FY 2021 Travis County Balcones Canyonlands Preserve
Non-native Plant Management Program Report



Ligustrum japonicum stump. (photo by Julie Murray)

Travis County
Department of Transportation and Natural Resources
Natural Resources and Environmental Quality Division

1 October 2020 – 30 September 2021

Non-Native Invasive Plants on the Travis County BCP

The Balcones Canyonlands Preserve (BCP) was created in May 1996 to protect the endangered golden-cheeked warbler (*Setophaga chrysoparia*, GCWA) and seven other federally endangered species. To date, the City of Austin, Travis County, The Nature Conservancy, Travis Audubon Society and other partners have protected 32,653 acres of primarily mature oak-juniper (*Quercus-Juniperus*) woodlands from loss to development, but the protected lands still face the threat of biological invasion, second only to habitat destruction in its contribution to biodiversity loss (Keane and Crawley, 2002). The primary invaders of the BCP are feral hogs (*Sus scrofa*), red imported fire ants (*Solenopsus invicta*) and, the focus of this report, non-native invasive plants (NNIPs).

When NNIP species invade, they tend to grow more vigorously, reproduce more quickly and live longer than native plant species (Willis and Blossey, 1999). Upon introduction to an exotic region, invading plants don't experience the same pressure from herbivory when compared to the local species (Keane and Crawley, 2002). Local herbivores that have developed resistance to the chemical defenses of native plants help to limit the distribution and abundance of native plants. White-tailed deer (*Odocoileus virginianus*) are the largest herbivore in the region and have been shown to prefer native plants to exotic plants (McShea, 2012). The suppression of native plants by herbivory coupled with the lack of herbivory on non-native species lends the competitive advantage to the invaders. As NNIP species proliferate, declines in biodiversity among native plants and pollinators have been detected (Hudson *et al*., 2013; Vitousek *et al*., 1997). This phenomenon was also observed in a recent study that showed insectivorous birds prefer areas dominated by native plants and bird abundance declined as NNIP species abundance increased (Narango, *et al*., 2017). A study of pollinator response to Chinese privet (*Ligustrum sinense*) found reduced abundance of bees and butterflies in plots infested with the NNIP when compared to plots where NNIPs had been removed or did not occur (Hudson *et al.*, 2013). Considering that approximately one third of the diet of GCWA is *Lepidopteran* larvae and other pollinator insects (Pulich, 1976; Quinn, 2000), areas that become infested with NNIPs could provide diminished foraging opportunities for GCWA.

Vitousek *et al.* (1997) estimated that nearly 10% of the plant species in Texas are established aliens. While such an estimate would be an exaggeration of the non-native plant composition found on the BCP, the threat to the biodiversity of the limited GCWA habitat available is problematic. Studies have shown that a diverse composition of tree species is important to GCWA foraging success (Smith-Hicks, *et al*., 2016).

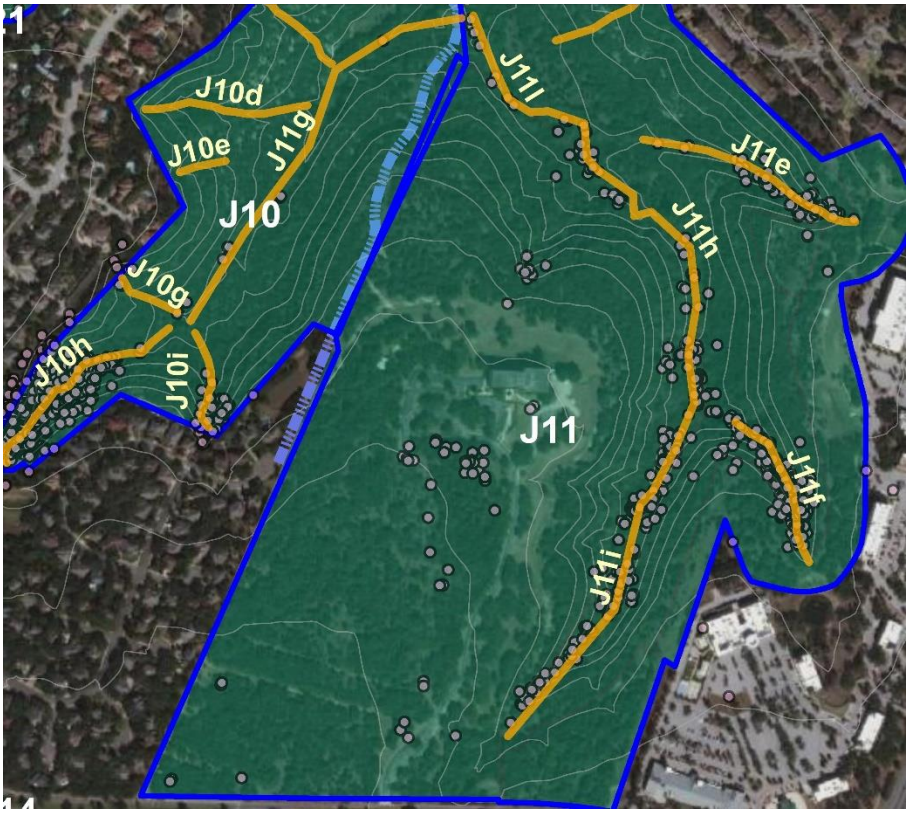
Compounded by lagging hardwood regeneration rates (Russell and Fowler, 1999), prime foraging habitat for the GCWA is at a premium.

Areas most impacted by NNIPs are those near the wildland-urban interface (WUI) and in riparian areas. The Travis County-managed BCP shares more than 140 miles of perimeter boundary with primarily single-family residential units that back up to the preserve. Most of the development occurs in the uplands on the tops of ridges with the majority of the preserve land comprising the canyons below. NNIPs used for landscaping in residential and commercial areas spread into the preserve using sexual reproduction (dissemination of seeds) and/or vegetative reproduction (budding from parent). Many NNIPs produce abundant fruit which germinate near the parent tree. The parent trees attract birds which consume the fruit and deposit the seeds further in the preserve, sometimes at a great distance from the source. Some species, such as Japanese honeysuckle (*Lonicera japonica)* invade vegetatively by sending out stolons, or runners, that take root as they extend from the parent plant. When NNIPs become established in the preserve, their seeds are often washed down drainages and into riparian areas found on the canyon bottoms. The rich soils and abundant water resources found in the riparian areas enable the exotics to thrive even during unfavorable weather conditions. As conditions become more favorable, the riparian areas serve as invasion corridors for rapid dispersal into the ecosystem (Stohlgren, *et al*., 1998).

NNIP Management Strategy

With over 12,000 acres of preserve land to manage by Travis County staff for NNIPs, there was a need to divide the treatment areas into manageable units to prioritize limited resources to the most impacted areas. Each management unit was divided into treatment plots based on topography and access. Within each treatment plot, each drainage and wildland urban interface segment was given a unique identifier (Figure 1). There are currently 463 segments identified. With these identifiers, the segments can be systematically searched, and the level of infestation can be evaluated. Once an infested area is located, consistent treatment can begin. Initial efforts are focused on the treatment of mature plants capable of bearing fruit. Once the seed producers are eliminated, efforts will shift to the removal of resprouts and seedlings until the seed bank is depleted. Following eradication, regular revisits, such as every five years, would be required to ensure that no new NNIPs have become established.

Figure 1. Example of NNIP Treatment Segments in Jollyville Unit



Treatment Methods

Travis County staff utilizes mechanical and/or chemical methods to treat NNIPs. Mechanical removal methods, such as hand-pulling or uprooting the plant utilizing WeedWrenchs™, hand weeders, or spades, are employed whenever feasible. In fiscal year 2021 (FY21), mechanical methods accounted for approximately 74% of plants removed from the County-managed BCP. When mechanical methods are inadequate or impracticable, chemical treatment is used judiciously. County staff is licensed by the Texas Department of Agriculture to administer site-specific herbicides. The “cut & treat” method (Figure 2a) is where the stem or trunk of the plant is cut low to the ground using a chainsaw, hand saw, or loppers. The cut stumps are immediately painted with a site-appropriate herbicide. The “girdle & squirt” method (Figure 2b) is used on larger trees where felling is problematic. Through this practice, a narrow band of the bark and underlying tissue is removed from the circumference of the targeted tree, interrupting the flow of water and nutrients between the leaves and roots. The removal of this band creates a small lip of exposed living tissue where herbicide can be applied to hasten the demise of the tree. The E-Z-Ject™ lance (Figure 2c) provides an additional treatment method for large diameter trees and for plants such as the common fig (*Ficus carica*) and paper mulberry (*Broussonetia papyrifera)* that secrete

latex which can extrude liquid herbicide from wounds. The gravity-fed, spring-loaded lance delivers a cartridge of viscous herbicide under the bark of the tree for slow release. Cartridges are injected at intervals around the circumference of the trunk. This method is particularly useful in areas where felling is too labor-intensive and/or dangerous.

Figure 2. Treatment Methods



a. Cut & treat, with herbicide bottle



b. Girdle & Squirt



c. E-Z-Ject™ Lance

The preferred herbicide for “cut & treat” and “girdle & squirt” methods is a 50% concentration of Garlon 3A (triclopyr). The herbicide is applied using a medicine dropper style applicator for precise application to minimize non-target impacts (Figure 2a). Efficacy of treatment with Garlon 3A appears to be high but can vary depending on factors such as the time of year of treatment, site conditions, or the individual characteristics of the plant. For example, chinaberry trees growing near a steady source of water tend to resprout from the roots more readily than trees in a more xeric area. Also, some large, multi-stemmed wax-leaf privet (*Ligustrum japonicum,* privet) trees seem to be resistant to treatment unless each stem can be completely girdled or severed.

The E-Z-Ject™ cartridges contain a concentrated gel of imazapyr or glyphosate. Treatment with both herbicides is typically terminal when the cartridges are injected at intervals no more than an inch apart around the circumference of the tree. However, multi-trunked trees seem to be more resistant to treatment by the E-Z-Ject™ lance.

Staff collects data on species, size, quantity, and location of the treated plants using GPS and/or ArcGIS Collector. This data is used to track progress and prioritize future treatment efforts.

Treatment Results

Non-native plant treatment in FY21 focused on 37 of the treatment plots across 22 tracts. While volunteer hours sharply declined beginning in 2020 due to the COVID-19 pandemic, the overall effort has been increasing due to the work of Texas Conservation Corps, contracted to assist with NNIP treatment (Table 1).

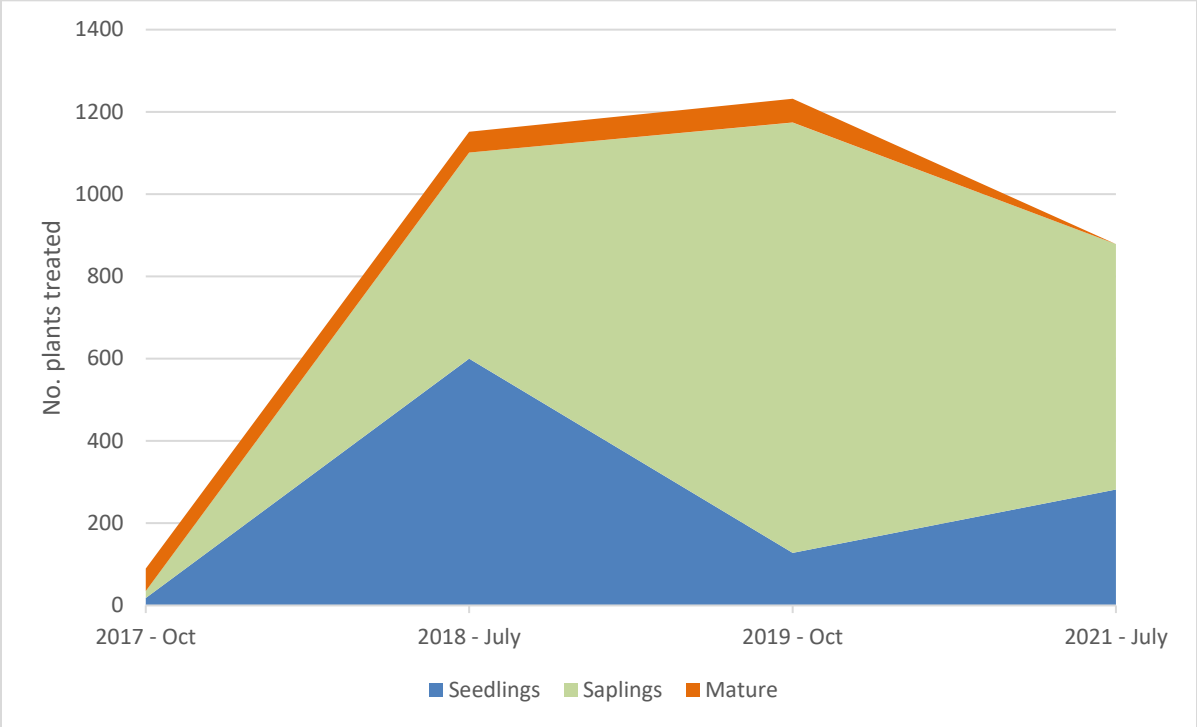
Table 1. NNIP Treatment Effort on Travis County BCP.

FY	Staff	Volunteer (hr)	Contractor (hr)	Total Hours	# Plants
2017	304	399	0	703	8,484
2018	184	358	0	542	6,460
2019	477	705	0	1182	15,400
2020	641	16	892	1548	40,052
2021	344	136	1497	1976	41,855

These figures do not include the vinca, bamboo, wisteria, or Macartney rose treated in areas of severe infestation.

Preliminary data show that consistent effort can interrupt the unchecked spread of NNIPs. Initial treatments are typically focused on plants of seed-bearing size with smaller individuals and resprouts targeted in subsequent visits. As the reproductive capabilities of the NNIPs diminish, the frequency of revisits may be reduced so that efforts can be directed to other priority locations. Reduction in the abundance of mature trees is evident at a treatment area in the Grandview Hills tract, segment J11f (Figure 1). Staff began work in this area on the western end of the drainage in October of 2018. In July of 2019, staff reached the head of the drainage where many mature *Ligustrum* trees were treated. In July of 2021, there were no seed-producing *Ligustrum* present. Subsequent visits will be required to cull the seedlings and saplings that emerge from the diminishing seed bank before they reach maturity.

Figure 3. Treated NNIPs per Size Class in Segment J11f.



Over 41,000 NNIPs were treated or removed during FY21 (Table 1). Approximately 81% of those were *Ligustrum*. This species is highly prolific and colonizes drainages with ease. Over 25,000 *Ligustrum* plants were hand pulled in areas where mature, canopy class trees had previously been treated.

Approximately 15% of the treated plants were *Nandina domestica* (*Nandina* or heavenly bamboo). The treatment method for *Nandina* has been slightly modified after observing prolific resprouting from stems cut six to twelve inches from the ground. The new approach is to dig around the base of the plant to expose where the *Nandina* stems split off from the main stem and cut the main stem as low as possible before applying herbicide (Figure 2a).

Infestations

Some NNIPs overtake native landscapes to form monocultures. Bamboo (*Bambusoideae* sp.), Japanese honeysuckle (*Lonicera japonica*), wisteria (*Wisteria floribunda*), Macartney rose (*Rosa bracteata*), lesser periwinkle (*Vinca minor*), Johnsongrass (*Sorghum halepense*) and King Ranch bluestem (*Bothriochloa ischaemum*; KR) are such species and have been found on the BCP. Treatment methods vary for these species and often it is more practical to document treatment by area rather than by individual plants treated.

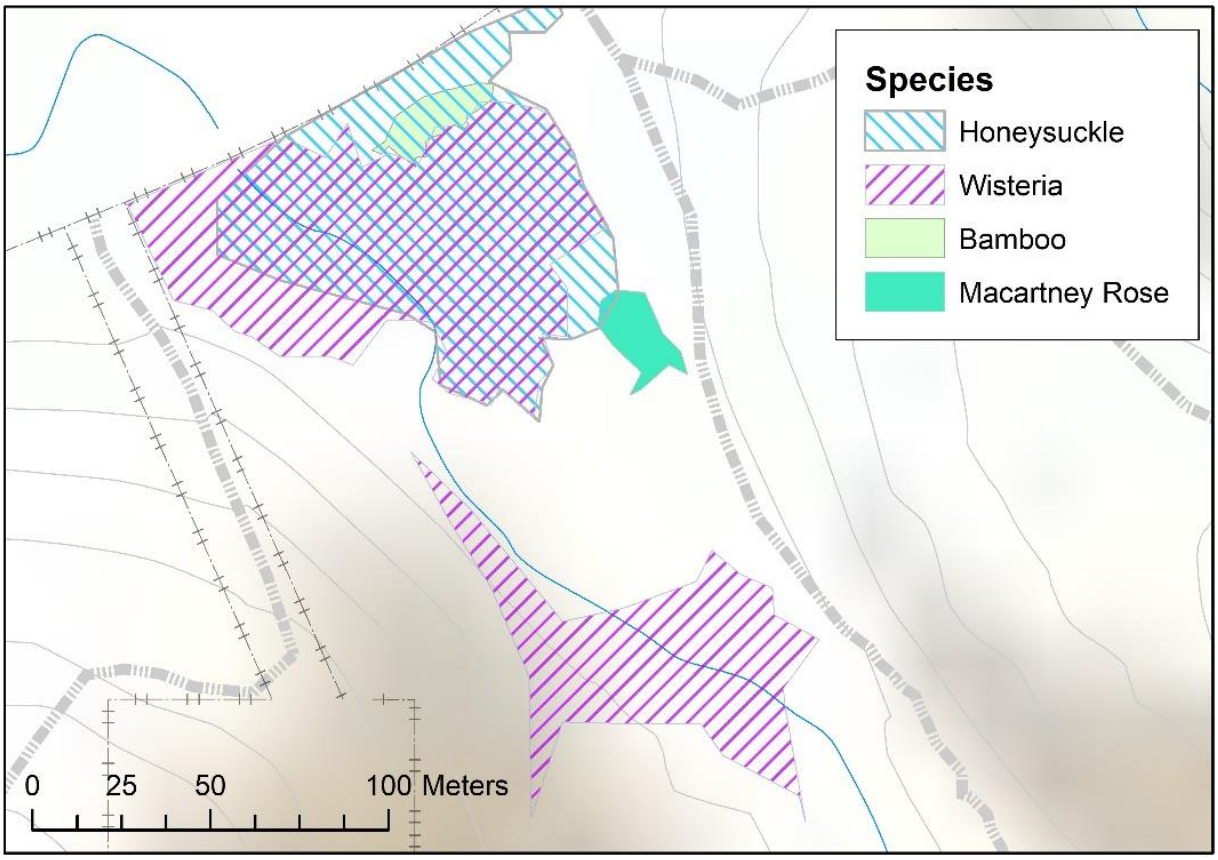
Bamboo

Bamboo (*Bambusoideae* sp.) infestations require a different approach than the traditional cut and treat methods. Since bamboo grows from underground rhizomes that spread below the surface, a two-step process is recommended for controlling this hardy grass. The first step is to cut the bamboo close to the ground. After several months when the plant begins to resprout, the exposed vegetation must be sprayed with an herbicide suitable to treat grasses, such as glyphosate. The herbicide will begin to damage the rhizome, but new shoots will sprout from untreated areas. The treated stalks and the new growth can be cut again and allowed to resprout for another dose of herbicide treatment. The process must be repeated until the rhizomes' energy stores are exhausted and the bamboo fails to resprout. There are two known sites that are infested with bamboo on the Travis County managed BCP. The 255 square meter patch of bamboo on the Attwood tract has been treated repeatedly since its discovery in 2017. Another infestation on the Bunten tract, approximately 330 square meter in area, was initially identified in February 2018. Due to the proximity to sensitive aquatic resources, the Bunten patch will not be treated with herbicide and control will rely solely on persistent mechanical treatment. Quarterly visits have shown a steady decline in the resprouting of bamboo shoots at the Attwood tract while the Bunten tract appears to be more resistant to treatment.

Invasive vines

Wisteria and honeysuckle are climbing vines that can girdle standing trees and dominate the canopy. Similarly, Macartney rose sends runners that reach up to the canopy to shade out the host, but it also forms impenetrable thorny thickets in the understory. The northern portion of the Bunten tract has been infested with these species and, since FY20, staff has expended approximately 176 hours treating these large infestations (Figure 4). In FY21, staff spent 14.5 hours maintaining treated areas. In addition, planning for a larger restoration project began with a projected start date in FY22.

Figure 4. Infestations on the northwestern portion of the Bunten Tract



Vinca

Lesser periwinkle, or *Vinca*, (Figure 5) poses unique control challenges on the BCP. *Vinca* has been found on the Lucas, Lime Creek Unit, Ribelin, Volente, Webb and Bunten tracts, with the latter hosting an extensive population. The planting of a single specimen of *Vinca* near the road on the Bunten tract in the 1950s (Bunten interview, 2002) has led to an invasion that spanned approximately 5.5 acres of riparian forest (Figure 6). The comely plant, with its dark glossy sheen and delicate purple blooms was once a source of income for the Bunten family. They sold *Vinca* to neighbors and local nurseries to revegetate residential landscapes following a period of drought. Their supply of *Vinca* never dwindled due to the pernicious nature of the plant. It spreads primarily through vegetative means by sending out

Figure 5. ***Vinca minor***



stolons, or long runners, that form new root masses when they make contact with the soil. The smallest bits of roots left behind can re-sprout and continue the invasion. The leaves are unpalatable to grazers due to their latex content and a waxy coating protects the plants from foliar herbicide applications. Once established, *Vinca* creates a thick mat of vegetation that smothers all other plant species. Studies have shown that once *Vinca* invades, native plant species richness and diversity decline (Cushman & Gaffney, 2009). Arthropod communities are drastically altered as well, as shown in a study of forest floor spider assemblage in *Vinca* infested areas (Bultman & DeWitt, 2008).

Schultz and Thelen (2000) had moderate success treating a *Vinca* infestation using a combination of cutting and herbicide treatments. At the Bunten tract, *Vinca* has invaded areas in and along the creek that serves as habitat for the threatened Jollyville Plateau salamander (*Eurycea tonkawae*). Therefore, the risk of herbicide overspray and runoff precludes the use of chemicals in the area, leaving mechanical removal as the most viable treatment option.

Figure 6. Vinca Extent at the Bunten Tract.



To control *Vinca*, County staff is experimenting with two techniques. The first follows the lead of a 2002 study of the South African vine Cape ivy (*Delairea odorata*) in Northern California. Similar to *Vinca*, Cape ivy reproduces via stolons, it can re-sprout from fragments, and it can dominate the forest floor (Alvarez & Cushman, 2002). The study found that native species diversity was significantly reduced in areas that had been invaded, but that after non-native reduction (hand-weeding three times over two years) the native species richness rebounded to levels similar to areas that had not been invaded. With the hope for a similar outcome, County staff and volunteers have begun hand-pulling vinca along the leading edge of the invasion. Current efforts are

focused on working downslope from the outer edges toward the epicenter with a quick check during subsequent visits of the formerly treated areas to pull any re-sprouts or overlooked plants. The hand-pulling approach is targeted at preventing the continued invasion of *Vinca* and a consistent effort will be essential to success. The *Vinca* in areas 1 and 2 has been all but eliminated and requires minimal maintenance to prevent reinvasion. The *Vinca* in Areas 3 and 8 have each been reduced by approximately one half by the repeated visits. These efforts have reduced the extent of the vinca more than 25% since 2017 from approximately 5.5 acres to approximately 4.1 acres.

The hand-pulling method has shown great promise for the removal of the *Vinca* discovered at the Lu II tract of the Lime Creek Unit in 2018. Most likely planted as a ground cover (perhaps from the Bunten family's garden) around an old house, the *Vinca* had expanded to cover approximately 206 square meters. *Vinca* was removed from the entire area in FY20, however periodic maintenance will be required to prevent reinvasion. In FY21, a quick sweep of the formerly infested area was sufficient to keep the area free of *Vinca*.

In FY21, treatment began on a 234 square meter patch of *Vinca* on the Ribelin tract near an old homestead. Hand-pulling will likely be sufficient to control this infestation due to its limited extent.

Yet another *Vinca* invasion was discovered in 2019 on the Lucas tract. Nearly 40 hours has been spent hand pulling in the area, but, considering the density of the vegetation, another approach may be more productive. This area was not visited in FY21. Finally, *Vinca* was discovered on the Webb and Volente tracts in late FY21 and treatment will be scheduled as staffing allows.

Shade cloth treatment

In the most densely infested areas, *Vinca* forms a thick mat of vegetation up to one half meter deep. Hand pulling in these areas is extremely labor intensive and deleterious to the volunteer labor pool. In pursuit of a viable control option, a series of experimental plots have been established to test the efficacy of alternative control methods.

The first control method tested was solarization. By covering the vinca with translucent plastic sheets during the summer months, the resultant intensified heat and sunlight should deter growth. A series of seven, 16-square meter plots were established where the vegetation in each plot was cut low to the ground using a brush cutter. The cut

material was hauled off site and the plastic sheets were installed on all but one of the plots. The plastic was left in place through nine weeks of the summer of 2017 when the average high temperatures ranged from 95.5 - 101.4° F. Despite the extreme heat, all but two of the plots showed little to no impact from the treatment. The two plots with the most observable impact where the ones with the least amount of canopy cover.

Vinca is tolerant of Texas winter temperatures and retains its leaves year-round. With the limited success of solarization, the next method employed was to smother the *Vinca* using blackout landscaping cloth. The same seven plots were brush cut again, the cut material was hauled off site, and the landscaping cloth was installed on the plots for several months. When the cloth was removed, very little regrowth was detected (Figure 7). Minimal hand-pulling around the edges and within the seams of the cloth strips was all that was required to rid the plot areas of *Vinca*. As the shade cloth was removed, native seeds were sown on the treated areas and subsequent maintenance by hand pulling was conducted to remove the occasional regrowth of *Vinca*.

As of September 2021, the treated plots are showing a significant recruitment of native plants from the seed bank. In addition to natural revegetation, to date 120 seedlings from 23 native species and seeds from 10 different native plants were planted or broadcast in the restoration areas. Staff and volunteers diligently watered the transplants throughout the summer and continued to expand the treatment areas. In FY21, approximately 331 hours of effort were spent treating *Vinca* at Bunten.

Figure 7. *Vinca* Shade Treatment Areas



Johnsongrass

Johnsongrass is an invasive perennial plant introduced to Alabama in the late 1800s. It is an aggressive invader that spreads through prolific seed production and through underground rhizomes. Johnsongrass is most susceptible to herbicide when it emerges in the spring and early summer. To control infestations on the BCP, staff sprayed several patches with Outrider™ (active ingredient Sulfosulfuron) beginning in June of 2021. Treatments were suspended as the summer heat dried out the grasses and uptake of the herbicide became less efficient. In addition to annual herbicide treatments, these areas may also require periodic mowing to effectively control the infestation. Table 3 details a list of tracts and areas treated in FY21.

Table 3. Johnsongrass Treatment in FY21

Tract	Acres
Blackmore	0.13
Crossings	1.07
New Life	0.48
Nootsie	0.68
Snowden	1.13

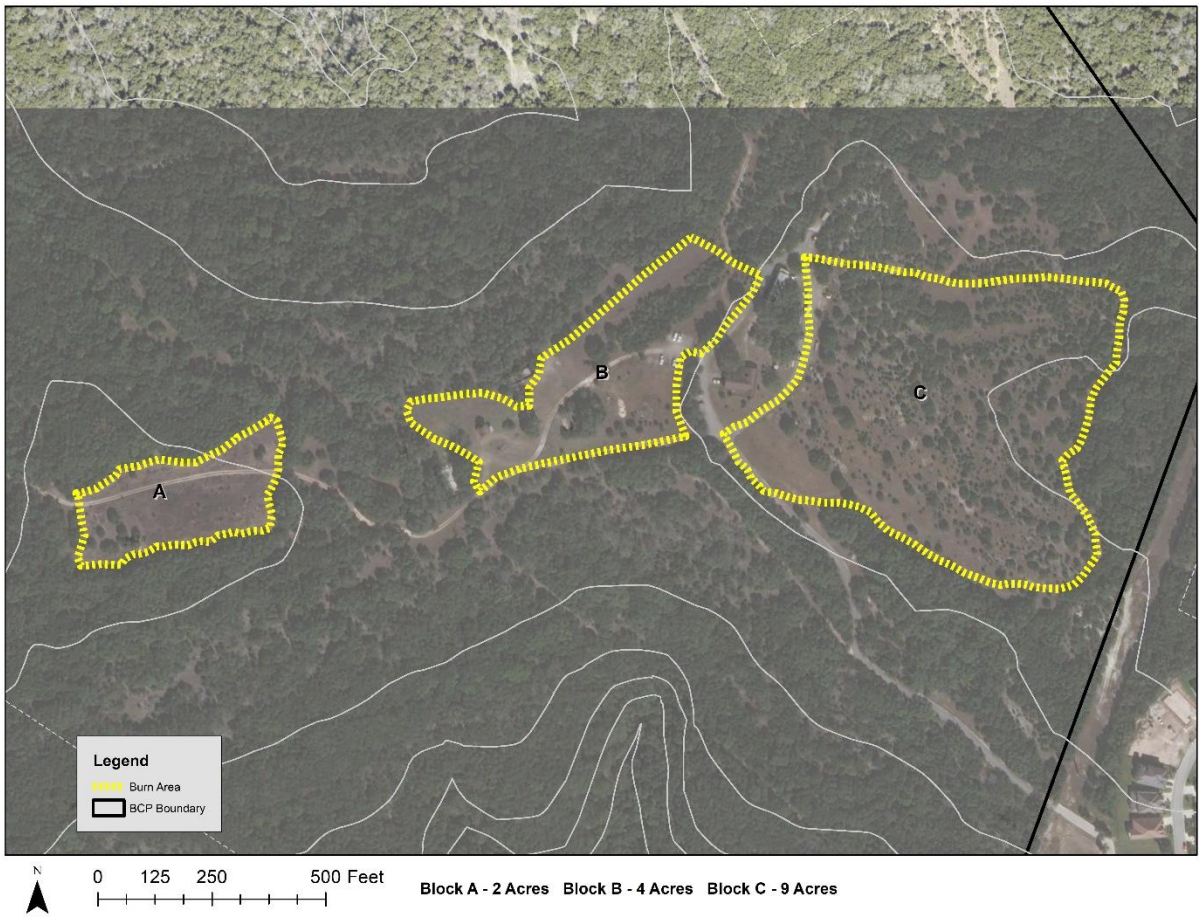
Grassland Restoration Project

King Ranch Bluestem (*Bothriochloa ischaemum*; KR) is an invasive bunchgrass introduced from Europe and Asia in the late 1800s as forage for grazing animals. Its ability to form a monotypic grassland leads to reduced biodiversity. Research has shown that late-summer burns with their higher intensity help to reduce the presence of KR and encourage the growth of other forbs (Reemts, *et al*., 2019). Seeding the burned areas with native grasses and forbs helps to provide competitive pressure to the KR and hasten the return of native species. A regimen of seeding and repeated burning will help return biodiversity to the impacted grasslands.

A restoration project was initiated in September of 2020 to replace the KR that dominates the approximately 15 acres of former cattle pastures on the Nootsie tract with native grasses and forbs. The impacted grasslands were divided into three treatment blocks (Figure 8). Block A was burned in September of 2020, followed with seeding in November of 2020. Blocks B and C were burned in September of 2021 with seeding planned for the fall.

Block A has shown an abundant growth of little bluestem (*Schizachyrium scoparium)* that may have been present in the seed bank prior to the burn. The KR has resprouted and will likely require repeated burning before it is adequately suppressed for the native grasses to gain a competitive edge.

Figure 8. Nootsie Grassland Restoration Project Areas



Locally sourced native plant seeds, installed via a seed drill, were used to restore diversity to the burned grassland. See Table 4 for species and planting rate.

Table 4. Native Seeds for Grassland Restoration at Nootsie

Common Name	**Scientific Name**	**lbs/acre**
Canada Wild rye	*Elymus canadensis*	10
Side oats grama	*Bouteloua curtipendula*	10
Indiangrass	*Sorghastrum nutans*	10
Big bluestem	*Andropogon gerardi*	1.5
Little bluestem	*Schizachyrium scoparium*	1.5
Cut leaf daisy	*Erigeron compositus*	1.5
Maximillian sunflower	*Helianthus maximiliani*	1.5
Firewheel	*Gaillardia pulchella*	1.5
Bluebonnet	*Lupinus texensis*	1.5

Conclusion

More than 4,180 hours of labor were dedicated to non-native plant treatment on Travis County BCP tracts in FY21. Despite this effort, there is much work yet to be done to find and treat the NNIPs that have become established on the preserve. Staff will continue to seek out infestations and recruit volunteers to assist in treatment and maintenance. While these efforts shall be required for decades to come, their efficacy can be undermined by the continued re-introduction of NNIPs from neighboring properties. To address the cause, in addition to treating the symptoms, public education will be essential to prevent the continued planting and preference for NNIPs in landscaping. Non-native plant management goals for the next fiscal year include implementing a native plant exchange program with neighbors, partnering with community organizations to promote more native plant awareness and distribution, and conducting outreach to local retailers and nurseries who sell NNIPs with information about native alternatives. With consistent efforts to control and prevent the establishment of NNIPs, the high-quality habitat which the endangered and threatened species of the BCP rely upon can be preserved.

Literature Cited

Alvarez, Maria E., and J. Hall Cushman. 2002. Community-level consequences of a plant invasion: Effects on three habitats in coastal California. *Ecological Applications*, 12(5):1434-1444.

Bultman, Thomas L., and David J. DeWitt. 2008. Effect of an invasive ground cover plant on the abundance and diversity of a forest floor spider assemblage. *Biological Invasions*. 10:749. https://doi.org/10.1007/s10530-007-9168-z

Bunten, M. (2002, February). Personal interview by Rose Farmer.

Cushman, J. Hall, and Karen A. Gaffney. 2009. Community-level consequences of invasion: Impacts of exotic clonal plants on riparian vegetation *Biological Invasions, 12*, 2765-2776.

Hudson, Jacob R., James L. Hanuala, and Scott Horn. 2013 Removing Chinese privet from riparian forests still benefits pollinators five years later. Biological Conservation 167: 355-362.

Keane R. M., and M. J. Crawley. 2002. Exotic plant invasions and the enemy release hypothesis. Trends Ecol Evol 17:164-170.

McShea, William J. 2012. Ecology and management of white-tailed deer in a changing world. Annals of the New York Academy of Sciences, 1249: 45–56. doi:10.1111/j.1749-6632.2011.06376.x

Narango, D. L., D.W. Tallamy, and P.P. Marra, 2017. Native plants improve breeding and foraging habitat for an insectivorous bird. Biological Conservation, 213, pp. 42-50.

Pulich, W. M. 1976. The Golden-cheeked warbler: A bioecological study. Texas Parks and Wildlife Department, Austin, Texas, USA, 115 pp.

Quinn, M. A. 2000. Abundance and distribution of potential arthropod prey species in a typical golden-cheeked warbler habitat. Unpublished master's thesis, Texas A&M University, College Station, Texas.

Reemts, C. M., W.M. McCaw, T.A. Greene, and M.T. Simmons. 2019. Short-term control of an invasive C4 grass with late-summer fire. Rangeland Ecology & Management, 72 (2019) 182-188.

Russell, F. Leland, and Fowler, Norma L. 1999. Rarity of oak saplings in savannas and woodlands of the eastern Edwards Plateau, Texas. The Southwestern Naturalist, 44(1):31-41.

Schultz, Kurt and C. Thelen. 2000. Impact and control of Vinca minor L. in an Illinois Forest Preserve (USA). Natural Areas Journal. 20:189-196.

Smith-Hicks, Kathryn N., John C. Newnam, Melanie R. Colon, Ashley M. Long, and Michael L. Morrison. 2016. Golden-cheeked warbler behavior in relation to vegetation characteristics across their breeding range. The American Midland Naturalist, 176(1):81-94.

Stohlgren, Thomas J., Kelly A. Bull, Yuka Otsuki, Cynthia A. Villa and Michelle Lee. 1998. Riparian zones as havens for exotic plant species in the central grasslands. Plant Ecology 138:113-125.

Vitousek, P.M., Carla M. D'Antonio, Lloyd L. Loope, Marcel Rejmanek, and Randy Westbrooks. 1997. Introduced species: a significant component of human-caused global change. New Zealand J. Ecol. 21:1-16.

Willis, Anthony J., and Bernd Blossey. 1999. Benign environments do not explain the increased vigour of non-indigenous plants: A cross-continental transplant experiment. Biocontrol Science and Technology 9. 567-577. 10.1080/09583159929523.