Minnesota to Maine and south to Tennessee, and *T. floridana* has a very limited distribution in northwest Florida. There are no severe pests or diseases facing native U.S. *Taxus* species and vulnerability to climate change is generally predicted to be low, other than potential impacts to *T. canadensis* from decreased snowfall and increased deer activity (Tables 1-3). Past population decreases from extraction for both wood and cancer-treating compounds caused initial threats to native U.S. *Taxus* species, but these pressures have mostly ceased. Native populations are now most affected by changing land use and natural systems modification.

Conservation quality of *ex situ* collections: Based on data from 54 *ex situ* collections that submitted accessions data for native U.S. *Taxus* species, all are represented globally by fairly substantial collections. *Taxus canadensis* is represented by the most *ex situ* individuals (595), with about half of wild origin. About 80% of these individuals had the spatial data necessary for mapping their wild *ex situ* source locality, and the resulting average geographic (12%) and ecological (32%) coverage are the lowest of any native U.S. *Taxus* species. *Taxus brevifolia* is also represented by many individuals in *ex situ* collections (295) and a higher proportion of wild origin individuals (73%), though approximately 50% had enough information to map their wild provenance; geographic and ecological coverage were 23% and 47%, respectively. Populations in Alaska were not included in calculations of geographic and ecological coverage because the ecoregions layer is only available for the contiguous U.S. There is no known representation of the Alaska populations of *T. brevifolia* in *ex situ* collections, therefore geographic and ecological coverage are lower than reported here. *Taxus floridana* has the fewest individuals in *ex situ* collections (140), though still a fairly high number compared to other rare species. Encouragingly, 80% are of wild origin and 80% of these individuals were able to be mapped to their wild collection locality, resulting in an estimated geographic coverage of 86% and ecological coverage of 100%. Although, because *T. floridana* is so rare, further efforts are necessary to ensure as many genotypes as possible are conserved in *ex situ* collections (Figures 2-6; Table 4).

Taxus canadensis (Rob Routledge)

Taxus canadensis (Ed Hedborn, The Morton Arboretum)

Conservation actions: For the Tree Conservation Action Questionnaire, conservation activities were reported by ten institutions for *T. brevifolia* and seven institutions for *T. floridana*, out of more than 200 participating institutions total. For both *Taxus* species included in the questionnaire, collect and distribute germplasm was the most common activity reported, followed by public awareness or education. Occurrence surveys or population monitoring was also reported frequently for *T. floridana*. Protecting and/or managing habitat was the conservation activity most frequently identified as most urgent. Agriculture, silviculture, and/or ranching, climate change, and disturbance regime modification were frequently identified as the most significant threats to target *Taxus* species. It is encouraging to see collection and distribution of germplasm, public education, and occurrence surveys/population monitoring as the most-pursued activities, considering the predicted continuing decline of native U.S. *Taxus* species. Continuation, and expansion in some instances, of these activities will be vital for conservation success, in addition to collaboration and coordination among stakeholders, especially for *T. floridana.* Further research regarding impacts from climate change and natural systems modification would also aid in developing targeted conservation planning (Figure 7).

Overall summary and recommendations: Other than *T. floridana*, with its very limited distribution and limited regeneration, native U.S. *Taxus* species do not face significant threats currently. But, due to past declines and predicted population decline moving forward, U.S. native *Taxus* species should be a priority for continued monitoring, research, and conservation. Updated surveying and distribution modelling efforts would be helpful in tracking the conservation status of these species. *Ex situ* representation of native U.S. *Taxus* species is fairly robust, but further collecting efforts should be focused especially on *T. floridana*, to secure germplasm from all individuals, and the southern range of *T. canadensis*, in the event that climate change pushes the species further north. Native U.S. *Taxus* species are both a beautiful and important part of natural areas, in addition to their role in cultivated landscapes, and deserve continued conservation attention.

REFERENCES

Allison, T. D. (1990). The influence of deer browsing on the reproductive biology of Canada yew (*Taxus canadensis* marsh.). Oecologia, 83, 523-529. Retrieved from https://doi.org/10.1007/BF00317204

Beckman, E., Meyer, A., Denvir, A., Gill, D., Man, G., Pivorunas, D., Shaw, K., & Westwood, M. (2019). *Conservation Gap Analysis of Native U.S. Oaks*. Lisle, IL: The Morton Arboretum. Retrieved from https://www.mortonarb.org/files/conservation-gap-analysis-of-native-US-oaks.pdf

Chamberlain, S. & Boettiger C. (2017). R Python, and Ruby clients for GBIF species occurrence data. *PeerJ PrePrints*. Retrieved from https://doi.org/10.7287/peerj.preprints.3304v1.

CPC (Center for Plant Conservation). (2018). *Best plant conservation practices to support species survival in the wild*. The Center for Plant Conservation.

Data Portal. (2020). Retrieved from http//:sernecportal.org/index.php.

Earle, C. J. (Ed.). (2020). *Taxus*. The Gymnosperm Database. Retrieved from https://www.conifers.org/ta/Taxus.php

Forest Inventory and Analysis Database (2019). St. Paul, MN: U.S. Department of Agriculture, Forest Service, Northern Research Station. Retrieved from https://apps.fs.usda.gov/fia/datamart/datamart.html

Forest Research. (2020). *Taxus baccata*. Retrieved from https://www.forestresearch.gov.uk/tools-and-resources/seed-storage/taxus-baccata/

Flora of North America Editorial Committee (Eds). (1993). *Flora of North America north of Mexico* (Vol. 2). New York and Oxford.

GBIF.org (23 September 2020). GBIF Occurrence Download. https://doi.org/10.15468/dl.hdjwfz

Graul, C. (2016). leafletR: Interactive Web-Maps Based on the Leaflet JavaScript Library. R package version 0.4-0. Retrieved from http://cran.r-project.org/package=leafletR.

Hanson, J. O., Rhodes, J. R., Riginos, C., & Fuller, R. A. (2017). Environmental and geographic variables are effective surrogates for genetic variation in conservation planning. *Proceedings of the National Academy of Sciences*,114(48), 12755-12760. doi:10.1073/pnas.1711009114

IUCN. (2020). The IUCN Red List of Threatened Species. Version 2020-2. Retrieved July, 2020 from https://www.iucnredlist.org.

Kartesz, J. T. (2018). The Biota of North America Program (BONAP). Taxonomic Data Center, Floristic Synthesis of North America, Version 1.0. Chapel Hill, NC. Retrieved from http://www.bonap.net/tdc

Khoury, C. K., Carver, D., Barchenger, D. W., Barboza, G. E., Van Zonneveld, M., Jarret, R., . . . Greene, S. L. (2019). Modelled distributions and conservation status of the wild relatives of chile peppers (Capsicum L.). *Diversity and Distributions*, 26(2). doi:https://doi.org/10.1111/ddi.13008

Khoury, C. K., Heider, B., Castañeda-Alvarez, N. P., Achicanoy, H. A., Sosa, C. C., Miller, R. E., . . . Struik, P. C. (2015). Distributions, *ex situ* conservation priorities, and genetic resource potential of crop wild relatives of sweetpotato [Ipomoea batatas (L.) Lam., I. series Batatas]. *Frontiers in Plant Science*, 6. doi:10.3389/fpls.2015.00251

Maitner, B. (2020). BIEN: Tools for Accessing the Botanical Information and Ecology Network Database. R package version 1.2.4. https://CRAN.R-project.org/package=BIEN.

Michonneau, F. & Collins, M. (2017). ridigbio: Interface to the iDigBio Data API. R package version 0.3.5. Retrieved from https://CRAN.R-project.org/package=ridigbio.

Potter, K. M., Crane, B. S., & Hargrove, W. W. (2017). A United States national prioritization framework for tree species vulnerability to climate change. *New Forests*, 48(2), 275–300. doi: 10.1007/s11056-017-9569-5

Potter, K. M., Escanferla, M. E., Jetton, R. M., & Man, G. (2019a). Important Insect and Disease Threats to United States Tree Species and Geographic Patterns of Their Potential Impacts. *Forests,* 10(4), 304. doi: 10.3390/f10040304

Potter, K. M., Escanferla, M. E., Jetton, R. M., Man, G., & Crane, B. S. (2019b). Prioritizing the conservation needs of United States tree species: Evaluating vulnerability to forest insect and disease threats. *Global Ecology and Conservation*, 18. doi: 10.1016/j.gecco.2019.e00622

R Core Team (2020). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Retrieved from https://www.R-project.org/.

Spector, T., Thomas, P. & Determann, R. (2011). *Taxus floridana*. *The IUCN Red List of Threatened Species* 2011: e.T30965A9584928. https://dx.doi.org/10.2305/IUCN.UK.2011-2.RLTS.T30965A9584928.en. Downloaded on 16 December 2020.

Thomas, P. (2013). *Taxus brevifolia*. *The IUCN Red List of Threatened Species* 2013: e.T34041A2841142. Retrieved from https://dx.doi.org/10.2305/IUCN.UK.2013-1.RLTS.T34041A2841142.en.

Thomas, P. (2013). *Taxus canadensis. The IUCN Red List of Threatened Species* 2013: e.T42547A2986960. Retrieved from https://dx.doi.org/10.2305/IUCN.UK.2013-1.RLTS.T42547A2986960.en.

Thomas, P. & Polwart, A. (2003). T*axus baccata L. Journal of Ecology*, 91, 489-524. Retrieved from https://doi.org/10.1046/j.1365-2745.2003.00783.x

U.S. EPA Office of Research & Development. (2013a). Level III Ecoregions of the conterminous United States. National Health and Environmental Effects Research Laboratory (NHEERL). Retrieved from ftp://ftp.epa.gov/wed/ecoregions/us/us_eco_l3.zip

U.S. EPA Office of Research & Development. (2013b). Level IV Ecoregions of the conterminous United States. National Health and Environmental Effects Research Laboratory (NHEERL). Retrieved from ftp://ftp.epa.gov/wed/ecoregions/us/us_eco_l4.zip

USDA, NRCS. (2018). The PLANTS Database. National Plant Data Team. Greensboro, NC. Retrieved from http://plants.usda.gov

USGS. (2019). Biodiversity Information Serving Our Nation (BISON) -- Species occurrence data for the Nation. U.S. Geological Survey General Information Product 160, version 1.1., U.S. Geological Survey, 2015. Retrieved from https://doi.org/10.3133/gip160.

Zizka, A., Silvestro, D., Andermann, T., Azevedo, J., Duarte Ritter, C., Edler, D., . . . Antonelli, A. (2019). CoordinateCleaner: Standardized cleaning of occurrence records from biological collection databases. *Methods in Ecology and Evolution*, 10(5), 744-751. doi:https://doi.org/10.1111/2041-210X.13152

APPENDIX A. LIST OF PARTICIPANTS

Institutional participants in the 2018 *ex situ* collections survey:

Agro-Botanical Garden of USAMV Cluj-Napoca • Antony Woodland Garden • Arboretum Bramy Morawskiej w Raciborzu • Arboretum Bukovina • Arboretum Kirchberg, Musée national d'histoire naturelle • Arboretum National des Barres • Arboretum w Przelewicach • Arboretum Wespelaar, Foundation • Arboretum Wojslawice, University of Wroclaw • Arizona-Sonora Desert Museum • Arnold Arboretum of Harvard University, The • Atlanta Botanical Garden • Auckland Botanic Gardens • Bamboo Brook Outdoor Education Center • Bartlett Tree Research Laboratories Arboretum • Bayard Cutting Arboretum • Beal Botanical Gardens, W. J. • Bedgebury National Pinetum and Forest • Belmonte Arboretum • Bergius Botanic Garden, Stockholm University • Bessey Nursery, Nebraska National Forests and Grasslands • Boerner Botanical Gardens • Bok Tower Gardens • Botanic Garden Meise • Botanic garden of Le Havre, Ville du Havre • Botanic Garden of Smith College, The • Botanic Gardens of South Australia • Botanischer Garten der Philipps-Universität Marburg • Brenton Arboretum, The • Brookgreen Gardens • Brooklyn Botanic Garden • Bureau of Land Management, Prineville District • Cheryl Kearns, private garden • Chicago Botanic Garden • Cornell Botanic Gardens • Cox Arboretum • Darts Hill Garden Park • Davis Arboretum of Auburn University • Dawes Arboretum, The • Denver Botanic Gardens • Dunedin Botanic Garden • Eastwoodhill Arboretum • Eddy Arboretum, Pacific Southwest Research Station Placerville, The Institute of Forest Genetics (IFG) • Eden Project • Estancia San Miguel • Fairchild Tropical Botanic Garden • Finnish Museum of Natural History LUOMUS • Frelinghuysen Arboretum • Ghent University Botanical Garden • Green Bay Botanical Garden • Green Spring Gardens • GRIN Database, National Plant Germplasm System (NPGS) • Hackfalls Arboretum • Holden Forests & Gardens (Cleveland Botanical Garden and The Holden Arboretum) • Hollard Gardens • Honolulu Botanical Gardens System • Hørsholm Arboretum • Hoyt Arboretum • Huntington, The • Ioulia & Alexandros Diomidis Botanical Garden • Jardin Botanique de l'Université de Strasbourg • Jardin botanique de Montréal • JC Raulston Arboretum • Keith Arboretum, The Charles R. • Key West Tropical Forest and Botanical Garden • Linnaean Gardens of Uppsala, The • Longwood Gardens • Lovett Pinetum • Lyon Arboretum & Botanical Garden of the University of Hawaii • Marie Selby Botanical Gardens • Mercer Botanic Gardens • Millennium Seed Bank Partnership, Royal Botanic Gardens Kew • Missouri Botanical Garden • Montgomery Botanical Center • Morris Arboretum of the University of Pennsylvania, The • Morton Arboretum, The • Moscow State University Botanical Garden Arboretum • Mount Auburn Cemetery • Mt. Cuba Center, Inc. • Muséum national d'Histoire naturelle, Paris • Naples Botanic Garden • National Tropical Botanical Garden • NDSU Dale E. Herman Research Arboretum, Woody Plant Improvement Program • New York Botanical Garden • Norfolk Botanical Garden • North Carolina Arboretum, The • Orto Botanico dell'Università degli studi di Siena • Orto Botanico dell'Universita della Calabria • Peckerwood Garden • Pinetum Blijdenstein • Polly Hill Arboretum, The • Powell Gardens • Pukeiti • Pukekura Park • Rancho Santa Ana Botanic Garden • Real Jardín Botánico Juan Carlos I • Red Butte Garden, The University of Utah • Reiman Gardens, Iowa State University • Rogów Arboretum of Warsaw University of Life Sciences • Royal Botanic Garden Edinburgh • Royal Botanic Gardens Kew, Wakehurst Place • Royal Botanic Gardens Ontario • Royal Botanic Gardens Victoria • Royal Horticultural Society Garden, Wisley • Smale Riverfront Park • Starhill Forest Arboretum • State Botanical Garden of Georgia, University of Georgia • State Botanical Garden of Kentucky, The Arboretum • Stavanger Botanic Garden • Tasmanian Arboretum Inc., The • Timaru Botanic Garden • Tucson Botanical Gardens • Tyler Arboretum • U.S. National Arboretum • UBC Botanical Garden, The University of British Columbia • UC Davis Arboretum and Public Garden • University of California Botanical Garden at Berkeley • University of Connecticut Arboretum • University of Delaware Botanic Gardens • University of Florida/IFAS, North Florida Research and Education Center, Gardens of the Big Bend • University of Guelph Arboretum • University of Washington Botanic Gardens • USFS Brownwood Provenance Orchard • USFS western white pine, sugar pine, and whitebark pine seed orchards in OR and WA • Utrecht University Botanic Garden • Vallarta Botanical Gardens A. C. • VanDusen Botanical Garden • Village of Riverside, Illinois • Waimea Valley Botanical Garden • Wellington Botanical Gardens • Westonbirt, The National Arboretum • Willowwood Arboretum • Winona State University, The Landscape Arboretum at • Xishuangbanna Tropical Botanical Garden (XTBG) of Chinese Academy of Sciences (CAS) • Zoo and BG Plzen

Taxus canadensis (Ed Hedborn, The Morton Arboretum)

Taxus floridana (Susan McDougall)

Institutional participants in the 2019 Tree Conservation Action Questionnaire:

Adkins Arboretum • Agnes Scott College • Aldrich Berry Farm & Nursery, Inc • Alpha Nurseries, Inc • American Chestnut Foundation, The • American University • Arboretum des Grands Murcins • Arboretum Kalmthout • Arboretum San Miguel • Arboretum Wespelaar • Arkansas Natural Heritage Commission • Atlanta Botanical Garden • Auckland Botanic Gardens • Baker Arboretum • Bartlett Tree Research Lab & Arboretum • Bayard Cutting Arboretum • Bergius Botanic Garden • Bernheim Arboretum and Research Forest • Better Forest Tree Seeds • Blue Mountains Botanic Garden, The • Boehm's Garden Center • Boerner Botanical Gardens • Bok Tower Gardens • Borderlands Restoration Network • Botanic Garden of Smith College • Botanic Garden TU Delft • Botanical Garden of the University of Turku • Bowman's Hill Wildflower Preserve • Brenton Arboretum, The • Brookgreen Gardens • Brooklyn Botanic Garden • California Department of Fish and Wildlife • California Native Plant Society • Catawba Lands Conservancy • Chatham University Arboretum • Chicago Botanic Garden • Cincinnati Zoo & Botanical Garden • City of Columbia Stephens Lake Park Arboretum • City of Hamilton • City of Kansas City, Missouri • Colonial Williamsburg Foundation • Connecticut College Arboretum • Cowichan Lake Research Station • Cox Arboretum and Gardens • David Listerman & Associates, Inc • Dawes Arboretum, The • Delaware Division of Fish and Wildlife • Denver Botanic Gardens • Donald E. Davis Arboretum at Auburn University • Downtown Lincoln Association • Draves Arboretum • Dunedin Botanic Garden • Dunn School • Earth Tones Natives • Ed Leuck Louisiana Academic Arboretum, The • Eden Project • Elmhurst College • Evergreen Burial Park and Arboretum • Excelsior Wellness Center • Fairchild Tropical Botanic Garden • Farmingdale State College • Florida Fish and Wildlife Conservation Commission • Florida Forest Service • Florida Natural Areas Inventory • Folmer Botanical Gardens • Frostburg State University • Georgia Department of Natural Resources • Green Bay Botanical Garden • Growild, Inc • Hackfalls Arboretum • Hastings College • Hazel Crest Open Lands • Holden Forests and Gardens • Huntington, The • Illinois Department of Natural Resources Mason State Nursery • Indiana Native Plant Society • Jane E. Lytle Memorial Arboretum • Jardin Botanique de Paris, Arboretum de Paris • John F. Kennedy Arboretum • Johnson's Nursery, Inc. • Keefer Ecological Services Ltd. • L.E. Cooke Co • Lauritzen Gardens • Le Jardin du Lautaret de la Station alpine Joseph Fourier • Longfellow Arboretum • Longwood Gardens • Louisiana Department of Wildlife and Fisheries • Lovell Quinta Arboretum, The • Maryland Department of Natural Resources • McKeithen Growers, Inc. • Meadow Beauty Nursery • Michigan Natural Features Inventory • Mill Creek MetroParks, Fellows Riverside Gardens • Minnesota Department of Natural Resources • Minnesota Natural Resources Commission • Missouri Arboretum • Missouri Native Plant Society • Missouri State University • Montgomery Botanical Center • Morris Arboretum • Moscow State University Botanical Garden • Mt. Cuba Center • Mt. Desert Land & Garden Preserve • Muscatine Arboretum • Naples Botanical Garden • National Botanical Garden of Georgia • Native Plant Society of Oregon • Native Plant Trust • Natural Resources Canada • Nature Conservancy, The • New College of Florida • New Jersey Audubon • New York Botanical Garden, The • New York City Department of Parks & Recreation • New York Natural Heritage Program • Norfolk Botanical Garden • North Carolina Natural Heritage Program • North Dakota State University • Parque Botânico da Tapada da Ajuda • Peaceful Heritage Nursery • Peckerwood Garden • Pennsylvania Department of Conservation & Natural Resources • Pennsylvania Natural Heritage Program • Pizzo Group • Polly Hill Arboretum, The • Powell Gardens • Pronatura Veracruz • R.L. McGregor Herbarium • Rancho Santa Ana Botanic Garden • Reeseville Ridge Nursery • Regional Parks Botanic Garden • Reveg Edge, The • Rogów Arboretum of Warsaw University of Life Sciences • Royal Botanic Garden Edinburgh • Royal Botanic Gardens Victoria • San Diego Botanic Garden • Santa Barbara Botanic Garden • Sidmouth Civic Arboretum • Sister Mary Grace Burns Arboretum at Georgian Court University • Smith Gilbert • Smithsonian • Springfield-Greene County Parks • Starhill Forest Arboretum • State Botanical Garden of Kentucky, The Arboretum • Strasbourg University Botanic Garden • Tasmanian Arboretum, The • Tennessee Division of Natural Areas • Texas A&M Forest Service • Tower Grove Park • Town of Winthrop • Tree Musketeers • Tucson Botanical Gardens • Twin Peaks Native Plant Nursery • UC Davis Arboretum and Public Garden • United States Botanic Garden • United States Fish and Wildlife Service • United States National Arboretum • University of California • University of California Botanical Garden at Berkeley • University of Florida North Florida Research and Education Center • University of Guelph Arboretum • University of Leicester Botanic Garden • University of Maribor Botanic Garden • University of Minnesota • University of Notre Dame • University of Oklahoma • University of Washington Botanic Gardens • USDA Agricultural Research Service • USDA Forest Service • USDI Bureau of Land Management • VanDusen Botanical Garden • Vietnam National University of Forestry • Village of Bensenville • Village of Riverside • West Virginia Native Plant Society • West Virginia Wesleyan College • Westonbirt, The National Arboretum • Wilson Seed Farms, Inc • Woodland Park Zoo • WRD Environmental, Inc. • Wright Nursery Alberta • Yellowstone Arboretum

Taxus floridana (Susan McDougall)

Taxus brevifolia (brewbooks)

APPENDIX B. RESULTS FROM THE 2019 TREE CONSERVATION ACTION QUESTIONNAIRE

To receive contact information for a specific respondent and target species, please email treeconservation@mortonarb.org.

Species	Institution reporting conservation activities	Country (U.S. state)	Collect and distribute germplasm	Implement protection policies or regulations	Occurrence surveys or population monitoring	Population reinforcement or introduction	Protect and/or manage habitat	Public awareness or education	Research (e.g., genetics, climate change, pests)
Taxus brevifolia	Bayard Cutting Arboretum[1]	United States (NY)				X	X		
	Cowichan Lake Research Station[2]	Canada	X						
	Keefer Ecological Services Ltd.[8]	Canada	X						
	Rogów Arboretum of Warsaw University of Life Sciences[1]	Poland	X						
	Royal Botanic Garden Edinburgh[1]	United Kingdom	X					X	
	Santa Barbara Botanic Garden[1]	United States (CA)	X						
	University of California Botanical Garden at Berkeley[9]	United States (CA)	X						
	VanDusen Botanical Garden[1]	Canada						X	
	Westonbirt, The National Arboretum[1]	United Kingdom						X	X
	Name not shared[1]	Ireland	X					X	
Taxus floridana	Atlanta Botanical Garden[1]	United States (GA)	X					X	
	Bayard Cutting Arboretum[1]	United States (NY)				X	X		
	Donald E. Davis Arboretum at Auburn University[1]	United States (AL)	X					X	
	Florida Natural Areas Inventory[6]	United States (FL)			X				
	Nature Conservancy, The ; Florida[4]	United States (FL)			X		X		X
	Peckerwood Garden[1]	United States (TX)	X		X			X	
	Name not shared[1]	Ireland	X					X	

Institution types

[1] Arboretum/botanical garden [2] Government (local) [3] Government (national) [4] Land conservancy [5] Native plant society [6] Natural heritage program [7] Other non-governmental organization [8] Private sector [9] University

List of state abbreviations used in Appendix B

U.S. State	Abbreviation	U.S. State	Abbreviation	U.S. State	Abbreviation
Alabama	AL	Kentucky	KY	New Mexico	NM
Arkansas	AR	Louisiana	LA	New York	NY
Arizona	AZ	Massachusetts	MA	Ohio	OH
California	CA	Maryland	MD	Oklahoma	OK
Colorado	CO	Michigan	MI	Oregon	OR
Florida	FL	Minnesota	MN	Pennsylvania	PA
Georgia	GA	Missouri	MO	South Carolina	SC
Iowa	IA	Mississippi	MS	Tennessee	TN
Illinois	IL	North Carolina	NC	Texas	TX
Indiana	IN	North Dakota	ND	Utah	UT
Kansas	KS	New Jersey	NJ	Washington	WA

Taxus brevifolia (Joe Blowe)

Conservation Gap Analysis of Native

U.S. Yews

For further information please contact:

The Morton Arboretum
4100 Illinois Route 53
Lisle, IL 60532
Tel: 630-968-0074
Fax: + 44 (0) 1223 461481
Email: treeconservation@mortonarb.org
Web: www.mortonarb.org

BGCI
Descanso House
199 Kew Road, Richmond
Surrey, TW9 3BW
United Kingdom
Tel: +44 (0)20 8332 5953
Fax: +44 (0)20 8332 5956
E-mail: info@bgci.org
Web: www.bgci.org

Front cover images:
Taxus brevifolia (Jason Hollinger)
Taxus canadensis (Ed Hedborn, The Morton Arboretum)
Taxus floridana (Tom Cox)

Back cover image:
Taxus brevifolia (Wsiegmund)

Design:
John Morgan. www.seascapedesign.co.uk